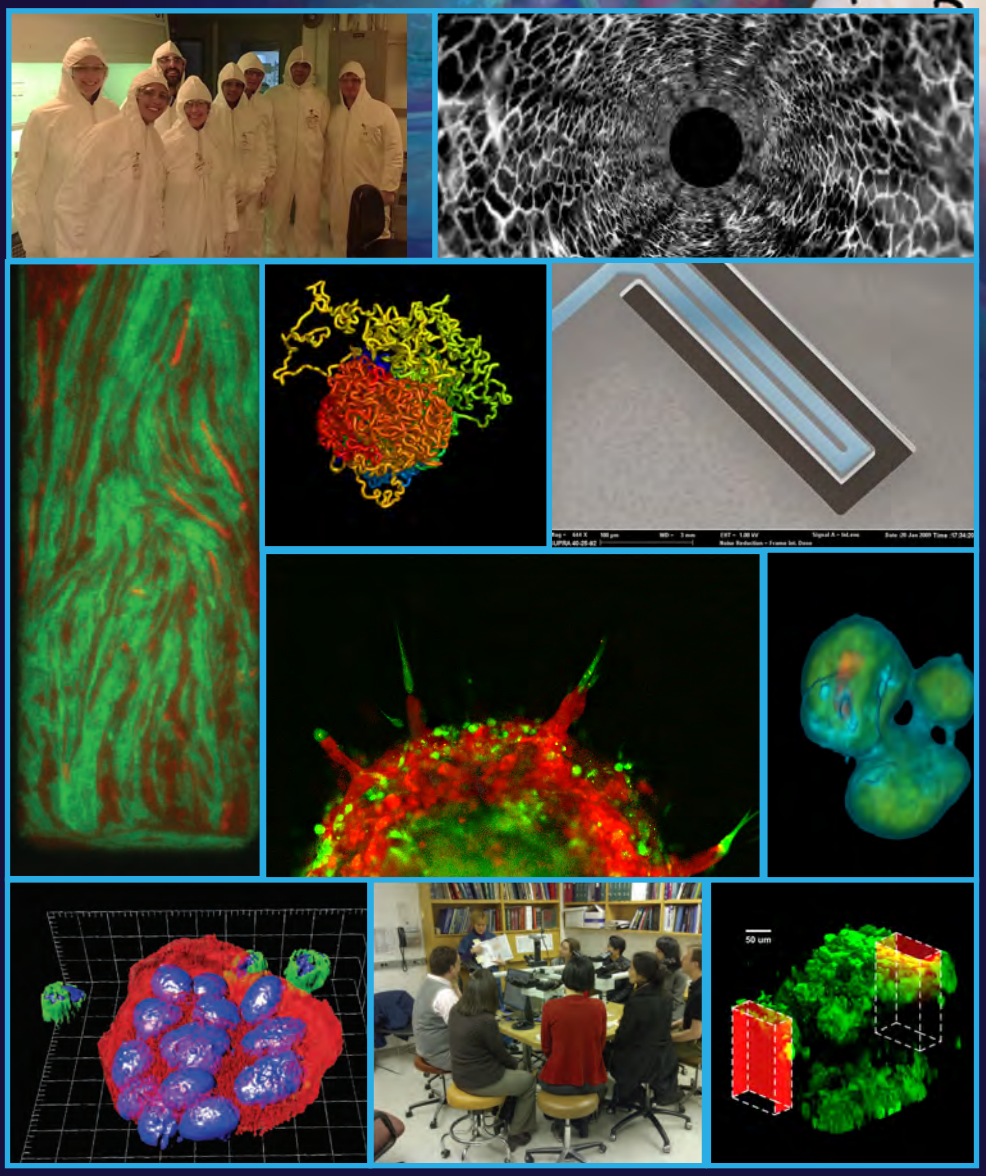
National Cancer Institute



PHYSICAL SCIENCES-ONCOLOGY CENTER PROGRAM

Appendix

Fall 2012

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

National Institutes of Health

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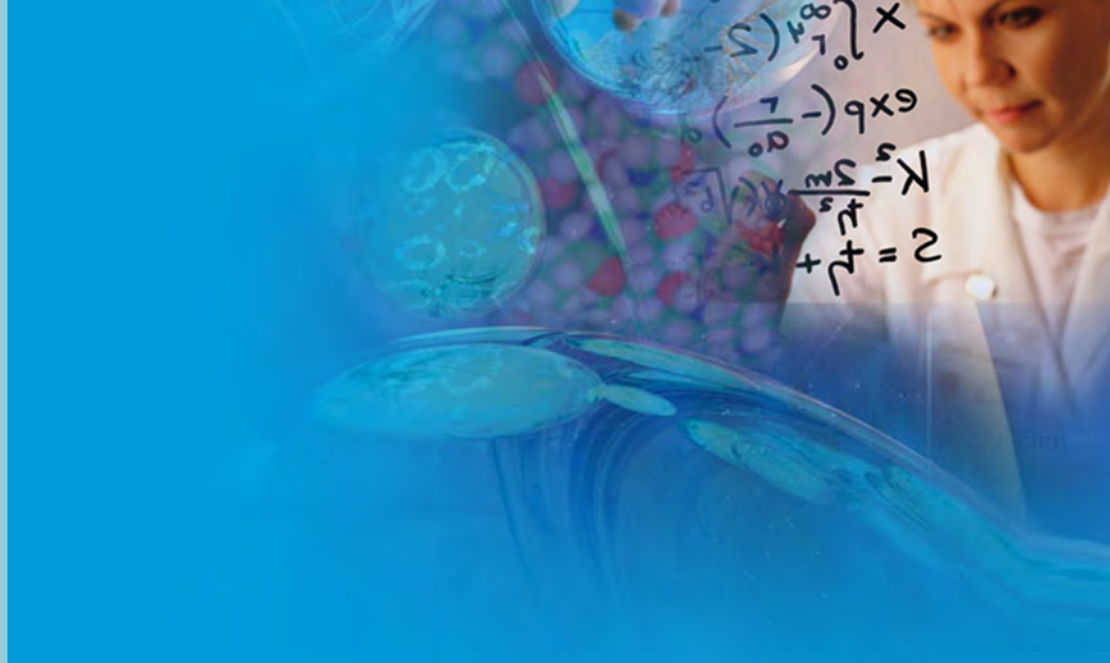

1. Publications

1. PS-OC Peer-Reviewed Publications

1. Abaci, H.E., Devendra, R., Smith, Q., Gerecht, S. & Drazer, G. Design and development of microbioreactors for long-term cell culture in controlled oxygen microenvironments. *Biomed Microdevices* **14**, 145-152 (2012).

2. Balzer, E.M. & Konstantopoulos, K. Intercellular adhesion: Mechanisms for growth and metastasis of epithelial cancers. *Wiley Interdisciplinary Reviews-Systems Biology and Medicine* **4**, 171-181 (2012).

3. Barrett, L.E.*, et al.* Self-renewal does not predict tumor growth potential in mouse models of high-grade glioma. *Cancer Cell* **21**, 11-24 (2012).

4. Basanta, D., Gatenby, R.A. & Anderson, A.R.A. Exploiting evolution to treat drug resistance: Combination therapy and the double bind. *Molecular Pharmaceutics* **9**, 914-921 (2012).

5. Basanta, D.*, et al.* Investigating prostate cancer tumour-stroma interactions: Clinical and biological insights from an evolutionary game. *Br J Cancer* **106**, 174-181 (2012).

6. Battistini, F., Hunter, C.A., Moore, I.K. & Widom, J. Structure-based identification of new high-affinity nucleosome binding sequences. *Journal of Molecular Biology* **420**, 8-16 (2012).

7. Bergethon, K.*, et al.* Ros1 rearrangements define a unique molecular class of lung cancers. *J Clin Oncol* **30**, 863-870 (2012).

8. Bryan, A.K., Engler, A., Gulati, A. & Manalis, S.R. Continuous and long-term volume measurements with a commercial coulter counter. *PLoS One* **7**, 17 (2012).

9. Carbonaro, M., Escuin, D., O'Brate, A., Thadani-Mulero, M. & Giannakakou, P. Microtubules regulate hypoxia-inducible factor-1 alpha protein trafficking and activity implications for taxane therapy. *Journal of Biological Chemistry* **287**, 11859-11869 (2012).

10. Carey, S.P., Kraning-Rush, C.M., Williams, R.M. & Reinhart-King, C.A. Biophysical control of invasive tumor cell behavior by extracellular matrix microarchitecture. *Biomaterials* **33**, 4157-4165 (2012).

11. Charest, J.M., Califano, J.P., Carey, S.P. & Reinhart-King, C.A. Fabrication of substrates with defined mechanical properties and topographical features for the study of cell migration. *Macromol Biosci* **12**, 12-20 (2012).

12. Chen, S.H., Dallas, M.R., Balzer, E.M. & Konstantopoulos, K. Mucin 16 is a functional selectin ligand on pancreatic cancer cells. *Faseb Journal* **26**, 1349-1359 (2012).

13. Cheng, Y.K.*, et al.* A mathematical methodology for determining the temporal order of pathway alterations arising during gliomagenesis. *PLoS Comput Biol* **8**, 5 (2012).

14. Chmielecki, J.*, et al.* Egfr-mutant lung adenocarcinomas treated first-line with the novel egfr inhibitor, xl647, can subsequently retain moderate sensitivity to erlotinib. *Journal of Thoracic Oncology* **7**, 434-442 (2012).

15. Cho, E.H.*, et al.* Characterization of circulating tumor cell aggregates identified in patients with epithelial tumors. *Phys Biol* **9**, 3 (2012).

16. Ciriello, G., Cerami, E., Sander, C. & Schultz, N. Mutual exclusivity analysis identifies oncogenic network modules. *Genome Res* **22**, 398-406 (2012).

17. Damani, S.*, et al.* Characterization of circulating endothelial cells in acute myocardial infarction. *Sci Transl Med* **4**(2012).

18. Fraley, S.I., Feng, Y., Giri, A., Longmore, G.D. & Wirtz, D. Dimensional and temporal controls of three-dimensional cell migration by zyxin and binding partners. *Nat Commun* **3**(2012).

19. Galban, S., *et al.* Dw-mri as a biomarker to compare therapeutic outcomes in radiotherapy regimens incorporating temozolomide or gemcitabine in glioblastoma. *PLoS One* **7**, 20 (2012).

20. Gao, D., *et al.* Myeloid progenitor cells in the premetastatic lung promote metastases by inducing mesenchymal to epithelial transition. *Cancer Res* **72**, 1384-1394 (2012).

21. Gibson, D.S., *et al.* Biomarkers in rheumatology, now and in the future. *Rheumatology* **51**, 423-433 (2012).

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23. Gu, S., *et al.* Applying a patient-specific bio-mathematical model of glioma growth to develop virtual [18f]-fmiso-pet images. *Math Med Biol* **29**, 31-48 (2012).

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27. Hughes, A.D., *et al.* Microtube device for selectin-mediated capture of viable circulating tumor cells from blood. *Clin Chem* **58**, 846-853 (2012).

28. Huynh, K.A., McCaffery, J.M. & Chen, K.L. Heteroaggregation of multiwalled carbon nanotubes and hematite nanoparticles: Rates and mechanisms. *Environ Sci Technol* **46**, 5912-5920 (2012).

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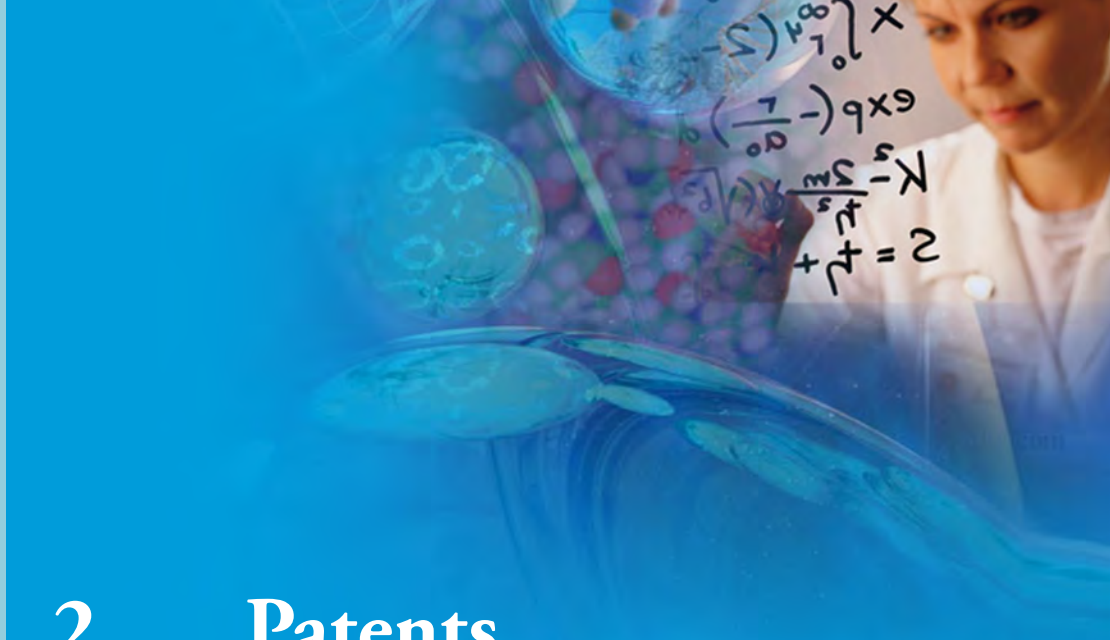
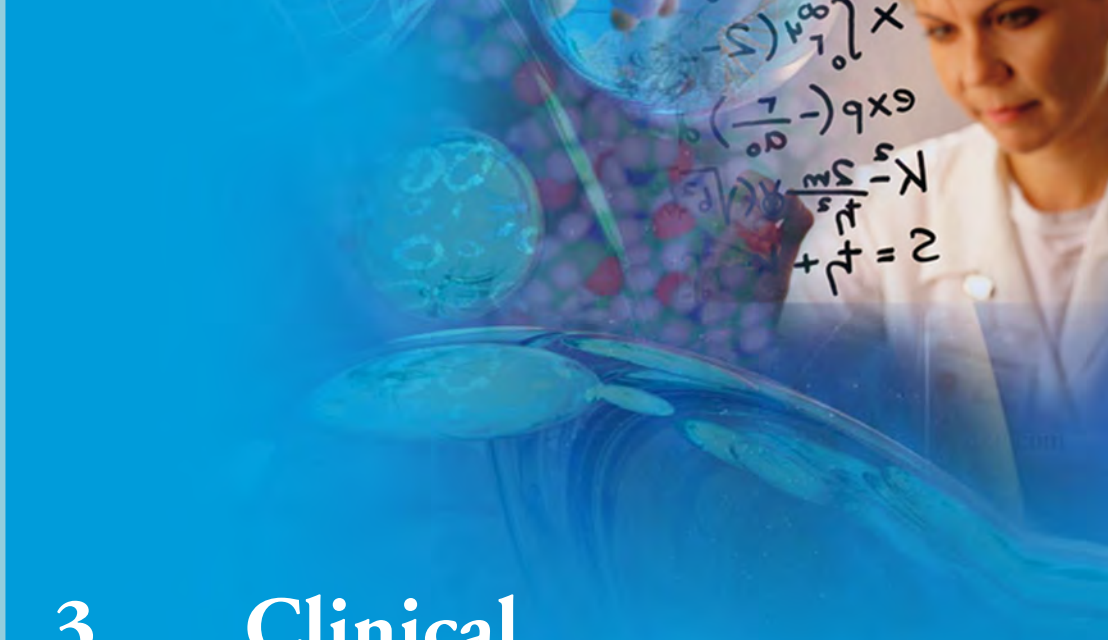


2. Patents Disclosures/ Applications

2. Patents Disclosures/Applications

PS-OC Name	Title	Inventor
ASU	Biocompatible Gel Formulation	Johnson, Su, Kelbauskas, Nandakumar, Tian, and Meldrum
Cornell	Integrated Nano/Microfluidic Device for DNA Extraction and Single Molecule Analysis	Craighead, Tian, Wallin, and Topolancik
Moffitt	The Use of Non-Volatile Buffers in the Treatment of Cancer	Gatenby and Gillies
Moffitt	The Use of Vasodilators in Combination With Hypoxia or Acid Activated Prodrugs in the Treatment of Cancer	Gatenby and Gillies
Moffitt	Method of Reducing Intratumoral pHe and Acid-Mediated Invasion	Gatenby and Gillies
Moffitt	Transient Hypoxia Inducers and Their Use	Gatenby and Gillies
JHU	Vascular Endothelial Growth Factor and Substrate Mechanics Regulate Vascular Tubulogenesis	Gerecht
JHU	Three Dimensional, High Throughput Device and Assays for Diagnostic Uses, Therapeutic Uses, and Monitoring of Patient Care in the Clinical Setting as Well as the Study of Human Diseases and Drug Discovery in the Research Setting	Fraley, Feng, Longmore, and Wirtz
JHU	An Assay to Quantify the Local Matrix Deformation Induced by Living Matrix-embedded Cells	Bajpai, Khatau, and Wirtz
JHU	Measurement of Cellular Mechanosensing Response Using 2D Soft Substrates and Development of 3D Mechanosensing Matrix System	Kim and Wirtz
JHU	A Novel Method for Improved Staging/Diagnosis of Cancerous Tissues That Will Also Enable Better Matching for Treatment	Wirtz, Wu, Khatau, and Binder
JHU	Using the Shape Factor of Nuclei in Pathological Slices to Better Diagnose Cancerous Tissue	Wirtz, Wu, Khatau, and Binder
JHU	High Throughput Image-based Single-cell Cytometry for Cancer Diagnosis	Wirtz, Wu, Khatau, and Binder
JHU	Accurate Count Fluorescent Intensity in Image Based Cytometer Microscopy System	Wu, Khatau, Chiang, Phillip, Binder, and Wirtz
JHU	Novel Protein Patterning Chemistry for Use on Soft Substrate Gels	Fraley, Dickinson, Gerecht, and Wirtz
NU	Integrated Ultramicroelectrode-Nanopipette Probe for Concurrent Scanning Electrochemical Microscopy and Scanning Ion Conductance Microscopy	Comstock and Hersam
NU	Magnetic Nanostructures as Theranostic Agents	Dravid, Sharma, Tomita, Viola, and Klein
NU	Near-Field Penetrating Optical Microscopy (NPOM): A Technique to Measure Mass Density at Nanoscale	Backman, Dravid, Taflove, Strasser, and Shekhawat
TMHRI	Enhancing MRI Contrast by Geometrical Confinement of Small Imaging Agents within Nanoporous Particles	Decuzzi, Ananta, Godin, and Wilson

PS-OC Name	Title	Inventor
UCB	Phenotypic Change in Live Invasive Cancer Cell Lines Induced by Simultaneous Presentation of Mobile and immobile Ligand-bound Receptor	Groves, Salaita, Nair, and Lomuller
UCB	Quantitative Structured-Illumination Polarization Microscopy For Cancer Research and Diagnosis	Liphardt, Shi, Hwang, and Weaver
UCB	Scanning Angle Interference Microscopy: Fluorescence Imaging with Nanometer Axial Precision	Paszek, Liphardt, and Weaver
USC	Advanced Reverse-phase Magnetic Immunoassay	Lee, Gaster, and Wang
Scripps	Methods for Categorizing CTCs Using Various Cellular Markers and Revealing or Non-Revealing Assays	Kuhn
Scripps	The Use of Non-CTCs to Detect CTCs (Data-Centric Data Collection and Data Reduction Approach to Minimize False Negatives)	Kolatkar, Kuhn, Kunken, Marrinucci, Stuelpnagel, and Yang
Scripps	Circulating Tumor Cells (CTCs)	Kuhn
Scripps	Duolayer Cartridge for Live Cells	Honnatti, Kolatkar, Kuhn, and Marienfeld
Scripps	Methods and Apparatus for the Detection of Circulating Tumor Cells (CTCs)	Kolatkar, Kuhn,and Marrinucci



3. Clinical Samples and Trials

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Clinical Research in the PS-OC Network

Ongoing Clinical Trials with Exploratory Objectives Informed by PS-OC Research

1. Cornell PS-OC (Project 3): Identify drug crossover points for castrate resistant prostate cancer (CRPC) patients using prostate specific antigen measurements and analysis of circulating tumor cells (CTC) captured on GEDI microchips.
2. DFCI PS-OC (Project 3): Evaluate high-dose weekly erlotinib (type I EGFR kinase inhibitor) treatment schedule for EGFR mutant glioblastoma.
3. Moffitt PS-OC (Project 2): Determine if oral bicarbonate improves overall survival or progression free-survival in patients with unresectable pancreatic cancer.
4. Moffitt PS-OC (Project 2): Evaluate the efficacy of oral sodium bicarbonate as an adjuvant pain reliever in patients with tumor related moderate to severe pain.
5. Scripps PS-OC (Core 1): A phase I study to evaluate the safety and efficacy of Temsirolimus and Sorafenib in subjects with Hepatocellular Carcinoma. The collection of HD-CTCs will provide information in understanding potential impacts of the therapeutics on HD-CTCs.

Planned Clinical Trials with Exploratory Objectives Informed by PS-OC Research

1. DFCI PS-OC (Project 1): Planning clinical trial with intermittent lapatinib dosing for EGFR mutant glioblastoma and using mathematical modeling to provide guidance regarding the dose and dosing-schedule for lapatinib.
2. TMHRI PS-OC (Core 2): Initiating a pilot clinical trial in collaboration with the University of Botswana for early detection of cervical precancer. Accrued 14 patients to the study.
3. TMHRI PS-OC (Core 2): Initiating a clinical trial in collaboration with two sites in China, for screening of cervical precancer and esophageal precancer.

PS-OC Research in Conjunction with Ongoing Clinical Trials

1. Cornell, Moffitt, Scripps, & USC PS-OCs (PS-OC Trans-Network Project): The main clinical material for this project will come from 40 patients with metastatic CRPC about to received docetaxel based chemotherapy who consent to an optional prospective correlative study for blood and data acquisition.

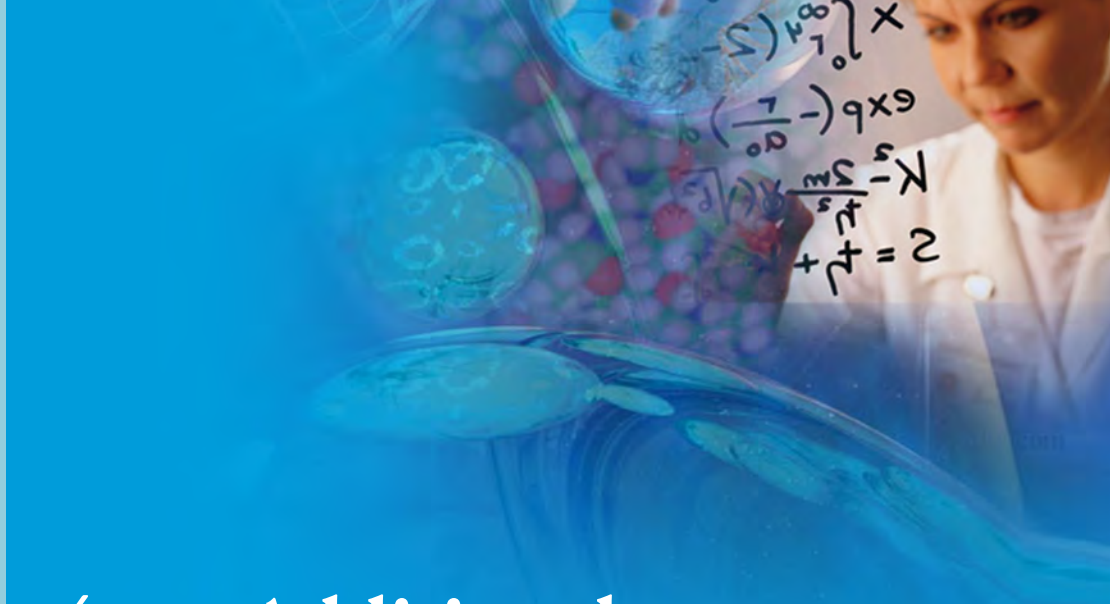
PS-OC Research Using Clinical Samples

1. ASU PS-OC (Project 2): Perform cell computed tomographic (CT) imaging on human esophageal biopsy samples.
2. DFCI PS-OC (Pilot Project): Performed mutational analysis of 18 genes in 398 patients with AML younger than 60 years of age randomized to receive induction therapy including high-dose or standard dose daunorubicin and validated our prognostic findings in an independent set of 104 patients. Genetic predictors of outcome were identified that improved risk stratification in AML independent of age, WBC count, induction dose, and post-remission therapy.
3. JHU PS-OC (Pilot Project): High-throughput physical phenotyping of colorectal and breast cancer cells.
4. MIT PS-OC (Project 3): Weighed glioblastoma multiform tumor cells from patient sample within 2 hours following resection in the OR (in collaboration with Keith Ligon, DFCI). The Ligon lab has immediate access to patient samples through collaboration with the DFCI/BWH Neurooncology Program.
5. MIT & Princeton PS-OCs (Trans-Network Project): Mapping the landscape of tumor heterogeneity of breast cancer tissue by quantitative single-cell assays.
6. Northwestern PS-OC (Project 3): Studies using partial wave spectroscopy (PWS) have demonstrated that chromatin compaction (quantified by a parameter referred to as the disorder strength, Ld, which is proportional to the amplitude and the spatial correlation length of local macromolecular density variations) is a universal early event in carcinogenesis, as confirmed by our data in the colon, pancreatic, lung, esophageal, and ovarian carcinogenesis.
7. Scripps PS-OC (Project 1): Initiated a HD-CTC processing campaign of previously collected non-small cell lung cancer samples representing all stages of the disease. The complete data set encompasses now 88 patients across all stages.
8. Scripps PS-OC (Pilot Project): Determining whether the HD-CTC Fluid Biopsy can be used to detect tumor cells in patients with liver cancer and, eventually, be used to augment the current tumor-staging modalities that are available for hepatocellular carcinoma.
9. Scripps PS-OC (Pilot Project): Analyze the correlation of HD-CTCs in patients with resectable breast cancer and recurrence rates. Human blood and tissue samples will be taken from the participants at time of resection, prior to breast cancer diagnosis. HD-CTC images will be analyzed and then cross referenced with clinical data regarding positive or negative diagnoses and rates of recurrence.
10. Scripps PS-OC (Pilot Project): Evaluation of RAD001 with Docetaxel and Bevacizumab in patients with Metastatic androgen independent prostate cancer.
11. Scripps (Core 1): Exploring tumor cell heterogeneity across geography, by multiple geographically designed samplings of a primary tumor, its locoregional metastases, and CTCs from various blood vessel locations, all simultaneously.
12. UCB PS-OC (Pilot Project): Profiling tissue mechanics in premenopausal AA women (1) during breast cancer initiation and (2) in breast biopsy tissue from pre-menopausal AA women with palpable versus non-palpable breast cancer.
13. UCB PS-OC (Project 2): Fresh breast tumor specimens that can be used for nano AFM analysis. By way of progress on this work the Weaver laboratory has developed a novel in situ force mapping protocol that will permit the spatial mapping of the materials properties of human breast specimens as a function of tumor progression.
14. USC PS-OC (Pilot Project): Simultaneous mappings of multiple mutations in colorectal cancer tissue slices by microfluidic PCR matrix.

PS-OC Retrospective Clinical Trials

1. USC PS-OC (Project 3): Performing a retrospective clinical trial in which they are mining patient data for 360 patients with CLL (chronic lymphocytic leukemia), SLL (small lymphocytic lymphoma), or SMZL (splenic marginal zone lymphoma) to search for correlations between blood pressure (which was found to spike upon cell burst) and white blood cell/ lymphocyte counts. We are also stratifying according to patients on ACE inhibitors and statins.

2. Moffitt PS-OC (Core 1): Twenty-five retrospective cases of invasive breast cancer with Nottingham Grade scores of I, II, and III were selected and indentifying information was blinded. Three H&E sections and 30 unstained 4µm histology sections were collected. The H&E slides were reviewed by a pathologist to confirm diagnosis and grade stage. Unstained slides were immunohistochemically stained in triplicate against optimized HIF1α , GLUT1, MMP7, MMP9 biomarkers and are being stained against KI67, CD31 and hypoxyprobe. Furthermore, multiplex test samples are being stained for multiple biomarker combinations including HIF1α/GLUT1 and MMP7/MMP9. Triplicate stains are cross references for internal validation of scoring algorithms and staining consistency.



4. Additional Center Highlights

4. Additional Center Highlights

Arizona State University PS-OC

Principal Investigator: Paul Davies, Ph.D.
Senior Scientific Investigator: William M. Grady, M.D.

Summary

The Arizona State University (ASU) PS-OC focuses on cells as material objects and seeks to characterize changes in the physical properties of cells as a function of cancer progression. The physical properties of interest cover all scales of size from chromatin through cells to tissues, and they include quantum and electrical effects, changes in chromatin architecture, epigenetic markers, nuclear and cellular morphology, and cell motility, as well as changes in cell and tissue elasticity and metabolism. The objective is to create a testable theory of cancer, from its deep evolutionary roots in the dawn of multicellularity to the evolution of neoplasms and the dynamics of metastases. Special attention is given to trans-disciplinary links among fields that include astrobiology, evolutionary biology, developmental biology, physics, and chemistry. Work on conceptual development is augmented by mathematical and computational modeling.

Physical Sciences Perspective: Cells are physical objects with measurable properties that change as a function of cancer progression. Cancer cells do not arise de novo, but are the products of billions of years of evolution. Cancer is a fundamental property of multicellularity, and part of the story of life itself.

Mainstream cancer research focuses on the genetic and biochemical properties of cells, on pathways and linear causal chains, and downplays the physical aspect and the systems aspect. Yet the physical properties of cells and their microenvironment, be they mechanical, electrical, or even (possibly) quantum, can profoundly affect the behavior of cells and the progress of malignancy and the metastatic cascade. Mainstream research downplays the pervasive nature of cancer in the multicellular realm and ignores its deep evolutionary origins. It regards cancer as an aberration rather than an integral part of the story of life itself. Links to evolutionary biology and developmental biology, both of which are replete with clues about the nature of cancer, are sidestepped.

The ASU PS-OC realizes that it is not possible to study the physical properties of cells without physicists, chemists, and engineers, and that it is not possible to meaningfully study cancer cells without cancer biologists. In order to see the "big picture" of cancer and how it fits into the story of life, it is necessary to draw on insights from physical science, astrobiology, evolutionary and developmental biology, biosystems, complexity theory, and other related branches of science.

Key Center Accomplishments

1. Development of a testable theory of cancer. Amid the frantic search for an elusive "cure" for cancer, few researchers bother to ask why cancer exists. Why is it an integral part of the story of life? How did it originate in our evolutionary past? Why is cancer progression such a systematic and predictable disease? A major goal of the ASU PS-OC is to explain these basic facts and create a testable theory of cancer. Two pointers suggest that cancer has deep evolutionary origins. The first is that it is pervasive in biology, affecting most animals and many plants. It may have analogs in fungi and even yeast. Oncogenes and tumor suppressor genes have lineages that may stretch back hundreds of millions of years. Secondly, cancer is a highly efficient systematic response to a trigger event such as inflammation, deploying a sequence of survival traits in an organized manner; it mostly does not consist of rogue cells running amok. This suggests that cancer is pre-programmed into most somatic cells. Investigators at the ASU PS-OC

have developed a theory that cancer is a type of atavism involving a core toolkit of ancient genes that are normally silenced in the adult form. The genes are retained because they play a crucial role in early-stage embryogenesis, when the basic – and ancient – body plan of organisms is laid down. Analogs between embryogenesis and tumorigenesis are well known. Now, evidence suggests that some embryonic genes are explicitly reawakened in cancer. The model predicts that cancer cells will service this toolkit of genes as a priority, while other less critical genes mutate rapidly as the resources for error correction are focused on the toolkit. This prediction should be testable by studying the cancer genome atlas. Connecting the dots between the so-far mostly siloed fields of evolutionary biology, astrobiology, developmental biology, and cancer biology promises to change the conceptual basis of cancer research and open up an entirely new field of therapeutic opportunity.

2. Integration with astrobiology. Astrobiologists are trained to reflect on the nature of life itself. Cancer is an integral part of the story of life on Earth. Therefore, insights from astrobiology could be crucial in effecting a culture change among cancer researchers. The ASU PS-OC has worked hard from the inception of the PS-OC to involve astrobiologists by inviting them to cancer forum workshops, developing joint research projects, identifying links—such as radiation resistance, hypoxia and ancient life, reactive oxygen species, biofilms and the extracellular matrix (ECM), and phylostratigraphy of oncogenes—and giving lectures to astrobiologists on the PS-OC concept. The ASU PS-OC is working with the NASA Astrobiology Institute to hold joint workshops and identify joint research opportunities.

3. A "rare events" mathematical model of metastases. Metastatic cancer involves a huge selection effect: patients present with symptoms after the event. This post-selection conceals the fact that the vast majority of migrating cancer cells fail to successfully metastasize. The formation of a secondary tumor is therefore an extremely rare event. Given the number of circulating tumor cells (CTCs), the probability that at least one will succeed is not all that low within a given patient. Nevertheless, the quasi-inevitability of metastasis for a given organism with primary cancer distorts one's intuition about the dynamics of the process. Investigators in the ASU PS-OC have demonstrated this starkly by creating a simple mathematical model of post-selected rare events, and proved in the rigorous mathematical sense that if, against vast odds, a micrometastasis does in fact form and stabilize, then the dynamics of its growth are deterministic and explosively rapid. Intriguingly, the less fit cancer cells will have multiplied faster. Although a given fitter cell may individually have a greater chance of successfully forming a micrometastasis, the greater number of less fit cells may outweigh their relative disadvantage, depending on the values of the model parameters. Thus in certain regimes, a metastatic neoplasm may not be populated by the most malignant cells.

4. Gene silencing by methylation explained in terms of hydrophobic bonds and the aqueous environment of chromatin. The serendipitous discovery by ASU PS-OC researchers that methylated and unmethylated chromatin has markedly different mechanical properties in an aqueous medium explains gene silencing via Newton's third law: the hydrophic methyl bonds projecting into the surrounding water induce a mechanical back-reaction from the water on the chromatin that, in effect, clamps it to the nucleosomes and prevents the read-out machinery from traversing the chromatin strand.

5. Creation of a cancer course for physical scientists. The ASU PS-OC has created an innovative and extremely popular undergraduate course on physicals science and oncology that is taught to hand-picked students in the Barrett's Honors College. The class is addressed by PS-OC researchers, including graduate students; clinicians from the Mayo Clinic; interstate and overseas visiting cancer researchers; and non-PS-OC cancer specialists at ASU and Translational Genomics Research Institute (Tgen). The course involves lectures ranging from cancer epidemiology to radiation therapy, and lays special emphasis on the work of the PS-OC. Students tour laboratories and learn about the culture and techniques of physical science, as well as the basics of cancer biology. The course is attended by the PS-OC advocate. All students choose a research topic on which they present a talk to the class and produce a detailed discussion paper

for grading. Several of the students have gone on, or will go on, to summer internships in cancer research. Group discussion and interaction are a major part of the classroom culture. High educational standards are maintained.

New Trans-Disciplinary Research

Timothy Newman, theoretical physicist at the ASU PS-OC, and Thea Tlsty, a cancer biologist at the University of California, San Francisco, and the Senior Scientific Investigator of the Princeton University PS-OC, are attempting to quantify dormancy in metastasis, which is currently the subject of a trans-network proposal. The idea is to use mouse models, implanting mammary tumors and then measuring the appearance of disseminated tumor cells and micrometastases in the mouse lung at fixed time intervals. This will be statistical information from an ensemble, since mice will be sacrificed to obtain these measurements. Dr. Newman will apply his mathematical model of rare event statistical analysis to calculate the expected number of DTCs and micrometastases, along with their size distribution, as a function of time, using a simple three-compartment model of mammary gland to blood to lung.

Paul Davies, astrobiologist and Principal Investigator of the ASU PS-OC, and Alastair Thompson, breast cancer surgeon, University of Dundee (UD), are using their respective physics and clinical cancer backgrounds as a catalyst to provoke new research collaborations at the University of Dundee. Their regular discussions have already yielded an article on the "reverse Warburg effect," in which they take an ecological perspective, and they are currently drafting a position piece for the clinical oncology community on insights into cancer progression from an ecological viewpoint. The collaborators are starting a collaboration with Andrew South of the University of Dundee Medical School to use skin cancer cell lines to investigate the effects of intra-tumor competition on response to chemotherapeutic agents. They are also heading the creation of a physical oncology effort at the University of Dundee that brings together colleagues from experimental physics, medical imaging, mathematics, and computing.

New Infrastructure Built to Support the PS-OC

The ASU PS-OC has enjoyed unparalleled success in its program of brainstorming workshops, pushing the boundaries of research and trying to change the culture of cancer research by challenging its conceptual basis and importing genuine insights from the physical and life sciences. This has generated dozens of new research ideas and several concept papers.

Several of the ASU PS-OC Cancer Forum workshops have been co-organized with other PS-OC personnel. The most recent were the March 2012 workshops on the electrical properties of healthy and cancer cells, and on mitochondria and metabolism. These were organized with crucial input from Robert Gatenby, principal investigator of the Moffitt PS-OC. The ASU PS-OC is dominated by physical scientists, but Dr. Gatenby has a background in cancer biology. As a result, the collaborators were able to make good progress in both of these overlapping subjects, and identify important clinically relevant research outside the PS-OC network that promises to leverage the stated goals of the ASU PS-OC to develop both a novel conceptual basis for cancer, and a quantitatively testable theory of cancer.

Future Plans

- Expand the nascent links with the astrobiology community to identify new areas of overlap for future workshops and joint research projects. In particular, seek support for the atavism hypothesis developed by the ASU PS-OC by identifying the deep evolutionary origins of cancer in the context of eukaryogenesis and the evolution of multicellularity.
- Begin integration of the results of the experimental work, in particular the cell CT and elasticity measurements as a function of cancer progression. This will be accomplished through an accelerated think tank program and better coordination of the sample schedule.

Cornell University PS-OC

Principal Investigator: Michael Shuler, Ph.D.
Senior Scientific Investigator: Barbara L. Hempstead, M.D., Ph.D.

Summary

The Cornell PS-OC is organized both to de-convolve cancer's complexity and to understand the interaction of mechanical forces and chemical cues in cancer metastasis. The goal is to pursue experimental and theoretical approaches, derived from the physical sciences, to address major questions and barriers in the understanding and treatment of cancer. This new detailed, quantitative information is unlike any prior studies on the tumor environment and will enable a fundamental level of understanding that is likely to yield new pathways to intervene in the progression of cancer.

The center's research is organized around three research projects:

1. Physicochemical transducer networks and their role in regulating the angiogenic switch across multiple scales
2. Physical and chemical cues in tumor cell migration
3. Adhesion of tumor cells in the vascular microenvironment

The physical sciences perspective presented is a multiscale, quantitative approach to understanding the response of tumors to multiple, interacting chemical and physical signals as well as recognizing tumors as intrinsically heterogeneous. Using novel, three-dimensional in vitro tissue models, the experiments and analysis bridge the molecular and cellular phenomena through the tissue level and to the system level. For example, novel systems that allow investigation of isolated single cells are a necessary component, as well as models that mimic key aspects of tissue-to-tissue interactions to animal systems. All of these levels must be considered to provide appropriate context for understanding cancer cell response to specific stimuli. The Cornell PS-OC uses the techniques of microfabrication and nanofabrication available through Cornell's facilities for nanofabrication to allow its investigators to construct precise, well-controlled models and use the mathematical models to aid in the interpretation of this PS-OC's experimental observations and as the basis for prediction of responses to novel combinations of inputs. Such a multiscale, quantitative approach offers the possibility of deconvoluting the complexity of cancer's response to its microenvironment.

Key Center Accomplishments

1. Development of nanobiotechnological techniques to probe precisely and quantitatively cancer heterogeneity, development, and metastasis as a basis to develop potential therapeutic interventions. Many of the research achievements of the Cornell PS-OC are based on the applications of nano- and microfabrication techniques to biological systems. Investigators at the Cornell PS-OC have applied nanotechnology to epigenomic analysis on as few as four DNA molecules and have examined the potential use of traction force generation by cancer cells as a biomarker of metastatic ability. Investigators at the Cornell PS-OC have developed a microfabricated device to selectively capture almost all of the rare circulating tumor cells from blood at a purity of greater than 80% in a viable form to be used in a recently initiated clinical trial to test when to alter drug therapy to best treat prostate cancer.

   Researchers at the Cornell PS-OC have recently described a complementary technology for capture of viable circulating tumor cells from blood based on a microfluidic device where the surface has been modified with halloysite nanotube coating and the surfaces functionalized with E-selectin and antibody molecules against epithelial markers. The nanotubes not only increase surface area, they discourage spreading of leukocytes and their attachment, thus improving purity. This system captures 50% of the target cells at greater than 50% purity. A potential advantage of the device is

an increase in processing speed over other microfluidic devices and a relatively simple operation which should facilitate widespread adoption. Such a device could also be used as a component of a personalized therapeutic strategy for cancer treatment.

Another team at the Cornell PS-OC has generated major new insights into the role of stromal cells in tumor growth, angiogenesis, and metastasis. By applying a range of biomaterials, tissue engineering, and biophysical characterization tools, these investigators have identified adipose-derived stem cells (ASCs) as key contributors to breast cancer stiffness, angiogenesis, and overall malignancy. This work capitalized on the expertise of numerous investigators within the Cornell PS-OC. Another team has applied innovative cancer biology and microfabrication approaches to evaluate the relevance of different subpopulations of CD11b+ bone marrow progenitors in key metastatic processes. This work revealed that myeloid progenitors enhance metastasis by releasing versican and cathepsin-G, which in turn enhance survival of metastatic tumor cells at secondary sites by inducing mesenchymal to epithelial transition and promoting angiogenesis via downregulation of thrombospondin, respectively. These in vitro and in vivo approaches provide us with new insight into the process of metastasis that will allow us to test novel therapeutic strategies to interfere with metastasis.

2. The Cornell PS-OC unit has developed a course on nanobiotechnology which is videocast to four other sites, including Weill Medical College and The Methodist PS-OC; has placed about eight physical science and engineering students per year in a seven week long immersion term at Weill Cornell Medical College, and has developed a student-run "Brainstorming Club." The Cornell PS-OC believes that our educational unit has been particularly effective. One of the three signature programs in this effort is a course on nanobiotechnology that is videocast to University College, Dublin, Ireland; Ecole Nationale Superieure Des Mines, France; Weill Cornell Medical College; and Methodist PS-OC. The course not only introduced Cornell Ithaca students to nanobiotechnology in the context of cancer, but serves other students, including students from two other PS-OC facilities. The second program is our immersion term at Weill Cornell Medical College, which provides physical science and engineering students with an opportunity to shadow a clinician and do a small research project with their clinician mentor over a seven-week period. This experience introduces students to the challenges faced by clinicians working with cancer patients, helps them understand the rigors of the operating room, and introduces them to issues in medical research.

   The Cornell PS-OC sponsors a Cancer Brainstorming Club (http://www.cmm.cornell.edu/brainstorming-club.html), organized by students and postdocs to promote communications, collaborations, and career development opportunities for Center participants. The Brainstorming Club fosters critical thinking by having participants present their own work, as well as work from the literature, to their peers. Only students and postdocs participate, so the agenda and discussion is determined to meet their needs. The Brainstorming Club meets approximately bi-monthly with 20-30 people attending the evening videoconference meetings for participants in Ithaca and at Weill Cornell in New York City. Recently, participation has been expanded to include students at the Moffitt PS-OC, and a workshop for the two groups was held at Cornell March 4-7, 2012, followed by a visit of Cornell Brainstorming Club student leaders to Moffitt PS-OC prior to the April PS-OC Meeting. The Brainstorming Club held a further workshop at the 3rd Annual NCI PS-OC meeting in April 2012, which was attended by 45 researchers from the network. The ASU PS-OC Young Investigators Forum and the University of California, Berkeley, PS-OC have announced that they are conducting programs directly inspired by the Cornell Brainstorming Club.

New Trans-Disciplinary Research

While many Cornell PS-OC projects have led to strong collaborations between a physical scientist and cancer researcher, a particularly striking relationship is between Brian Kirby, associate professor of Mechanical & Aerospace Engineering, Cornell, Ithaca, and David Nanus, Pasmantier professor of Hematology and Oncology at Weill Cornell Medical College. Prior to the PS-OC grant, Dr. Kirby had no experience in cancer and only very modest experience in biology, while Dr. Nanus had little experience with engineers. In less than three years, their collaborative efforts have resulted in a clever, novel device for selective capture and recovery of circulating tumor cells that is the subject of an active clinical trial. Due to the influence of the PS-OC effort, Dr. Kirby spent his sabbatical at Weill Cornell Medical College, where he developed multiple connections with a variety of cancer researchers. Dr. Nanus has provided the constraints and performance criteria for the development of the device made by Dr. Kirby. The system made by Dr. Kirby is far more efficient and effective than the corresponding commercial technology, and enables the clinical trials on optimizing therapeutic intervention for treating prostate cancer. The device design is successful because of the use of sophisticated computational design of the fluid dynamics in the device to maximize the contact of circulating tumor cells with antibody-coated posts; an intuitive design could have been less effective. The device by itself would be largely a toy without the insight and practical experience of Dr. Nanus to define the potential opportunity and to implement the clinical trials. Three years is a remarkably short time to develop a concept, implement a novel device, test it rigorously in an in vitro system, and then bring it into clinical trials as a method to allow the physician to anticipate failure of one chemotherapeutic regimen and switch to an alternative before chemoresistance has become a major problem.

New Infrastructure Built to Support the PS-OC

The Cornell PS-OC Outreach and Dissemination Unit has created workshops and minicourses that serve to create a truly interdisciplinary group of researchers. The minicourses, in particular, are designed to bring researchers who are new to a particular topic "up to speed" as quickly as possible. In the time since the Cornell PS-OC has been established, it has developed materials for three different three-day minicourses on the topics of mammalian cell culture and staining, microfluidic device manufacture, and surface modification. Portions of these materials are available on the Cornell PS-OC website.

These outreach activities provide training to researchers who are new to the field and do not have experience with specific aspects of these interdisciplinary projects. The training rapidly brings researchers up to speed on practical lab techniques, protocols, and vocabulary, enabling them to accomplish their desired research and communicate with researchers in the physical, biological, and clinical sciences with greater effectiveness. To date, over 85 researchers have received this small-group instruction, while several hundred more have attended one of the other Outreach and Dissemination activities, including 9 workshops, 12 seminars, and 2 symposia.

The Cornell PS-OC's facilities build upon the existing Cornell nanobiotechnology facilities, and have added the BioPlex 200 specifically to meet the needs of PS-OC researchers. The Bioplex 200 system with high-throughput fluidics is a suspension array system which offers protein and nucleic acid researchers a reliable multiplex assay solution that permits analysis of up to 100 biomolecules in a single sample. This system allows researchers to multiplex immunoassays, enzyme assays, receptor-ligand assays, and nucleic acid hybridization assays.

New Trans-Disciplinary Research

Cornell PS-OC members have benefited from the PS-OC Network, and the exchange has greatly enriched their research. Most of the Ithaca-based faculty did not have a cancer focus before this grant, and now do. The network meetings have been valuable in enriching the knowledge base of our participants and in encouraging their interactions with faculty and students from other PS-OCs. The most direct expression of this factor is the development of trans-network projects. For example, the

Cornell PS-OC's recent trans-network project on "The Effects of Multiple Microenvironmental Parameters on Tumor Progression," involving investigators from the Cornell, Berkeley, Dana Farber, Methodist, USC, and Moffitt PS-OCs, will enable Cornell PS-OC investigators to connect their microscale in vitro studies of cancer response to multiple interacting mechanical and chemical stimuli to corresponding studies in animals. The translation of the in vitro studies to animals and humans will be greatly facilitated because of the PS-OC Network.

Cornell PS-OC researchers are also contributing to another new trans-network project, "The Impact of Higher-Order Chromatin Structure and Cellular Context on Chromosome Stability and Gene Expression," involving researchers from the Dana Farber, Northwestern, MIT, Berkeley, USC, and Cornell PS-OCs. At the Cornell PS-OC, Ari Melnick's lab focuses on rapid, effective analysis of epigenomic markers in cancer and its impact on disease progression. Michael King has contributed to the trans-network project, "Rheological Hotspots Drive Metastasis," a collaboration among the USC, ASU, Johns Hopkins, and Cornell PS-OCs, through the development of a comprehensive computational model of CTC trafficking in the body. In all of these projects, what will be or has been accomplished is more than any single investigator could do. For example, Cornell PS-OC investigators will be able to ascertain the complex interaction of multiple mechanical and chemical stimuli on cancer progression in ways that no single lab could accomplish on its own. Also, by participating in a larger project, the Cornell PS-OC's epigenomic analysis will lead to insights into the causes of tumor heterogeneity and the development of chemotherapy resistance. In the Cornell PS-OC project on the comprehensive computational model for CTCs, the resulting model will be the most complete model of its type and will be experimentally validated; the sophistication and completeness of the model will go well beyond what any individual investigator could have achieved.

Future Plans

- To build increasingly authentic in vitro human models of tumors and their interaction with both mechanical, chemical and cellular the microenvironment.
- To apply knowledge gained from designing pathologically relevant culture microenvironments to maintaining viability of normal tissues and tumor biopsies in vitro, with the ultimate goal to identify cellular and molecular components critical to tumor heterogeneity.
- To take the increasing understanding of the mechanisms of metastasis, developed through our in vitro and animal studies, towards testing potential human therapeutics.

Johns Hopkins University PS-OC

Principal Investigator: Denis Wirtz, Ph.D
Senior Scientific Investigator: Gregg L. Semenza, M.D. Ph.D

Summary

The overall goal of the Johns Hopkins University PS-OC is to discover the physical underpinnings of cancer metastasis. Metastasis is a complex, multistep process responsible for greater than 90% of cancer-related deaths. In addition to genetic and external environmental factors, the physical interactions of cancer cells with their microenvironment, as well as their modulation by mechanical forces, are key determinants of the metastatic process. The Johns Hopkins PS-OC has developed trans-disciplinary research teams to reconstruct the metastatic process from the bottom-up and describe the importance of key physical and mechanical processes at each step of the cascade. The emerging insight into these physical interactions may help to solve some longstanding questions in disease progression and may lead to new approaches to developing cancer diagnostics and therapies.

The Johns Hopkins PS-OC studies the effect of confining, shear, rheological, and pressure forces, as well as spatial dimensionality, on cancer cell initiation, development, selection, evolution, survival during transport, distal colonization, dormancy, and re-activation. Studies on these subjects require a trans-disciplinary approach that synergistically combines expertise in cancer cell biology/medicine and physical sciences to ensure that its investigators both ask truly original questions in cancer, so as not to be influenced by past apparent successes and based on conventional molecular biology and genetics, and cancer relevance at the same time.

Key Center Accomplishments

1. The Johns Hopkins PS-OC investigates the functional interactions between hypoxic pathways and extracellular matrix (ECM)-driven cues that are essential for vascular morphogenesis and network assembly. Utilizing advanced scaffolding approaches, Johns Hopkins PS-OC investigators have demonstrated that vascular tubulogenesis is regulated by ECM adhesion, degradation, and new matrix deposition, and that those cues alter in varying oxygen tensions. Current studies exploit these systems to understand how such cues modulate tubulogenesis during tumor angiogenesis.

2. The Johns Hopkins PS-OC investigates the physical mechanism by which cancer cells negotiate and invade the three-dimensional matrix of the tumor stroma. Its investigators have discovered that the role of focal adhesion proteins, which cluster at large integrin clusters on the ventral surface of cells on traditional two-dimensional substrates, is not predicted by their role in two-dimensional migration. Rather, focal adhesion proteins mediate a novel type of dendritic protrusions that dynamically tug on matrix fibers and forge open paths for collective cell invasion. The Johns Hopkins PS-OC has also found that three-dimensional cell migration requires additional molecular controls of the spatio-temporal character of the trajectories followed by cells in the matrix.

3. No clear mutational profile that is reliably predictive of the metastatic potential of tumor cells has so far been established. Investigators in the Johns Hopkins PS-OC have developed a high-throughput scanning microscope that allowed us to determine and validate an extremely robust, multi-parameter phenotypic signature of cancer metastasis for pancreatic cancer patients. In particular, this PS-OC has discovered that the degree of phenotypic heterogeneity is dramatically higher in cells from primary tumors than among cells that successfully metastasized to the liver. Through collaborations in the PS-OC network, this approach is being extended to determine the drug responsiveness and time of survival in a wide range of cancers, including prostate cancer, ovarian cancer, and leukemia.

4. Cell migration on planar surfaces is driven by cycles of actin protrusion, integrin-mediated adhesion and myosin-mediated contraction; however, this mechanism may not accurately describe movement in three-dimensional space. By subjecting cells to restrictive three-dimensional environments, investigators at the Johns Hopkins PS-OC demonstrated that physical confinement constitutes a biophysical stimulus that alters cell morphology and suppresses mesenchymal motility in human breast carcinoma. Dorsoventral polarity, stress fibers and focal adhesions are markedly attenuated by confinement. Inhibitors of myosin, Rho/ROCK or β1-integrins do not impair migration through confined three micron-wide channels, even though these treatments repress motility in 50 micron-wide channels, representing unconfined migration, by 50% or more. Confined migration persists even when F-actin is disrupted, but depends largely on microtubule (MT) dynamics. Interfering with MT polymerization and depolymerization causes confined cells to undergo frequent directional changes, thereby reducing the average net displacement by at least 80% relative to vehicle controls. Live-cell EB1-green fluorescent protein imaging reveals that confinement redirects MT polymerization toward the leading edge where MTs continuously impact during advancement of the cell front. These results demonstrate that physical confinement can induce cytoskeletal alterations that reduce the dependence of migrating cells on adhesion contraction force coupling. This mechanism may explain why integrins can exhibit reduced/altered function during migration in three-dimensional environments.

New Trans-Disciplinary Research

The Johns Hopkins PS-OC fostered the collaboration between engineer Denis Wirtz and cancer cell biologist Gregory Longmore to study cancer cell migration. This research collaboration, combining complementary expertise in physics and cancer biology, revealed completely novel insights in cell migration, a cell function critical to metastasis. Conventional two-dimensional cell motility depends upon forces generated from the dynamic remodeling of the acto-myosin cytoskeleton as transmitted through cell surface focal adhesions (FAs) to the extracellular matrix. Focal adhesions are complex, integrin-based macromolecular complexes that are a hallmark of cells on flat substrates. They play both a mechano-sensory role and a signaling function, which serve to mediate the important interplay between the intracellular milieu and the extracellular matrix. Focal adhesion complexes, which contain more than 100 different receptor, structural, and signaling proteins, are readily observed at the basal surface of cells in two-dimensional cultures. When cells are partially embedded in a three-dimensional matrix, i.e., only the apical surface of the cell is embedded in the matrix, FAs become smaller and their composition changes compared to the conventional two-dimensional case. However, when the cell is completely buried inside a three-dimensional matrix – which is the in vivo case – FA size is reduced dramatically.

Since FAs are not apparent when cells are completely embedded inside a three-dimensional matrix, this finding prompted the collaborators to explore the role of key components of FAs when cells are in a three-dimensional matrix that more closely mimics the physiological condition. Understanding this phenomenon is particularly important since the level of expression of several focal adhesion proteins, including focal adhesion kinase (FAK), paxillin, and zyxin, correlates with metastatic potential in vivo. Quantitative live-cell microscopy conducted in the Johns Hopkins PS-OC showed that for cells fully embedded in a three-dimensional matrix, focal adhesion proteins, including vinculin, paxillin, talin, zyxin, VASP, FAK, and p130Cas, did not cluster into appreciable aggregates, but are diffusively distributed in the cytoplasm of cells. Despite the absence of detectable FAs, focal adhesion proteins still modulated cancer cell motility but in a manner distinct from cells moving on conventional planar substrates. Rather, focal adhesion proteins in matrix-embedded cells regulated cell speed by modulating protrusion activity and matrix deformation, two cellular processes that play no direct role in controlling two-dimensional cell speed. This study showed that actively growing membrane protrusions constitute a critical motility/matrix-traction module that drives cancer cell motility in a three-dimensional matrix.

New Infrastructure Built to Support the PS-OC

Upon award of the PS-OC grant, Johns Hopkins University committed enormous resources to jump-start a major multidisciplinary effort at the interface of physical sciences and oncology. All Johns Hopkins-based faculty members of the Johns Hopkins PS-OC moved to renovated research laboratories and offices in the NEB building on the university's Homewood campus. These facilities house state-of-the-art imaging facilities and custom high-throughput equipment. Predoctoral and postdoctoral fellows with highly diverse scientific backgrounds, including oncologists, surgeons, pathologists, cancer cell biologists, biophysicists, and engineers, work together in these new facilities.

The Johns Hopkins PS-OC sponsored a major symposium on physical sciences and oncology at Hopkins with more than 500 participants; organized a hands-on laboratory course for predoctoral students enrolled in the PS-OC training program; and sponsored a new course on the physical sciences fundamental for cancer medicine. Moreover, the Johns Hopkins PS-OC sponsored seminars on the topic of physical sciences and oncology and sponsored and participated in symposia at multiple national and international conferences, promoting this new field.

Interactions with the PS-OC Network

The PS-OC network allowed Johns Hopkins PS-OC faculty to develop large-scale projects involving highly diverse expertise in computational modeling with collaborators at the USC PS-OC; epigenetics with collaborators at the Northwestern and Cornell PS-OCs; cell biomechanics with collaborators at the ASU PS-OC; computational modeling with collaborators at the Stanford University and USC PS-OCs; hydrogel engineering with collaborators at the University of Pennsylvania; and access to well-annotated specimen, thanks to a collaboration with researchers at Cedars-Sinai. These new collaborations could not have happened without PS-OC trans-network funding, highly engaging PS-OC-sponsored meetings; and NCI and PS-OC officers' ability to identify complementary expertise and introduce researchers who otherwise would not think of working together.

Future Plans

- Realize the ongoing projects—involving the Johns Hopkins PS-OC and the Northwestern, USC, Memorial Sloan-Kettering Cancer Center PS-OCs and other cancer centers—to establish highly predictive, robust, multi-faceted phenotypic signatures of drug resistance, patient stratification, and patient survival in ovarian cancer, prostate cancer, leukemia, and pancreatic cancer through the application of novel, single cell-based technologies.
- Through novel computational and microfabrication methods, establish the biophysical underpinnings of the mechanism of single-cell and collective migration in three-dimensional complex stromal microenvironments in vitro and in vivo.
- Foster the formation of a theoretical/computational center for theoretical oncology, which will combine expertise in statistical mechanics, biostatistics, and computational modeling, and will closely interface with experimentalists in the PS-OC network.

Massachusetts Institute of Technology

Principal Investigator: Alexander van Oudenaarden, Ph.D.
Senior Scientific Investigator: Tyler Jacks, Ph.D.

Summary

The overarching goal of the Massachusetts Institute of Technology (MIT) PS-OC is to use both theoretical and experimental approaches inspired by physics and engineering to attack important problems in cancer biology by developing novel technology and analytical and computational methods to track the dynamics of cancer at the single-cell level. Most investigators from our team are affiliated with institutes in the Boston area including MIT, the Whitehead Institute for Biomedical Research, the Broad Institute of MIT and Harvard, Harvard Medical School (HMS), Brigham and Women's Hospital, and Boston University. Investigators from several other institutions are located on the West Coast, including the University of California, San Francisco. One of the team members is located at the Hubrecht Institute and University Medical Center Utrecht in The Netherlands.

Key Center Accomplishments

A collaborative effort between the Jaenisch lab and the van Oudenaarden lab has shown that reprogramming is a stochastic process. Direct reprogramming of somatic cells into induced pluripotent stem (iPS) cells can be achieved by overexpression of Oct4, Sox2, Klf4, and c-Myc transcription factors, but only a minority of donor somatic cells can be reprogrammed to pluripotency. This team demonstrated that reprogramming by these transcription factors is a continuous stochastic process where almost all mouse donor cells eventually give rise to iPS cells on continued growth and transcription factor expression. Quantitative analyses define distinct cell division rate-dependent and -independent modes for accelerating the stochastic course of reprogramming, and suggest that the number of cell divisions is a key parameter driving epigenetic reprogramming to pluripotency. This collaborative work was published in Nature. In a recent publication in Nature Biotechnology, the Mirny lab described how high-order chromatin architecture shapes the landscape of chromosomal alterations in cancer. The accumulation of data on structural variation in cancer genomes provides an opportunity to better understand the mechanisms of genomic alterations and the forces of selection that act upon these alterations in cancer. The Mirny lab tested evidence supporting the influence of two major forces, spatial chromosome structure and purifying (or negative) selection, on the landscape of somatic copy-number alterations (SCNAs) in cancer. Using a maximum likelihood approach, they compared SCNA maps and three-dimensional genome architecture as determined by genome-wide chromosome conformation capture (HiC) and described by the proposed fractal-globule model. This analysis suggests that the distribution of chromosomal alterations in cancer is spatially related to three-dimensional genomic architecture and that purifying selection, as well as positive selection, influences SCNAs during somatic evolution of cancer cells.

In a collaboration between the van Oudenaarden, Jacks, and Clevers labs, it was reported in Cell earlier this year that general optimality principles might govern the development of the mammalian intestine. Intestinal crypts in mammals are comprised of long-lived stem cells and shorter-lived progenies, maintained under tight proportions during adult life. In this project, the collaborators asked what are the design principles that govern the dynamics of these proportions during crypt morphogenesis. They used use optimal control theory to show that a stem cell proliferation strategy known as a 'bang-bang' control minimizes the time to obtain a mature crypt. This strategy consists of a surge of symmetric stem cell divisions, establishing the entire stem cell pool first, followed by a sharp transition to strictly asymmetric stem cell divisions, producing non-stem cells with a delay. The investigators validated these predictions using lineage tracing and single molecule fluorescent in-situ hybridization of intestinal crypts in newborn mice and found that small crypts are entirely composed of Lgr5 stem cells, which become a minority as crypts grow further. This approach can be used to uncover similar design principles in other developmental systems.

In a large collaborative effort between the Lees, Jacks, Clevers, and van Oudenaarden labs, a technology was developed to count single transcripts of stem cell markers in murine intestinal tissue. Determining the molecular identities of adult stem cells requires novel technologies for sensitive transcript detection in tissues. In mouse intestinal crypts, lineage-tracing studies suggested that different genes uniquely mark spatially distinct stem-cell populations, residing either at crypt bases or at position +4, but a detailed analysis of their spatial co-expression has not been feasible. These investigators applied three-color single molecule fluorescent in-situ hybridization to study a comprehensive panel of intestinal stem-cell markers during homeostasis, aging, and regeneration. They found that the expressions of all markers overlap at crypt-base cells. This co-expression includes Lgr5, Bmi1 and mTert, genes previously suggested to mark distinct stem cells. Strikingly, Dcamkl-1 tuft cells, distributed throughout the crypt axis, co-express Lgr5 and other stem cell markers that are otherwise confined to crypt bases. They also detected significant changes in the expression of some of the markers following irradiation, suggesting their potential role in the regeneration process. This approach can be used to identify stem-cell signatures in other tissues and in tumors. This work was published recently in Nature Cell Biology.

A collaborative effort between the Sharp lab and the van Oudenaarden lab demonstrated that microRNAs can generate threshold in gene expression. MicroRNAs (miRNAs) are short, highly conserved non-coding RNA molecules that repress gene expression in a sequence-dependent manner. The investigators performed single-cell measurements using quantitative fluorescence microscopy and flow cytometry to monitor a target gene's protein expression in the presence and absence of regulation by miRNA. They found that while the average level of repression is modest, in agreement with previous population-based measurements, the repression among individual cells varies dramatically. In particular, the researchers showed that regulation by miRNAs establishes a threshold level of target messenger RNA (mRNA) below which protein production is highly repressed. Near this threshold, protein expression responds sensitively to target mRNA input, consistent with a mathematical model of molecular titration. These results demonstrate that miRNAs can act both as a switch and as a fine-tuner of gene expression. This work was published in Nature Genetics.

The Weinberg lab and van Oudenaarden lab collaborated to identify stem cell markers in mammary tissue. Regulatory networks orchestrated by key transcription factors (TFs) have been proposed to play a central role in the determination of stem cell states. However, the master transcriptional regulators of adult stem cells are poorly understood. These collaborators have identified two TFs, Slug and Sox9, that act cooperatively to determine the mammary stem cell (MaSC) state. Inhibition of either Slug or Sox9 blocks MaSC activity in primary mammary epithelial cells. Conversely, transient coexpression of exogenous Slug and Sox9 suffices to convert differentiated luminal cells into MaSCs with long-term mammary gland-reconstituting ability. Slug and Sox9 induce MaSCs by activating distinct autoregulatory gene expression programs. They also showed that coexpression of Slug and Sox9 promotes the tumorigenic and metastasis-seeding abilities of human breast cancer cells and is associated with poor patient survival, providing direct evidence that human breast cancer stem cells are controlled by key regulators similar to those operating in normal murine MaSCs. The results of this project were recently published in Cell.

New Trans-Disciplinary Research

The MIT PS-OC has been a key catalyst in bringing teams of leading cancer biologists and leading physical scientists together. For example, the successful collaborations between the van Oudenaarden lab (physics), Jacks lab (cancer biology), and Clevers lab (stem cell and cancer biology) have only have been possible because of the PS-OC funding. In the absence of the PS-OC, it would be hard to imagine how these collaborations would have started. A similar argument can be made for the collaboration between the Manalis lab (engineering) and Kirschner lab (cancer biology). All of the key accomplishments mentioned above were possible because of the trans-disciplinary approaches used. For example, the project on the optimality of crypt development was a close collaboration between the Jacks lab, Clevers lab, and van Oudenaarden lab. In this project, the Jacks lab made a major contribution by providing the right mouse models and helping with mouse injections and manipulations. The Clevers lab was essential because of their expertise in lineage tracing. The van Oudenaarden lab developed the optimality

theory and developed all the tools related to imaging and transcript labeling. In summary, this was a complementary collaboration that could only have been performed by combining these different viewpoints.

New Infrastructure Built to Support the PS-OC

The PS-OC is running two important cores that are providing important services for our center, but also for several of the other PS-OCs. The Single-Cell Transcript Counting Core provides the investigators of this PS-OC and investigators of other PS-OCs in the network with the infrastructure to image individual mRNA molecules in single cells, both in culture and in tissue. In addition to the exceptional sensitivity and spatial resolution that are superior to other existing mRNA imaging methods, this technique allows measurements of absolute quantities of up to four different mRNAs in a single cell. Custom-designed software is provided to computationally detect single RNA molecules and analyze images. The Cell Sorting and Physical Measurement Core provides the PS-OC investigators with emerging microfluidic technologies for sorting cells and for dynamic single-cell measurements of physical properties such as mass and density. The cell sorting system consists of microfluidic technology developed by Innovative Micro Technology (IMT) that utilizes fluorescence-activated sorting, but differs from conventional FACS in three important aspects: It can achieve a throughput of a million events per second, which is an order of magnitude faster than existing machines such as the BD FACSAria; it maintains high viability without the need to compromise throughput; and all the key cell sorting elements are microfabricated and are therefore disposable. The single cell measurement platform is based on the suspended microchannel resonant (SMR) mass sensor, which is capable of measuring the size of single cells with a precision that is orders of magnitude better than what can be achieved by optical microscopy. In addition, the SMR measures mass, which in the context of studying cell proliferation and cancer is a superior description of cell size than is volume. The MIT PS-OC is now developing SMR-based technologies that, by monitoring the mass of single cells over time, will measure the rate of single cell growth, i.e., the accumulation of biomass, with unprecedented precision and accuracy.

Interactions with the PS-OC Network

A trans-network collaboration between the MIT PS-OC and the Princeton PS-OC led to the development of transcript counting technology for use with clinical breast cancer samples. Human cancers almost invariably consist of heterogeneous cell populations with aberrant karyotype and gene expression profiles. This evidence mostly derives from either studies that analyzed tumors as a whole using mass techniques such as microarrays, deep sequencing, Western blotting, and proteomics, or from studies that used semi-quantitative in situ techniques such as immunohistochemistry. This collaboration has begun to systematically study the spatial pattern of expression of defined transcripts in human breast cancer using quantitative single-molecule RNA in situ fluorescent hybridization (FISH). By imaging hundreds of random positions in a single tumor section, and counting the number of specific RNAs in each cell of a grid of computationally generated pseudo-cells, the collaborators have found that the relative frequency of unrelated tumor-specific transcripts such as ERBB2/HER2, estrogen receptor 1, mucin 1, and cytokeratin 7 is constantly distributed according to a one-phase exponential decay. Typically, clusters of four to five pseudo-cells with high levels of expression surrounded by pseudo-cells with lower expression intensity are observed throughout the same section. The investigators will verify if this pattern holds true for more unrelated transcripts, and whether it can be found in dense monolayers of cultured breast cancer cells as well. In parallel, these collaborators will elaborate a mathematical model for the observed spatial and frequency distributions using the evolutionary dynamics theory as a framework. This study will advance our knowledge about tumor heterogeneity, while paving new ways to the molecular diagnostics of cancer.

Future Plans

- Further expand the applications of our technology to clinical samples.
- Further expand our network of collaborations and assist others to use technology developed by the MIT PS-OC for new applications.

H. Lee Moffitt Cancer Center & Research Institute

Principal Investigator: Robert A. Gatenby, M.D.
Senior Scientific Investigator: Robert J. Gillies, Ph.D.

Summary

The Moffitt PS-OC is a dynamic and eclectic program that builds around the goal of understanding the role of the physical microenvironment in cancer. In particular, this PS-OC's starting point focused on physical parameters such as oxygen and pH in cancer biology and treatment. Many of the highlighted results below stem specifically from this work. Through its interactions with other PS-OC programs, the Moffitt PS-OC's interests have broadened. In particular, it has expanded its experimental portfolio to include new physical science technologies made available through other centers. Investigators at the Moffitt PS-OC are now able to use sophisticated microfluidic devices to recreate in vivo oxygen and pH gradients in vitro to better investigate their effects on cell biology and response to therapy. In addition, Moffitt PS-OC investigators are now using nanoparticles for high resolution of intra- and extracellular measurements of pH and oxygen.

More broadly, the Moffitt PS-OC's participation in the PS-OC network has encouraged the Moffitt investigators to employ the typical physical science paradigm by searching for first principles. A lesson tumor biologists learn from physicists is that while systems like cancer can be very complex, they are almost never hopelessly so. In other words, most such systems are built upon straightforward fundamental dynamics. In this spirit, Moffitt PS-OC investigators have increasingly focused on our work on identifying Darwinian dynamics as the fundamental principle governing carcinogenesis, invasive cancer, metastatic spread, and tumor therapy.

Key Center Accomplishments

1. Defining the role of intra- and peri-tumoral acidosis in tumor invasion. Moffitt PS-OC investigators hypothesized that increased glycolysis in the tumor confers an evolutionary advantage because of the consequent acid production. Specifically, the acid-mediated invasion hypothesis proposed that intra-tumoral acid flows along concentration gradients into adjacent normal tissue, causing normal cell death, breakdown of extracellular matrix, blunting of the immune response, and promotion of angiogenesis. This facilitates subsequent tumor growth and invasion. This hypothesis was initially framed mathematically and was shown to be feasible based on computer simulations. Using intra-vital microscopy in dorsal window chamber experiments, these investigators have now clearly demonstrated that tumor-induced acidification precedes subsequent tumor invasion. This led to subsequent therapeutic and prevention strategies described next.

2. System buffers inhibit growth of metastases. Initial experiments adding 200 mM of sodium bicarbonate to the drinking water of tumor-bearing mice demonstrated substantial reduction of metastatic disease in many but not all cancer lines examined. Moffitt PS-OC investigators have now demonstrated that other systemic buffers including lysine are equally effective in reducing metastatic growth. Clinical trials using oral sodium bicarbonate to reduce tumor growth and tumor-related pain are underway at Moffitt and European sites.

3. Systemic buffers prevent development of prostate cancer in TRAMP mice. Moffitt PS-OC investigators hypothesized that hypoxia and acidosis develop in in-situ cancers as tumor growth away from the basement membrane increases cell distance from the blood vessels which remain deep to the membrane. They demonstrated using computational models that selection forces produced by hypoxia caused upregulation of glycolysis, which then produced selection for acid resistance. This phenotype had a substantial evolutionary advantage because it created

an acidic environment to which it was well adapted, but it was toxic to competing populations. Evidence for these evolutionary events has been demonstrated by us in breast cancer and by others in cervical cancer. The investigators then hypothesized that systemic buffers, by reducing acidity in in-situ cancers, could remove selection forces driving the acid-adapted phenotype and delay or prevent transition from in-situ to invasive tumor growth. This hypothesis was initially framed mathematically and shown to be feasible. The researchers then tested the hypothesis in vivo using TRAMP mice, which develop prostate cancer with 100% penetrance. The researchers found that all control animals did develop prostate cancer with the primary tumor evident on three-dimensional ultrasound by 13 weeks and 100% mortality by 52 weeks, with mean age at death of 37 weeks. However, if 200 mM of sodium bicarbonate was added to the drinking water before weeks of age, none of the mice developed cancer visible on three-dimensional ultrasound prior to reaching senescence at age 76 weeks.

New Trans-Disciplinary Research

The Moffitt PS-OC is focused on examining the environment in carcinogenesis. One of the key projects that has emerged from this is a collaboration between Sandy Anderson, an applied mathematician, and Kieran Smalley, a tumor biologist. Their work examines the importance of tumor-stromal interactions in melanoma progression. Utilizing a combination of three-dimensional cell culture, pathology, and an in silico virtual skin model, they have begun to unravel new routes of melanoma initiation. Critically, these collaborators had developed and applied a multiscale mathematical model that captures the essence of normal skin development and maintenance and have systematically perturbed it to find the most likely routes tumors can propagate down once initiated from a spectrum of mutated melanocytes. This integrated approach has shown that minimally transformed melanocytes combined with senescent stroma are just as effective at promoting melanoma progression as very aggressive melanocytes are on their own. This finding connects well with the observation that melanoma is a disease of the aged – as humans age, normal regulatory mechanisms may begin to malfunction and stroma may become senescent. The collaborators are now working closely with pathologist colleagues to validate this hypothesis from patient-derived biopsies. While not conclusive, these experiments highlight the fact that stroma, rather than tumor, is producing matrix-degrading enzymes, at least indicating that they are contributing to melanoma progression.

New Infrastructure Built to Support the PS-OC

The Moffitt PS-OC seeks to recreate the classical physics organization in which experimentalists and physicists work in close proximity. To this end, five faculty physical scientists/mathematicians and their eight postdoctoral fellows have been placed on the fourth floor of the Stabile Research Building (SRB) at Moffitt. Although located together, the physical scientists are "co-localized" with experimentalists and clinicians. In addition, the 1400 sq. ft. wet lab run by the Moffitt PS-OC PI and SI is on the same floor of the SRB and is open to all members of the PS-OC. Both the PI and SI also have active research programs within the animal core facility which is available to all PS-OC members. While collaborations are fostered by random hallway encounters, they are also actively promoted though a 400 sq ft "collaboratorium" within the office space of the SRB fourth floor. The collaboratorium features wall-to-wall chalkboards and a "smart board" for integrative computer-based presentations. The room can be scheduled for formal presentations but also contains coffee makers, an espresso machine, and refrigerator to foster random encounters. Finally, the PS-OC sponsors weekly trans-disciplinary conferences, typically attended by over 40 people, as well as long- and short-term visiting scholars who often present their work in informal ad-hoc conferences.

Future Plans

- Extend current work on the effects of intra- and extra-tumor acidosis to: Develop systemic buffering strategies for clinical trials; explore systemic buffers to improve tumor response to immunotherapy (T cell function is significantly decreased in acidic pH); and explore a range of buffering agents for tumor prevention.
- Continue developing Darwinian dynamics as first principles for understanding carcinogenesis, cancer invasion, metastases formation, and tumor therapy.
- Extend the investigation of tumor physical environment to the cell cytoplasm to identify regional intra-cellular variations in pH, oxygen, glucose, and ATP.

Princeton University

Principal Investigator: Robert H. Austin, Ph.D.
Senior Scientific Investigator: Thea D. Tlsty, Ph.D.

Summary

The Princeton University PS-OC concentrates on the evolutionary dynamics of cancer growth and metastasis from a fundamental perspective of Darwinian natural selection. The Center remains focused on several provocative questions:

- Does cancer start due to the presence of pre-existing mutant cells in the body which slowly evolve until some sort of transition to full uncontrolled growth occurs due to the buildup of several critical mutations, or can cancer begin ab initio in a community of healthy cells due to the response of cells to high-stress conditions?
- Do the physical parameters of a tumor, such as pressure, temperature, metabolic state, and nutrient feeds, lead in the evolutionary progression of a tumor to an uncontrollable state?
- What is the role that network dynamics play in the development of cancer from an evolution perspective?
- What is the role that heterogeneity plays in the evolution of resistance to chemotherapy in cancers?

Physical sciences perspective: The Princeton PS-OC's perspective is two-fold: (1) that there exist fundamental principles of evolution dynamics which can be succinctly stated in a few mathematical lines but which have far-reaching consequences, much as Maxwell's equations—just four lines of simple but powerful mathematics—can be used to develop an enormous quantitative understanding of electromagnetic phenomena; and (2) that there exist powerful experimental technologies and methods of analysis that have not yet been developed for the dynamics of cancer growth and metastasis.

While physics has always played a role in the development of tools for biology and cancer in particular, what makes this PS-OC unique is that it claims that there are fundamental concepts to take from physics and apply to cancer. And while this PS-OC is developing tools, it is also developing new concepts to be used in understanding cancer at a deeper level. For example, Maxwell's equations can serve as an illustration of how physics develops from basic principles into powerful fields of knowledge. Unfortunately, the analogy gets frayed when confronting a complex biological phenomena such as cancer; pure reason alone can only go so far in leading to true clinical impact. It is essential for the physicists, engineers, and oncologists to work together, with each set of investigators bringing their own perspective and knowledge base.

Key Center Accomplishments

1. The logic of gene placement and stress response. Cells have to adapt and evolve in a complex and heterogeneous world. Probably the first line of defense to external toxins is to over-express membrane-associated pumps expressed by the rbsA gene which lower the internal concentration of toxins if possible to a level where replication is possible in the case of a genotoxic toxin. A similar response is often seen in cancer cells when they are treated with a mutagenic chemotherapy agent. Princeton PC-OC investigators have shown that the arrangement of the genes on the E. coli chromosome is logically and physically organized in such a way as to make sure the first line of defense can be expressed initially.
2. Stress-induced changes in nuclear structure and higher order DNA organization. It is clear that changes in cellular structure along with the microenvironment can be important modulators of the evolution of therapeutic resistance in cancer. In order to examine some potential mechanisms of drug resistance, Princeton PC-OC investigators

have evaluated cellular models. Prostate cancer cells that are resistant to paclitaxel elicited a discrete loss of epithelial cell markers and had a significantly lower expression of keratins, while at the same time these paclitaxel-resistant cells gained expression of mesenchymal markers typically implicated in an epithelial mesenchymal transition (EMT). Consistent with these molecular manifestations of EMT, biophysical studies revealed that paclitaxel resistance also conferred to the cells the ability to exercise higher cell traction forces, invade the surrounding extracellular matrix (ECM), and form colonies in soft agar. The internal network of the cytoskeleton in paclitaxel-resistant cells showed an unanticipated fluid-like behavior and displayed faster remodeling dynamics than the parental cells. While these resistant cells appear to demonstrate an EMT-like phenotype, the development of resistance to chemotherapeutic agents results in their being more sensitive to other microenvironmental stresses such as temperature, pH, and glucose deprivation. In this regard, combinations using classical therapeutic approaches for cancer such as chemotherapy and radiation therapy and approaches which modulate microenvironmental stress may decrease the ability of cancer cells to develop resistance and therefore may increase the efficacy of these currently used therapies.

Overall, this project is revealing novel information about the evolution of resistance, and is developing concepts and tools that might attack the cancer at its Achilles heel.

Evolution of drug resistance in a stress gradient. The tumor microenvironment plays a crucial role in the cancer's evolution of drug resistance. To address this issue, Princeton PC-OC investigators have performed in vitro experiments that mimic the tumor microenvironment—experiments in which cells are not exposed to uniform concentrations but rather to gradients of drugs, nutrients, and other factors. Compared to traditional in vitro methods, microfluidic structures enable better control of the temporal and spatial profile of gradients. Princeton PC-OC investigators have also developed a microfluidic platform with a stable doxorubicin gradient and heterogeneous landscapes to mimic the tumor microenvironment. The investigators have seen emergent colonies forming in high-doxorubicin regions above their minimal inhibitory concentrations in one week. Going forward, the Princeton PC-OC investigators will compare the genetic difference between the rapid-resistant myeloma cells from our chip and the chronic-resistant myeloma cells from traditional protocols.

3. Probing the invasiveness of prostate cancer cells in a three-dimensional microfabricated landscape. The metastatic invasion of cancer cells from primary tumors to distant ecological niches, rather than the primary tumors, is the cause of much cancer. Metastasis is a three-dimensional invasion process where cells spread from their site of origin and colonize distant micro-environmental niches. It is critical to be able to assess quantitatively the metastatic potential of cancer cells. Princeton PC-OC investigators constructed a microfabricated chip with a three-dimensional topology consisting of lowlands and isolated square highlands, or Tepuis, that stand hundreds of microns above the lowlands, in order to assess cancer cell metastatic potential as they invade the highlands. As a test case, the invasive ascents of the Tepui by highly metastatic PC-3 and noninvasive LNCaP prostate cancer cells were used. The vertical ascent by prostate cancer cells from the lowlands to the tops of the Tepui was imaged using confocal microscopy and used as a measure of the relative invasiveness. The less-metastatic cells (LNCaP) never populated all available tops, leaving about 15% of them unoccupied, whereas the more metastatic PC-3 cells occupied all available Tepuis. The investigators argue that this distinct difference in invasiveness is due to contact inhibition.

New Trans-Disciplinary Research

The Princeton PS-OC initiated a trans-disciplinary project with Robert Gatenby of the Moffitt PS-OC to investigate the evolution of drug resistance in multiple myeloma (MM). The evolution of chemotherapy resistance was recreated in the Death Galaxy, a three-dimensional representation of the bone marrow microenvironment, composed of red fluorescent human MM cell lines, a green fluorescent stromal cell line, and extracellular matrix composed of matrigel. A stable gradient of doxorubicin

was established through this micro-habitat for 10 days, during which the investigators used fluorescent imaging to quantify cell death in high-drug-concentration regions, replication in low-drug-concentration regions, and migration. At the end of these experiments, it was observed that some cells were still alive and capable of replication in regions with chronic high concentrations of chemotherapy (200 nM). These cells were collected, and after expansion, showed a significant increase in the expression of p-glycoprotein pumps, a common mechanism of drug resistance observed in patients treated with doxorubicin. These results suggest that the microfluidics system used to select for drug resistance in MM cell lines may be used for patient primary cells. Although the investigators may not be able to expand the selected clones in patient primary cells, they should be able to sequence them.

New Infrastructure Built to Support the PS-OC

The Princeton PS-OC has maintained a strong program of intellectual outreach to the wider community via two workshops, and has also initiated a series of Boot Camps for Microfluidics to reach out to the community of biologists who would like to learn the techniques we are developing. The microfluidics facility is one of the three core facilities of the Princeton PS-OC. In 2011, for the inaugural camp, the Princeton PS-OC hosted 16 students for this week-long course. The course consisted of a series of lectures and hands-on lab work, constituting a broad introduction to microfluidics. Participants successfully built their own microfluidic devices from start to finish and performed several experiments using them. The material from this course is posted on the Princeton PS-OC website. This PS-OC conducted our second camp July 30 - August 10, 2012, building on last year's experience.

Interactions with the PS-OC Network

Using Microfabricated Microecologies to Probe the Fundamentals of Evolution of Drug Resistance in Bacteria was one of the keystone projects in this PS-OC's original proposal. Princeton PC-OC investigators showed that while as in cancer chemotherapy, the emergence of resistance to antibiotics by bacteria is a fundamental problem, the variables that influence the rate of emergence of resistance were not well understood but could be attacked by using the tools developed in this PS-OC. Using a microfluidic device designed to mimic naturally occurring niches, resistance of E. coli to the antibiotic ciprofloxacin was shown to emerge within 10 hours. Resistance emerged with as few as 100 bacteria in the initial inoculation, showing that in this case, the evolution of resistance was de novo. Whole-genome sequencing revealed the fixation of four functional single nucleotide polymorphisms (SNPs). The principles of rapid emergence of antibiotic resistance in heterogeneous environments shown in this work will apply to the emergence of resistance in chemotherapy.

Future Plans

- Quantitatively explore cellular phenotype dynamics during the evolution of drug resistance in complex, three-dimensional ecologies using primary tissue cell lines.
- Track in three-dimensions the development of the micro-environment using nanoprobes for oxygen, pH, and various metabolites, and physics-based probes such as isotope ratios.
- Sequence the dynamics of genomic changes during stress in a spatially and temporally specific way and correlate with the changes in gene expression dynamics.
- Using physics probes, study the development of cellular communication during the process of tumor development and the onset of metastasis.

The Methodist Hospital Research Institute

Principal Investigator: Mauro Ferrari, Ph.D.
Senior Scientific Investigator: Steven A. Curley, M.D.

Summary

The scientific premise upon which The Methodist Hospital Research Institute PS-OC is formulated is that the physics of mass transport within a cancer lesion, as well as the mass exchanges between cancer and the host biology, are fundamental in identifying characteristics of cancer onset and cancer development. The governing determinants of transport dynamics are a multi-scale set of biophysical and biological barriers collectively known as biobarriers. These comprise biobarriers that govern mass exchange at a compartmental level, such as the vascular endothelium and intestinal epithelium compartments; within the architecture of individual cancer lesions, including the inhomogeneity of tissue diffusion, hydrostatic interstitial fluid, and oncotic pressure; and at the cell and subcellular organelle levels such as the cell, endosomal, and nuclear membranes, molecular and ionic efflux pumps. The Methodist PS-OC's overarching hypothesis is that transport differentials are fundamental in cancer growth and development, and the ability to diagnose and treat cancer effectively. These differentials form the physics milieu within which cancer develops as a complex adaptive system. Thus, the overall goal of the Methodist PS-OC is to construct a reference system for understanding cancer, where the multi-dimensional "unit vectors" are the differential laws of transport physics across a fundamental set of biobarriers as they present themselves and evolve in tumorogenesis, that is, the transport oncophysics. In recognition that physical science-based tools are required for the probing and understanding of transport oncophysics, an additional fundamental scientific premise of this PS-OC is that the same physical science-based tools offer excellent opportunities for selective transport and penetration into cancer lesions. These can be exploited for novel and clinically advantageous diagnostic and therapeutic approaches. To capitalize on this idea, the Methodist PS-OC's second goal is to demonstrate the therapeutic efficacy of the novel systems and approaches developed within the PS-OC, which include multi-stage systems, nanoshuttles, carbon nanotubes, gold colloids, and oral administration carriers, in appropriate animal models.

Physical Sciences Perspective. To verify or disprove this transport oncophysics approach, a trans-disciplinary collaboration is compulsory for the necessary integration of cancer biology, biophysics, biomathematics, imaging, clinical and experimental therapeutics, biomaterials, and nanotechnology. These efforts require several concurrent, novel investigational modalities and tools that are based on mathematics and the physical sciences: A multiscale mathematical theory of mass and momentum transport through the body; multiscale imaging that enables the tracking of mass transport in living organisms, with integrated resolution from subcellular to full body levels; and multiscale probes, in conjunction with imaging techniques, to determine the transport properties at various levels, as functions of the characteristics of the transported object. The overarching goal for this new perspective of cancer is to reduce the complexity of apparently disparate biological hallmarks to the unifying notion that these hallmarks all reflect the deregulation of mass transport. In this framework, cancer is viewed as a disease of mass transport deregulation at multiple scales—bridging the molecular to the cellular, microenvironmental, organ, and organism levels. An intriguing view emerges of a family of diseases characterized by pathological disruptions of mass transport, in hierarchically nested systems.

Key Center Accomplishments

1. Directed transport physics and multi-scale therapy of liver metastases. Significant advancements have been made in designing drug delivery vectors that multiply the probability of target recognition for the imaging and therapy of liver metastasis. Studying the localization of Kuppfer cells in the proximity of metastatic lesions in the liver has shown that these phagocytic cells can be targeted by the multistage delivery carrier and that ligands can enhance targeting efficiency. Transport phenomena were found to be significantly different in the proximity of liver metastasis

as compared to primary tumors. Because transport phenomena in different tissues are distinct, the rational design of carriers is important to overcome biobarriers. Initial therapy experiments show that experimental liver metastases can be treated when transport differentials are accounted for.

2. Targeted nanoparticles for RF-induced thermal cancer treatment. The Methodist PS-OC has made significant improvements in differentiating between cancerous and normal tissue parameters in terms of tissue hyperthermia and delivering nanoparticles for treating hepatocellular carcinoma or pancreatic adenocarcinoma. For improved cancer imaging, targeted gold nanoparticles (AuNPs) were used as a CT contrast agent, and gadolinium fullerenes or gadolinium super short nanotubes were used as MRI contrast agents. In animal models, these contrast agents are far superior for detecting small areas of tumor, compared to current commercially available and clinical contrast agents. Physical characteristics of nanoparticles are being optimized to deliver them from the tumor neovasculature to the cancer cells. It was also found that adding very low doses of cytotoxic chemotherapy enhances the RF-induced hyperthermic cytotoxicity without causing any systemic side effects in the animals.

3. Study of the biophysical mechanisms regulating the efficacy of orally administered anti-cancer therapeutics from engineered nanocarriers. The overall goal of this project was to study the physics of the transport of chemotherapeutic agents from engineered polymeric carriers within the gastrointestinal (GI) tract and across the GI epithelium in vitro using conditions designed to mimic the in vivo environment. The research focused on the design and optimization of novel, pH-responsive hydrogel materials with loading of hydrophobic drug molecules, protein-based chemotherapeutics, and gold nanoparticles. Successful synthesis of these pH-responsive complexation hydrogels demonstrated the ability to load and release cancer drugs, including doxorubicin and interferon-alpha. Cytotoxicity studies demonstrated that these synthesized particles have a significant effect on cell proliferation. In addition, in vitro transport using a GI tract model comprised of human Caco2 epithelial colorectal adenocarcinoma cells and the mucus secreting human adenocarcinoma HT29-MTX goblet cells showed that the synthesized nanoparticles effectively increased the bioavailability of interferon alpha. A diffusion/facilitated transport/endocytosis mathematical model was developed and solved for a range of boundary conditions, drug diffusion coefficients, and superficial velocities.

4. Recognizing the inherent scientific needs of the Center and the initiative to evolve the program to address these needs. To expand the Methodist PS-OC's understanding of transport, cancer geneticists Neal Copeland and Nancy Jenkins were recruited to join the PS-OC to test the overarching hypothesis that the heterogeneity in transport barriers of pancreatic cancer is a direct result of the multitude of genetic aberrations seen in the disease. Drs. Copeland and Jenkins have extensive expertise in conducting and analyzing insertional mutagenesis screens using Sleeping Beauty (SB) transposon model to produce human cancers in the mouse. They have developed a model of pancreatic cancer using SB in conjunction with oncogenic Kras and characterized these tumors both histopathologically and through bioinformatic analysis of commonly mutated sites in the genome. Their anticipated contributions will provide tumor material and mutation data for the characterization of the transport phenotype in both the SB model of pancreatic cancer and orthotopic transplantation studies. This new project, "Genomic Correlates of Mass Transport Differentials," will also use the quantitative analysis of the transport phenotype to rationally design nanotherapies capable of delivering siRNAs or small molecules that target specific genes in order to enhance transport. The design of new therapies will rely on predictive mathematical models that incorporate measurements of the transport phenotype. It is anticipated that efficient delivery of rationally designed particles that are loaded with siRNA or small molecules targeting transport-related pathways will result in a more favorable tumor transport phenotype, enhancing our ability to treat pancreatic cancer.

   In addition to evolving the Methodist PS-OC's overall program, it is also improving capabilities by developing a dual core initiative in which three-dimensional neovascular modeling is coupled with advanced intravital microscopy (IVM).

This study represents the first development of a mathematical computation based on a biophysical model of diffusion-limited mass growth through porous media, which quantitatively demonstrated that it is physically impossible to fully eradicate a solid tumor via systemic delivery of drugs. Thus, an integrated model for predicting the vascular transport and adhesion; variable vessel radius and blood flow; and extravasations of nanoparticles with different size, shape and surface properties are possible input parameters for this project. This multi-scale, three-dimensional model is the first ever to incorporate a detailed description or quantitative assessment of the transport of drug nanocarriers through tumor tissue coupled to a PKPD model of local tumor regrowth and drug response. These results are calibrated and validated in vivo by IVM data and are re-evaluated by the experimental team in terms of the nanoparticle design parameters in order to maximize their specificity and efficacy.

IVM is an operational microscopy core, developed for in vivo tracking of nanoparticles in various organs with optically active agents. Using video rate intravital fluorescence microscopy, accumulations and dynamics of nanoparticles in vasculature within the primary tumor models can be seen with improved spatial resolution and sub-surface imaging. This program has successfully simulated aggregation of cell species, active transport of drug concentrations in three-dimensional tissue and barriers, vessel density, and size of the viable and necrotic tissue regions.

5. Intravital optical imaging in awake mice using tools and techniques developed by the the Methodist PS-OC to measure glucose distribution and uptake in glioblastoma. In anticipation of performing animal studies, a team of Methodist PS-OC Young Investigators initiated two-dimensional and three-dimensional in vitro studies. The kinetics of 2-NBDG, a fluorescent deoxyglucose analog, were measured in real time using drug-sensitive and drug-resistant U87 glioblastoma cell clones. They found that 2-NBDG uptake was rapid, with paclitaxel-sensitive cells exhibiting the highest rate of 2-NBDG uptake. After treatment, paclitaxel-resistant cells showed a relative increase in 2-NBDG uptake, whereas paclitaxel-sensitive cells showed a relative decrease. The investigators are now beginning to repeat these studies using self-assembled levitating three-dimensional cultures. Preliminary data suggest 2-NBDG uptake is faster in three-dimensional cultures, and better recapitulates glucose kinetics in vitro. This model was introduced as an intermediate between cell culture and animal imaging to aid the development of three-dimensional glucose imaging and analysis techniques. One exciting finding is that U87 cell clones, when self-assembled in a 1:1:1 mixture, selectively partition into different regions of the three-dimensional cultures like MDA-MB-231 clones. The investigators are currently working to determine how and why this happens by comparing these two cell lines. In parallel with this work, they have been very active in optimizing in vivo imaging protocols, including the real-time imaging of 2-NBDG uptake, first-pass perfusion of vascular tracers, and cell-cycle analysis using DNA/RNA dyes.

6. Quantitatively measure tumor phenotypic parameters from intravital microscopy data, and employ mathematical modeling to simulate glucose distribution in tumors in vivo. In this project, the investigators performed a preliminary calibration of the mathematical model from intravital data. They simulated the effect of drug delivered via porous silicon particles to melanoma tumors, and varied the parameters to determine how much drug per particle and how many particles need to be released within the vasculature in order to achieve remission of the tumor. The tumor model predicts that tumor shrinkage begins to level off several days after treatment due to heterogeneities in tumor and vascular structures, limiting the drug transport. Assuming an average delivery of 15,700 particles/mm3 and loading of 0.5 mg doxorubicin per 1010 particles, one can realistically expect to deliver doxorubicin in the μM range (~1.35 μM) with a single administration of nanoparticles. Although this number is still lower than is experimentally estimated as the IC50 for melanoma cells (10–100 μM), further technology developments with silicon-based nanoparticles are expected to bridge this gap. These results suggest that simply delivering more nanoparticles or more drug per particle in a single injection may not necessarily be better.

New Trans-Disciplinary Research

The Methodist PS-OC is committed to expanding its program through trans-network outreach and education mechanisms in parallel with internal growth. One such example of a successful and ongoing collaborative accomplishment is the collaborative outreach pilot projects between Methodist PS-OC investigators and external investigators. The pilot projects program is intended to fund important new pilot/feasibility projects focused on biophysical and biological barriers concepts in cancer—that develop a new research direction, explore an innovative idea, or test an unconventional but potentially important new hypothesis. The fundamental strategy is to supplement our investigations of biobarriers in cancer and transport mechanisms pertaining to diagnosis, therapy, imaging, and modeling. Each qualified proposal is supported through the pilot project mechanism and integrated into the Methodist PS-OC projects and cores in the studies of mass transport deregulation. Projects are funded for one year up to $50,000 in direct costs, with the possibility of a second year renewal of support awarded upon demonstration of sufficient progress. This program fosters competitive emerging technology and ideas to become part of the forefront of the Methodist PS-OC.

The Methodist PS-OC Outreach and Dissemination Unit hosts trans-network training programs that enable principal investigators, faculty, post-doctoral fellows, trainees, and students within the PS-OC Network to attend the Center for Transport Oncophysics Annual Workshop, held by The Methodist Hospital Research Institute (TMHRI). The program invited several speakers from TMHRI, the Cornell PS-OC, and Weill Cornell Medical College to discuss the oncophysics of metastasis and angiogenesis. Over 120 people participated in the event that provided training in microfabricated models for testing candidate chemotherapies, conducted by Cornell PS-OC PI Michael Shuler, and training in understanding barriers to successful thermal therapies for cancer, conducted by Methodist PS-OC PI Steven Curley.

The Methodist PS-OC Outreach and Dissemination Unit continues to support the PS-OC's goals to disseminate and increase awareness of concepts, capabilities, and results of the PS-OC to the physical sciences and cancer research communities; and to provide a mechanism to bridge to and develop external collaborations. These aims are achieved by virtual seminars, workshops in transport oncophysics, virtual networking through interactive websites, and external pilot projects. Since the development of these training workshops, there has been a 140% increase in the outreach pilot project efforts.

One of the unique aspects of the PS-OC program is the availability of additional funding for young investigators associated with PS-OCs. One such example is the Trans-Network Project opportunity for Young Investigators that requires junior investigators from different PS-OCs to join forces to work on a relevant seed project. At the 2nd Annual PS-OC Investigators Meeting, Anne van de Ven from the Methodist PS-OC and Hermann Frieboes from the USC PS-OC were awarded a Trans-Network Project for their project titled, "Identification of tumor initiating cells (tics) using an integrated physics approach to characterize spatiotemporal heterogeneities in glucose uptake." Dr. van de Ven is one of the leaders of the Methodist PS-OC's IVM core whose specialty is imaging the biodistribution of nanovectors in small animal cancer models utilizing IVM. Dr. Frieboes is a computational mathematician who assists in the development of the in silico three-dimensional neovasculature tumor model that is supported by the USC PS-OC.

New Infrastructure Built to Support the PS-OC

The Methodist PS-OC has taken a dynamic approach scientifically to evolve the PS-OC, as discussed above. In 2011, it became apparent that the PS-OC needed a centralized core for animal models, and this core was initiated in 2011 to provide services for establishment of orthotopic animal tumor models. The animal protocols necessary for the projects and cores were transferred and approved by The Institutional Animal Care and Use Committee (IACUC). The animal vivarium in the Methodist PS-OC has been in service since June 2011. During the first stages of operation, the core has supported the establishment of the cancer models. The established liver metastasis mouse models not only had colon cancer (KM12SM, human colon cancer;

CT26, murine colon cancer) but also lung cancer (3LL, murine lung cancer; PC14, human lung cancer), breast cancer (4T1, murine breast cancer), pancreatic cancer (L3.6pl human pancreatic cancer), and melanoma (K1735 and B16, murine melanoma). Ongoing discussion has Methodist PS-OC investigators wanting to refine orthotopic pancreatic cancer models in terms of producing more stroma reaction to tumor cells for reconstitution of clinical pathology into mouse models. The animal models core also provides liver metastasis models and histological and immunohistological analysis of the tumor sections, as well as various types of primary pancreatic tumor models in collaboration. The animal models core has also provided Methodist PS-OC investigators with in vivo models for live imaging of the structure and function of tumors in small animals. IVM has provided real-time nanoparticle dynamics in normal and diseased vasculature, time-lapse imaging of metastatic cell engraftment and proliferation, longitudinal studies of multi-stage particle partitioning into different organs, and characterization of disease response to locally activated therapies.

In addition to the creation of this new core facility, the Methodist PS-OC is expanding its IVM capabilities by purchasing a multiphoton laser that allows deeper light penetration and increased sensitivity for imaging heterogeneity throughout tumors. The IVM core is also working on a multi-function collaboration with in the Methodist PS-OC to develop and integrate a portable radio frequency-ablation system for real-time intravital monitoring and optimization of tissue heating. Because of the synergistic ties among the projects and cores, it is imperative to continuously seek methods to improve the systems for use.

The Methodist PS-OC recognizes the uncommonly broad multi-disciplinary nature of the research activities of the center. The projects and cores feature and require advanced expertise in physics, mathematics, multiple branches of engineering, and imaging science, as well as fundamental cancer biology, biochemistry, pathophysiology, and clinical insight. On these grounds, the Methodist PS-OC provides training opportunities along the multi-disciplinary modes of development of education, communication, and network outreach in its operations. The Methodist PS-OC Educational and Training Unit implements initiatives to provide training to develop multidisciplinary trainees who can tackle cancer-related problems through physical sciences and engineering approaches, and to provide the mechanism for and manage the exchange between graduate and postdoctoral trainees and junior and senior investigators as needed among participating PS-OCs. These aims are achieved by organizing a journal club; developing an integrated virtual course in transport oncophysics; providing travel awards for trainees to attend conferences, boot camps, and workshops hosted by other PS-OCs; establishing graduate and postdoctoral fellowships; and providing funding and logistic support to facilitate trainee exchange within PS-OCs, junior faculty sabbatical visits, and senior faculty visits/seminars. Through the Education and Training Unit, the Methodist PS-OC is confident in its infrastructure for trainees to supplement the program projects and cores and to expand new project collaborations within the PS-OC Network.

Interactions with the PS-OC Network

On January 10-11, 2012, the Methodist PS-OC and Cornell PS-OC co-hosted an event titled "Translational Oncophysics Workshop" in Houston, Texas. The purpose of the workshop was to provide a venue to seed new trans-network collaborations that leveraged the technology strengths and clinical expertise of the Centers. The Workshop featured three primary topic areas: (1) Nanomedicine to Cancer Clinic: Instruments, Therapy, Diagnosis, and Models, (2) Inflammation and Immunology in Cancer, and 3) System Biology and Mathematical Modeling of Cancer. The Cornell PS-OC manufactures nano- and microfluidic devices to devise and assemble a three-dimensional tumor model to investigate cancer progression. This design imparts spatial and temporal resolution far greater than that obtained by conventional two-dimensional tissue culture models. Moreover, this platform facilitates the monitoring of non-linear responses to a combination of physical, chemical, genetic, and epigenetic stimuli. The overarching goals of the Cornell PS-OC resonate well with those of the Methodist PS-OC, thereby creating an ideal strategic partnership.

Future Plans

- Continue cutting-edge research on the effort of transport differentials on development and efficient therapy of primary and metastatic tumor lesions.
- Support and develop the advancement of the newly re-structured PS-OC project on genomic correlates of mass transport differentials.
- Continue the Nanotechnological Tools Workshop Series, which will incorporate training tools for trainees to learn techniques that will not only advance their knowledge in technical skills but will also bridge the gap of learning to transport materials using the physical sciences.

University of California, Berkeley

Principal Investigator: Jan Liphardt, Ph.D.
Senior Scientific Investigator: Valerie M. Weaver, M.D.

Summary

Cell mechanics play a fundamental role in regulating cell fate, organ development, and tissue homeostasis. For example, matrix compliance regulates stem cell differentiation and modulates VEGF signaling. Perhaps cell mechanics and tissue architecture also influence tumor progression and transition to an invasive phenotype. The University of California, Berkeley, (UCB) PS-OC is investigating this possibility with a complementary set of precision measurement tools, theoretical approaches, model systems, and clinical samples. This PS-OC's long-term objective is to interrelate oncogenes, cell and tissue mechanics, and tumor dynamics. UCB PS-OC investigators believe that the quantitative integration of traditionally somewhat separate views of cancer – oncogenes, mechanics, and tumor dynamics – will significantly increase the field's understanding of how this disease progresses, thereby improving detection, risk stratification, and treatment.

Physical Sciences Perspective: Tissues are complex, adaptive, highly coupled systems with relevant dynamics on timescales of nanometers to millimeters. The physical sciences have been grappling with equivalent systems for at least 7 decades. Highly coupled systems cannot be readily broken down, experimentally or theoretically, into smaller pieces. It is possible that specialized experimental approaches and theoretical tools from the physical sciences can assist the cancer biology community in its efforts to follow the temporal and spatial development of tumors across time and length scales, and ultimately, predict how tumors will respond to internal and external changes, such as random mutations and drugs.

A physical sciences perspective is important because contemporary cancer research has at least 20 distinct subfields, including environmental risk factors, immunology, metabolism, epigenetics, the micro-environment, stem cells, aging, and evolutionary dynamics. There is evidence that all these aspects of cancer influence overall disease progression and treatment outcome. To develop fundamentally new interventions, personalize treatment in a cost-effective manner, improve risk stratification, and reduce cancer incidence, it will be important to quantitatively integrate data from these 20 or more fields. This task sounds impossible at first, but it is scientifically and clinically necessary, and moreover, recent developments in soft condensed matter physics, applied mathematics, and supercomputers are beginning to make it tractable. Suitable theoretical and computational frameworks will help the cancer research and oncology fields synthesize their discoveries into an integrated, unified view of the problem.

Mechanical and micro-anatomical signals differ fundamentally from chemical cues. Mechanical and micro-anatomical signals cannot be extracted from tissues and then analyzed. Instead, they must be measured in place, inside living tissues. Moreover, unlike most chemical cues, the generation and propagation of mechanical signals in a cell or a tissue constitute a nonlinear process wherein many spatial and temporal scales are all equally important; the problem thus cannot be readily broken down into tractable smaller pieces, such as by cell type, length scale, or time scale. Progress therefore requires the integration of capabilities in polymer physics, supercomputer algorithms, the tumor microenvironment, membrane biophysics, advanced optical imaging, high-throughput sequencing, and mouse models. In addition, discoveries must be related to actual disease in actual patients, further requiring capabilities in the clinic, which then must inform and guide Center activities.

Key Center Accomplishments

1. Discovery of new potentially drug-able Ras interface. Ras is the most frequently mutated gene in human cancer, but is difficult to drug. Using measurement technologies from the physical sciences, investigators from the McCormick, Gray, and Chu laboratories have discovered that Ras dimerization at the membrane is needed for Ras signaling. Ras dimerization involves previously undetected, non-canonical interface. Screening for small molecules that bind this interface has commenced at the California Institute for Quantitative Biology (QB3) screening facility.

2. Basis of the "field" effect: Long-range mechanical cooperation drives transition to invasive phenotype. Inappropriately stiffened extracellular matrix environments promote the disorganization of multicelluar structures and drive tumor progression in vivo. The Weaver and Liphardt labs have collaborated to show, in three-dimensional cell cultures, that certain mammary acini—the basic organizational units of the mammary gland and the structures where most breast cancers start—are able to coordinate their disorganization towards a malignant phenotype through long-range mechanical interactions. Ras-transformed acini directionally interacted via collagen cables that formed between them due to acinar contractility and the nonlinearity of collagen mechanics. Disorganization of mechanically interacting acini was more probable, rapid, and extensive than that of isolated acini. Therefore, groups of oncogenically transformed mammary acini can work together and help one another to become invasive, at least in our three-dimensional model system.

3. Computation of cell-tissue mechanics from first principles. Investigators at the UCB PS-OC are building computational models to understand the mechanics of cell and cell/tissue interaction. They have made unexpectedly rapid progress in developing a single, unified framework for calculating certain mechanical properties of acini in the MCF10 tumor progression series, the motion of acini on a liquid-collagen interface, the proliferation of malignant cells through basement membranes, and the shearing of tumor clusters in three-dimensions as they are transported through the vasculature. These investigators are basing their unified framework for calculating cell and tissue dynamics on the underlying physical laws, such as the laws of elasticity and fluid dynamics. Therefore, they are not modeling any one aspect of cancer in the traditional sense, but we are constructing a physics-based framework for cell and tissue dynamics that can be gracefully extended to include many apparently diverse types of cancer-relevant data, Including cell shape, tissue architecture, gene expression, and ECM microanatomy.

4. Pilot project: Direct testing of center predictions concerning tumor mechanics in the clinic. Many breast cancers form a palpable mass but some do not. These nonpalpable cancers are referred to as clinically "silent" and are typically detected only at an advanced clinical stage. Silent breast cancers are especially prevalent in African American women. Using the PS-OC pilot project mechanism, UCB PS-OC investigators are now directly testing specific predictions generated by their basic research in the clinic. They are asking whether certain biophysical properties of a patient's interstitial collagen are risk factors for developing silent breast cancers. In an established cohort of high-risk African American women, this group is testing the hypothesis that the relative strengths of mammary cell versus matrix mechanics distinguish palpable from nonpalpable breast cancers and represent a target for early detection.

5. First significant change in how math is taught to biology majors at UCB in many decades. In the traditional math class required of all biologists at UCB, there are no examples of how mathematics is currently being used in biochemistry, genetics, physiology, bioinformatics, or medicine. The new UCB PS-OC supported Math 91ab class—Math for Biologists: Statistics & Discrete Math—is cancer-themed and integrates statistics, discrete math, and computation with an innovative, inverted approach to calculus. The class is currently on track to become a requirement for all biology majors at UCB in the next five years.

New Trans-Disciplinary Research

Accomplishment 1 required a cancer biologist to work with a physicist specializing in super-resolution imaging, Dr. Chu. Accomplishment 2 required a cancer biologist to work with a soft condensed matter physicist and an applied mathematician. Accomplishment 3 required an applied mathematician to work with two cancer biologists and a physicist. Accomplishment 4 required a clinician to work with a physicist and a cancer biologist. Accomplishment 5 required a discrete mathematician to work with multiple cancer biologists.

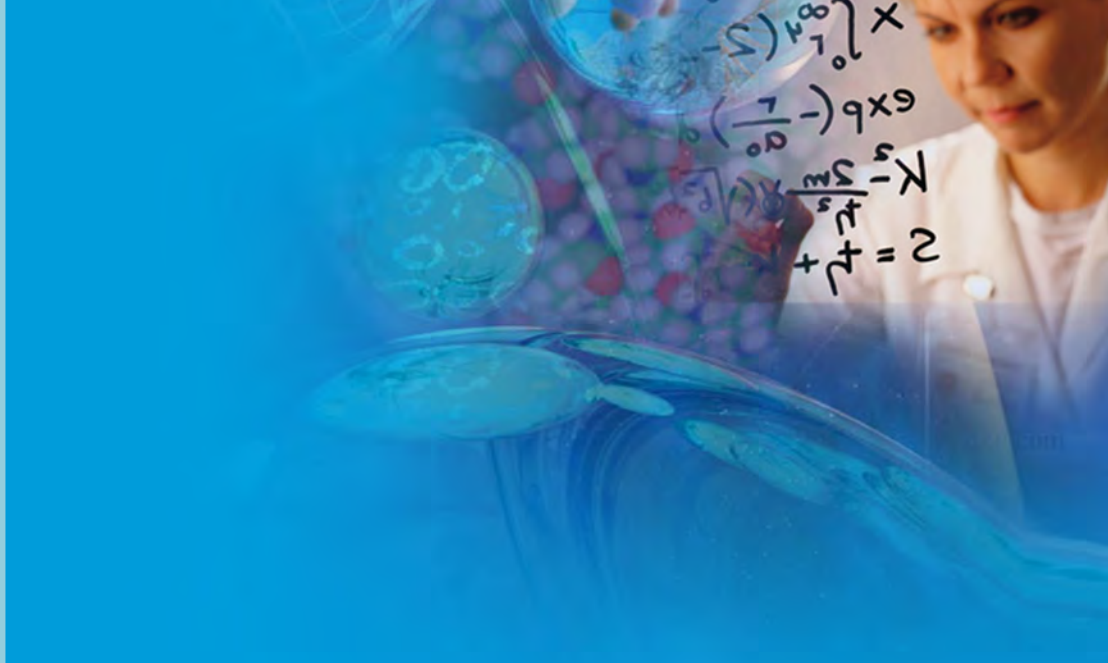
When the UCB PS-OC started in 2009, its members did not fully appreciate the role of evolution in disease progression and its treatment, especially the clinically highly relevant development of resistance to chemotherapy. The PS-OC Network brought them into frequent contact with specialists in evolutionary biology and clinical oncology, and then provided a mechanism to turn initial discussions into funded research projects, such as its trans-network project with Franziska Michor at the Dana Farber Cancer Center PS-OC.

New Infrastructure Built for PS-OC

As described above, the Math 91a class is designed to help an entire cohort of future cancer biologists and clinicians become familiar with contemporary mathematical tools and concepts, which they can then carry with them as they move into their research and clinical careers.

Future Plans

- Begin targeted effort in designing approaches for targeting and normalizing abnormal ECM mechanics and microanatomy.
- Reduce number of parallel theoretical efforts from three to one. Also, extend theoretical effort by explicit consideration of (limited) genes and regulatory logic.
- Emphasize rapid and direct investigation of "basic" results from in vitro and single-cell studies to three-dimensional culture, mice, and clinical samples.



5. Pilot Projects

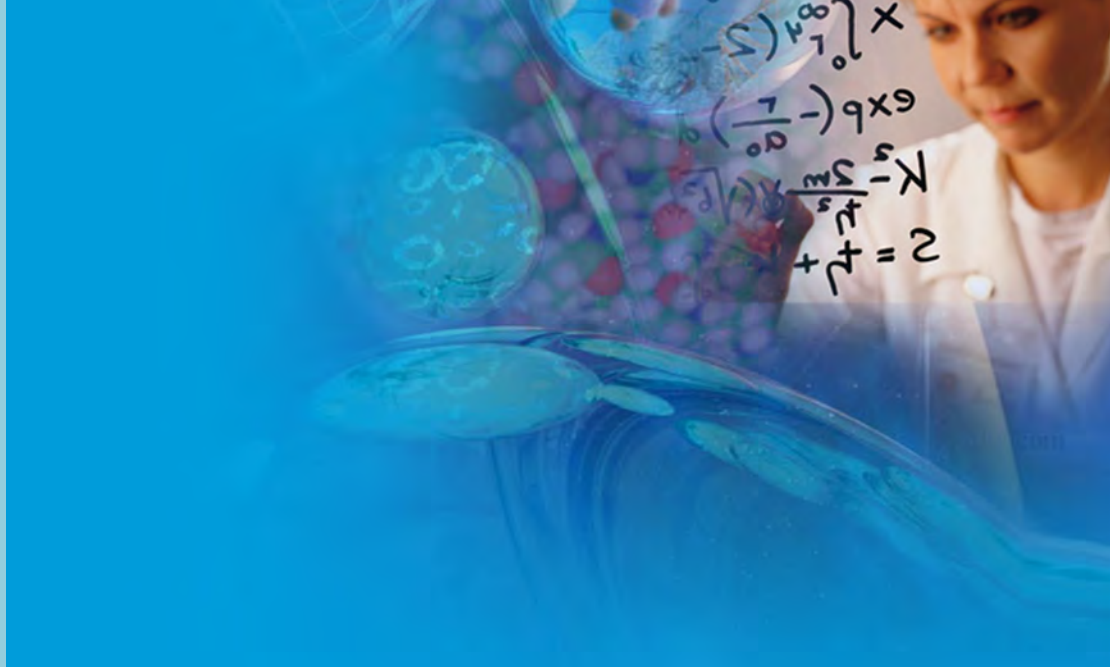
5. Pilot Projects

PS-OC Name	Title	Direct Cost ($)	Investigator(s)
ASU	Differences in Metabolic and Physical Properties Between Tamoxifen Sensitive and Resistant Breast Cancer Cells	90,208	Meldrum, Ros, LaBaer, Staunton, Kelbauskas, Johnson, Gonzales, Banyai
Cornell	3D Mechanically-Heterogeneous Scaffolds for the Study of Metastatic Cell Migratory Response to Matrix Stiffness	95,640	Bonassar, Reinhart-King
Cornell	Impact of the cellular microenvironment on genomic integrity	91,862	Weiss, Fischbach-TeschlInfanger, Li
Cornell	Is a tissue invasive phenotype conferred on malignant breast cancer cells after adherence to lung microvascular endothelial cells?	46,496	Seandel, Stokol, Shuler
Cornell	Molecular characterization of circulating tumor cells captured by use of geometrically enhanced differential immunocapture	92,490	Kirby, Giannakakou, Hicks
DFCI	Elucidating the Evolution of Metastasis in Lung Adenocarcinoma	50,000	Beroukhim, Michor, Getz, Hahn, Mermel
DFCI	Examining the role of reactive oxygen species (ROS) induction in the development of second-site resistance mutation in EGFR mutant lung cancer	25,000	Pao, Michor
DFCI	Investigating the origins of genomic instability in cancer	25,000	Michor
DFCI	Mathematical and Experimental Analysis of Mutational Acquisition in AML	50,000	Levine, Michor
DFCI	Mathematical and Experimental Analysis of Mutational Acquisition in GBM	25,000	Mellinghoff, Michor
DFCI	Maximum Entropy Estimation of Molecular and Genetic Diversity	47,534	Gonen
DFCI	Prognostic Relevance of Integrated Genetic Profiling in Acute Myeloid Leukemia	69,992	Gonen, Levine
JHU	Development of a Stress-Delivery Platform to Probe Cellular Mechanosensing	25,000	Gagnon, Robinson
JHU	Diffusional and Mechanical Properties of Tissue Surrounding Pancreatic Tumors for New Screening and Drug Delivery Approaches	25,000	Katz, McGuiggan, Wolfgang
JHU	Elucidation of the Roles of Giant Obscurins in Breast Cancer Development and Progression	50,000	Kontrogianni-Konstantopoulos, Konstantopoulos
JHU	High-throughput separation of circulating tumor cells using microfluidics	25,000	Drazer, Konstantopoulos
JHU	Measuring Interstitial bulk flow kinetics as a potential method to elucidate glioma cell migration along white matter tracts	25,000	McVeigh, Li, Herzka, Grossman

PS-OC Name	Title	Direct Cost ($)	Investigator(s)
JHU	Microfluidics for Studies of Angiogenesis in Oxygen Gradients	25,000	Drazer, Gerecht
JHU	Microribonucleic Acids in the Physical Properties of Cancer Cells	25,000	Tseng, Konstantopoulos
JHU	Novel nano-based targeted proteostasis-inhibition strategy to control NSCLC progression and metastasis	25,000	Vij, Pomper
JHU	Role of dc electric fields in the motility of cancer cells	50,000	Searson, Wirtz
JHU	Understanding the cellular mechanical dynamics regulated by AIM1, a novel putative metastasis suppressor gene in prostate cancer	25,000	Yegnasubramanian, An
JHU	Unraveling the Roles of Obscure Obscurins In Cancer Development	25,000	Kontrogianni-Konstantopoulos, Konstantopoulos
MIT	Cell-Penetrating nanoparticles as a tool for in vivo cancer cell biological manipulation and therapy	57,500	Irvine, Stellacci
MIT	Examining DNA damage, signaling and repair on the single molecule level	57,000	Yaffe, Doyle
MIT	Quantitative detection of cancer gene fusions by single-molecule RNA FISH	56,900	van Oudenaarden, Chiarle
Moffitt	Ablative MR Thermotherapy in Gliomas	24,555	Martinez, Gillies
Moffitt	Forcing the way to metastasis: physical interactions between tumor cells and endothelial	50,000	Rejniak
Moffitt	Image analysis of heterogeneity in breast cancer and the physical microenvironment	50,000	Lloyd, Bui
Moffitt	In silico experimentation of novel microenvironment-targeting therapeutic interventions in gliomas	50,000	Swanson, Rockne, Massey, Hawkins-Daarud
Moffitt	Somatic Evolution within Breast Cancer Histology	50,000	Lloyd, Rejniak, Bui, Johnson
Moffitt	The role of the physical microenvironment in defining glioma stem cell tumorigenicity	50,000	Bassanta Gutierrez,Scott, Chinnaiyan
NU	A Quantitative Description of MicroRNA-Transcriptome Interactions	100,000	Carthew, Hilgenfeldt
NU	Argonaute-Mediated Epigenetic Regulation of Gene Expression in Stem Cells	100,000	Wang
NU	Combining Chip-Seq and Mass Spectrometry to Measure the Effects of Histone Methylation on Nucleosome Positioning and Aberrant Methyltransferases in Lymphoma	87,500	Kelleher, Licht
NU	Development of novel tools to detect and inhibit microRNAs	152,500	Peter
NU	Epigenetic Regulation of the stem cell state, and relation to EMT and invasiveness	87,500	LaBonne

PS-OC Name	Title	Direct Cost ($)	Investigator(s)
NU	Establishing RNA-Directed DNA Targeting in Eukaryotic Cells	100,000	Sontheimer
NU	Nucleosome Dynamics Determine Androgen Receptor Function	152,500	Yu
Princeton	A Single-Cell Genealogy Assay for Measuring Somatic Evolution	80,250	Maley, Pourmand
Princeton	Adhesive Heterogeneity as an Indicator of Metastatic State	97,250	Engler, Tlsty, Fuhrmann
Princeton	Advancing Metronomic Therapy	109,510	Tlsty, Liao, Kamen, Estevez-Salmeron
Princeton	Microfluidic Culture Models to Explore How Fluid Pressure Affects The Evolution Of Tumors	50,000	Nelson
Princeton	Rapid Evolution of Drug Resistance Across a Drug Gradient	72,866	Hwa, Austin
Princeton	The Role of Mechanical Stress in the Tumor Microenvironment on the Progression of Breast Cancer from Ductal Carcinoma In Situ to Invasive (Infiltrating) Ductal Carcinoma	89,048	Yu, Tlsty, Botvinivick
Scripps	Can HD-CTCs Predict Recurrence in Patients with Resectable Breast Cancer? Biologic Characterization of the Breast Cancer Tumor Microenvironment	46,417	Hwang
Scripps	Evaluation of RAD001 with Docetaxel and Bevacizumab in Patients with Metastatic Androgen Independent Prostate Cancer	455,007	Gross
Scripps	Geographic Genomics in Epithelial Cancers	22,140	Bethel
Scripps	HD-CTCs as an Adjunct to Clinical Staging and Monitoring Therapy Response in Patients with or at Risk for HCC	45,507	Dago, Bethel, Schaffer
TMHRI	A novel strategy to avoid Reticulo-Endothelial System uptake of targeted multi-stage nanovectors enhancing their accumulation into the stroma of primary pancreatic cancer	55,000	Godin Vilentchouk, Yokoi
TMHRI	In vivo imaging of nanoparticle dynamics in colorectal tumor and Monitoring effect of VEGF inhibition on nanoparticles transport	55,000	Yun
TMHRI	Induction of cancer cells apoptosis using mechanical oscillation of targeted non-spherical magnetic constructs by locally induced magnetic field	55,000	Godin Vilentchouk
TMHRI	Optimization of gold nanoparticle delivery to pancreatic tumors	55,000	Koshkina
UCB	Branched Nanocrystal Force Sensors as Luminescent Probes of Tumor Mechanics	63,910	Werb, Alivisatos

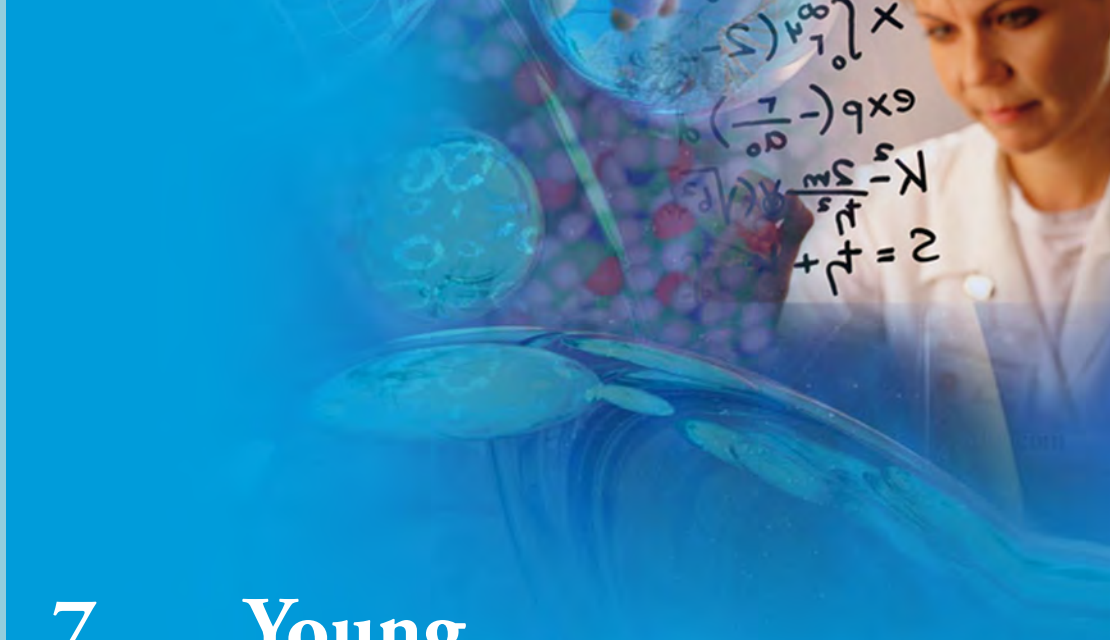
PS-OC Name	Title	Direct Cost ($)	Investigator(s)
UCB	Effects of Local Environment on the Ultralow-Field NMR Relaxation Time in Ex Vivo Healthy and Cancerous Prostrate Tissue	115,125	Clarke
UCB	Engineering a Model of the Bone Marrow (BM) Microenvironment to Identify Mediators of Breast Cancer Dormancy and Drug Resistance	112,893	Bissell, Lyden
UCB	Investigating clinically silent breast cancer in African American women	77,000	Seewaldt, Weaver
UCB	Precision 3D Mapping of the Cytoskeleton in Acini	84,574	Auer
UCB	Programming of Cyto-architecture by External Mechanical Environment in Normal and Malignant Cells	76,750	Marshall
UCB	Super-resolution Molecular Imaging of the Interplay Between Tension and EGF-R	79,956	Vu
UCB	The Mechanobiology of Circulating Breast Tumor Cells	66,435	Park
USC	Biomechanical Investigation of Response to Therapy	50,000	Povinelli
USC	Characterizing disease site specificity of regulatory proteins in cancer. YR1	39,749	McIntosh
USC	Game Theoretic Modeling of Cancer	59,773	Tambe, Maheswaran
USC	Machine Learning for Rapid, Accurate Quantification of Macrophage Interactions in Intravital Microscopy Data	10,000	Gambhir, Smith, Horowitz, Moussavi
USC	Magneto-Nanosenor Enhancement for Assessing Humoral Immune Function	94,878	Wang, LaBaer, Magee
USC	Microfluidic Image Cytometry (MIC) Technology for Parallel Monitoring of Upstream Signaling Profiles and Downstream Phenotypic Readouts in Cancer Tissues	10,000	Tseng
USC	Quantifying Tumor heterogeneity using dynamic PET	10,000	Li
USC	Simultaneous Mappings of Multiple Mutations in Tissue Slices by Microfluidic PCR Matrix	94,000	Kartalov
USC	Wave propagation effects on small objects with a varying density fields	10,000	Eliasson, Gross



6. Trans-Network Projects

6. Trans-Network Projects

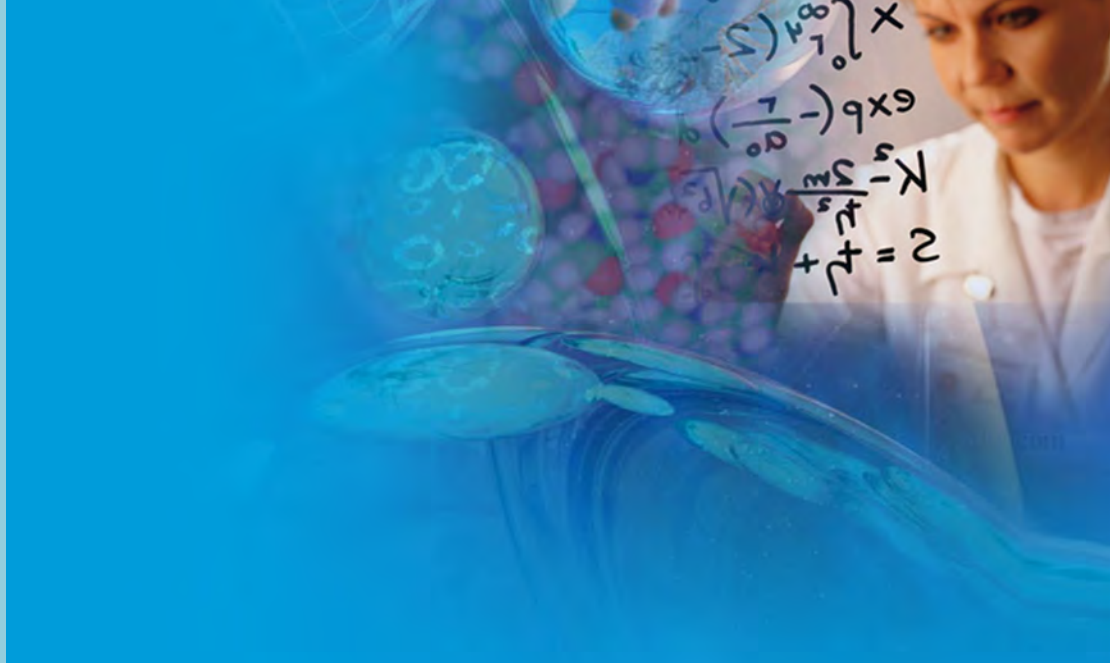
Project Title	Participant	PS-OC
Development of Models of Penetration of Resistance	Franziska Michor, Thea TIsty, Parag Mallick	DFCI, Princeton, USC
Genotypic Determinants of Metastatic Fitness - a Delicate Balance of Passenger and Driver Mutations	Leonid Mirny, David Morse	MIT, Moffitt
Analysis of heterogeneity in signaling networks during T cell leukemogenesis	Jeroen Roose, Garry Nolan, Franziska Michor	MIT, USC, DFCI
Emergence of therapy resistance in Multiple Myeloma: the roles of genomic and microenvironmental Heterogeneity	Robert Austin, Robert Gatenby	Princeton, Moffitt
Epigenetic Heterogeneity and Evolution in Leukemia	Jonathan Licht, Ari Melnick, Franziska Michor, Ross Levine	Northwestern, Cornell, DFCI
Heterogeneity of Cytoskeletal Architecture as an Indicator of Treatment Response	Mitchell Gross, Peter Kuhn, Brian Kirby, Kasia Rejniak	USC, Scripps, Cornell, Moffitt
In Vivo Analysis of Cell Cycle Progression Heterogeneity during Intestinal Tumorigenesis	Alexander van Oudenaarden, Andy Yun	MIT, TMHRI
3D Chromatin Organization in Curable and Incurable Human Cancers	Robert Getzenberg, Donald Coffey, Deirdre Meldrum, Roger Johnson, Jan Liphardt	Princeton, ASU, UCB
Role of Cellular Microrheology in the Metastatic Adhesion of Circulating Tumor Cells	Bryan Smith, Michael King, Timothy Newman, Denis Wirtz	USC, Cornell, ASU, JHU, TMHRI
"Big Question" Chromatin structure, chromosome stability, and gene expression	Franziska Michor, Jonathan Licht, Ari Melnick, Ross Levine, Alexander van Oudenaarden, Leonid Mirny, Scott Manalis, Jan Liphardt, Val Weaver, Parag Mallick, Matteo Pelligrini	DFCI, Northwestern, Cornell, MIT, UCB, USC
"Big Question" What makes a microenvironment permissible for tumor growth?	Mike Shuler , Jan Liphart , Claudia Fischbach , Cynthia Reinhart-King , Mike King , Val Weaver , Robert Gillies , Owen McCarty , Paolo Decuzzi , Eric Holland	Cornell, UCB, Moffitt, Scripps, TMHRI, DFCI
"Big Question" Pilot - Why do Cancers Make a Phase Transition?	Robert Austin, Jim Health, Robert Gatenby	Princeton, Moffitt
"Big Question" Pilot - Sleeping Uglies – Properties mediating tumor dormancy and regrowth	Thea TIsty, Timothy Newman, Paul Davies	Princeton, ASU
TIME AWARD - Differential Role of Oxygen Tension on Cellular Networks in 2-D and 3-D	Claudia Fischbach-Teschl, Parak Mallick	Cornell, USC
TIME AWARD - Characterization of procoagulant leukemic cells	Owen McCarty, Ross Levine	Scripps, DFCI
TIME AWARD - Vorinostat-induced chromatin remodeling modulates genes implicated in tamoxifen resistance	Deirdre Meldrum, Josh LaBaer	ASU, USC



7. Young Investigator Trans-Network

7. Young Investigator Trans-Network

Project Title	Participant	PS-OC	Project Site Dollars	Year
Probing Transcriptional Response as a Function of Spatial Organization of Signaling Complexes Across Length Scales	Pradeep Nair, Matt Paszek, Amneet Gulati	UCB, UCB, MIT	10,604	
Identification and characterization of circulating tumor cells by partial wave spectroscopy	Kevin Phillips	Scripps, NU	12,563	
Tracking the Intracellular Mechanics of Cancer in Living Subjects using Nanorheology	Christopher Hale	JHU, USC	10,931	
Synergistic Effects of Hypoxia and Substrate Stiffness on Cancer Cell Force Generation and Hypoxia-Mediated Protein Expression	Casey Kraning	Cornell, JHU	10,813	
Using tumor genomic diversity as a prognostic marker for metastasis	Shalev Itzkovitz	MIT, DFCI	12,797	
Towards a predictive theory of driver mutations in cancer	Jasmine Foo	DFCI, MIT	12,797	
Identification of tumor-initiating cells using an integrated physics approach	Anne van de Ven	TMHRI, USC	22,980	
Nuclear architecture reflects functional links between cellulr metabolism and tension	Vivek Nandakumar	ASU, UCB	22,945	
Understanding the formation of circulating tumor cell clusters	Edward Cho	Scripps, DFCI	27,471	
Control of EGFR pathways via amplitude-modulated low-frequency electric-field modulation	Stuart James Corr, Veronica Estrella, Jessica Cunningham	TMHRI, Moffitt	TBD	
Identifying the impact of nuclear architecture in the regulation of metabolic pathways	Joo Sang Lee, Subhajyoti De, Behnam Nabet, Eliza C. Small	NU, DFCI	TBD	
The Role of the 3D Mechanical Environment in Regulating Angiogenesis	Brooke N. Mason, Mark C. Lloyd, Shawn P. Carey	Cornell, Moffitt	TBD	



8. PS-OC Cores

8. PS-OC Cores

PS-OC Name	Title	Project Leader(s)
ASU	The Cancer Forum	Davies
ASU	The Materials Core	Grady, Mikhael, Fleischer, Anderson
ASU	Computational Modeling	Newman
Cornell	Nano/Microfabrication	Craighead, Porri, Kerslick
Cornell	Epigenomic Analysis Core	Melnick, Craighead, Topolancik, Wallin, Tian, Cipriany, Benitez
DFCI	Single cell Phosphoprofiling	Altan-Bonnet
JHU	Imaging Core	McCaffery, Wirtz, Konstantopoulos, Gerecht, Searson, Sun
JHU	Microfabrication Core	Searson, Wirtz, Konstantopoulos, Pomper, Maitra
MIT	Cell Sorting and Physical Measurement	Manalis
MIT	The Single Cell Transcript Counting Core	van Oudenaarden, Clevers, Jacks, Jaenisch, Manalis, Roose
Moffitt	Computational/Mathematics Core	Anderson, Gatenby, Brown, Frieden, Silva
NU	The Bioinformatics Core	Wang, Jiang, Jiang
NU	Deep Sequencing Core	Kopp, Shipma, Jafari
Princeton	Microfluidic Facility Shared Resource and Imaging Center	Vyawahare, Austin, TIsty, Getzenberg, Sturm, Emerson
Princeton	Cell and Tissue Shared Resource	TIsty
Princeton	Nano-Analysis Shared Resource Core	Pourmand
Scripps	Collection and Distribution of CTCs and Tissue Biopsies	Bethel, Nieva, Bazhenova, Lin, Thistlethwaite, Perricone
Scripps	Clinical Sample Core	Bethel, Kuhn, Nieva, Kosty, Bazhenova, Perricone, Thistlethwaite
TMHRI	Advanced Intravital Microscopy	Richards-Kortum, Yun, Macklin, Van De Ven
TMHRI	Biosimulation Core	Cristini, Decuzzi, Hossain, Singh, Frieboes, Chuang, Wright, Young, Wu, Lowengrub
TMHRI	Orthotopic Tumor Models Core	Yokoi, Godin, Vilentchouk, Curley, Decuzzi, Cristini, Frieboes, Yun, Fidler
USC	Resource for the Coordination and Dissemination of BioModels and Samples	Gross, Lowe, Melthing
USC	Data and Computational Models	Kesselman

9. PS-OC Outreach Programs

9. PS-OC Outreach Programs

PS-OC Name	Date	Workshop Name	Attendance
ASU	2/2010	Mechanical Properties of Cancer Cells	22
ASU	6/2010	Cancer as a Dynamical System	17
ASU	8/2010	Cellular Differentiation and Response to Stress: Modeling Cancer Initiation and Progression	7
ASU	10/2010	Quantum Mechanics and Cancer Biology	19
ASU	1/2011	Investigating Chromatin	19
ASU	1/2011	Chromatin, Nuclear Structure and Cancer	NA
ASU	5/2011	Cancer Cell Motility and the Metastatic Cascade	22
ASU	11/2011	Cancer and Physical Changes to Mitochondria	20
ASU	2/2012	Evolution, Development, and Cancer	20
ASU	3/2012	Electrical Properties of Cancer Cells	20
ASU	3/2012	Mitochondria	20
Cornell	10/2009	10th Annual Nanobiotechnology Symposium	NA
Cornell	11/2009	Cell Culture Minicourse	3
Cornell	12/2009	Cell Culture Minicourse	2
Cornell	12/2009	Nanobiotechnology: The Cutting Edge of Healthcare, Materials, and Security	NA
Cornell	4/2010	pH Measurement Workshop	7
Cornell	4/2010	FT-IR Spectroscopy/TIRF Microscopy Seminar	19
Cornell	6/2010	Microfluidics Workshop	6
Cornell	7/2010	Cell Culture and Staining Workshop	3
Cornell	8/2010	Microfluidics Workshop	4
Cornell	8/2010	Cell Culture and Staining Workshop	5
Cornell	8/2010	Center Seminar Series	50
Cornell	9/2010	Microfluidics Workshop	4
Cornell	9/2010	Cell Culture and Staining Workshop	5
Cornell	9/2010	Microfluidics Workshop	6
Cornell	10/2010	Center Seminar Series	5
Cornell	11/2010	Annual Symposium	NA
Cornell	12/2010	Center Seminar Series	50

PS-OC Name	Date	Workshop Name	Attendance
Cornell	1/2011	Center Seminar Series (w/ Biophysics)	50
Cornell	2/2011	Cell Culture Minicourse	5
Cornell	2/2011	Center Seminar Series (w/ Biophysics)	50
Cornell	3/2011	Microfluidics Minicourse	3
Cornell	3/2011	Cell Culture Minicourse	3
Cornell	4/2011	Cell Culture Minicourse	3
Cornell	5/2011	Microfluidics Minicourse	4
Cornell	7/2011	Cell Culture Minicourse	5
Cornell	8/2011	Microfluidics Minicourse	3
Cornell	9/2011	Cell Culture Minicourse	3
Cornell	10/2011	Microfluidics Minicourse	5
Cornell	11/2011	Surface Modification Minicourse	4
Cornell	12/2011	Cell Culture Minicourse	3
Cornell	12/2011	Surface Modification Minicourse	4
Cornell	12/2011	Surface Modification Minicourse	5
Cornell	1/2012	Surface Modification Minicourse	5
Cornell	2/2012	Cell Culture Minicourse	5
Cornell	2/2012	Microfluidics Minicourse	5
Cornell	2/2012	Introduction to CMM Microfabrication Core Workshop	20
Cornell	3/2012	Cell Culture Minicourse	1
Cornell	3/2012	Surface Modification	4
Cornell	3/2012	Introduction to Microfluidics Workshop	4
Cornell	3/2012	Image Analysis Workshop	4
Cornell	4/2012	Surface Modification Minicourse	3
Cornell	4/2012	Microfluidics Minicourse	4
Cornell	4/2012	Introduction to CMM Microfabrication Core Workshop	6
Cornell	4/2012	Introduction to AFM Workshop	18
Cornell	5/2012	Microfluidics Minicourse	4
Cornell	6/2012	Microfluidics Minicourse	5
Cornell	8/2012	Surface Modification Minicourse	10

PS-OC Name	Date	Workshop Name	Attendance
Cornell	9/2012	Cell Culture Minicourse	5
Cornell	9/2012	Microfluidics Minicourse	10
DFCI	10/2009	MSKCC Community Outreach Board	25
DFCI	3/2010	Evolutionary Dynamics of Brain, Lung, and Hematopoietic Tumors	50
DFCI	7/2010	Summer High School Student Program	50
DFCI	11/2010	Nanobiotechnology and Cancer Symposium	110
DFCI	1/2011	Blum Family Resource Center – What Does Physics Have to Do With Cancer?	50
DFCI	5/2011	Outreach With Area High Schools	30
DFCI	8/2011	Museum of Science Podcast	NA
DFCI	10/2011	AACR Networking Luncheon	300
DFCI	1/2012	Blum Family Resource Center – What Does Physics Have to Do With Cancer?	50
DFCI	1/2012	Inside the Institute, DFCI	NA
DFCI	4/2012	Women in Science – Museum of Science	100
DFCI	4/2012	TEDMED 2012	2,000
DFCI	6/2012	DFCI's Paths of Progress	NA
DFCI	4/2013	Museum of Science – Women in Science	100
JHU	4/2010	Cell Mechanics	10
JHU	5/2010	Plenary	NA
JHU	6/2010	USC PS-OC Symposium	NA
JHU	10/2010	Biomaterials Day	80
JHU	3/2011	INBT Student Cancer Nanotechnology Symposium (Spring)	30+
JHU	5/2011	JHU PSOC Annual Symposium	300+
JHU	5/2011	JHU PSOC/CCNE Annual Symposium	300+
JHU	10/2011	INBT Student Cancer Nanotechnology Symposium (Fall)	50
JHU	10/2011	INBT Student Cancer Nanotechnology Symposium	30+
JHU	3/2012	Semiannual INBT Student Cancer Nanotechnology Symposium	40+
JHU	5/2012	JHU PSOC/CCNE Annual Symposium	200+
MIT	6/2010	Transcript Counting Workshop	5
Moffitt	6/2010	IMO/PSOC Seminar	NA

PS-OC Name	Date	Workshop Name	Attendance
Moffitt	10/2010	IMO/PSOC Seminar	NA
NU	10/2008	Physical Sciences & Oncology Mini-Symposium	89
NU	3/2009	The Role of Accurate Mass Proteomics in Chromatin/Cell Biology	56
NU	1/2010	PSOC Science Jam	65
NU	9/2010	Caltech Bioengineering Boot Camp	3-5
NU	6/2011	Physical Sciences Approaches to Cancer Research	125
NU	7/2011	Cancer Therapy: Victories and Defeats	140
NU	7/2011	Physical Sciences Approaches to Cancer Research	155
NU	9/2011	Bioengineering Bootcamp	25
NU	3/2012	Jon Widom Memorial Symposium	150
NU	4/2012	Physical Sciences Approaches to Cancer Research	150
NU	4/2012	Past, Present, and Future of Cancer Research	250
NU	7/2012	Biological and Clinical Aspects of Cancer Metastasis	75
NU	NA	Physical Sciences Workshop	20
NU	NA	Tumor Biology Workshop	25
NU	NA	Physical Sciences Workshop	25
NU	NA	Physical Sciences Approaches to Cancer Research	155
NU	NA	Woods Hole Physiology Course	3-5
Princeton	9/2009	The GASP/wt System in Bacteria as a Model for Interactions Between Normal, Premalignant, and Malignant Cells I	NA
Princeton	10/2009	Environmental Control in Microfabricated Microscope Timelapse Fluorescence Imaging Systems	NA
Princeton	10/2009	Mechanical Signaling	NA
Princeton	10/2009	The GASP/wt System in Bacteria as a Model for Interactions Between Normal, Premalignant, and Malignant Cells II	NA
Princeton	10/2009	The GASP/wt System in Bacteria as a Model for Interactions Between Normal, Premalignant, and Malignant Cells II	NA
Princeton	11/2009	Microfabricated and Valve Systems for Continuous Cell Culture and Trypsin-Free Passage	NA
Princeton	11/2009	p53, RNA Polymerase, and DNA: Transcription in Eukaryotes, I	NA
Princeton	12/2009	p53, RNA Polymerase, and DNA: Transcription in Eukaryotes, II	NA
Princeton	1/2010	Review of Experimental Data	NA

PS-OC Name	Date	Workshop Name	Attendance
Princeton	1/2010	Research Methods and Background	NA
Princeton	1/2010	Discussion of Prostate Cancer Origins	NA
Princeton	1/2010	TGF-Beta and DNA-Damage Responses in Mammalian Epithelial Cells, Part I	NA
Princeton	2/2010	TGF-Beta and DNA-Damage Responses in Mammalian Epithelial Cells, Part II	NA
Princeton	2/2010	The Death Galaxy Experiments: Bacterial Population Dynamics in a Microfabricated Hexagonal Patch Array With Antibiotic Stress Gradient	NA
Princeton	2/2010	Cancer/Testis Antigens and Prostate Cancer	NA
Princeton	4/2010	2nd Annual PS-OC Meeting	NA
Princeton	4/2010	Microfluidics Devices for Application of Taxol to Cancer Cell Cultures and Microfabrication of Sklyands for Studying Population-Size Effects	NA
Princeton	4/2010	Princeton Center for Theoretical Sciences Workshop on "Understanding Cancer via the Theoretical Sciences"	NA
Princeton	4/2010	Genomic Regions and Sequencing Techniques for Studying the Death Galaxy	NA
Princeton	4/2010	One-Day Princeton–JHU Workshop	NA
Princeton	4/2010	2nd Annual PS-OC Meeting	NA
Princeton	5/2010	Cancer Cells Reach Out and Touch Each Other	NA
Princeton	8/2010	Cellular Differentiation and Response to Stress: Modeling Cancer Initiation and Progression	NA
Princeton	8/2010	Cellular Differentiation and Response to Stress: Modeling Cancer Initiation and Progression	NA
Princeton	9/2010	PPSOC Pilot Project: Toward Genealogies of Neoplastic Cells	NA
Princeton	9/2010	PS-OC Pilot Project: On Growth, Drug Resistance, and Evolution	NA
Princeton	10/2010	15th International p53 Workshop	NA
Princeton	11/2010	Characterizing Spatial Statistics of Cancer Cells	NA
Princeton	1/2011	Chromatin and Cancer – Beyond the Genome	NA
Princeton	6/2011	Workshop on the Physics of Tumor Heterogeneity	61
Princeton	8/2011	Microfluidics Bootcamp	8
Princeton	9/2011	University of California, San Diego, Division of Biological Sciences Annual Retreat	200
Princeton	11/2011	Winter Bootcamp in Physics and Mathematics for Biological Scientists	NA
Princeton	12/2011	Salk Cancer Course	100

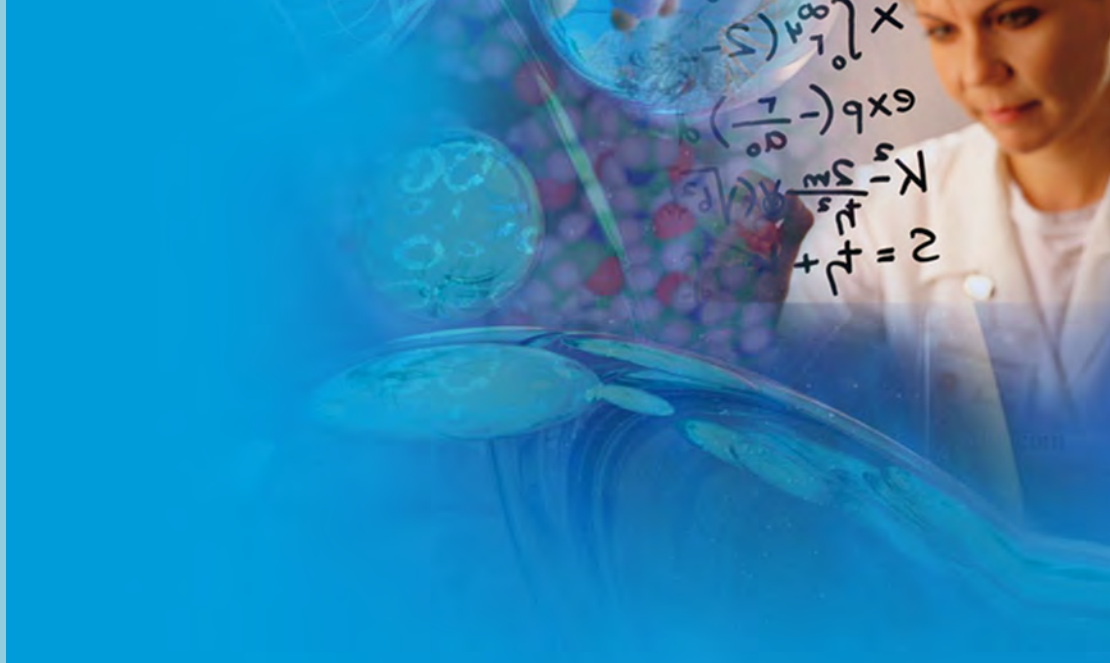
PS-OC Name	Date	Workshop Name	Attendance
Princeton	2/2012	APS Focus Session: Physics of Cancer I – Evolution and Resistance	NA
Princeton	3/2012	APS Focus Session: Physics of Cancer III – Imaging	NA
Princeton	3/2012	APS Spring Meeting	NA
Princeton	3/2012	I2CAM	NA
Princeton	7/2012	Clinical Implications and Applications of Evolution in Chemotherapy	50+
Princeton	NA	Pew Scholars Reunion in the Biomedical Sciences	NA
Princeton	NA	Physics of Cancer	NA
Princeton	NA	Transcription Factor TGFB1 Response to Stress	NA
Princeton	NA	Whole Genome Single Cell Sequencing	NA
Princeton	NA	Intrinsically Disordered Proteins	NA
Scripps	10/2009	4DB Kickoff Meeting	40+
Scripps	2/2010	Rare Event Detection	30
Scripps	2/2010	IME and Flow CTC Detection	30
Scripps	2/2010	Partial Wave Spectroscopy of Cancer Cells	30
Scripps	2/2010	Cyro Transmission X-ray Microscopy	30
Scripps	3/2010	AFM-Based Forced Spectroscopy	30
Scripps	3/2010	Twist in Tumor Metastasis	30
Scripps	3/2010	Ionizing Radiation and Variant Cell Outgrowth	30
Scripps	6/2010	Nakamura Lectureship	120
Scripps	8/2010	EMI Conference Keynote	100
Scripps	8/2010	AMLI Annual Meeting	500
Scripps	9/2010	AACR Molecular Diagnostics	500
Scripps	1/2011	SPIE Photonics West Meeting	200
Scripps	3/2011	American Chemical Society National Meeting	250
Scripps	3/2011	Keystone Symposia	400
Scripps	4/2011	PSOC Annual Meeting	200
Scripps	5/2011	Cancer Cell Motility and the Metastatic Cascade	20
Scripps	5/2011	Grand Rounds UCSD	25
Scripps	5/2011	Stochastic Multiscale Models	100
Scripps	6/2011	ASCO 2011 Annual Meeting	500

PS-OC Name	Date	Workshop Name	Attendance
Scripps	7/2011	Department of Medicine, University of Yamanashi	50
Scripps	7/2011	XXIII Congress of the International Society on Thrombosis and Haemostasis	500
Scripps	7/2011	XXIII ISTH Congress	500
Scripps	8/2011	IEEE Nanotech Conference	50
Scripps	10/2011	The 48th Annual Technical Meeting of Society of Engineering Sciences	200
Scripps	11/2011	Clinical Challenges in Rare Cell Analysis	30
Scripps	12/2011	Center for Applied Molecular Medicine, USC	50
Scripps	12/2011	2011 ASH Meeting	500
TMHRI	11/2009	In Vivo Endoscopic Microscopy	45
TMHRI	5/2010	Mathematical Engines of Nanomedicine (MEND)	50
TMHRI	5/2010	Gap Analysis in Nanomedicine	150
TMHRI	9/2010	CTO Annual Workshop	120
TMHRI	1/2011	CTO Annual Workshop	120
TMHRI	6/2011	Summer Intern Program	NA
TMHRI	8/2011	Nanotechnological Tools Workshop Series Journal Club	NA
TMHRI	11/2011	CTO Annual Workshop	120
TMHRI	1/2012	Translational Oncophysics Workshop	75
TMHRI	1/2012	Translational Oncophysics Workshop	50+
TMHRI	6/2012	Summer Intern Program	NA
TMHRI	10/2012	Biomedical Engineering Society (BMES)	NA
UCB	11/2009	All Hands Bay Area PS-OC meeting	40
UCB	1/2010	Joint meeting with Princeton PS-OC	35
UCB	1/2010	Physical Sciences Oncology Dinner Seminar Series	45
UCB	1/2010	2010 UCSF Breast Oncology Program Scientific Retreat	200
UCB	2/2010	Physical Sciences Oncology Dinner Seminar Series	40+
UCB	6/2010	Physical Sciences Oncology Dinner Seminar Series	NA
UCB	7/2010	Physical Sciences Oncology Dinner Seminar Series	NA
UCB	8/2010	Joint meetings with LBNL's Integrative Cancer Biology Program (ICBP)	NA
UCB	9/2010	Physical Sciences Oncology Dinner Seminar Series	NA
UCB	9/2010	Joint meetings with LBNL's Integrative Cancer Biology Program (ICBP)	NA

PS-OC Name	Date	Workshop Name	Attendance
UCB	9/2010	PS-OC Site Visit: Mini-Workshop for Advocates and Physical Scientists on Imaging and Histology	NA
UCB	10/2010	Joint meetings with LBNL's Integrative Cancer Biology Program (ICBP)	NA
UCB	11/2010	Physical Sciences Oncology Dinner Seminar Series	NA
UCB	12/2010	Physical Sciences Oncology Dinner Seminar Series	NA
UCB	12/2010	Joint meetings with LBNL's Integrative Cancer Biology Program (ICBP)	NA
UCB	1/2011	UCSF Breast Oncology Program Scientific Retreat	100
UCB	2/2011	ICBP-PSOC Joint Meeting	20
UCB	3/2011	ICBP-PSOC Joint Meeting	20
UCB	4/2011	ICBP-PSOC Joint Meeting	20
UCB	5/2011	New Frontiers in Basic Cancer Research: Tumor Mechanics	30
UCB	6/2011	ICBP-PSOC Joint Meeting	20
UCB	6/2011	Research Innovation & Translational Application	NA
UCB	7/2011	Fundamental Cancer Mechanobiology	NA
UCB	10/2011	ICBP-PSOC Joint Meeting	30
UCB	11/2011	Heterogeneity in the Tumor Microenvironment	NA
UCB	12/2011	Extrinsic and Intrinsic Force Regulation of Breast Cancer Progression and Treatment	NA
UCB	12/2011	Challenges and Success: Treatment of Metastatic Breast Cancer 2011	NA
UCB	1/2012	ICBP Joint Meeting	20
UCB	2/2012	ICBP-PSOC Joint Meeting	20
UCB	2/2012	ICBP-PSOC "Day of Science"	30
UCB	2/2012	AAAS Symposia	30
UCB	2/2012	ICBP Joint Meeting	40
UCB	2/2012	SPORE Breast Cancer Retreat	200
UCB	2/2012	Focus Session: Physics of Cancer, March APS Meeting	NA
UCB	3/2012	ICBP Joint Meeting	20
UCB	5/2012	ICBP Joint Meeting	20
UCB	5/2012	NA	NA
UCB	9/2012	ICBP-PSOC "Day of Science"	30
UCB	11/2012	PSOC Tissue Mechanics Workshop	60

PS-OC Name	Date	Workshop Name	Attendance
UCB	NA	PS-OC Summer Camp Beta Test	NA
UCB	NA	Physical Sciences Oncology Dinner Seminar Series	NA
UCB	NA	PS-OC Theory & Modeling Workshops	NA
UCB		Breast Oncology Program Annual Retreat	NA
USC	6/2009	Statistical Modeling and Machine Learning in Computational Systems Biology	NA
USC	9/2009	Embo Practical Course on Networks in Biology Analysis, Modeling, and Reverse Engineering	NA
USC	10/2009	USC/Norris Comprehensive Cancer Center: Genitourinary Program Retreat	20
USC	1/2010	Prostate Cancer (World Economic Forum)	40
USC	1/2010	Personalized Medicine (World Economic Forum)	400
USC	1/2010	What is Life (World Economic Forum)	400
USC	2/2010	Physical Biology of the Cell	60
USC	2/2010	Proteomics and Biomarkers – National Epilepsy Foundation	NA
USC	3/2010	Hormonal and Adjuvant Therapy in Prostrate Cancer	12
USC	4/2010	Pfizer Innovation Board	30
USC	4/2010	TEDx-USC "Ideas Empowered" Conference 2010! "Technology is changing the way we live, work, and play. What role will technology play in treating cancer and other diseases over the next decade?"	1,200
USC	4/2010	TEDx-USC	3,000
USC	5/2010	Healthspottr Innovation Salon	100
USC	5/2010	The Conner Bubble Radio Program	3,000
USC	6/2010	Saban Research Institute	NA
USC	7/2010	A Systems Approach to Cancer	NA
USC	8/2010	Molecular Cell Dynamics and Mechanics Physical Microenvironmental Regulations of Tumor and Stem Cell Biology in the Central Nervous System	NA
USC	8/2010	CCNE	NA
USC	9/2010	Nucleosome Positioning and Chromosome Structure from Archaebacteria to Man	NA
USC	9/2010	PIBBS	NA
USC	9/2010	Multiple Sclerosis	NA
USC	9/2010	Physics and Oncology: Oil and Water, or Peanut Butter and Jelly?	NA

PS-OC Name	Date	Workshop Name	Attendance
USC	10/2010	Evolutionary Game Theory and Treatment Resistance in Cancer	NA
USC	10/2010	President's Cancer Panel	NA
USC	11/2010	Modeling Active Processes in Cancer Progression and Embryogenesis	NA
USC	12/2010	Pfizer PEAC Annual "Having the Courage to Shape the Future"	800
USC	1/2011	Tumor Immunology/Immunotherapy Work Discussion Meeting	50
USC	1/2011	Technology Pioneers Welcome Reception at World Economic Forum (WEF) 2011	2,200
USC	1/2011	Personalized Medicine, WEF 2011	2,200
USC	1/2011	The Cancer Epidemic, WEF 2011	2,200
USC	1/2011	Digital Life Design Conference 2011	4,200
USC	2/2011	Renaissance Weekend	300
USC	3/2011	Cal-Tech Talk	50
USC	5/2011	Novartis LEAD Kick-Off Meeting	400
USC	7/2011	USC PSOC - Brainstorm Collaboration	20
USC	7/2011	CAMM Scientific Retreat	30
USC	8/2011	Nanotechnology in Medicine	100
USC	10/2011	2nd Annual Symposium	200
USC	10/2011	World Economic Forum, Summit on the Global Agenda: Genetics	3,000
USC	10/2011	TEDMED 2011	3,000
USC	12/2011	Physical Biology of Circulating Tumor Cells and Thrombosis	50
USC	1/2012	Cancer Cell Migration in 3D	50
USC	4/2012	Microfluidic In Vitro Models for Tumor Cell Dissemination	50
USC	6/2012	Computational Brainstorm Meeting	20
USC	6/2012	Brainstorming Meeting	25

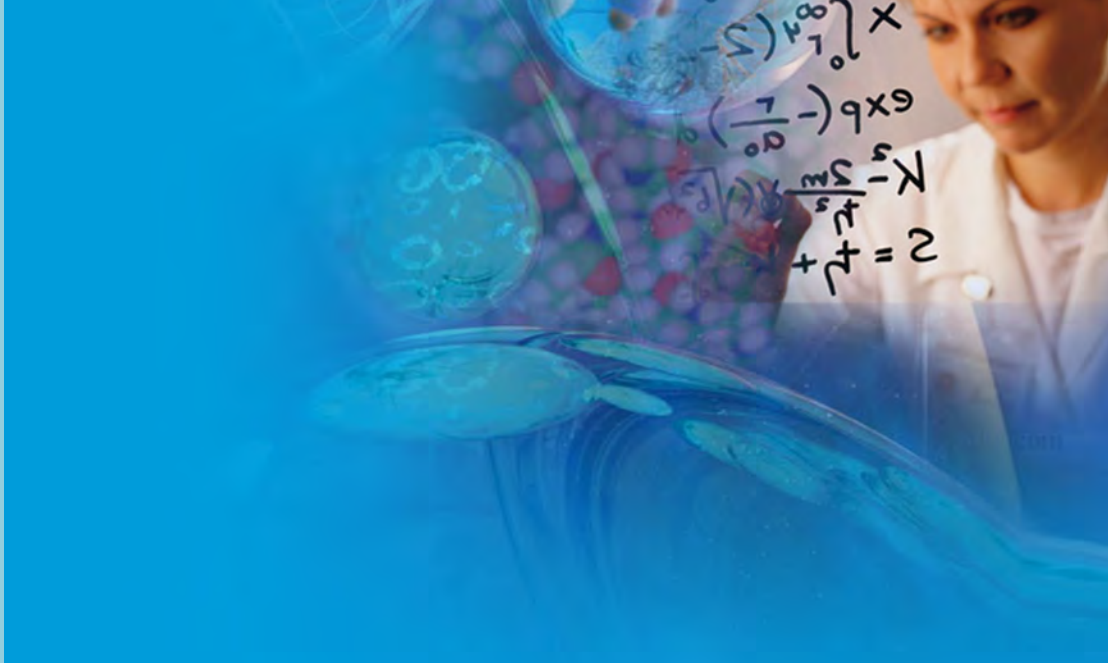


10. PS-OC Courses

10. PS-OC Courses

PS-OC Name	Course Number	Course Name
ASU	BDE 598	Engineering and Technology
ASU	BIO 298	Introduction to Biological Research
ASU	CONJ 539	Biological Basis of Neoplasia
ASU	CPCOM120	Physical Science and Cancer
ASU	HON 394	Physical Sciences and Cancer
ASU	PHY 542	Topics in Biophysics 1
ASU	PHY111	General Physics
Cornell	BME 4110	Science and Technology Approaches to Problems in Human Health (revised)
Cornell	BME 6670	Nanobiotechnology (revised)
Cornell	BME 7130	Core Concepts in Disease (new)
DFCI	NA	Circulating Tumor Cells and the Fluid Phase Biopsy of Solid Tumors
DFCI	NA	Evolutionary Systems Biology of Cancer
DFCI	NA	Mathematical Modeling of Cancer
JHU	500.609	Communication for Scientists and Engineers
JHU	500.616	Boot Camp
JHU	500.621	Nanobio Lab
JHU	500.695	Animation in Nanotech
JHU	670.627	Commercializing Emerging Technologies
Princeton	BIMM 112	Regulation of Gene Activity in Eucaryotices
Princeton	BME 140	Bioinstrumentation
Princeton	BME 215	Applied Gene Technologies
Princeton	BME 280B	Seminar in Bioinformatics
Princeton	BME281P	Seminar in Biotechnology
Princeton	BMS270	Cellular Stress Responses in Disease Processes: Stem and Somatic Cell Biology
Princeton	CHM 510/PHY 544	Random Walks in Physical Sciences
Princeton	MSE 302	Laboratory Techniques in Materials Science and Engineering
Princeton	PB 219	Modeling Biological Systems
Princeton	QCB 301	Experimental Project Laboratory in Quantitative and Computational Biology
Scripps	MGEN 606C	Blood Cell Biology Working Group
Scripps	NA	Pathology Boot Camp
TMHRI	GS210071100	Seminars in Nanomedicine
TMHRI	NA	Biomaterials: Concepts and Laboratory Practice I
TMHRI	NA	Nanomedicine Journal Club
UCB	24	Freshman Seminar: Physics of Tissue
UCB	111	Advanced Lab: Fluorescent Laser Tweezers for Manipulating Single Cells
UCB	180.04	Breast Cancer: From Basics to Beyond
UCB	180.3	Introduction to Breast Oncology
UCB	221	Tissue Mechanobiology
UCB	230	Biomedical Sciences : Tumor Matrix as Regulator of Instrinsic and Extrinsic Signaling

PS-OC Name	Course Number	Course Name
UCB	151/250	Applied Physics & Cancer
UCB	168L	Practical Light Microscopy
UCB	180.x	Special Topics in Quantitative Biology of Cancer
UCB	91a (will be renamed 10a)	(Tentative) Math Biologists: Calculus & Probability
UCB	91b (will be renamed 10b)	(Tentative) Math Biologists: Calculus & Probability
UCB	NA	Breast Cancer Biology
USC	#210055	Physical Biology of Macromolecules
USC	#G23.1127	Bioinformatics and Genomes
USC	#V22.04130	Programing With Large Datasets
USC	BCH 598	Biochemistry of Cancer
USC	BE 600	Modeling of Biological Phenomena
USC	BIOM 505	Introduction to Computational Biomedicine
USC	BIOM 505-004	Introduction to Computational Biomedicine (Physical Oncology Focus)
USC	EE225	Bio-chips, Imaging, and Nanomedicine
USC	NA	Functional Genomics
USC	NA	PhosphoFlow/Immune Monitoring 2012 Course
USC	NA	Quantitative Principles of Cell and Tissue Engineering

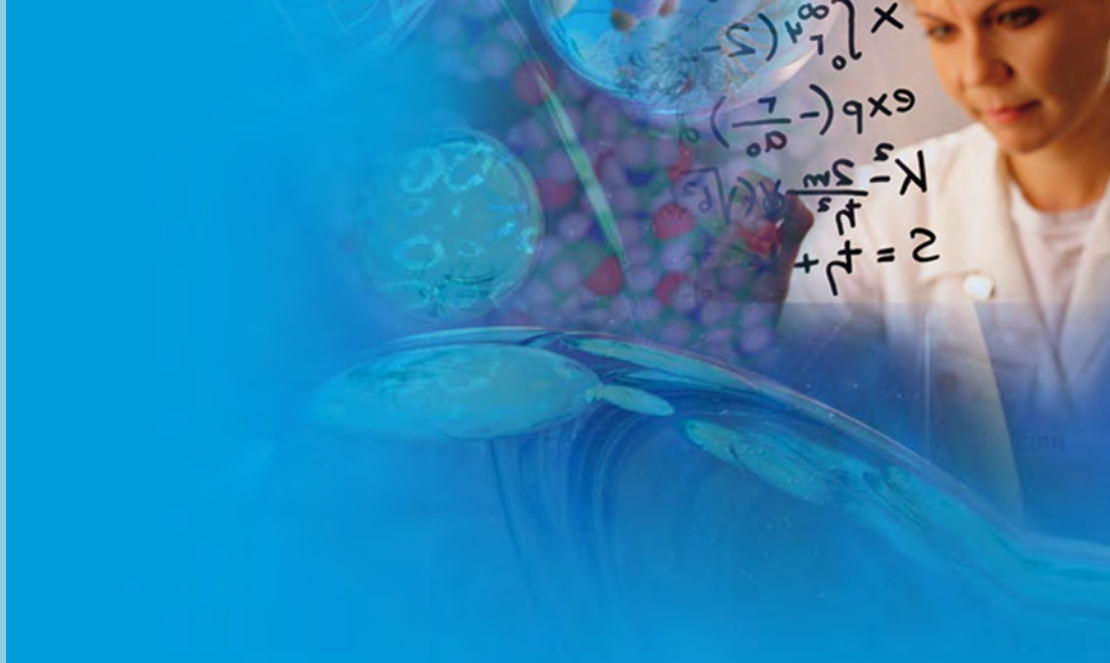


11. Trainee Exchanges

11. Trainee Exchanges

PS-OC Name	Trainee Name	Trainee PS-OC Title	Trainee Mentor	Exchange Mentor
ASU	Kaur, Parminder	Graduate Student	Lindsay	Henikoff
ASU	Wolff, Erika	Postdoctoral Fellow	Henikoff	Lindsay
Cornell	Charles, Nikki	Postdoctoral Fellow	Unknown	Unknown
Cornell	Kraning, Casey	Postdoctoral Fellow	Unknown	Unknown
JHU	Duarte, Filipa	Postdoctoral Fellow	Unknown	Wirtz
JHU	Feng, Yungfeng	Postdoctoral Fellow	Longmore	Longmore
JHU	Lonza, A.	Postdoctoral Fellow	Unknown	Longmore
JHU	Robinson, David K.	Postdoctoral Fellow	Unknown	Wirtz
JHU	Rosseel, Sophie	Undergraduate	Unknown	Wirtz
JHU	Wu, Pei-hsun	Postdoctoral Fellow	Wirtz	Fan
Moffitt	Bailey, Kate	Graduate Student	Gillies	Schaffer
Moffitt	Chen, Tingan	Postdoctoral Fellow	Unknown	Schaffer
Moffitt	Epstein, Tamir	Postdoctoral Fellow	Gatenby	Austin
Moffitt	Epstein, Tamir	Postdoctoral Fellow	Gatenby	Schaffer
Moffitt	Kasprzak, Aga	Postdoctoral Fellow	Unknown	Schaffer
Moffitt	Kim, Mun Ju	Postdoctoral Fellow	Unknown	Schaffer
Moffitt	Liu, Liyu	Postdoctoral Fellow	Austin	Silva
Moffitt	Lloyd, Mark	Postdoctoral Fellow	Unknown	Liphardt
Moffitt	Lloyd, Mark	Postdoctoral Fellow	Unknown	Schaffer
Moffitt	Verduzco, Daniel	Postdoctoral Fellow	Gillies	Schaffer
Moffitt	Wojtkowiak, Jonathan	Postdoctoral Fellow	Gillies	Schaffer
NU	Gunn, Kathryn	Postdoctoral Fellow	Unknown	Unknown
NU	Lee, Joo Sang	Graduate Student	Motter	Unknown
NU	Mayer, Meghan Hodgal	Graduate Student	O'Halloran	Maeshima
NU	Schnabel, Michael	Postdoctoral Fellow	Motter	Unknown
NU	Wells, Daniel K.	Graduate Student	Motter	Unknown
NU	Yungster, Nir	Graduate Student	Kath	Unknown
Princeton	Bougot-Robin, Kristelle	Postdoctoral Fellow	Unknown	Austin
Princeton	Duclos, Guillaume	Graduate Student	Silberzan	Silberzan
Princeton	Estevez-Salmeron, Luis	Postdoctoral Fellow	Tlsty	Austin
Princeton	Kim, So Hyun	Postdoctoral Fellow	Park	Park
Princeton	Kurup, Abishek	Graduate Student	Botvinivick	Tlsty
Princeton	Lambert, Guillaume	Graduate Student	Austin	Gatenby
Princeton	Liu, Liyu	Postdoctoral Fellow	Austin	Getzenberg
Princeton	Liu, Liyu	Postdoctoral Fellow	Austin	Tlsty
Princeton	Lopez-Diaz, Fernando	Postdoctoral Fellow	Emerson	Tlsty
Princeton	Loutherback, Kevin	Graduate Student	Sturm	Tlsty
Princeton	Oh, Steven	Postdoctoral Fellow	Tlsty	Austin
Princeton	Wu, Amy	Graduate Student	Sturm	Porri

PS-OC Name	Trainee Name	Trainee PS-OC Title	Trainee Mentor	Exchange Mentor
Princeton	Wu, Amy	Graduate Student	Sturm	Austin
Princeton	Wu, Amy	Graduate Student	Sturm	Silva
Princeton	Wu, Amy	Graduate Student	Sturm	Gatenby
Scripps	Aslan, Joseph	Postdoctoral Fellow	McCarty	McCarty
Scripps	Baehring, Franziska	Postdoctoral Fellow	Unknown	Kuhn
Scripps	Cianchetti, Flor	Postdoctoral Fellow	McCarty	Schaffer
Scripps	Effenberger, Katharina	Postdoctoral Fellow	Unknown	Kuhn
Scripps	Loren, Cassandra	Undergraduate	McCarty	Unknown
Scripps	Patel, Ishan	Undergraduate	McCarty	Levine
Scripps	Voight, Kathie	Postdoctoral Fellow	Unknown	Kuhn
TMHRI	Godin-Vilentchouk, Biana	Postdoctoral Fellow	Unknown	Unknown
TMHRI	Van De Ven, Anne L.	Postdoctoral Fellow	Decuzzi	Kuhn
UCB	Acerbi, Irene	Postdoctoral Fellow	Unknown	Moses
UCB	Goldfien, Gabriel	Postdoctoral Fellow	Unknown	Weaver
UCB	Jovanovic, Bojana	Postdoctoral Fellow	Unknown	Unknown
UCB	Matisse, Lauren	Postdoctoral Fellow	Unknown	Alcaraz
UCB	Nair, Pradeep	Postdoctoral Fellow	Unknown	Groves
UCB	Paszek, Matthew	Postdoctoral Fellow	Weaver	Weaver
UCB	Sistrunck, Chris	Postdoctoral Fellow	Unknown	Weaver
UCB	Zheng, Sarah Yici	Postdoctoral Fellow	Unknown	Weaver
USC	Brown, Matt	Postdoctoral Fellow	Unknown	Wirtz
USC	Greenfield, Alex	Postdoctoral Fellow	Bonneau	Mallick
USC	Greenfield, Alex	Postdoctoral Fellow	Bonneau	Nolan
USC	Ito, Ken	Postdoctoral Fellow	Gambhir	Agus
USC	Kotsuma, Masakatsu	Postdoctoral Fellow	Unknown	Agus
USC	Kwa, Tim	Postdoctoral Fellow	Unknown	Manalis
USC	Mumenthaler, Shannon	Postdoctoral Fellow	Unknown	LaBaer
USC	Mumenthaler, Shannon	Postdoctoral Fellow	Mallick	Weaver
USC	Poultney, Chris	Postdoctoral Fellow	Bonneau	Mallick
USC	Poultney, Chris	Postdoctoral Fellow	Bonneau	Lowe
USC	Rak, Roni	Postdoctoral Fellow	Unknown	Kloog
USC	Smith, Bryan	Graduate Student	Wang	Cristini
USC	Smith, Bryan	Graduate Student	Wang	Wirtz
USC	Song, Lusheing	Postdoctoral Fellow	Unknown	Magee
USC	Vogelsang, Maryann	Research Scientist	Unknown	Manalis



12. Trainee Transitions

12. Trainee Transitions

PS-OC Name	Trainee Name	Title	New Title	New Organization
ASU	Cusati, Teresa	Postdoctoral Fellow	Postdoctoral Fellow	University of Paris
ASU	Fu, Qiang	Graduate Student	Research faculty	Chung Chang Key State Laboratory
ASU	Fuhrmann, Alexander	Graduate Student	Postdoctoral Fellow	UCSD
ASU	Kaur, Parminder	Graduate Student	Postdoctoral Fellow	ASU
ASU	Linhart, Mark	Undergraduate	Postdoctoral Fellow	University of Arizona
ASU	Sandersius, Sebastian	Postdoctoral Fellow	Postdoctoral Fellow	Caltech
Cornell	Baboumian, Shaunte	Postdoctoral Fellow	Unknown	Unknown
Cornell	Cipriany, Ben	Postdoctoral Fellow	Unknown	IBM
Cornell	Gleghorn, Jason	Postdoctoral Fellow	Postdoctoral Fellow	Princeton University
Cornell	Levy, Stephen	Researcher	Associate Professor	University of Binhgampton
Cornell	Rana, Kuldeep	Graduate Student	Postdoctoral Fellow	Colorado School of Mines
Cornell	Starchenko, Alina	Undergraduate	Graduate Student	Vanderbilt University
Cornell	Tasseff, Ryan	Graduate Student	Unknown	Unknown
Cornell	Yuan, Libin	Postdoctoral Fellow	Assistant Research Scientist	McGill
DFCI	Cheng, Yu-Kang	Postdoctoral Fellow	Unknown	DFCI
DFCI	Chmielecki, Juliann	Postdoctoral Fellow	Postdoctoral Fellow	DFCI
DFCI	Foo, Jasmine	Postdoctoral Fellow	Postdoctoral Fellow	University of Minnesota
DFCI	Leder, Kevin	Postdoctoral Fellow	Assistant Professor	University of Minnesota
JHU	Bajpai, Saumendra	Graduate Student	Postdoctoral Fellow	Unknown
JHU	Balzer, Eric	Postdoctoral Fellow	Scientist	Nikon
JHU	Dickinson, L	Graduate Student	Postdoctoral Fellow	Unknown
JHU	Fraley, Stephanie	Postdoctoral Fellow	Postdoctoral Fellow	JHU
JHU	Hale, Christopher	Graduate Student	Scientist	Amgen (CA)
JHU	Heim, Erin	Undergraduate	Unknown	University of Florida
JHU	Khatau, Shyam B.	Graduate Student	Scientist	Unknown
JHU	Louie, Rachel	Undergraduate	Unknown	Unknown
JHU	Robinson, David Kyle	Undergraduate	Returned to finish B.S. degree	Oregon State University
JHU	Smith, Quinton	Undergraduate	Graduate Student	JHU
JHU	Tong, Tommy	Graduate Student	Postdoctoral Fellow	JHU
JHU	Walcott, Sam	Postdoctoral Fellow	Assistant Professor	UC Davis
JHU	Wang, Pu	Researcher	Associate Research Professor	JHU
JHU	Zhu, Fei	Researcher	Associate Research Scientist	JHU
Massachussetts General Hospital	Kim, Pilham	Postdoctoral Fellow	Assistant Professor	KAIST, Republic of Korea

PS-OC Name	Trainee Name	Title	New Title	New Organization
Massachussetts General Hospital	Lee, Woei Ming	Postdoctoral Fellow	VC Fellow	UNSW, Australia
Moffitt	Basanta Gutierrez, David	Researcher	Assistant Member (Faculty)	Moffitt IMO
Moffitt	Silva, Ariosto	Researcher	Assistant Member	Moffitt Cancer Ecology
Moffitt	Vibet, Sophie	Researcher	Medical Student	France, MD Program
NU	Brogaard, Kristin	Graduate Student	Postdoctoral Fellow	University of Washington
NU	Dadiani, Maya	Postdoctoral Fellow	Researcher	Tel Hashomer Hospital, Israel
NU	DeChant, Shirley	Other	Discovery Research Scientist	Baxter Bioscience Division
NU	Dore, Louis	Graduate Student	Postdoctoral Fellow	University of Chicago
NU	Field, Yair	Postdoctoral Fellow	Postdoctoral Fellow	Weizmann Institute
NU	Fondufe-Mittendorf, Yvonne	Researcher	Assistant Professor	University of Kentucky
NU	Froberg, John	Undergraduate	Graduate Student	Harvard University
NU	Grilley, Daniel	Postdoctoral Fellow	Assistant Professor	University of Wisconsin-La Crosse
NU	Hafets, Ora	Graduate Student	M.Sc. Student	Weizmann Institute
NU	Heyrman, Georgette	Other	Postdoctoral Fellow	NU
NU	Kaplan, Noam	Graduate Student	Postdoctoral Fellow	University of Massachusetts
NU	Kellar, Joshua	Researcher	Environmental Consultant	Boston Consulting Group
NU	Na, Youjin	Postdoctoral Fellow	Unknown	Samsung, Korea
NU	Prytkova, Tatiana	Researcher	Assistant Professor	Chapman University
NU	Qin, Fujun	Postdoctoral Fellow	Postdoctoral Fellow	University of Virginia
NU	Sadka, Tali	Graduate Student	Postdoctoral Fellow	UCB
NU	You, Eun-ah	Graduate Student	LG Chemistry	LG Chemistry, Korea
NU	Zhu, Xiao	Postdoctoral Fellow	Research Associate	University of Texas-Austin
Princeton	Giovincci, Mario	Researcher	Researcher	MagArray Inc.
Princeton	Lambert, Guillaume	Postdoctoral Fellow	Postdoctoral Fellow	New York University
Princeton	Liao, David	Postdoctoral Fellow	Postdoctoral Fellow	UCSF
Princeton	Liu, Liyu	Postdoctoral Fellow	Associate Research Scholar	Princeton
Princeton	Loutherback, Kevin	Graduate Student	Postdoctoral Fellow	Lawrence Berkeley National University
Princeton	Morachis, Jose	Researcher	Postdoctoral Fellow	UCSD
Princeton	Pal, Gayatri	Postdoctoral Fellow	Postdoctoral Fellow	Unknown
Princeton	Pedersen, Jonas	Postdoctoral Fellow	Postdoctoral Fellow	Technical University of Denmark
Princeton	Penfold, Catherine	Researcher	Researcher	Alabama University
Princeton	Segers, Adam	Postdoctoral Fellow	Engineer	MagArray Inc.

PS-OC Name	Trainee Name	Title	New Title	New Organization
Princeton	Tariq, Akram	Postdoctoral Fellow	Researcher	University of Punjab, Pakistan
Princeton	Zare, Nazanin	Researcher	Unknown	Unknown
Rice University	Corr, Stuart	Postdoctoral Fellow	Postdoctoral Fellow	UT MD Anderson
Rice University	Rosbach, Kelsey	Graduate Research Assistant	Field Applications Specialist	Nexcelom Bioscience
Rice University	Schwarz, Richard	Research Fellow	Research Scientist	Rice University
Scripps	Berny-Lang, Michelle	Graduate Student	Postdoctoral Fellow	Harvard Medical School
Scripps	Cho, Edward	Postdoctoral Fellow	Senior Scientist	BioNano Genomics
Scripps	Liao, Stephen	Graduate Student	Teacher	Taiwan
Scripps	Malchiodi, Michael	Researcher	Research Associate	TSRI
Scripps	Marrinucci, Dena	Postdoctoral Fellow	Director, Pharma Services & Laboratory Operations	Epic Sciences
Scripps	Matrone, Michael	Postdoctoral Fellow	Postdoctoral Fellow	TSRI
Scripps	Nelson, David	Postdoctoral Fellow	President & CEO	Epic Sciences
Scripps	Sok, Devin	Graduate Student	Graduate Student	TSRI
Scripps	Tiron, Roxanna	Postdoctoral Fellow	Lecturer	Korean National University
Scripps	Wendel, Marco	Postdoctoral Fellow	Life Science Consultant	NovuMed GmbH
Scripps	Yang, Xing	Postdoctoral Fellow	VP of R&D	Epic Sciences
Scripps	Ysasi, Adam	Graduate Student	Scientific Staff	General Dynamics Electric Boat
UCB	Camarillo, David	Postdoctoral Fellow	Assistant Professor	Stanford
UCB	Cassereau, Luke	Undergraduate	Graduate Student	UCSF
UCB	Collison, Eric	Other	Assistant Adjunct Professor	UCSF
UCB	Giles, Ryan	Researcher	Dentistry Student	UCSF
UCB	Hartman, Nina	Graduate Student	Unknown	Unknown
UCB	Lopez, Jose	Postdoctoral Fellow	Director of Training	BioRad
UCB	Manz, Boryana	Graduate Student	Postdoctoral Fellow	UCSF
UCB	McCullough, Emma	Graduate Student	Postdoctoral Fellow	Fundacion Ciencia para la Vida (Santiago, Chile)
UCB	Nair, Pradeep	Other	Staff position	Genentech
UCB	Paszek, Matthew	Postdoctoral Fellow	Postdoctoral Fellow	Cornell
UCB	Sen, Shamik	Postdoctoral Fellow	Assistant Professor	IIT Bombay
UCB	Tanner, Kandice	Postdoctoral Fellow	Staff Scientist	NCI
UCB	Triffo, Sarah	Graduate Student	Assistant Professor	Elon University
UCB	Ulrich, Theresa	Postdoctoral Fellow	Postdoctoral Fellow	MIT
UCB	Woodbury-Bell, Erika	Postdoctoral Fellow	Unknown	Unknown
UCB	Wu, Hung-Jen	Postdoctoral Fellow	Unknown	Unknown
UCB	Xu, Elizabeth	Graduate Student	Postdoctoral Fellow	University of Chicago
UCB	Xu, Ren	Researcher	Assistant Professor	University of Kentucky

PS-OC Name	Trainee Name	Title	New Title	New Organization
USC	Gaster, Richard	Graduate Student	Medical Student	Stanford University
USC	Hall, Drew	Researcher	Scientist	Intel Lab
UT Austin	Llechty, William	Graduate Research Assistant	NSF Graduate Research Fellow	UT Austin
UT Austin	Marek, Stephen	Postdoctoral Fellow	Lecturer	UT Austin
UT Austin	Schoener, Cody	Graduate Research Assistant	NSF Graduate Research Fellow	UT Austin
UT Health	Alexander, Jenolyn	Research Assistant I	Research Assistant II	TMHRI
UT Health	Frieboes, Hermann	Postdoctoral Fellow	Assistant Professor	University of Louisville Kentucky
UT Health	Godin-Vilentchouk, Biana	Postdoctoral Fellow	Assistant Professor	TMHRI
UT Health	Lee, Sei-Young	Postdoctoral Fellow	Senior Engineer	Samsung
UT Health	Liu, Xuewu	Assistant Professor	Associate Professor	TMHRI
UT Health	Novellino, Tomasso	Graduate Research Assistant	Postdoctoral Fellow	Unknown
UT Health	Sakamoto, Jason	Research Scientist	Assistant Professor	TMHRI
UT Health	Van De Ven, Anne	Postdoctoral Fellow	Research Associate	TMHRI
UT MD Anderson	Cardo-Vila, Marina	Postdoctoral Fellow	Research Scientist	UT MD Anderson
UT MD Anderson	Raoof, Mustafa	Postdoctoral Fellow	General Surgery Resident	University of Arizona

13. PS-OC Investigator Interactions with the Media

13. PS-OC Investigator Interactions with the Media

Investigator(s) or Project	Media Type (i.e. journal, TV, radio, iPod cast, institution news)	Dates	Links/Press Releases/Websites
Mina Bissell	Honoree of Issue of Scientific Journal	April 2011	http://blogs.rsc.org/ib/2011/04/06/integrative-biology-issue-4-online-in-honor-of-mina-j-bissell/
Paul Davies and Charles Lineweaver	Science News ... from universities, journals, and other research organizations ScienceDaily Conceptualizing Cancer Cells as Ancient 'Toolkit'	February 7th, 2011	http://www.sciencedaily.com/releases/2011/02/110207133704.htm
Paul Davies and Charles Lineweaver	Astrobiologists design cancer-fighting model - Article about research of Paul Davies and Charles Lineweaver-Cosmos Magazine	February 8th, 2011	http://www.cosmosmagazine.com/news/4030/astrobiologists-join-fight-against-cancer
Paul Davies and Charles Lineweaver	ANU (Australian National University) News release "Cancer goes back to basics"	Spring 2011	http://news.anu.edu.au/?p=10391
Paul Davies	ABC Science Broadcasting organization on-line "Researchers ponder cancer origins"	February 8th, 2011	http://www.abc.net.au/science/articles/2011/02/08/3133245.htm
Paul Davies	New Scientist Magazine -Tumours could be the ancestors of animals	March 11th, 2011	http://www.newscientist.com/article/mg20928033.700-tumours-could-be-the-ancestors-of-animals.html
Paul Davies	Cancer Ancestor Interview HORIZON Eight, Arizona PBS	March 24th, 2011	http://www.youtube.com/watch?v=p3S0atOBbqQ
Paul Davies	Scientific American magazine 'Physics Could Help Fight Cancer'	April 13th, 2011	http://www.scientificamerican.com/podcast/episode.cfm?id=paul-davies-physics-could-help-figh-11-04-13
Paul Davies	Cancer: The beat of an ancient drum? Rather than rogue cells gone berserk, cancers may be the foot soldiers of ages-old atavisms	April 25th, 2011	http://www.guardian.co.uk/commentisfree/2011/apr/25/cancer-evolution-ancient-toolkit-genes

Investigator(s) or Project	Media Type (i.e. journal, TV, radio, iPod cast, institution news)	Dates	Links/Press Releases/Websites
Paul Davies	Article in Nature 474, 20-22 (2011) Physics meets cancer: The disruptor. Profile of Paul Davies and his PSOC involvement	June 1st, 2011	http://www.nature.com/news/2011/110601/full/474020a.html
Paul Davies	Australian Broadcasting Corporation's Health Report	June 20th 2011	http://www.abc.net.au/radionational/programs/healthreport/paul-davies-and-highly-evolved-cancer/2917094
Paul Davies	NPR radio	January 9th, 2012	http://kjzz.org/content/1112/beyond-science-fiction
Paul Davies	The Telegraph Newspaper, (National, UK) "The final frontier in the war on cancer" by Paul Davies.	March 30th, 2012	http://www.telegraph.co.uk/science/science-news/9065707/The-final-frontier-in-the-war-on-cancer.html
Interviews by Pauline Davies, featuring Roger Johnson, Paul Davies and others	BBC radio report	September 17th, 2010	http://www.bbc.co.uk/blogs/today/tomfeilden/2010/09/could_physics_provide_the_key.html
Roger Johnson	KTAR Phoenix News Radio	January 11th, 2012	http://ktar.com/?sid=1485512&nid=6
Mike King	Book (Superfreakonomics)	3/2011	http://cmm.cornell.edu/news/mike-king-featured-in-freakonomics.html
Peter Kuhn	Greek Newspaper, VIMAScience	03/13/12	http://www.tovima.gr/science/article/?aid=444138&wordsinarticle=kuhn
Peter Kuhn	Journal article, "Peter Kuhn on detecting circulating tumor cells"	02/16/12	Xconomy
Peter Kuhn	Journal, Clinical Oncology News, "Circulating Tumor Cells: The Ultimate Assay?	01/2012	http://www.clinicaloncology.com/ViewArticle.aspx?d=Solid+Tumors&d_id=148&i=January+2012&i_id=808&a_id=20044
Peter Kuhn	San Diego Business News, Business Newspaper, "Local Biotechs Focus on Blood Tests for Cancer"	Nov/2011	Local Biotechs Focus on Blood Tests for Cancer
Peter Kuhn, Kelly Bethel	10 News.com, TV, "Local Scientists develop test to find cancer cells"	02/20/12	Aired on Channel 10 News http://www.10news.com/news/30503584/detail.html

Investigator(s) or Project	Media Type (i.e. journal, TV, radio, iPod cast, institution news)	Dates	Links/Press Releases/Websites
Peter Kuhn and Kelly Bethel	Union Tribune, San Diego Newspaper, "New Test Could Aid in Cancer Therapy"	02/03/12	http://www.utsandiego.com/news/2012/feb/03/tp-new-test-could-aid-in-cancer-therapy/
Cynthia Reinhart-King	Journal (Nature Medicine)	3/2011	http://www.nature.com/nm/journal/v17/n3/pdf/nm0311-271.pdf
Itzkovitz, van Oudenaarden (project 1)	Web:	Spring 2012	http://www.hfsp.org/frontier-science/awardees-articles/optimality-development-intestinal-crypts
Itzkovitz, van Oudenaarden (project 1)	web	Spring 2012	http://www.hfsp.org/frontier-science/awardees-articles/single-molecule-transcript-counting-stem-cell-markers-mouse-intes
Valerie Weaver	Scientific Journal profile	May 2011	http://jcb.rupress.org/content/193/5/802.full

14. PS-OC Investigator Conferences and Seminars

14. PS-OC Investigator Conferences and Seminars

Progress Report Period	Meeting Name	Date
June 2010	101st Annual Meeting of the American Association for Cancer Research	April 2010
January 2010	101st International Titisee Conference	March 2010
June 2011	102nd AACR Annual Meeting	April 2011
June 2010	103rd Statistical Mechanics Conference	May 2010
June 2012	10th Annual BioExpo	March 2012
December 2010	10th Annual Midwest Center for Structural Genomics [MCSG] Meeting	July 2010
June 2012	10th Oncology Update: Advances and Controversies	January 2012
December 2010	11th Annual Targeted Therapy of Lung cancer meeting	January 2011
December 2011	12th International Workshop on Scleroderma Research	July 2011
June 2010	13th International Membrane Research Forum	January 2010
June 2011	15th International p53 Workshop	October 2010
December 2010	16th International Workshop on Single Molecule Spectroscopy & Ultrasensitive Analysis in Life Sciences	September 2010
December 2010	17th Annual Prostate Cancer Foundation Scientific Retreat	September 2010
June 2012	17th International Biophysics Congress	November 2011
December 2011	17th International Biophysics Congress	October 2011
December 2010	17th IUPAB International Biophysics Congress	October 2011
December 2010	19th Annual Short Course on Experimental Models of Human Cancer	August 2010
June 2010	1st Annual NCI Physical Sciences-Oncology Centers Network Investigators' Meeting	April 2010
December 2011	1st French American Workshop on Electronic Materials at the Interface with Biology	June 2011
January 2010	1st International Symposium on Biomimetic Functional Surfaces with Fluid Interactions (Biomimetic FSFI'09)	September 2009
December 2010	1st Midwest Single-Molecule Biophysics Conference	July 2010
January 2010	2009 SPIE Optics and Photonics Conference	August 2009
June 2010	2010 Advanced Imaging Methods Workshop	January 2010
January 2010	2010 Breast Oncology Program Scientific Retreat and Poster Session	January 2010
January 2010	2010 Engineering Mechanics Institute of ASCE Annual Conference	August 2010
June 2010	2010 Society for Basic Urologic Research (SBUR)	November 2010
June 2012	2010 Symposium of the Systems Biology Center New York	December 2011
January 2010	2010 World Conference on Interventional Oncology Conference	June 2010
December 2010	2011 AACR Annual Meeting	January 2011
December 2011	2011 Biomedical Engineering Society Annual Meeting	October 2011
December 2011	2011 Biophysical Society	March 2011
June 2011	2011 Cancer Forum on Cancer Cell Motility and Metastasis	May 2011
December 2011	2011 CNF Annual Meeting	September 2011

Progress Report Period	Meeting Name	Date
June 2011	2011 Genitourinary Cancers Symposium	February 2011
December 2011	2011 Gordon Research Conference: Biomaterials and Tissue Engineering	July 2011
December 2011	2011 International Melanoma Congress	November 2011
December 2010	2011 Molecular Membrane Biology Gordon Research Conference	July 2011
June 2012	2011 Symposium of the Fondzione Pezcoller	June 2010
December 2011	2012 American Physical Society March Meeting	February 2012
June 2012	2012 American Physical Society March Meeting	March 2012
June 2012	2012 Annual Meeting of the Society for Nuclear Medicine (SNM)	January 2012
June 2012	2012 Materials Research Society Spring Meeting, Special Symposium on "Manipulating Cellular Microenvironments"	April 2012
June 2012	2012 Moffitt Scientific Symposium	January 2012
June 2012	2012 World Online Cancer Conference.	January 2012
June 2010	217th Electrochemical Society Meeting	April 2010
June 2012	219th Electrochemical Society	May 2011
June 2011	21st Century Oncologic Imaging on the Baltic, Copenhagen	August 2010
June 2010	21st International Thrombosis Congress	July 2010
June 2012	22B, Fourth Annual BEE Research Symposium	March 2012
June 2012	22nd annual meeting on Structural Biology, CABO XXII	May 2012
June 2011	22nd EDRN Steering Committee Meeting, National Cancer Institute/Division of Cancer Prevention Early Detection Research Network (EDRN),	March 2011
January 2010	22st Annual CSU Biotechnology Symposium: Program Schedule At-A-Glance	January 2010
January 2010	239th ACS National Meeting	March 2010
June 2011	23rd Annual Pezcoller Symposium, Engineering in Cancer Research	June 2011
June 2011	241st American Chemical Society National Meeting & Exposition	March 2011
June 2012	243rd National Meeting of the American Chemical Society	March 2012
June 2012	24th EDRN Steering Committee Meeting, National Cancer Institute/Division of Cancer Prevention Early Detection Research Network (EDRN)	March 2012
June 2011	24th International Conference on Screening for Lung Cancer, The International Early Lung Cancer Action Program	February 2011
June 2011	25th Anniversary Meeting, Protein Society	July 2011
June 2012	28th Southern Biomedical Engineering Conference	May 2012
December 2011	2nd Annual PSOC-Center for Transport Oncophysics Symposium 'Oncophysics of Metastasis and Angiogenesis'	November 2011
December 2011	2nd International Definiens Symposium	October 2011
June 2012	2nd International Symposium on Translational Regenerative Medicine	October 2011
December 2010	2nd NCI Physical Sciences – Oncology Center (PS-OC) Cell Line Exercise Meeting	June 2010
December 2010	2nd Sao Paulo School of Translational Science	September 2011
December 2010	2nd US–China Symposium on Cancer Nanotechnology and Nanomedicine	September 2010
June 2012	37th Annual Meeting & Exposition of the Controlled Release Society (CRS)	June 2010
June 2012	38th Annual Meeting & Exposition of the Controlled Release Society (CRS)	July 2011

Progress Report Period	Meeting Name	Date
January 2010	3rd Annual Engineering Cell Biology meeting	August 2009
June 2012	3rd Annual Physical Sciences in Oncology Meeting	April 2012
June 2012	3rd Annual PS-OC Investigator's Meeting, 2012	January 2012
December 2010	3rd International Conference of Bionic Engineering	September 2010
December 2010	3rd International Conference on Advanced NanoMaterials	September 2010
June 2011	3rd International Conference on Biomolecular Engineering	January 2011
December 2011	3rd World Circulating Tumor Cells Summit	November 2011
June 2012	4/4/2012	April 2012
December 2011	40 Years and Counting: AWM's Celebration of Women in Mathematics Conference	September 2011
June 2011	48th Annual Technical Meeting of SES : New Advances in Fluid Mechanics	October 2011
January 2010	49th Annual ASCB Meeting	December 2009
December 2011	4th Annual Meeting of Australasian society for stem cell research	October 2011
June 2011	4th ICGC Workshop	December 2010
June 2011	4th International Conference on Tissue Engineering	January 2011
December 2010	4th Scientific workshop ICGC	December 2010
June 2010	50th Annual Meeting of the American Society for Cell Biology	December 2010
June 2011	55th Annual Meeting of the Biophysical Society	March 2011
December 2011	57th Scientific and Standardization Committee: Biorheology, XXIII Congress of the International Society on Thrombosis and Haemostasis	July 2011
June 2012	58th Annual Scientific & Standardization Committee of the International Society on Thrombosis and Haemostasis	June 2012
December 2011	5th Annua l q-bio Conference on Cellular Information Processing	January 2011
December 2010	5th annual CCR Nanobiology Program Think Tank	June 2010
June 2010	5th Annual Houston Conference on MDS and MPN	April 2010
December 2011	5th International Workshop on Breast Densitometry and Breast Cancer Risk Assessment	June 2011
December 2011	64th Annual Meeting of the American Physical Society's Divis ion of Fluid Dynamics	January 2011
June 2011	6th European Molecular Imaging Meeting	June 2011
June 2011	6th Johns Hopkins Prostate Research Day	January 2010
December 2011	76th Annual Meeting of the German Physical Society (DPG)	March 2012
January 2010	7th International Conference on Nanochannels, Microchannels and Minichannels	June 2009
December 2010	7th International Symposium for Minimal Residual Cancer	September 2009
December 2011	7th NCI – Early Detection Research Network (EDRN) Scientific Workshop	September 2011
June 2011	7thABA Symposium and Annual Meeting of the Indian Biophysical Society	January 2011
December 2011	7tn International Conference on Biological Physics (ICBP2011)	June 2011
December 2011	8th AIMS International Conference on "Dynamical Systems, Differential Equations and Applications"	May 2010
June 2010	8th Annual Alvord Lecture in Neuropathology	May 2010

Progress Report Period	Meeting Name	Date
December 2011	8th European Conference on Mathematical and Theoretical Biology	June 2011
June 2012	8th European Conference on Mathematical and Theoretical Biology / Annual Meeting of the Society for Mathematical Biology (ECMTB/SMB)	January 2011
December 2010	8th Int. Conference on Nanochannels, Microchannels, and Minichannels	August 2010
December 2011	8th International Workshop on Nanomechanical Sensing in Dublin	May 2011
June 2011	9th Annual BioExpo	March 2011
December 2011	9th Annual Tamest Conference.	January 2012
December 2011	9th International Conference on Nanochannels, Microchannels and Minichannels. American Society of Mechanical Engineers	June 2011
June 2012	AAAS Annual Meeting	February 2012
January 2010	AAAS/ Food and Drug Law Institute Colloquium on Personalized Medicine	October 2009
June 2010	AACR Advances in Cancer Research: From the Laboratory to the Clinic	March 2010
June 2012	AACR Annual Meeting 2012	January 2012
June 2011	AACR Conference on Frontiers in Basic Cancer Research	September 2011
June 2011	AACR Conference: Translation of the Cancer Genome: Scientific, Clinical, and Operational Challenges	October 2011
January 2010	AACR Conference: Translational Cancer Medicine 2010,	July 2010
January 2010	AACR Dead Sea Conference	March 2010
December 2011	AACR Frontiers in Basic Cancer Research	September 2011
December 2011	AACR Metabolism and Cancer	January 2011
June 2012	AACR San Antonio Breast Cancer Symposium	December 2011
January 2010	AACR Special Conference	December 2009
December 2010	AACR Special Conference in Molecular Diagnostics in Cancer Therapeutic Development: Challenges and New Horizons	September 2010
June 2012	AACR Special Conference Meeting	May 2012
June 2012	AACR Special Conference on Pancreatic Cancer	June 2012
June 2011	AACR Special Conference on Tumor Microenvironment Complexity: Emerging Roles in Cancer Therapy	November 2011
January 2010	AACR Workshop on Glioblastoma	December 2009
June 2010	AACR: The Future of Molecular Epidemiology: New Tools, Biomarkers, and Opportunities	June 2010
June 2012	AACR-IASLC Joint Conference on Molecular Origins of Lunch Cancer	January 2012
December 2010	AACR-NCI Conference on Systems Biology	February 2010
June 2011	AACR-NCI Conference on Systems Biology	February 2011
June 2011	AACR-NCI Conference on Systems Biology: Confronting the Complexity of Cancer	March 2011
January 2010	AARC Death Mechanism and Cancer Therapy Special Conference	February 2010
June 2011	Abcam Epigenetics and Stem Cells Conference, (Plenary Lecture)	January 2010
June 2010	ACS National Meeting	March 2010
June 2012	Advanced Bioimaging workshop	January 2012
June 2011	Advanced Imaging Methods Workshop	January 2011

Progress Report Period	Meeting Name	Date
December 2011	Advanced Imaging Methods Workshop	January 2012
June 2010	Advanced Imaging Methods Workshop, International House	January 2010
June 2011	Advanced Optical Methods Workshop, Molecular Imaging Center	January 2011
December 2010	Aegean International Conferences on Tissue Engineering	May 2010
June 2011	Aegean International Conferences on Tissue Engineering	May 2011
December 2011	AFM Biomed Meeting	August 2011
June 2010	AFM methods Workshop	April 2010
December 2011	Albany Conversation: Perspectives on Nucleosome Positioning	June 2011
January 2010	Albert Einstein College of Medicine Cell Biology Department	December 2009
June 2012	Alice Hamilton Award Lecture	April 2012
June 2012	Ambrosetti Forum	November 2011
June 2010	American Academy of Allergy, Asthma & Immunology Shapiro Lectureship	January 2010
June 2011	American Association for Cancer Research 102nd Annual Meeting	April 2011
June 2012	American Association for Cancer Research Annual Meeting	March 2012
June 2012	American Association for Cancer Research Frontiers in Cancer Prevention annual conference	October 2011
June 2012	American Association for Cancer Research Special Conference on Nano in Cancer: Linking Chemistry, Biology, and Clinical Applications in Vivo	January 2011
June 2010	American Association of Anatomists Annual Meeting	April 2010
June 2011	American Association of Physicists in Medicine	June 2011
December 2011	American Association of Physicists in Medicine Annual Meeting	August 2011
December 2010	American Association of Physicists in Medicine Annual Meeting	July 2011
December 2011	American Cancer Society National Meeting	August 2011
June 2012	American Chemical Society (ACS) 243rd National Meeting, Division of Colloid and Surface Chemistry,	March 2012
June 2011	American Chemical Society (ACS) Annual Meeting	March 2011
January 2010	American Chemical Society Annual Meeting	March 2010
December 2010	American Chemical Society Annual Meeting. Division of Polymeric Materials: Science and Engineering	August 2010
December 2011	American College of Veterinary Pathology Annual Meeting	January 2011
January 2010	American Heart Association Scientific Sessions	November 2009
June 2012	American Institute of Chemical Engineers (AiChe) Annual Meeting	November 2011
January 2010	American Institute of Chemical Engineers Annual Meeting	November 2009
June 2011	American Institute of Chemical Engineers Annual Meeting	November 2010
June 2012	American Institute of Chemical Engineers Annual Meeting	October 2011
June 2012	American Physical Society Annual Meeting	February 2012
December 2010	American Physical Society Annual Meeting	March 2010
June 2012	American Physical Society March Annual Meeting	January 2012
June 2010	American Physical Society March Meeting	March 2009

Progress Report Period	Meeting Name	Date
December 2010	American Physical Society March Meeting	March 2011
June 2012	American Physical Society, High Content Biophysical Data for Dynamic Studies in Cancer	February 2012
January 2010	American Society for Cell Biology Annual Meeting	December 2009
June 2012	American Society for Cell Biology Meeting	December 2011
June 2012	American Society for Clinical Investigation	January 2012
June 2012	American Society for Clinical Oncology Annual Meeting	June 2012
June 2011	American Society for Matrix Biology, (Plenary Lecture)	January 2010
January 2010	American Society for Mechanical Engineers (ASME) 2010 First Global Congress on Nanoengineering for Medicine and Biology Global Conference on Nanomedicine: Detection and Analysis of Circulating Tumor Cells	February 2010
December 2010	American Society of Cell Biology Annual Meeting	December 2010
June 2011	American Society of Cell Biology Annual Meeting, Mini-Symposium: Cancer and Cancer Microenvironment	December 2010
June 2011	American Society of Cell Biology Annual Meeting, Special Interest Subgroups: Cellular Mechanics in Development and Disease	December 2010
January 2010	American Society of Hematology Annual Meeting	December 2009
June 2011	American Thoracic Society International Conference (Keynote Lecture)	January 2010
June 2012	American Urological Association	May 2012
June 2012	American Urological Association Annual Meeting	May 2012
June 2011	American-Italian Cancer Foundation, (Scientific Excellence in Medicine Award Lecture)	January 2010
January 2010	Annual Biomedical Research Conference for Minority Students	January 2009
December 2010	Annual Biomedical Research Conference for Minority Students	November 2010
June 2012	Annual Biomedical Research Conference for Minority Students	November 2011
June 2010	Annual Conference of the Genetics Society of Israel	February 2010
December 2010	Annual Fall Meeting of Biomedical Engineering Society (BMES)	July 2010
January 2010	Annual HUPO World Congress	September 2009
June 2012	Annual Interdisciplinary Symposium of the NCI-ICBP Center for Modeling Cancer Development	February 2012
January 2010	Annual International Conference on Intelligent Systems for Molecular Biology	July 2010
January 2010	Annual meeting for the American Association of Immunologists (AAI)	May 2010
December 2011	Annual Meeting of AICHE	October 2011
June 2012	Annual Meeting of the American Society for Investigative Pathology	December 2011
June 2012	Annual Meeting of the American Society of Hematology	December 2011
June 2010	Annual Meeting of the Association of Medical Laboratory Immunologists (AMLI)	August 2010
December 2011	Annual Meeting of the Biomedical Engineering Society	October 2011
June 2010	Annual Meeting of the Biophysical Society	February 2010
June 2012	Annual Meeting of the Dermatological Nursing Association	May 2012
June 2012	Annual Meeting of the Materials Research Society	April 2012

Progress Report Period	Meeting Name	Date
December 2011	Annual Meeting of the Society for Neuro- Oncology	January 2011
June 2011	Annual Meeting of the Society for Nuclear Medicine (SNM)	June 2011
June 2010	Annual Meeting of The Society of Mathematical Biology	July 2010
December 2010	Annual Molecular Medicine Tr-Conference, Cambridge Healthtech Institute	February 2011
December 2011	Annual PSOC Meeting 2011	January 2011
June 2010	Annual UCSF Stem Cell Retreat	April 2010
January 2010	Annual International Conference of the IEEE Engineering in Medicine and Biology Society	September 2009
June 2011	April 15th Presentation at Entrepreneurship @ Cornell Expo, highlighting Center activities, including microfabrication facilities and minicourses	April 2011
December 2010	APS Division of Fluid Dynamics	November 2010
June 2010	Arizona Imaging and Microanalysis Society	March 2010
June 2010	Arizona State University (ASU) PS-OC Workshop	February 2010
June 2011	Arizona State University Physical Sciences / Oncology Symposium	January 2011
June 2011	Arizona State University Workshop on Cancer Cell Motility and Metastasis	May 2011
June 2010	Arteriosclerosis, Thrombosis and Vascular Biology 2010 Scientific Sessions	April 2010
June 2012	ASCO Annual Meeting	June 2012
December 2011	ASCO GU Symposium,	February 2012
June 2012	ASCO/AGA/ASTRO/SSO GI Cancer Symposium	January 2012
June 2012	ASCO/ASH symposium	June 2012
June 2012	ASGE Topic Forum (Endoscopic Quality Outcomes)/Digestive Disease Week/26th Annual Society-for-Surgery-of-the-Alimentary-Tract Residents and Fellows Research Conference (SSAT)	May 2011
December 2010	ASME 2010 1st Global Congress on NanoEngineering for Medicine and Biology: NanoEngineering for Medical Diagnostics	February 2010
December 2010	ASME 2010 International Mechanical Engineering Congress and Exposition	November 2010
December 2011	ASME 2011 Summer Bioengineering Conference	June 2011
December 2011	ASME Applied Mechanics and Materials Conference	May 2011
June 2012	Aspen Center for Physics Winter Conference on Growth and Form: Pattern Formation in Biology	January 2012
December 2011	Aspen Lung Conference	January 2011
January 2010	Assembly of the Mitochondrial Respiratory Chain	January 2009
January 2010	Association for Laboratory Automation	January 2010
June 2012	Association for Research in Vision & Ophthalmology	May 2012
December 2011	Association for Research in Vision and Ophthalmology	May 2011
January 2010	Association for Research in Vision and Opthalmology Annual Meeting	May 2009
January 2010	Astrobiology Science Conference	April 2010
June 2012	ASU Foundation- President's Community Enrichment Programs (PCEP)	October 2011
June 2010	ASU PSOC workshop: Controlling cancer through the mechanical micro-environment	February 2010

Progress Report Period	Meeting Name	Date
June 2012	ASU Workshop and Mitochondria Meeting	March 2012
December 2011	ASU: Arizona State University Seminar	April 2012
June 2010	Atomic Force Microscopy Biomed Meeting	May 2010
June 2012	AVS Meeting	October 2011
December 2010	AZ (AstraZeneca) R & D Oncology Seminar	July 2010
June 2012	Banff International Research Station	March 2011
December 2011	Banff International Research Station (BIRS)	July 2011
June 2011	Banff International Research Station Annual Meeting	August 2011
June 2011	Bar Ilan University Biophysics Seminar	April 2011
June 2011	Bardonecchia 2011 Workshop	February 2011
June 2012	Barret's Esophagus Translational Research Network (BETRNet) Steering Committee Meeting	May 2012
June 2011	Basic Sciences Provocative Questions Workshop	February 2011
June 2011	Bauer Center Forum	March 2011
June 2010	Bay Area PSOC seminar series	May 2010
January 2010	Bay Area PS-OC/Princeton PS-OC Joint Meeting	January 2010
December 2011	Baylor Cancer Center Symposium speaker	November 2011
June 2012	Baylor College of Medicine and Nikon Instruments Microscopy Symposium	March 2012
June 2012	BCRF Symposium	October 2011
June 2011	Beckman Coulter Particle Characterization Key Opinion Leader Advisory Seminar	April 2011
June 2012	Beijing Cancer Hospital	February 2012
December 2011	Beyond Center Seminar Series	October 2011
December 2011	Beyond Sequencing Workshop	June 2011
December 2011	Bio Mechanical Engineering Conference	May 2011
June 2011	Biochemical Society, Sanger Center	August 2011
December 2010	Biochemistry Departmental Research Conference	September 2010
December 2010	Biochemistry seminar	November 2010
June 2010	Biocomplexity Institute Seminar	April 2010
June 2010	Biocomplexity X: Quantitative Tissue Biology and Virtual Tissues and Cell Behavior Ontology meeting	October 2009
December 2010	Bio-Convergence Section of the G20 Symposium	November 2010
June 2011	Biodesign Institute Seminar	February 2011
June 2010	Bioengineering Graduate Seminar	April 2010
January 2010	Bioengineering Seminar, UC Berkeley	November 2009
June 2012	Bioinformatics and Systems Biology	February 2012
June 2010	Biological Physics Seminar	April 2010
December 2010	Biology and Mathematics in the Bay Area Conference	November 2010
December 2010	Biology Department Seminar	November 2010
December 2010	Biology Graduate Program Lecture	December 2010

Progress Report Period	Meeting Name	Date
December 2011	Biology Seminar	November 2011
December 2011	Biomarkers and Imaging Meeting	October 2011
June 2012	Biomaterials Day	May 2011
January 2010	Biomaterials: Perspective and Possibilities; NSF sponsored workshop	November 2009
December 2010	Biomed Israel 2010: 9th National Life Science and Technology Week	June 2010
January 2010	Biomedial Engineering Society Annual Meeting	October 2009
June 2012	BioMedical Engineering Society (BMES) 2010 Annual Fall Meeting	October 2010
December 2010	Biomedical Engineering Society (BMES) Conference	February 2011
December 2010	Biomedical Engineering Society Annual Meeting	January 2010
June 2011	Biomedical Engineering Society Annual Meeting, Integrated Cellular Systems	October 2011
June 2011	Biomedical Graduate Program Retreat	September 2011
June 2011	Biomedical Imaging Research Center Seminar	March 2011
December 2011	Biomedical Science Department Seminar	November 2011
December 2011	Biomedical Sciences Retreat	October 2011
June 2012	Biomedicine in 4D Symposium	March 2012
December 2011	BioMethods Boston Conference	July 2011
June 2011	Biomolecular Stereodynamics Workshop	June 2011
June 2012	BioNanoMed 2012 – Scientific Board	March 2012
June 2011	Bionanotechnology and Nanomedicine Laboratory Seminar	January 2011
June 2012	Biophest	April 2012
June 2010	Biophest 2010, University of Arizona	April 2010
June 2012	Biophysical Society 56th Annual Meeting	February 2012
December 2010	Biophysical Society Annual Conferenc	March 2011
June 2011	Biophysical Society Annual Meeting, Symposium on Cell and Tissue Mechanics and Modeling AFM and Rheology, Small to Tissue Scale	March 2010
June 2011	Biophysical Society Dynamic Assemblies meeting	July 2011
June 2011	Biophysical Society Workshop on Actin, the cytoskeleton, and the nucleus	November 2010
June 2011	Biophysical Society, 54th Annual Meeting	February 2010
December 2011	Biophysical Society, Dynamic DNA Packaging Across Kingdoms: Chromatin & Beyond	July 2011
June 2012	Biophysics and Bioengineering Cancer Seminar	April 2012
December 2011	Biophysics Seminar	June 2012
December 2010	Biophysics Seminar, Department of Physics and Biophysics Graduate Program, Ohio State University	October 2010
June 2010	Biophysics Society Workshop on Super Resolution Imaging and Optical Probes	February 2010
January 2010	Biophysics: Population, Evolution and Physics Meeting	January 2010
June 2012	Biostatistics/Computational Biology/DFCI	May 2012
June 2012	BIOT: Division of Biochemical Technology, American Chemical Society	March 2012

Progress Report Period	Meeting Name	Date
January 2010	Blue Ribbon Panel on Genomics Research for the NIH National Institute of Allergy and Infectious Diseases (NIAID), Division of Microbiology and Infectious Diseases	February 2010
June 2012	BME Distinguished Seminar Series	March 2012
December 2011	BMES	October 2011
June 2012	BMES Annual Meeting	October 2011
December 2011	BMES annual meeting	October 2011
June 2012	BMES National Meeting	October 2011
June 2012	BMSE 2012	June 2012
December 2011	Board Meeting, National Cancer Institute National Institutes of Health, Board of Scientific Advisors (BSA)	June 2011
December 2010	Board Meeting, National Cancer Institute National Institutes of Health, Board of Scientific Advisors (BSA)	November 2010
June 2011	Board Meeting, National Cancer Institute National Institutes of Health, Board of Scientific Advisors (BSA),	March 2011
June 2012	Board Meeting, National Cancer Institute National Institutes of Health, Board of Scientific Advisors Board Meeting, National Cancer Institute National Institutes of Health, Board of Scientific Advisors Board Meeting, National Cancer Institute National Institutes of Health, Board of Scientific Advisors (BSA)	November 2011
December 2010	Board of Scientific Advisors (BSA) Meeting	June 2010
June 2010	Boehringer Ingelheim Fonds International Titisee Conference on Mechanics of Cells and Tissues: Sensing, Generating and Coordinating Forces in Biological Systems	March 2010
June 2010	Booz Allen Hamilton Distinguished Colloquium	April 2010
December 2011	Boston University, Dept. of Biomedical Engineering seminar series	December 2011
January 2010	BPS Workshop Actin, the cytoskeleton, and the nucleus	November 2010
December 2010	Brain Tumor Course	July 2010
January 2010	Brain Tumor Funder's Collaborative Annual Meeting	October 2009
January 2010	Brazilian Physical Society	May 2010
June 2011	Brazilian Society for Cell Biology, (Plenary Lecture)	January 2010
January 2010	Breast Cancer Research Foundation Annual meeting	October 2009
December 2010	Breast Cancer Research Foundation Seminar	October 2010
June 2010	Breast Cancer Specialized Programs of Research Excellence Annual Meeting	January 2010
June 2010	Breast Cancer SPORE lecture	May 2010
December 2010	Bridging the gap between mathematical analysis and scientific and engineering applications	April 2011
June 2010	Briefing of the Congressional Biomedical Research Caucus	May 2010
June 2011	Brown University Physics Colloquium	November 2010
June 2011	Bryn Mawr College, (The Bernard Rothenberg Lecture in Biology and Public Policy)	January 2011
January 2010	CalDay: UC Berkeley's Open House	April 2010
December 2011	Caltech Bioengineering Lecture Series	November 2011

Progress Report Period	Meeting Name	Date
December 2011	Cambridge Healthtech Institute 4th Annual Emerging Molecular Markers of Cancer - Evaluating for Clinical Use	August 2011
December 2010	Cambridge Healthtech Institute's Eighth Annual Protein Biomarkers CHI's Protein Biomarkers meeting at the ADAPT 2010: Accelerating Development & Advancing Personalized Therapy Congress	September 2010
December 2011	Cambridge Healthtech Institute's Second Annual Future Diagnostics conference	April 2012
June 2012	Can Care Conference	August 2011
June 2011	Cancer Biology Seminar Series	January 2011
December 2011	Cancer Detection & Diagnostics Technologies for Global Health	August 2011
June 2010	Cancer Forum Workshop 1: Mechanical Properties of Cancer Cells and Their Micro-Environment	February 2010
December 2011	Cancer Forum: Workshop on Cancer Cell Motility and Metastasis	May 2011
December 2011	Cancer Research and Treatment Fund: 6th International Patient Symposium	November 2011
December 2011	Cancer Research Center Seminar	June 2012
June 2012	Cancer Research Seminar	February 2012
December 2010	Cancer Research UK Beatson International Cancer Conference	July 2010
June 2012	Cancer Systems Biology Group, St. Elizabeth Medical Center	August 2011
June 2011	Cargese Center for Physics Workshop	April 2011
January 2010	Case Comprehensive Cancer Center Blood Club seminar	March 2010
June 2010	Case Comprehensive Cancer Center Blood Club Seminar	October 2010
December 2011	Catalonian Institute for Bioengineering (IBEC)	June 2011
December 2011	CCTCC-20, Conference on Current Trends in Computational Chemistry	October 2011
June 2010	CECAM Meeting on DNA Mechanics	June 2010
June 2011	CECAM Meeting on DNA Mechanics	September 2011
June 2012	CEGS Special Emphasis Panel Applicant Interview (AI)	November 2011
December 2011	Cell Based Assays and Bioanalytical Method Development	October 2011
December 2011	Cell Behavior Ontology Workshop IV,	January 2011
June 2012	Cell Press Webinar	May 2012
June 2011	Cell Signalomics	January 2011
June 2011	Cells Circuits and Computation	January 2011
January 2010	Cells, Circuits and Computation, Council for Systems Biology in Boston	January 2010
June 2010	Cellular Signaling and Molecular Medicine	May 2010
December 2010	Centenary Institute Melanoma Colloquium	November 2010
December 2011	Center for Applied Molecular Medicine	December 2011
June 2010	Center for Applied Molecular Medicine, University of Southern California (USC)	February 2010
June 2011	Center for Biological Physics Graduate Seminar	February 2011
June 2011	Center for Comparative Medicine	May 2011
June 2012	Center for Control, Dynamics, Computation	May 2012
June 2010	Center for Integrated Systems Round Table Day	May 2010

Progress Report Period	Meeting Name	Date
June 2011	Center for Theoretical Biological Physics (CTBP)	January 2011
June 2012	Center for Tranport Oncophysics (CTO) 1st annual workshop	September 2010
June 2012	Center for Transport Onco-physics Annual Workshop	November 2011
June 2011	Centre for Protein Engineering meeting: Three decades of Protein Engineering: Impact on Structural Biology and Therapy.	September 2010
June 2012	CERN investigators meeting	April 2012
June 2012	CGC/CBG Meeting Epigenetics and non- coding RNAs	November 2011
December 2011	Champalimaud Foundation Cancer Symposium	January 2011
December 2010	Chancellor's Advisory Board for Life Sciences	November 2010
June 2010	Chemical Biology Symposium on Chemical Biology	December 2010
December 2011	Chemical Therapeutics Retreat	June 2011
January 2010	Chemistry Department Seminar	February 2010
December 2010	Chemistry Departmental Seminar	May 2011
June 2012	CHI Future Diagnostics	April 2012
December 2010	CHI Meeting on Circulating Tumor Cells (CTCs) for Cancer Detection, Diagnosis, Prognosis and Treatment	February 2011
December 2011	Children's Memorial Research Center 3rd Annual Biomedical Research Symposium: (oral presentation, abstract 17)	September 2011
June 2012	China Anti-cancer Association	February 2012
June 2012	China PLA Navy General Hospital	February 2012
June 2012	Chinese Academy of Medical Sciences	February 2012
June 2012	Chinese Academy of Science Symposium	April 2012
December 2011	Chromatin and Nuclear Organization Minisymposium	May 2011
June 2012	Chromatin Changes in Differentiation Symposium	September 2011
June 2010	Chromatin Structure and Function meeting	January 2011
January 2010	CIFAR Program in Genetic Networks	September 2009
June 2012	CIHR Strategic Training Program in Cancer Research & Technology Transfer (CaRTT)	March 2012
June 2012	Cincinatti Children's Blood Division	January 2012
June 2012	Circulating Tumor Cells 2012	February 2012
June 2011	Cleveland Clinic Cancer Center Grand Rounds	November 2010
January 2010	Clinical Applications of Magnetic Carriers	May 2010
December 2010	Clinical Proteomic Technologies for Cancer, Establishing the Standards in Clinical Proteomics, 2010 Annual Meeting	September 2010
June 2011	Clinical Translation of Epigenetics in Cancer Therapy	January 2011
June 2011	CNIO Frontiers Meeting	February 2011
June 2011	CO-CHAIR and speaker, Session on Biology of Metastases, ASCO Breast cancer Symposium	December 2010
June 2010	Cold Spring Harbor 75th Symposium: Nuclear Organization & Function	June 2010
June 2011	Cold Spring Harbor Laboratory series	April 2011

Progress Report Period	Meeting Name	Date
June 2010	Cold Spring Harbor meeting on Molecular Chaperones and Stress Responses	January 2010
June 2010	College of Life Sciences Seminar	March 2010
January 2010	Colloquium in Department of Physics University of Oregon	April 2010
December 2010	Colloquium of the Department of Physics	November 2010
June 2011	Colloquium on Cancer Modeling (Project 2)	April 2011
December 2011	Colon Cancer Biomarker Validation Project	June 2011
June 2012	Columbia University Seminar on Cancer in New York; Lecture	April 2012
June 2012	Company of Biologists Epigenetics Conference	June 2012
December 2010	Company of Biologists Workshop	October 2010
June 2012	Comparative Cancer Biology Symposium,	December 2011
June 2011	Comparative Cancer Biology Training Program Retreat. Tissue factor and canine cancer.	January 2011
June 2012	Complex Systems Seminar	December 2011
December 2011	Computational Biology Seminar	August 2011
December 2011	Computational Biology Seminar	December 2011
December 2010	Computational Biology/Genomics Center Laufer Center seminar series	September 2010
June 2011	Computational Mathematics and Mathematical Biology Seminar	January 2010
June 2011	Conference "Partial Differential Equation in Mathematical Biology"	September 2010
January 2010	Conference BO132: Biomedical Applications of Light Scattering IV, SPIE Photonics West	January 2010
December 2011	Conference on Biological Membranes and Membrane Proteins	June 2011
December 2010	Conference on Cancer Systems Biology	October 2011
June 2012	Conference on the Systems Biology of Human Disease	January 2012
December 2010	Controlled Release Society Annual Meeting	July 2010
June 2012	Controlled Release Society Annual Meeting	July 2011
June 2011	Cornell Biophysics Colloquium	February 2011
December 2011	Cornell NanoScale Facility Annual Meeting	September 2011
December 2011	Cornell Physical Sciences Oncology Center Seminar	September 2011
December 2011	Cornell Translational Cancer Research Symposium	October 2011
June 2010	Cornell University Entrepreneurship Expo 2010	April 2010
June 2010	Cornell University Seminar	October 2010
December 2010	Cornell, Mechanical Engineering	January 2010
December 2011	CRI Symposium	October 2011
December 2010	Crump Institute for Molecular Imaging	November 2010
June 2012	CSH China Epigenetics Symposium	April 2012
June 2011	CSHL meeting: The Biology of Cancer: Microenvironment, Metastasis & Therapeutics	April 2011
December 2010	CTBP Seminar Invitation (Center for Theoretical Biological Physics, UC San Diego and Salk Institute Collaboration)	January 2011

Progress Report Period	Meeting Name	Date
June 2012	CTS-IXA Joint International Congress	October 2011
December 2011	Curry International Tuberculosis Center Seminar	September 2011
June 2012	Czech Academy of Sciences Gregor Mendel Lecture	May 2011
January 2010	Dalian Institute of Chemical Physics	September 2009
December 2011	DCP Mathematical Modeling Seminar Series therapy	September 2011
January 2010	Decision Making: Psychophysics Application of Network Science	January 2010
June 2010	Department of Biomedical Engineering	October 2010
June 2010	Department of Biomedical Engineering, University of Southern California (USC)	February 2010
December 2011	Department of Biotechnology Engineering Ben-Gurion University of the Negev	January 2012
June 2010	Department of Chemical and Biological Engineering	January 2010
December 2011	Department of Chemical and Petroleum Engineering, University of Pittsburgh,	September 2011
June 2010	Department of Chemical Engineering, Northeastern University	April 2010
June 2010	Department of Chemical Engineering, University of Delaware	March 2010
June 2011	Department of Defense IMPACT Conference	January 2011
June 2010	Department of Energy 2010 Genomic Science Contractor-Grantee and Knowledgebase Workshop	February 2010
June 2011	Department of Molecular and Cellular Biology, Florida International University Seminar	January 2011
June 2011	Departmental Colloquium	February 2011
June 2010	Dept. of Energy AMS meeting	May 2010
June 2012	Design of Medical Devices Conference (10th Anniversary), Mini-Symposium on Nano-Medical Devices	April 2011
June 2012	Digestive Disease Week 2012	May 2012
June 2012	Discovery Days	January 2012
December 2011	Discrete Models in Molecular Biology	March 2012
June 2010	Distinguished Lecture Series at the Karolinska Institute	June 2010
December 2011	DNA Photonics meeting	September 2011
June 2011	DOD Breast Cancer Program - LINKS Meeting	February 2011
December 2011	DOD Breast Cancer Research Program Era of Hope 2011 Conference	August 2011
January 2010	Doris Duke Charitable Foundation	October 2009
January 2010	DSR Sarma Lectureship in Oncologic Pathology	November 2009
January 2010	Dynamics Days Conference	January 2010
January 2010	Dynamics Days South America	July 2010
December 2010	Early Detection Research Network Annual Meeting	November 2010
June 2010	Early Detection Research Network Meeting	March 2010
December 2011	ECMTB 2011, 8th European Conference on Mathematical and Theoretical Biology & Annual Meeting of The Society of Mathematical Biology, minisymposium	June 2011
December 2010	Ecole Normale Superieure-Northwestern University Research Conference	November 2010
June 2012	EDRN Network Consulting Team (NCT) Meeting	November 2011

Progress Report Period	Meeting Name	Date
December 2010	EDRN Orientation and Planning Meeting	August 2010
June 2012	Electrical Engineering and Applied Physics Seminar	April 2012
December 2011	Electrical Properties of Healthy and Cancer Cells Workshop	March 2012
June 2011	EMBO Conference on Gene Transcription in Yeast	June 2012
December 2011	EMBO Conference Series Chromatin and Epigenetics EMBL	June 2011
December 2011	EMBO Meeting on Nuclear Structure and Dynamics	September 2011
December 2010	EMBO Workshop on Biophysical Mechanisms of Development	May 2011
June 2011	EMBO Workshop on Chromatin Structure, Organization and Dynamics	April 2011
June 2012	EMBO/MRC workshop on imaging and microscopy	March 2012
June 2012	Embryo Physics Seminar Series	January 2012
June 2012	Embryo Physics Seminar Series	May 2012
December 2010	EMI2010 (Engineering Mechanics Institute 2010), Viterbi School of Engineering	August 2010
January 2010	Enabling a Future of Personalized Cancer Medicine: Leveraging 30 Years of China-U.S. Scientific Progress	November 2009
January 2010	Engineering and Physical Sciences Research Council workshop	September 2009
January 2010	Engineering Conferences International, Engineering Cell Biology III	August 2009
December 2011	Engineering in Medicine and Biology Society Annual Meeting	September 2011
December 2010	Engineering Influences in Cancer Research, Perzcoller Foundation	June 2011
June 2012	Epigenetic Control Symposium	December 2011
December 2010	Epigenetics/Translational Oncology Meeting	January 2011
December 2011	Erasmus Hematology Lectures	September 2011
December 2011	ESH-EHA Scientific Workshop on Acute Myeloid Leukemia	October 2011
December 2011	Eukaryotic DNA Replication & Genome Maintenance meeting	September 2011
December 2011	Eukaryotic Transcription Keystone Symposia	March 2012
June 2011	European Association for Cancer Research, (Plenary Lecture)	January 2010
June 2011	European Biology Annual Mweeting	April 2011
June 2010	European Breast Cancer Conference	April 2010
June 2011	European Breast Cancer Conference (Keynote Speaker)	January 2010
December 2011	European Conference on Mathematical and Theoretical Biology	June 2011
December 2011	European Conference on Mathematical and Theoretical Biology (ECMTB)	January 2011
December 2011	European Cooperation in Science and Technology (COST) Meeting	August 2011
January 2010	European Molecular Biology Organization Annual Meeting	August 2009
June 2010	European Neuropathology	March 2010
June 2011	European School of Haematology- International Conference on Myeloproliferative Neoplasms	September 2010
December 2011	European Society for Microcirculation	January 2011
December 2010	European SocieTy for Radiotherapy and Oncology Annual Meeting	September 2010
June 2011	Evans Center — Biochemistry Thematic Seminar Series	January 2011
December 2010	Evolution of Cooperation Workshop	December 2010

Progress Report Period	Meeting Name	Date
June 2012	Experimental Biology annual meeting	April 2012
June 2010	Experimental Biology Meeting	April 2010
June 2011	FASEB Dynamic DNA Structures in Biology	June 2012
December 2011	FASEB Meeting on Hematological Malignancies	August 2011
June 2012	FASEB research summer conference	June 2012
December 2010	FASEB research summer conference Ubiquitin and Intracellular Protein Degradation	June 2010
January 2010	Fidler Lectureship in Cancer Metastasis Research	December 2009
June 2012	Fields Institute Workshop on Mathematical Oncology IV	March 2012
January 2010	Fifth International Tumor Microenvironment Conference	October 2009
December 2011	Fifth q-bio Summer School and Conference on Cellular Information Processing	July 2011
December 2010	First Annual USC Physical Sciences in Oncology Symposium	June 2010
December 2011	First Biannual International Evolution and Cancer Conference	June 2011
June 2010	First Global Congress on NanoEngineering for Medicine and Biology (NEMB)	February 2010
June 2012	First opponent to dissertation by Siver Andreas Moestue	January 2012
June 2012	First USACM Thematic Conference	February 2012
June 2011	Five lecture series	May 2011
June 2010	Florida Oncology Symposium	May 2010
December 2010	Fluid Motion Driven by Immersed Structures Workshop	August 2010
June 2012	Fondation des Treilles Meeting: Growth regulation by the TOR pathway	June 2012
June 2012	Fondazione Meeting per l'amicizia fra I popoli	August 2011
June 2012	Forbeck Forum on Cancer Epigenetics	November 2011
June 2012	Formal Approaches to Modelling Biochemical Networks Workshop	April 2012
June 2012	Fourth Annual BEE Research Symposium	March 2012
December 2010	Fourth q-bio Conference on Cellular Information Processing	August 2010
June 2011	French National Alliance for Life Sciences and Biomedical Research (Aviesan)	September 2011
January 2010	Frontiers in Biology Seminar series - Stanford	March 2010
December 2011	Frontiers in Cancer in Singapore	November 2011
June 2011	Frontiers in Cancer Research & Therapy Symposium, Nobel Forum at Karolinska Institutet	March 2011
December 2011	Frontiers in Cancer Science	October 2011
December 2011	Frontiers in Cell Migration and Mechanotransduction	May 2011
June 2010	Frontiers in Mathematical Biology: NSF-NIH PIs Meeting 2010	April 2010
January 2010	Frontiers of Chemistry Research Lectures	September 2009
January 2010	Future of Light Symposium	November 2009
June 2011	Gecko Workshop at Leibniz Institute for New Materials (INM)	July 2010
January 2010	General Chair, National Academy of Engineering Regional Grand Challenges Summit	April 2010
January 2010	General Chair, Ocean Observing Initiatives Science Workshop	April 2010

Progress Report Period	Meeting Name	Date
January 2010	Genetic Networks	September 2009
January 2010	Genetics and Biology of Brain Cancers	December 2009
June 2012	Genetics Society of Israel	February 2012
January 2010	Genome Informatics Workshop	October 2009
December 2010	Genomic Instability and Tumor Progression Program Meeting	June 2010
June 2011	Genomics Cluster Meeting	January 2011
June 2012	Georgia Tech Genomics Symposium (Dayhoff lecture)	November 2011
June 2012	Glioblastoma Conference	October 2011
January 2010	Global Enterprise for Micro-Mechanics and Molecular Medicine short course	January 2010
June 2011	Glycobiology Gordon Research Conference	May 2011
December 2011	Gordon conference on cell growth	June 2011
June 2011	Gordon conference on 'Stochastic Physics in Biology'	January 2011
June 2011	Gordon Conference on Tissue Repair and Regeneration, Matrix and Fibrosis Session	June 2011
December 2011	Gordon Conference, Fibronectin, Integrins & Related Molecules	July 2011
June 2011	Gordon Research Conference - Chemistry & Physics of Microfluidics	June 2011
June 2012	Gordon Research Conference, Metals in Biology	January 2012
June 2011	Gordon Research Conference, Salve Regina University, Mammary Gland Biology	June 2011
June 2010	Gordon Research Conference: Hemostasis	July 2010
December 2010	Gordon-Kenan Research Seminar, Signal Transduction by Engineered Extracellular Matrices	June 2010
June 2011	Grand Challenges in Proteomics Workshop	February 2011
December 2010	Green Hospital Grand Rounds, The Robert M. Nakamura Lectureship	June 2010
December 2011	Harvard Medical School Systems Biology Department Retreat	June 2011
June 2011	Harvard 'Squishy Physics' Seminar Series	December 2010
December 2011	Harvard University, SEAS, Bioengineering seminar series	October 2011
December 2011	Head Start-"UP" 2011	May 2011
January 2010	Hematology Grand Rounds University of Maryland Medicine,	December 2009
June 2011	Herbert Irving Comprehensive Cancer Center's Annual Symposium	May 2011
December 2010	HHMI Science Meeting on Signal Transduction	September 2010
June 2011	HHMI/FASEB Research Symposium - Keynote Presentation	March 2011
June 2012	High Throughput Cell-Based Studies and Protein Microarrays for Biomarker and Target	March 2012
January 2010	Hong Kong Workshop on Evolution: Foundations, Fundamentals and Disease	December 2009
June 2012	Honorary Lecture. University of California Los Angeles	March 2012
June 2011	Howard Hughes Series Special Lecture	January 2010
June 2011	ICB Army-Industry Collaboration Conference	February 2011
June 2010	ICBP Annual Conference	May 2010
December 2011	ICBP investigator meeting	September 2011

Progress Report Period	Meeting Name	Date
June 2011	ICBP Ped Brain Tumor Meeting	March 2011
December 2011	ICSB 2011 – Honorary lecture	August 2011
June 2012	IEEE International Conference on Bioinformatics and Biomedicine Annual Meeting	November 2011
January 2010	IEEE International Conference on Bioinformatics & Biomedicine	November 2009
January 2010	IEEE International Conference on Robotics and Automation	May 2010
June 2012	IEEE International Symposium on Biomedical Imaging 2012	January 2012
June 2011	IEEE Nano Annual Meeting	August 2011
June 2012	IEEE Photonics 2011	October 2011
June 2012	IEEE-ISBI (International Symposium on Biomedical Imaging)	May 2012
June 2012	Imaging in 2020	September 2011
January 2010	Imaging transcription in living cells: A systems and computational approach	March 2010
June 2011	Imaging, Diagnostics, and Therapeutics -CRR Mini-symposium	January 2011
June 2011	ImClone Seminar	April 2011
June 2012	IMEC annual conference	May 2012
December 2011	IMO Lab meeting	September 2011
June 2012	IMP Max Birnstiel Lecture	May 2011
June 2011	IMPAKT 2011 Breast Cancer Conference, (Plenary Lecture)	January 2011
June 2010	Improved Network Performance via Antagonism, Workshop	January 2010
June 2012	Innovative Sample Prep and target Enrichment Conference	April 2012
June 2012	Innovator Award of the Breast Cancer Program	September 2011
December 2011	Institut Curie Seminar	September 2011
December 2011	Institute Albert Bonniot- Cancer Institut Grenoble Seminar	September 2011
June 2011	Institute for Cell and Molecular Biology (ICMB)	March 2011
June 2011	Institute for Complex Adaptive Matter Annual Meeting	April 2011
December 2011	Institute Pasteur- ITMO Cancer 2nd Annual Meeting	September 2011
December 2010	Integrated Cancer Biology Program and Physical Sciences Oncology Center Joint Meeting,	August 2010
June 2012	Integrating Engineering and Biology in Cancer Research	January 2012
June 2012	Integrative Cancer Biology Workshop	March 2012
June 2012	Intelligence of the World, Europe and Italy	September 2011
December 2011	International Biometric Society Annual Meeting	April 2012
December 2010	International Conference Dynamics Days South America	July 2010
June 2012	International Conference of Nanodrug Delivery	October 2011
January 2010	International Conference On Differentiation Therapy	November 2009
June 2012	International Conference on Information Processing in Cells and Tissues	March 2012
December 2011	International Conference on Miniaturized Systems for Chemistry and Life Sciences	May 2010
January 2010	International Conference on Nano Science and Technology	February 2010

Progress Report Period	Meeting Name	Date
June 2012	International Conference on Nanoscience and Technology Annual Meeting	January 2012
June 2011	International Conference on Stem Cells and Cancer (ICSCC-2010)	December 2010
December 2011	International Congress of Industrial and Applied Mathematics	June 2011
December 2010	International Meeting NanoBiomedicine	June 2010
June 2010	International School and Conference on Network Science	May 2010
June 2010	International Society for Computational Biology Annual Meeting	July 2010
December 2010	International Society for Computational Biology DREAM/RECOMB Conference	November 2010
June 2012	International Society for Magnetic Resonnance and Medicine Annual Meeting	May 2012
June 2011	International Society for Magnetic Resonance in Medicine Cancer Workshop	September 2010
June 2011	International Society for Proton Dynamics in Cancer (ISPDC)	September 2010
December 2011	International Society for Stem Cell Research	June 2011
January 2010	International Society for Stem Cell Research (ISSCR) 7th Annual Meeting	July 2011
December 2010	International Society for Stem Sell Research Annual Meeting	June 2010
June 2010	International Society for the Biological Therapy of Cancer	October 2010
December 2011	International Symposium on Breast Cancer Prevention	October 2011
June 2011	International Symposium on Mapping the Human Proteome: Getting to the Heart of Proteomics	January 2011
December 2011	International Symposium on Mechanobiology	November 2011
June 2010	International Symposium on the Physicochemical Field for Genetic Activities	January 2011
December 2011	International Symposium on Translational Cancer Research	November 2011
June 2011	International Symposium on Translational Regenerative Medicine	October 2011
December 2010	International Vascular Biology Meeting	June 2010
December 2010	International Workshop on Mechanics and Growth of Tissues: From Development to Cancer Max Planck Institute for the Physics of Complex Systems (MPIPKS)	April 2010
December 2011	Investigative Workshop Solid Tumor Modeling: Biological, Computational and Clinical Challenges	January 2011
June 2012	Invitation: cBio @ MSKCC Seminar	June 2012
June 2012	Invited seminar	January 2012
June 2012	Invited seminar, Toronto Mathematical Oncology IV	March 2012
June 2012	ISMRM 20th Annual Meeting	May 2012
June 2011	ISMRM Annual Meeting	May 2011
June 2011	ISREC Symposium 2011: Hallmarks and Horizons of Cancer, Metastasis, Invasion, and Microenvironment.	September 2011
December 2011	ISSCR 2011, Annual meeting	June 2011
June 2010	James S. McDonnell Foundations	September 2010
December 2011	Japan Society for Cell Biology, Plenary Lecture	June 2011
June 2011	Japanese Society of Hematology- 72nd Annual Meeting of JSH	September 2010
June 2012	Johns Hopkins Biomedical Engineering Research Day (Fall 2011)	September 2011
June 2011	Johns Hopkins Biophysics Seminar	November 2011

Progress Report Period	Meeting Name	Date
June 2012	Johns Hopkins Prostate Research Day (Spring 2012)	March 2012
June 2012	Johns Hopkins Undergraduate Research Symposium (Spring 2012)	March 2012
December 2010	Joint Meeting NIEHS/NCI Breast Cancer and the Environment Research Program, Environmental Forces Regulate Breast Cancer Susceptibility	November 2010
June 2010	Joint Metastasis Research Society - AACR Conference	September 2010
June 2011	Joint PSOC-ICBP Seminar Series	March 2011
June 2011	Joint Retreat Pancreas Cancer Program & the Cancer, Immunity and Microenvironment Program	July 2011
June 2012	Joint Seminars in Molecular Biology series	January 2012
June 2010	Joint Society for Industrial and Applied Mathematics/RSME-SCM Annual Meeting	June 2010
June 2011	Joint Statistical Meetings	August 2010
December 2010	Joint Workshop Karolinska Institutet and UCSF on Breast Cancer	October 2010
June 2011	Karolinska Institute Nobel Forum, (Karolinska Research Lecture)	January 2011
December 2010	Kavli Institute for Theoretical Physics	May 2011
December 2010	Keck Center Annual Research Conference	October 2010
December 2011	Keystone Meeting on Cancer Complexity	June 2011
January 2010	Keystone Meeting on Transcription Dynamics	April 2010
June 2012	Keystone meeting: Lymphocyte Signaling (C4)	March 2012
June 2010	Keystone Structural Biology Meeting	January 2010
June 2012	Keystone Symposia Angiogenesis: Advances in Basic Science and Therapeutic Applications	January 2012
June 2012	Keystone Symposia on Hypoxia & Cancer Metabolism	January 2012
December 2011	Keystone Symposia on Hypoxia and Cancer Metabolism	February 2012
June 2011	Keystone Symposia: Stem Cells, Cancer and Metastasis	March 2011
June 2011	Keystone Symposium	February 2011
June 2011	Keystone Symposium "AAA and Related Protein Machines: Structure, Function and Mechanism"	March 2010
June 2012	Keystone Symposium in Chromatin Structure and Dynamics	January 2012
June 2012	Keystone Symposium on Angiogenesis	January 2012
June 2011	Keystone Symposium on Epigenomics/Chromatin Dynamics	January 2012
June 2011	Keystone Symposium on Structural Biology of Cellular Processes	January 2012
June 2012	Keystone Symposium on The Role of Inflammation during Carcinogenesis	May 2012
December 2011	Keystone Symposium: Fibrosis	March 2012
June 2010	KITP Conference	May 2011
June 2010	Koch Institute Symposium: Integrative Approaches to Cancer	June 2010
June 2012	Laurence Baker Professor	May 2012
December 2011	Lausanne Symposium	September 2011
June 2011	Lawrence Berkeley National Lab Life Sciences Divisional Seminar	January 2011
June 2012	Leiden University Medical Center	January 2012

Progress Report Period	Meeting Name	Date
December 2011	Leukemia and Lymphoma Society at American Society of Hematology	December 2011
January 2010	Leukemia & Lymphoma Society's Specialized Center of Research Program meeting	October 2009
June 2010	Leuven International Doctoral School Biomedical Sciences Oncoforum 7	May 2010
January 2010	Linz Winter Workshop in Single Molecule Biophysics	February 2010
December 2010	Living Mechanics: Cell, Tissue and Organism	November 2010
June 2012	LOCI Symposium	June 2012
January 2010	Lorentz Center Workshop on DNA	September 2009
December 2010	Lorentz Center Workshop: Circulating Tumor Cells and Associated (single cell) Molecular Diagnostics/Pathology Diagnostics	February 2011
December 2010	MAASTRO Clinic Seminar	December 2010
June 2011	March Meeting of the American Physical Society	March 2011
June 2012	Maryland Stem Cell Research Symposium	October 2011
June 2012	Material Research Society Fall Annual Meeting	November 2011
June 2011	Material Research Society Spring Meeting	April 2011
June 2012	Materials Research Society Annual Meeting	April 2012
December 2010	Materials Research Society Annual Meeting	November 2010
January 2010	Materials Research Society Fall Meeting	December 2009
December 2010	Materials Research Society Workshop	October 2010
June 2010	Mathematical Biology Seminar	April 2010
December 2011	Mathematical Biology Seminar	October 2011
June 2012	Mathematical Biology Seminar I	February 2012
June 2012	Mathematical Biology Seminar II	February 2012
June 2010	Mathematical Biology Seminar Series	March 2010
January 2010	Mathematical Biosciences Institute Conference	March 2010
June 2010	Mathematical Biosciences Institute workshop on Computational Challenges in Integrative Biological Modeling	October 2009
December 2011	Mathematical Frontiers in the Life Sciences	July 2011
December 2011	Mathematical Methods in Systems Biology and Population Dynamics.	January 2012
January 2010	Mathematical Methods in Systems Biology Workshop	January 2010
January 2010	Mathematical Modelling of Cancer Growth and Treatment	August 2010
June 2011	Mathematical Modelling of Cancer Growth and Treatment Summer School and Workshop	January 2010
December 2011	Mathematics of Regenerative Medicine Workshop	July 2011
December 2011	Max Planck Institute of Colloids and Interfaces	November 2011
June 2012	Mayo Clinic GI Specialty Spring Meeting/ASU/Mayo Collaboration Meeting	April 2012
June 2010	McElvain Lecture	April 2010
January 2010	McGill Chromatin Bioinformatics Workshop	April 2010
June 2012	MD Anderson/Baylor Texas Clinical Cancer Prevention and Molecular Carcinogenesis Retreat	December 2011

Progress Report Period	Meeting Name	Date
June 2012	Mechanical and Engineering Sciences Colloquium	April 2012
December 2011	Mechanisms of Eukaryotic Transcription	August 2011
December 2011	Mechanobiology of cells and materials at the 2012 Spring MRS Meeting	April 2012
June 2010	Mechanobiology workshop	November 2009
June 2012	MedConference: Medical Care and the Person: The Heart of the Matter	October 2011
January 2010	Melanoma Research Meeting	December 2010
June 2010	Melanoma Research Meeting	December 2010
January 2010	Memorial Sloan-Kettering Cancer Center PS-OC Lecture Series	December 2009
December 2010	MESA+ Institute for Nanotechnology, University of Twente	September 2010
December 2011	Methods in Bioengineering Conference	July 2011
January 2010	Miami 2010 Winter Symposium: Targeting Cancer Invasion and Metastasis	February 2010
June 2012	Miami Winter Symposium (organized by Nature Publishing Group)	February 2012
December 2011	Microarray World Congress	September 2011
June 2011	MicroTas	October 2011
December 2010	MicroTAS 2010	October 2010
June 2012	Microwave Materials and Their Applications (MMTA) 6th MMA	September 2010
June 2012	Midwest Center for Structural Genomics Annual Meeting	April 2012
June 2010	Midwest Yeast Meeting	October 2010
June 2012	Mini-Retreat, The Breast Cancer Research Foundation	October 2011
June 2010	Minisymposium at Society of Mathematical Biology Conference	July 2010
January 2010	Mini-symposium on Multi-scale Systems Biology: From Pathways to Organism,	January 2010
December 2010	MIT Bioengineering Colloquium	May 2011
December 2011	Moffitt Cancer Center Grand Rounds	October 2011
June 2011	Moffitt Grand Rounds	July 2010
June 2012	Mol Biol Cell 22, 1185. Presentation at the American Society for Cell Biology Annual Meeting 2011	December 2011
June 2010	Molecular Basis of Evolutionary Innovations	July 2010
June 2012	Molecular Bio. Cell. 1492a. ASCB	December 2011
December 2010	Molecular Biology seminar	November 2010
January 2010	Molecular Biology Society of Japan Annual Meeting	December 2009
January 2010	Molecular Biophysics seminar series – UCSD	April 2010
June 2011	Molecular Med TRI-CON	February 2011
January 2010	Molecular Programming Program Retreat (NSF funded center for Caltech and UW, Seattle)	January 2010
June 2010	Molecular Programming Project Annual Retreat	January 2010
June 2011	Mouse Models of Human Cancers Consortium Workshop	January 2011
June 2012	MRC CSC Symposium on Epigenetic Regulation	June 2012
December 2011	MRC Laboratory for Molecular Cell Biology	December 2011
June 2010	MRC-EMBO Advanced Optical Microscopy,	April 2010

Progress Report Period	Meeting Name	Date
June 2010	MSKCC Brain Tumor Center Retreat	March 2010
December 2010	Multicellular assemblies: Architectures, Properties, Engineering	October 2010
June 2011	Multi-Institutional Prostate Cancer Research Retreat	March 2011
June 2012	Multi--institutional Prostate Cancer Retreat	March 2012
June 2012	Nano Connect Scandinavia Conference Update 2012	March 2012
June 2012	Nano in Cancer: Linking Chemistry, Biology, and Clinical Applications In Vivo	January 2011
December 2010	Nano in the art competition on NanoIsrael Conference	November 2010
January 2010	Nano Science Technology Institute Conference	June 2010
June 2012	Nano Science Technology Institute Conference	November 2010
June 2011	NanoBio Symposium 2011	January 2011
December 2010	NanoBio-Europe Annual Meeting	June 2010
December 2010	Nanobiotechnology and Cancer Symposium	January 2010
December 2010	Nanobiotechnology and Cancer Symposium,	November 2010
January 2010	NanoBusiness Alliance Conference	September 2009
January 2010	Nanoforum XXII	October 2009
December 2010	NanoGagliato 2010 Meeting	July 2010
June 2012	NanoIsrael 2010	November 2010
June 2012	NanoMed 2010 – 7th International Conference on Biomedical Applications of Nanotechnology	December 2010
December 2011	NanoMex 2011	November 2011
December 2011	Nano-scale Nanosciences Nanoengineering Seminar	October 2011
December 2011	Nano-scale Nanosciences Nanoengineering Seminar	October 2011
December 2011	Nano-scale UCSF Nikon Imaging Center Seminar	July 2011
December 2011	Nanotechnology in Biomedicine	February 2012
June 2011	National Breast Cancer Coalition, Advocacy Training Conference	May 2011
December 2011	National Cancer Institute (NCI), National Heart, Lung, and Blood Institute (NHLBI), Food and Drug Administration (FDA), and American Association for Clinical Chemistry (AACC)Workshop: Statistical Experimental Design Considerations in Research Studies Using Proteomic Technologies,	August 2011
June 2012	National Cancer Institute –Cancer Institute/Hospital of the Chinese Academy of Medical Sciences (CICAMS) meeting, "Cancer Prevention, Biomarkers and Screening Research in China and the United States: Opportunities for Collaboration"	May 2012
January 2010	National Cancer Institute PS-OC meeting	October 2009
June 2011	National Cancer Institute/Division of Cancer Prevention Early Detection Research Network (EDRN)	February 2011
June 2011	National Cancer Policy Forum Workshop 1	January 2010
December 2011	National Center for Nanoscience and Technology Seminar	June 2011
June 2012	National Centre for Biological Sciences (NCBS) and Institute for Stem Cell Biology and Regenerative Medicine (inSTEM)	December 2011

Progress Report Period	Meeting Name	Date
June 2011	National Institute for Mathematical and Biological Synthesis Annual Meeting	January 2011
June 2011	National Institutes of Health Conference: Frontiers in Cell Migration & Mechanotransduction	May 2011
January 2010	National Research Council Ocean Infrastructure Needs in 2030 Workshop	February 2010
June 2010	National Science Foundation's Division of Civil, Mechanical and Manufacturing Innovation Research and Innovation Conference	June 2009
December 2011	NAVBO WORKSHOPS IN VASCULAR BIOLOGY 2011	October 2011
June 2011	NCI — CCR Eminent Lecture Series	January 2010
June 2012	NCI "Integrating the Physical Sciences Perspective to Open a New Frontier in Oncology" Meeting	February 2012
June 2012	NCI Alliance for Nanotechnology in Cancer Annual Meeting	January 2012
June 2012	NCI Annual Site visit	September 2011
June 2011	NCI Center for Cancer Research Eminent Lecture Series	January 2011
June 2011	NCI Center of Excellence in Integrative Cancer Biology and Genomics Seminar	December 2010
December 2011	NCI Clinical Proteomic Tumor Analysis Consortium	August 2011
January 2010	NCI ICBP Junior Investigators' Meeting	October 2009
June 2012	NCI Scientific Program Leaders and Office of Director Staff Retreat	January 2012
June 2012	NCI Scientific Program Leaders and Office of Director Staff Retreat	November 2011
June 2010	NCI Synthetic Workshop	April 2010
June 2010	NCI -TMEN Gradient Workshop	May 2010
June 2012	NCI Translational Science Meeting	July 2011
January 2010	NCI Translational Science Meeting	November 2009
January 2010	NCI Workshop on Transient Molecular Complexes	September 2009
June 2011	NCI/2011 Winter TMEN Steering Committee Meeting	February 2011
December 2010	NCI/DCP Early Detection Research Network (EDRN) Network Consulting Team Meeting	September 2010
December 2010	NCI: Androgen Receptor Signaling in Prostate Cancer: Translating Biology into Clinical Practice	December 2010
June 2011	NCI-CCNE Workshop	November 2010
January 2010	NCI's Transient Molecular Complexes Workshop,	August 2009
December 2011	Netherlands Consortium for Systems Biology, Annual Symposium	October 2011
January 2010	NetSci 2010 – International School and Conference on Network Science	May 2010
June 2012	Network Frontier Workshop	December 2011
December 2011	Neurosurgery Grand Rounds Seminar	June 2011
June 2012	New Directions in Leukemia Research	March 2012
June 2012	New Frontiers in Progeria Research Conference	January 2012
January 2010	New York Academy of Sciences Seminar for the retreat of the graduate program	December 2009
June 2012	New York Society of Cosmetic Chemists-Technology Transfer Conference	November 2011
December 2011	NIH Conference on Cancer Detection and Diagnostics Technologies for Global Health	August 2011

Progress Report Period	Meeting Name	Date
June 2011	NIH NCI Center of Excellence in Chromosome Biology Symposium	January 2012
December 2010	NIH NCI Center of Excellence in Chromosome Biology Symposium	November 2011
December 2010	NIH Protein Capture Workshop	October 2010
January 2010	NIH Structural Biology seminar	June 2010
June 2012	NIH Symposium: Cancer Detection and Diagnostics Technologies for Global Health	August 2011
December 2010	NIH Tumor Microenvironment Network Jr. Investigator Meeting	May 2011
December 2010	NIH/FDA/Pharma Biomarker Consortium Workshop on Qualification and Validation of CTC Assays	June 2010
June 2011	Nijmegen Centre for Molecular Life Sciences	January 2011
December 2010	Ninth International Conference on Nanochannels, Microchannels and Minichannels	June 2011
June 2012	Nobel Symposium on Breast Cancer	June 2012
December 2011	Noise in Life Workshop	October 2010
January 2010	Nonlinear Dynamics on Networks	April 2010
December 2010	Nonlinear Dynamics Seminar	October 2010
December 2010	Nonlinear Phenomena, A View from mathematics and Physics	January 2011
June 2012	Northwestern University Applied Mathematics Colloquium	March 2012
December 2011	Northwestern University PS-OC seminar series	December 2011
June 2012	Northwestern University, Dept. of Chemical and Biological Engineering seminar series	March 2012
June 2011	Northwestern-India-Israel Workshop	March 2011
June 2011	NSF National Nanotechnology Infrastructure Network Computation Symposium	April 2011
December 2011	NSF Workshop on Biologically Enabled Wireless Networks	July 2011
June 2010	NSF workshop on Cellular Decision Making	April 2010
June 2011	NSF Workshop: How Molecules Come to Life: Biophysics Vision 2016	April 2011
December 2010	Nuclear Pore Complex Meeting	July 2010
June 2010	Nuclear Pore Complex: Biology, Physics and Nanotechnology II	July 2010
December 2011	NY Structural Biology Group (NYAS)	January 2012
June 2012	NYSTEM SURF Program in Stem Cell Science	June 2012
June 2011	Ohio State Cancer Center Grand Rounds	October 2010
June 2011	OHSU Bioengineering Colloquium	April 2011
June 2012	OHSU biomedicine in 4D conference	March 2012
June 2012	OHSU Center for Spatial Systems in Biomedicine Inaugural Symposium	January 2012
June 2012	ONCO Workshop	February 2012
June 2011	Opital Society BIOMED Topical Meeting	April 2010
June 2010	Opitical Soceity Annual Meeting	March 2010
December 2011	Oz MRS CANCER METASTASIS SYMPOSIUM,	October 2011
June 2012	Pacific Symposium in Biocomputing	January 2012

Progress Report Period	Meeting Name	Date
June 2012	Pacifichem 2010	December 2010
June 2010	Palo Alto Research Center Seminar	February 2010
June 2011	Penn State University Summer Chromatin Symposium	June 2011
December 2011	Pezcoller Symposium	June 2011
December 2010	Physical Science Oncology Series	November 2010
December 2010	Physical Sciences and Metastasis, NSF Symposium	November 2010
December 2010	Physics Colloquium at the State University of Campinas	July 2010
December 2011	Physics Seminar	May 2012
January 2010	Pittsburgh University & Carnegie Mellon University Seminar	November 2009
December 2010	Policy Issues in Nanotechnology and Oncology, National Cancer Policy Forum Workshop	July 2010
January 2010	Pontifical Academy of Science Annual Meeting	November 2009
June 2010	Poster presentation at Keystone Meeting "Tolerance and Autoimmunity"	February 2010
December 2011	Poster presented at the AACR TMEN meeting	November 2011
December 2010	Post-Graduation Seminar at the Federal University of Latin American Integration	August 2010
June 2012	Present Challenges of Mathematics in Oncology and Biology of Cancer : Modeling and Mathematical Analysis	March 2012
January 2010	Princeton University Department of Chemistry Seminar Series	August 2009
June 2010	Proceedings of International Symposium on Circuits and Systems	May 2010
June 2012	Proceedings of the American Society for Clinical Oncology Genitourinary Conference (ASCO GU 2012)	February 2012
December 2011	Proceedings of the ASME 2011 9th International Conference on Nanochannels, Microchannels, and Minichannels	June 2011
December 2011	Program in Respiratory Biology & Lung Disease	October 2011
December 2011	Prostate Cancer Foundation Meeting, Annual Meeting	September 2011
June 2012	Protein Capture Reagents Consortia Meeting	December 2011
December 2011	Protein Society 25th Anniversary Meeting	July 2011
June 2012	Protein Structure Initiative (PSI) Annual Meeting	December 2011
December 2010	Protein Structure Initiative:Biology – Meeting	July 2010
June 2010	Proteins Gordon Conference	June 2011
December 2011	Proteoglycan International Conference/Annual Scientific Meeting of the Matrix Biology Society of Australia and New Zealand	October 2011
January 2010	Proteomics & Modeling from Bench to Bedside	January 2010
December 2011	Providence Hospital Oncology Grand Rounds	September 2011
June 2011	Pruess Conference	March 2011
June 2011	PSI: Biology Annual Meeting	December 2010
June 2012	PSOC Annual Meeting	January 2012
June 2011	PS-OC Cancer Workshop: Cancer Cell Motility and the Metastatic Cascade	May 2011
June 2012	PSOC Collaborative Retreat	March 2012
June 2012	PSOC Retreat	December 2011

Progress Report Period	Meeting Name	Date
June 2012	PSOC Retreat	February 2012
January 2010	PSOC Seminar Series	May 2011
June 2011	PS-OC Workshop on "Cellular Differentiation and Response to Stress: Modeling Cancer Initiation and Progression"	August 2010
June 2012	PSOC-Cornell Young Investigators Workshop	August 2010
June 2010	Public Engagement and Science Communication Symposium 2010	March 2012
June 2011	Public outreach, "The Latest in Groundbreaking Cancer Research" community seminar series	May 2010
December 2010	Q-bio conference	May 2011
December 2011	Quantitative Biology Seminar	April 2012
December 2010	Quantitative Biology: From Complex Networks to Simple Models	December 2011
June 2012	Quantitative Imaging Biomarkers Alliance Workshop	August 2010
December 2011	Quantum Leap Healthcare Collaborative (Quantum), Workshop	September 2010
December 2010	Quantum mechanics and cancer biology	May 2011
December 2010	Quantum mechanics and cancer biology	October 2010
December 2011	R S3-3, IEEE International Conference on Nano/Molecular Medicine and Engineering	October 2011
December 2011	Radiation Medicine Seminar	November 2011
January 2010	RECOMB Systems Biology meeting	August 2011
December 2011	RECOMB/DREAM conference	December 2009
December 2010	Regeneration of Solid Organs: Solving Vascularization Issues, Life Science Summit 2010	October 2011
June 2012	Regenerative Medicine Seminar Series	September 2010
December 2010	Research Conference in Biomedicine "NanoMedicine: from Bench to Bedside"	September 2009
December 2011	Research in Progress IMO Lab Meeting Seminar	October 2010
December 2011	Research visit to the Scripps Institute	November 2011
June 2011	Retroviral tumor modeling workshop	March 2011
January 2010	Review of Center for Convergence of Physical Science & Cancer Biology	March 2011
December 2011	RIKEN Center for Developmental Biology workshop	October 2009
January 2010	Robert Cedegren Bioinformatics Colloquium	June 2011
December 2011	Robert J. Doyle Lecture	November 2009
December 2011	Rockefeller University, Biophysics Seminar Series	September 2011
June 2012	RSNA Annual Meeting	November 2011
June 2010	Russell Marker Lectures in Genetic Engineering	November 2011
June 2011	Russell Marker Lectures in Genetic Engineering	March 2010
June 2012	SABCS, San Antonio Breast Cancer Symposium	September 2011
December 2011	Salve Regina University, Gordon Research Conference on Mammary Gland Biology	December 2011
December 2011	San Antonio Breast Cancer Symposium	January 2011
June 2012	San Antonio Breast Cancer Symposium	June 2011

Progress Report Period	Meeting Name	Date
December 2011	San Francisco Komen Annual Breast Cancer Conference	December 2011
December 2011	Sandia / UNM Cancer Center Symposium on Nanoparticle Human Interactions.	June 2011
June 2011	Science & Technology Colloquium at IBM Almaden Research Center	January 2011
January 2010	Scientific Seminar Research Center of Excellence in Mechanobiology	January 2011
June 2012	Scientific Symposium for the American Thoracic Society	December 2009
December 2011	Scientific, Clinical and Operational Challenges Conference	May 2012
June 2012	Scottish Stem Cell Network Workshop on Oscillations	October 2011
June 2010	Scripps 4DB Center for Physics Metastasis over Time and Space seminar	March 2010
December 2011	Scripps Research Institute Seminar	February 2012
January 2010	Second AACR Dead Sea International Conference	March 2011
June 2010	Second Annual BEE Research Symposium	March 2010
June 2012	Second Annual National Cancer Institute Physical Sciences-Oncology Centers Network Investigators' Meeting	February 2010
June 2011	Second Annual NCI Physical Sciences – Oncology Center (PS-OC). Network Investigators' Meeting	January 2011
December 2010	Sectoral Asset Management Biannual Meeting	April 2011
June 2012	Select Biosciences 3rd annual Single Cell Analysis Summit	September 2010
December 2010	Seminar at UT Houston	November 2010
December 2010	Seminar in the Department of Mathematics	May 2010
June 2010	Seminar series of Institute of Biological Engineering at Swiss Institute of Technology (EPFL)	February 2010
June 2011	Seminar Series of the Center for Vascular Biology Research	March 2010
December 2010	Seminar Series of the Program for Evolutionary Dynamics	March 2011
December 2011	Seminar, Institute of Pharmacology and Structural Biology	December 2010
December 2011	Seminar, Interdisciplinary Research Institute	October 2011
December 2010	Seminar, Laboratory for Micro- and Nanotechnology, Paul Scherrer Institute	October 2011
June 2011	Seminar, Laboratory of physics of living matter, EPFL	November 2010
December 2011	Session Q7: System Biology III: The Physics of Evolution, Abstract ID: BAPS.2011. MAR.Q7.1, Abstract: Q7.00001	September 2011
June 2012	Seve Balesteros Glioblastoma Conference	June 2010
June 2012	SFB Annual Meeting	June 2011
June 2012	Shanghai Jiaotong University	February 2012
December 2011	SIAM Conference on Applications of Dynamical Systems	May 2011
December 2011	SIAM Conference on Applications of Dynamical Systems	October 2011
June 2010	SIAM-SEAS Conference, Society of Industrial and applied Mathematics Southeastern-Atlantic Section Conference	March 2010
June 2010	SIAM-SEAS Conference, Society of Industrial and applied Mathematics Southeastern-Atlantic Section Conference	March 2010
December 2011	Siemens Corporate Research Site Visit	October 2010
June 2012	SIIM 2011 Annual Meeting	June 2011

Progress Report Period	Meeting Name	Date
June 2011	SIIM 2011 Annual Meeting	September 2011
December 2011	Simpar Meeting	June 2011
June 2012	Simposio Internacional Oncologia Translacional	November 2011
June 2011	Single-cell Analysis Summit	April 2012
June 2011	SISCA Workshop on Systems Medicine	October 2010
December 2010	SNU-UC Berkeley Joint Symposium	February 2012
June 2012	Society for Basic Urology Research Fall Symposium (Fall 2011)	September 2010
June 2010	Society for Biological Engineering 2nd International Conference on Stem Cell Engineering	September 2011
June 2012	Society for Biological Engineering 3rd International Conference on Stem Cell Engineering	May 2010
June 2012	Society for Biological Engineering, 3rd International Conference on Stem Cell Engineering	May 2012
June 2010	Society for Biomaterials 2010 Annual Meeting	April 2012
January 2010	Society for Biomaterials Annual Meeting	April 2010
December 2010	Society for Industrial and Applied Mathematics Conference on Applications of Dynamical Systems	April 2011
January 2010	Society for Mathematical Biology Annual Meeting	May 2011
June 2012	Society for Mathematical Biology Conference, NIMBioS, Submitted to the mini-symposium "Data-driven Modeling in Mathematical Oncology", Cristini et al. organizers	January 2009
June 2012	Society for Melanoma Research Meeting	November 2010
June 2011	Society for Neuro-Oncology Annual Meeting	November 2009
June 2012	Society for Neuro-Oncology (SNO), 16th Annual Scientific Meeting & Education Day	November 2011
December 2011	Society of Hispanic Professional Engineers	January 2010
December 2010	Society of Neuro-Oncology	October 2011
June 2011	Society of Neuro-Oncology Annual Meeting	November 2010
December 2010	Society of Toxicologic Pathology Annual Meeting	November 2010
June 2010	Soft Biomaterials Workshop	June 2010
June 2011	Soft Matter in Biology: Experiments and Theory	February 2010
June 2012	Solvay Institute Workshop	May 2011
June 2010	South America Dynamics Days Conference	February 2012
June 2012	Southern Biomedical Engineering Conference	April 2010
January 2010	Southern Biomedical Engineering Conference	July 2010
January 2010	Southwest Oncology Group Plenary (SWOG)	May 2012
June 2012	Spain and Portugal Conference in Bioinformatics	October 2009
January 2010	Spanish Mathematical Societies meeting	January 2012
June 2012	Special Conference on Nano in Cancer: Linking Chemistry, Biology, and Clinical Applications in Vivo, American Association for Cancer Research	May 2010

Progress Report Period	Meeting Name	Date
December 2010	Special Symposium University of Missouri-Columbia	September 2010
December 2011	SPIE Photonics West Conference	January 2010
January 2010	SPIE Photonics West Conference	October 2010
June 2012	SPIE Photonics West Meeting	January 2011
January 2010	SPORE Breast Cancer Retreat	January 2012
June 2012	Spring eMRS meeting	January 2010
June 2010	Spring Lecture	May 2012
June 2012	Spring School of the French Society of Theoretical Biology	January 2010
June 2011	Stanford Bioengineering Colloquium	August 2010
January 2010	Stanford University Chemical Engineering special colloquium series	May 2011
June 2012	Stanford University, Symposium	March 2011
June 2012	Stanford University, Symposium	September 2011
June 2011	Stem Cell Club	September 2011
June 2012	Stem Cell Engineering Center (SCEC)	January 2011
June 2011	Stem Cell Workshop	November 2011
December 2011	Stowers Institue for Medical Research	April 2011
June 2011	Stowers Institute, Seminar	October 2011
December 2011	STSI Integrated Biological Systems	November 2011
December 2011	SULSA Symposium on Systems Biology	November 2011
December 2011	Summer Symposium on Chromatin and Epigenetic Regulation of Transcription	June 2012
December 2011	SUNY Eye Institute annual meeting	June 2011
December 2010	Symposium 11: Biomarkers of Exposure, Environmental Mutagen Society Annual Meeting	October 2010
June 2010	Symposium at Sloan-Kettering Institute	October 2010
June 2010	Symposium Lecture	June 2010
June 2012	Symposium of the Fondazione Pezcoller	February 2010
December 2011	Symposium on “Forces in Biomolecular Systems	June 2011
June 2011	Symposium on “Forces in Biomolecular Systems”	July 2011
June 2012	Symposium on Biomedical Applications of Magnetic Nanoparticles and Nanostructures, International Conference on Magnetics (Intermag)	July 2011
December 2011	Symposium on Developmental Biology	May 2012
June 2012	Symposium on Nanofunctional Materials, Nanostructures and Nanodevices for Cancer Applications, MRS Fall Meeting	October 2011
December 2011	Symposium on Non-Coding RNA and Epigenetics	November 2011
December 2011	Symposium on Quantitative Models In Molecular Biology	December 2011
December 2011	Symposium on Transcriptional Regulation	September 2011
December 2011	Symposium on Translational Research of Military Relevance	July 2011
June 2012	SYND 1.1: German Physical Society Meeting	June 2011

Progress Report Period	Meeting Name	Date
December 2011	Synthetic Biology International Workshop: "International Synthetic Biology Workshop: A Bio-based Future,"	March 2012
June 2010	Systems Biology seminar	August 2011
January 2010	Systems biology: global regulation of gene expression	March 2012
June 2012	Taiwan Academia Sinica Seminar	May 2012
June 2010	Taiwan Cooperative Oncology Group (TCOG) Annual Meeting	January 2012
December 2010	Taiwan Cooperative Oncology Group, National Institute of Cancer Research, National Health Research Institutes	November 2010
June 2011	Takeda Stem Cell Symposium	November 2010
June 2011	TCGA Steering Committee Meeting	November 2010
June 2012	TechConnect World Conference and Expo	April 2011
June 2012	Technical Planning Committee (TPC) for the Department of Defense, Breast Cancer Research Program (BCRP), 2011 Era of Hope (EOH) Conference	June 2012
June 2012	TEDMED	August 2011
January 2010	Tenth Annual Ernest Everett Just Scientific Symposium Special Conference for African Americans	April 2012
December 2011	Texas A&M Health Science Center, Distinguished Speaker	February 2010
December 2011	Texas A&M Health Science Center, Distinguished Speaker	July 2011
December 2011	The 12th Hunter Meeting	July 2011
December 2010	The 2010 Cornell NanoScale Facility (CNF) Annual Meeting	March 2012
June 2012	The 243rd ACS National Meeting	September 2011
December 2010	The 2nd Joint U.S.-China Symposium on Nanobiology and Nanomedicine	March 2012
June 2012	The 6th Annual IEEE International Conference on Nano/ Molecular Medicine and Engineering (IEEE-NANOMED 2012)	September 2010
June 2011	The Breast Cancer Symposium "Think Tank 20,"	December 2011
June 2012	The Canadian Meteorological and Oceanographic Society Annual Meeting	September 2011
June 2012	The Center of Nanotechnology 15th Anniversary	January 2011
June 2012	The Company of Biologists Workshop: Growth, Division and Differentiation: Understanding Developmental Control	April 2012
June 2010	The Department of Genome Sciences 9th Annual Symposium	September 2011
January 2010	The Detection of Extra-terrestrial Life and the Consequences for Science and Society	April 2010
December 2011	The Dutch Annual Biophysical Meeting – Honorary lecture	March 2009
June 2012	The EITA-Bio 2012 Conference	October 2011
December 2010	The Fourth Q-Bio conference on Cellular Information Processing	June 2010
December 2011	The future of biomarker discovery	August 2011
June 2012	The Future of Surgical Oncology. A Festschrift in Honor of Charles M. Balch, MD, FACS	June 2011
January 2010	The George E. Palade Celebration Symposium. Skaggs School of Pharmaceutical Sciences. UCSD	May 2011

Progress Report Period	Meeting Name	Date
June 2011	The Inaugural International Prostate Cancer Symposium	January 2010
June 2012	The International Conference on Advances in Micro and Nanofluidics	May 2011
June 2010	The International Society on Dynamic Games	May 2012
June 2011	The Jackson Laboratory Seminar	June 2010
June 2011	The James Frank Institute Colloquim	August 2011
January 2010	the Joint Statistical Meeting	August 2009
January 2010	The Joint Statistical Meeting	March 2011
January 2010	The Litwin Foundation Symposium	August 2010
January 2010	The Mechanical Properties of Cancer Cells and Their Micro-Environment	October 2009
June 2012	The Methodist Hospital Research Institute Integrative Cancer Biology Program Seminar Series	February 2010
December 2011	The Michael W. Chapman Lecture	January 2011
June 2010	The New York Academy of Sciences	June 2011
June 2010	The Pittsburgh Conference Annual Meeting	March 2010
December 2010	The Scripps Research Institute Postdoctoral Research Symposium	January 2010
June 2011	The Second Annual NCI PS-OC Network Investigators' Meeting	September 2010
June 2012	The Sino-US Nano Forum	April 2011
June 2010	The sixth iCeMS International Symposium	June 2012
January 2010	The sixth iCeMS International Symposium: Mesodomain structures of the plasma membrane	August 2010
June 2012	The Southern America Biomedical Engineering Conference	January 2010
June 2011	Third Annual BEE Research Symposium	March 2011
June 2011	Third Annual BEE Research Symposium	March 2012
December 2011	Third International Gene Center and SFB 646 Symposium 'Regulatory Networks in Genome Expression and Maintenance"	April 2012
June 2010	Tissue Engineering and Regenerative Medicine International Society (TERMIS)	October 2011
December 2010	Tissue Engineering and Regenerative Medicine Society (TERMIS) - Pre-conference workshop: HA Biomaterials for Cell Therapy	September 2010
June 2011	Tissue Engineering Symposium, Biomedical Engineering Society Joint Meeting with American Physiological Society, The Experimental Biology	December 2010
June 2012	Tissue Issue Think Tank Meeting	April 2011
June 2012	TMEN Junior Investigator Meeting	February 2012
June 2011	Transformational Oncology Symposium	October 2009
December 2011	Translational Cancer Research Symposium	November 2010
December 2011	Translational Cancer Research Symposium	October 2011
June 2012	Translational Tissue Engineering Center (TTEC) Seminar Series	October 2011
June 2012	Tri-Beta Biology Honor Society	October 2011
June 2011	TTEC Seminar Series	February 2012
June 2012	Tufts University Medical School Gastroenterology Grand Rounds	September 2011
June 2011	Tulane University,(Fisher Distinguished Lecture)	June 2012

Progress Report Period	Meeting Name	Date
June 2012	Tumor Microenvironment Network Annual Meeting	January 2010
June 2011	U54 Annual Interdisciplinary Symposium	January 2010
December 2011	UC Systemwide Bioenginering Symposium	February 2012
June 2012	UCLA Cancer Center / Crump Institute	June 2011
June 2012	UCLA Molecular Biology Institute Seminar	April 2012
June 2012	UCSD Genetic Retreat	May 2011
December 2011	UCSF – Stem cell seminar series	June 2011
December 2011	UCSF – Systems biology seminar series	May 2011
June 2011	UCSF 20TH Annual Developmental Biology Symposium, Mechanical Forces in Development	January 2011
June 2011	UCSF BOP Presentation	June 2011
June 2012	UCSF Breast Cancer SPORE annual meeting	January 2011
June 2011	UCSF Breast Cancer SPORE Retreat	February 2012
June 2012	UCSF Breast Oncology Program Annual Meeting	January 2011
June 2011	UCSF Breast Oncology Program Scientific Retreat	May 2011
June 2012	UCSF Breast Oncology Program, Annual Meeting	February 2012
June 2012	UCSF Breast Oncology Program, Annual Meeting	May 2011
June 2010	UCSF Breast SPORE - EAB Meeting	February 2012
December 2010	UCSF Gastrointestinal Research Meeting	April 2010
December 2011	UCSF Nikon Imaging Center Seminar	May 2010
June 2012	UCSF Pancreas Cancer Program Annual Retreat	July 2011
June 2010	UCSF Seminar Department of Bioengineering	May 2012
December 2010	UCSF/UCB Bioengineering Conference, UCSF/UCB Graduate Group in Bioengineering Fall 2010 Group Conference	May 2010
December 2011	UCSF-UCB Bioengineering Conference Abstract	September 2010
June 2011	UK CNTC – Markey Cancer Center Experimental Therapeutics seminar series	October 2011
June 2011	Undergraduate Mathematical Sciences Seminar	May 2011
June 2012	United States & Canadian Academy of Pathology Annual Meeting	April 2010
June 2012	United States Association for Computational Mechanics Workshop on Biomechanics and Mechanobiology	March 2010
December 2010	United States-Japan Cooperative Medical Science Program (CMSP) sponsored 14th International Conference on Emerging Infectious Diseases (EID) in the Pacific Rim	March 2012
December 2010	Univ of Colorado Lung Cancer Grand Rounds	October 2010
June 2012	Univeraity of Texas Southwestern Medical Center -Advanced Imaging Research Center Advisory Meeting and Annual Symposium	November 2009
December 2010	University Lecture, 2011 Keck Biomembrane Retreat	November 2011
December 2011	University of California, San Diego/Salk Institute Program in Biological Sciences Retreat	October 2010

Progress Report Period	Meeting Name	Date
December 2011	University of California, San Francisco, 20th Annual Developmental Biology Symposium	September 2011
January 2010	University of Connecticut Polymer Program Seminar Series	January 2010
June 2011	University of Dundee College of Life Sciences Annual Retreat	November 2009
June 2011	University of Illinois at Chicago, Seminar	March 2011
December 2011	University of Illinois at Urbana-Champaign Seminar	October 2011
June 2011	University of Kansas Bioanalysis Retreat	October 2011
December 2010	University of Kansas Dept. Pharmacology Retreat	October 2010
December 2011	University of Kansas Research Presentation	October 2010
June 2011	University of North Carolina Cancer Center Grand Rounds	May 2011
June 2012	University of Oklahoma, Graduate Seminar Series	November 2010
June 2011	University of Pennsylvania Medicine Grand Rounds	January 2012
December 2011	University of Pennsylvania, Dept. of Biomedical Engineering seminar series	February 2011
June 2012	University of Pennsylvania, Dept. of Biomedical Engineering seminar series,	March 2012
June 2012	University of Virginia, UVA Seminar Series on Cancer	March 2012
December 2011	UPenn School of Medicine, Dept. of Biochemistry and Biophysics Seminar Series	May 2012
June 2011	US Canadian Academy of Pathology Annual Meeting	June 2010
June 2012	US HUPO (Human Proteome) 8th Annual Conference	January 2010
June 2012	US HUPO 8th Annual Conference	March 2012
January 2010	US HUPO, 6th Annual Conference	March 2012
June 2012	USACM Workshop on Biomechanics and Mechanobiology	February 2012
June 2010	USC – PS-OC First Annual Symposium	February 2012
December 2010	USC Physical Sciences in Oncology Symposium	June 2010
December 2010	USC PSOC monthly seminar series (ODU)	October 2010
December 2010	USC PSOC monthly seminar series (ODU)	September 2010
December 2011	USC PSOC Monthly Seminar Series Invitation	November 2010
June 2010	USC PSOC Monthly Seminar Series:	March 2012
June 2012	USC PSOC Symposium	May 2011
June 2010	USC PS-OC Symposium	October 2011
December 2011	USC-PSOC Monthly Seminar Series,	March 2011
June 2011	USD Cancer, Molecular Mechanisms & Therapeutic Targets Seminar	September 2011
June 2010	UT Southwestern: Symposium on Intermediary Metabolism in Cancer	February 2011
June 2010	UTHSC-H Office of Research -2009 Research Day – Engines of Discovery	October 2011
June 2011	Van Andel Research Institute, (Han-Mo Koo Memorial Seminar)	March 2010
December 2011	Vanderbilt Department of Obstetrics and Gynecology Grand Rounds	January 2010
January 2010	Vanderbilt University Medical Center	November 2009
December 2010	Vascular Matrix Biology and Bioengineering Workshop	November 2009
June 2012	Vascular Matrix Biology and Bioengineering Workshop	October 2011
December 2010	Vertex Pharmaceuticals	October 2011

Progress Report Period	Meeting Name	Date
December 2011	VIIM: Department of Energy P.I. Meeting	September 2011
December 2011	VIIM: Invited Pollak Lecture	October 2011
June 2010	Vince Kidd Postdoctoral Fellow Memorial	October 2011
June 2011	Vince Kidd Postdoctoral Fellow Memorial Lecture, Danny Thomas Lecture Series	March 2010
June 2011	Virginia Commonwealth University/Massey Cancer Center Seminar	January 2010
June 2010	Virginia G. Piper Foundation, Board of Trustee	October 2010
June 2012	Visiting Professor	June 2012
June 2012	Visiting Professor at University of Minnesota; Lecture: Stressed Out	January 2012
June 2010	W. Dial Black Family Lecture Series	January 2010
January 2010	Warburg symposium	January 2010
December 2011	Washington University School of Medicine: David M. Kipnis Lecture	January 2010
December 2011	Washington University, Dept. of Biomedical Engineering seminar series	April 2011
December 2011	Weill Cornell University Medical Center Medicine Grand Rounds	July 2010
December 2011	Weizmann Harvard Meeting on Systems Biology	October 2010
January 2010	Weizmann Institute Lecture	March 2011
June 2010	Weizmann Seminar	May 2010
December 2010	West Lake Translational Research Conference	March 2010
December 2010	Whitehead retreat	June 2010
June 2012	William C. Reynolds Memorial Seminar	September 2010
January 2010	William E. Schiesser Seminar	October 2011
December 2011	William Guy Forbeck Research Foundation Forum	November 2009
December 2011	William Lawrence and Blanche Hughes Foundation Retreat 2011	November 2011
June 2011	Winship Cancer Institute	October 2011
June 2010	Wistar Institute, Distinguished Seminar Series	October 2010
June 2012	WMIC Annual Meeting	September 2011
June 2011	Workshop "New Developments in Dynamical Systems Arising from the Biosciences"	January 2012
December 2010	Workshop at the Aspen Center for Physics (ACP)	March 2011
December 2011	Workshop on "Growth, division and differentiation: understanding developmental control"	August 2010
June 2010	Workshop on Cellular Differentiation and Response to Stress: Modeling Cancer Initiation and Progression	September 2011
December 2011	Workshop on Computational Biology	August 2010
June 2010	Workshop On Dynamics Of Protein-DNA Interactions	December 2011
June 2010	Workshop on Glioblastoma Multiforme	March 2010
June 2010	Workshop on Living Mechanics: Cell, Tissue and Organism	June 2010
January 2010	Workshop on Mathematical and experimental approaches to dynamics of protein-DNA interactions	November 2010
June 2012	Workshop on Mathematical Oncology IV: Integrative Cancer Biology	March 2010

Progress Report Period	Meeting Name	Date
June 2012	Workshop on Molecular Biology and Biotechnology	March 2012
June 2011	Workshop on Molecular Evolution	December 2011
June 2010	Workshop on Morphogen Gradients and Flow in the Tumor Microenvironment	February 2011
December 2011	Workshop on NanoBio Imaging and Applications, KRISS	June 2011
June 2011	Workshop on NanoBio Imaging and Applications, KRISS	May 2010
December 2011	Workshop on Nonlinear Physics and Applications	June 2011
June 2012	Workshop on statistical mechanics	September 2011
December 2011	Workshop on the Physics of Tumor Heterogeneity	February 2010
December 2011	Workshop on the Physics of Tumor Heterogeneity	June 2011
December 2010	Workshop Quantitative Biology: From Complex Networks to Simple Models	June 2011
December 2010	Workshop: Cellular Differentiation and Response to Stress: Modeling Cancer Initiation and Progression	September 2010
June 2011	Workshop: Circulating Tumor Cells	August 2010
June 2011	Workshop: Physical and Computational Approaches to Cancer Biology	February 2011
June 2012	World Biomaterials Congress	March 2011
December 2010	World Conference on Interventional Oncology Conference (WCIO)	June 2012
June 2010	World Congress of Biomechanics	August 2010
June 2010	World Congress of Biomechanics	June 2010
December 2010	World Congress of Neurotechnology	August 2010
December 2010	World Congress on Biomechanics	October 2010
June 2010	World Congress on Computational Mechanics Meeting	December 2011
June 2010	World Molecular Imaging Conference	August 2010
June 2012	World Molecular Imaging Conference Annual Meeting	May 2010
December 2011	World Theranostics Congress	September 2011
June 2012	XII TTS Basic Science Symposium / II ESOT Basic Science Meeting	November 2011
December 2011	XXI Porto Cancer Meeting	June 2011
June 2012	XXIII Congress of the International Society on Thrombosis & Haemostasis (ISTH)	April 2012
June 2011	XXIII Congress of the International Society on Thrombosis and Haemostasis, Kyoto, Japan	July 2011
June 2011	XXIV International Conference on Magnetic Resonance in Biological Systems	July 2011
December 2011	Yale Medical School Colloquium	August 2010
December 2011	Yale University Systems Biology Inaugural Symposium of West Campus	November 2011
December 2011	Young Researcher in Life Science Congress	July 2010
January 2010	Zeiss Fluorescence Correlation Spectroscopy Symposium	March 2010

15. OPSO Staff Invited Presentations

15. OPSO Staff Invited Presentations

1. "Physical Sciences & Life Sciences at the Interface: A Nanotechnology and Oncology Perspective," 1st Symposium on Nanotechnology for Public Health, Environment, and Energy, September 24-25, 2009, St. Louis, MO
2. "An Evolutionary Side to Cancer – Physical Sciences in Oncology Perspective," 49th Annual Meeting of the American Society for Cell Biology, December 5-9, 2009, San Diego, CA
3. "NCI's Physical Sciences in Oncology Initiative: An Evolutionary Perspective," Workshop on Evolution, Fundamentals, and Disease, December 8-10, 2009, Hong Kong, China
4. "Feeling Cancer: Cells as a Mechanical Transducer of their Environment," ASU Cancer Forum Workshop: Mechanical Properties of Cancer Cells and their Micro-Environment, February 10-12, 2010, Tempe, AZ
5. "Convergence of Physical and Life Sciences Perspectives: Emergent Trends in Cancer and Nanotechnology," International Conference on Nano Science and Technology (ICONSAT-2010), February 17-20, 2010, Mumbai, India
6. "NCI PS-OC Network," USC PS-OC Annual Symposium, June 18, 2010, Los Angeles, CA
7. "Cancer Nanotechnology – Prospect for a New Class of Diagnostic and Therapeutic Solutions," NSTI Nanotech 2010 Conference, June 21-25, 2010, Anaheim, CA
8. "What Makes a Quintessential PS-OC Investigator?," Center for Transport OncoPhysics Annual Workshop, September 24, 2010, Houston, TX
9. "Biomedical Nanotechnologies – Low Dimensional Nanoscale Devices for Disease Diagnostics & Therapy," 218th Electrochemical Society Meeting, October 10-15, 2010, Las Vegas, NV
10. "Physical Sciences & Nanotechnology for Cancer Diagnosis, Treatment, and Prevention," Academia Sinica Symposium, October 26, 2010, Taipei, Taiwan
11. "Clinical Translation of Nanotechnology," Taiwan National Health Research Institutes (NHRI) Seminar, October 27, 2010, Jhunan Township, Taiwan
12. "Bring the Physics, Not Just the Physicists, to Cancer," 2010 Physics Research Promotion Center (PRPC) Annual Meeting, October 30, 2010, Kaohsiung, Taiwan
13. Bring the Physical Science Perspective, Not Just the Physical Scientists, to Cancer Research," University of Washington, Seattle, Seminar, November 15, 2010, Seattle, WA
14. "Convergence of Physical and Life Sciences Perspectives: Cell Mechanics and Cancer," American Society of Mechanical Engineers (ASME) 2010 International Mechanical Engineering Congress & Exposition, November 12-18, 2010, Vancouver, Canada
15. "Take a Different Approach to Cancer: A Physical Sciences Perspective," 2010 Biomedical Nanoscience Initiative of University of Miami ("BioNIUM") Retreat, December 9-10, 2010, Miami, FL
16. "Epigenetics: The Physical Sciences in Oncology Perspective," 50th American Society for Cell Biology (ASCB) Annual Meeting, December 11-15, 2010, Philadelphia, PA

17. "What Makes the Quintessential Interdisciplinary Investigator?," University of Illinois, Urbana-Champaign Innovation Summit Workshop: Bridging the Gaps: Grand Challenges and Promising Practices in Interdisciplinary Research and Education in Biology, Engineering, and Health Sciences, February 4, 2011, Urbana, IL

18. "The PS-OC Network: Unique Elements and Evaluation" Science of Team Science Annual Conference, April 14-15, 2011, Chicago, IL

19. "The Physics of Cancer," 7th International Conference of Biological Physics (ICBP 2011), June 22-24, 2011, La Jolla, CA

20. "Comparative Innovation Systems: China-U.S. Cancer Innovation with a Physical Sciences Twist," National Academies of Sciences & Chinese Academy of Engineering Comparative Innovation Systems Summit, June 28, 2011, Tsinghua University, Beijing, China

21. "Biomedical Innovation & Health Policy: China-U.S. Computational Physics and Cancer," National Academies of Sciences Biomedical Innovation and Health Policy in China and the United States Innovation Summit, June 30, 2011, Peking University, Beijing, China

22. "Unfolding Printed Electronics and Nanotechnology to Bridge Biomedical Applications in Cancer," NanoPrint 2011, July 4-5, 2011, Singapore

23. "A Convergence of Physical Sciences & Nanotechnology to Bridge Biomedical Applications in Cancer," US Air Force Office of Science Research – Australia National Fabrication Facility Workshop, July 19, 2011, Melbourne, Australia

24. "Nanomaterial Applications: Changing the Face of Cancer," US Air Force Office of Science Research – Australia National Fabrication Facility Wollongong Hub Workshop, July 21, 2111, Wollongong, Australia

25. "NCI PS-OC Network," USC PS-OC Annual Symposium, October 17, 2011, Los Angeles, CA

26. "Evaluating Collaboration and Team Science in the National Cancer Institute's Physical Sciences-Oncology CentersNetwork," American Evaluation Association 2011: Values and Valuing in Evaluation, November 2-5, 2011, Anaheim, CA

27. "Convergence: The Death of Disciplinary Science?," Partnering for Cures, November 6-8, 2011, New York, NY

28. "Blending Materials Science, Nanotechnology, and Oncology through a Physical Sciences Perspective," 2011 Fall Materials Research Society Meeting, November 28 – December 2, 2011, Boston, MA

29. "3D Architecture: From Genome to Tissue and Back," 51st American Society for Cell Biology (ASCB) Annual Meeting, December 3-7, 2011, Denver, CO

30. "Convergence of Nanotechnology, Materials Science, and Oncology through a Physical Sciences Perspective," International Conference on Nano Science and Technology (ICONSAT-2012), January 20-23, 2012, Hyderabad, India

31. "NCI OPSO Perspective on Biomedical Applications in Cancer," Australia Interagency Working Group Meeting, February 15, 2012, Arlington, VA

32. "Physics of Cancer: Introduction to the Physical Sciences-Oncology Centers (PS-OC)," 2012 American Physical Society (APS) March Meeting, February 27 – March 2, 2012, Boston, MA

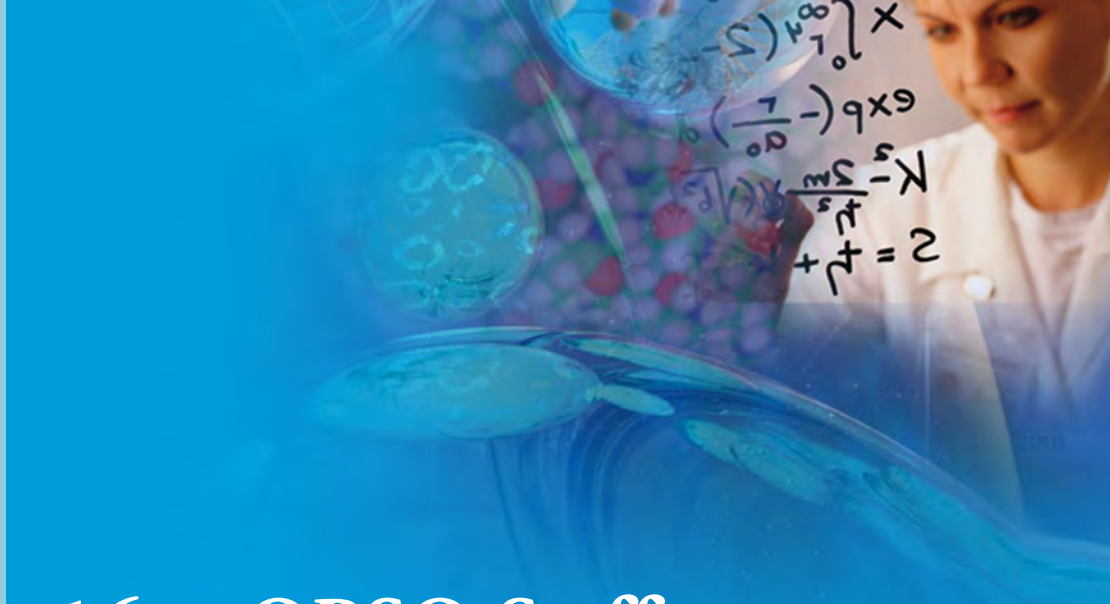
33. "The Convergence of Physical Sciences and Life Sciences in Biomedical Research" American Chemical Society Spring National Meeting, March 28, 2012, San Diego, CA

34. "Integrating the Physical Sciences & Engineering to Bridge Biomedical Applications in Cancer," US Air Force Office of Science Research – Australia National Fabrication Facility Program Review, April 30 – May 4, 2012, Washington, DC

35. "Challenges in Human Health: Physical Sciences Perspective and Cancer," 33rd Annual Council for Chemical Research (CCR), May 21-22, 2012, Dearborn, MI

36. "Unconventional Innovative Approaches in Oncology: Physical Sciences Perspectives," National Academies of Sciences: Building the Illinois Innovation Economy, June 28-29, 2012, Evanston, IL

37. "Turning Cancer on its Side: Unconventional Approaches in Physical Sciences – Oncology Centers (PS-OC Network)," Physics and Mathematics of Cancer, July 10, 2012, Kavli Institute for Theoretical Physics (KITP), UC Santa Barbara, CA



16. OPSO Staff Symposium and Workshop

16. OPSO Staff Symposium and Workshops

1. "Session W3: Physics of Circulating Tumor Cells and Metastasis," 2009 American Physical Society (APS) March Meeting, March 16-20, 2009, Pittsburgh, PA
2. "Symposium C2 - Dielectrics and Engineered Interfaces in Biological and Biomedical Applications," 215th Electrochemical Society (ECS) Meeting, May 24-29, 2009, San Francisco, CA
3. "Special Interest Subgroup: Cancer Cell Evolution: Is it Survival of the Fittest?", The American Society for Cell Biology Annual Meeting, December 5, 2009, San Diego, CA
4. "Track 1: NanoEngineering for Medical Diagnostics – Detection and Analysis of Circulating Tumor Cells," American Society for Mechanical Engineers (ASME) 2010 First Global Congress on NanoEngineering for Medicine and Biology, February 7-10, 2010, Houston, TX
5. "Track 7: Biological NanoMechanics – Nanomechanics and Cancer," American Society for Mechanical Engineers (ASME) 2010 First Global Congress on NanoEngineering for Medicine and Biology, February 7-10, 2010, Houston, TX
6. "Session V15: Focus Session: Novel Instrumentation and Measurements for Medical and Biological Systems Show," 2010 American Physical Society (APS) March Meeting, March 15-19, 2010, Portland, OR
7. "Session Y7: Convergence of Physics and Life Sciences: Emerging Perspectives in Cancer," 2010 American Physical Society (APS) March Meeting, March 15-19, 2010, Portland, OR
8. "Symposium J2: Electrochemical Nano/Bio Sensors 2," 217th Electrochemical Society (ECS) Meeting, April 25-30, 2010, Vancouver, Canada
9. "The Physics and Engineering of Cancer Cells and Their Microenvironment", The Biomedical Engineering Society Annual Meeting, October 9, 2010, Austin, TX
10. "Symposium MM: Nanofunctional Materials, Structures, and Devices for Biomedical Applications - II," 2010 Materials Research Society (MRS) Fall Meeting, November 30 – December 2, 2010, Boston, MA
11. "Special Interest Subgroup: The Role of Epigenetics in Cancer Cell Biology: A Physical Sciences Perspective", The American Society for Cell Biology 50th Annual Meeting, December 11, 2010, Philadelphia, PA
12. "D21 Focus Session: Novel Instrumentation & Measurements for Biomedical Research," American Physical Society (APS) March Meeting, March 21-25, 2011, Dallas TX
13. "Probing Cellular and Sub-Cellular Function via Surface Chemistry for Biomedical Applications," 241th American Chemical Society (ACS) National Meeting, March 27-31, 2011, Anaheim, CA
14. "Symposium E2: Bioelectronics, Biointerfaces, and Biomedical Applications," 219th Electrochemical Society (ECS) Meeting, May 1-6, 2011, Montreal, Canada
15. "Symposium J3: Sensors for Biomedical Applications," 219th Electrochemical Society (ECS) Meeting, May 1-6, 2011, Montreal, Canada
16. "Nano/Bio-Medicine," IEEE Nano 2011" August 15-18, 2011, Portland, OR

17. "Symposium J6: Sensor based Fluorescence, SERS, SPR, and Photoelectrochemistry," 220th Electrochemical Society (ECS) Meeting, October 9-14, 2011, Boston, MA

18. "Special Interest Subgroup: 3D Architecture: From Genome to Tissue and Back ", The American Society for Cell Biology Annual Meeting, December 3, 2011, Denver, CO

19. "Novel Instrumentation & Measurements for Biomedical Research," American Physical Society (APS) March Meeting, February 27-March 2, 2012, Boston, MA

20. "High Content Biophysical Data for Dynamic Studies in Cancer," American Physical Society (APS) March Meeting, February 27-March 2, 2012, Boston, MA

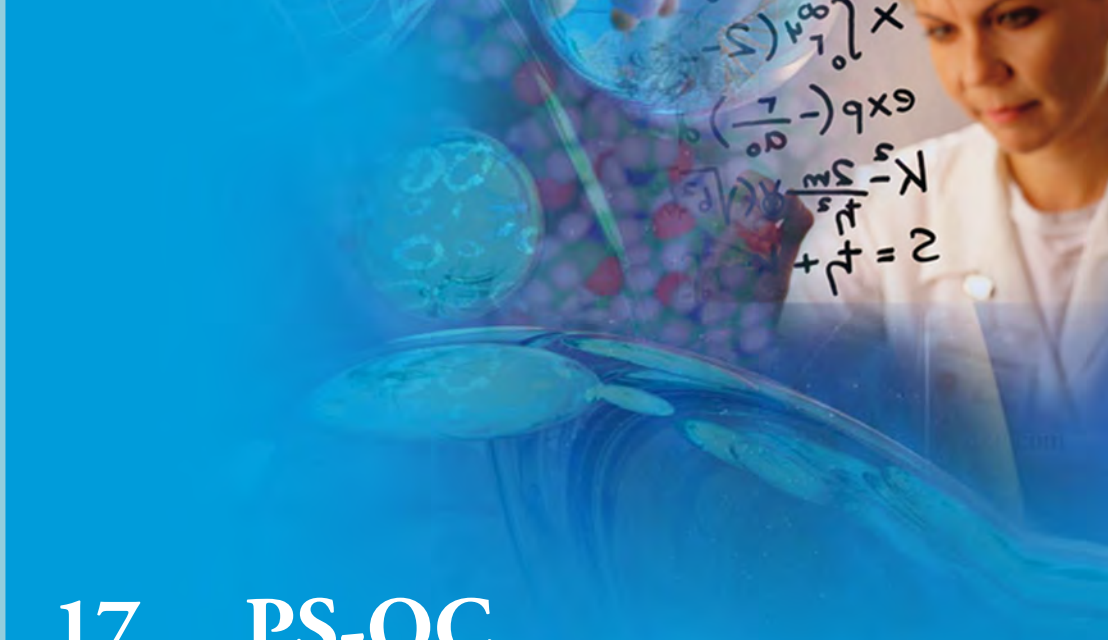
21. "Surface Chemistry in Oncology," 243rd American Chemical Society (ACS) National Meeting, March 25-29, 2012, San Diego, CA

22. "Symposium F2: Surface Treatments for Biomedical Applications," 221th Electrochemical Society (ECS) Meeting, May 6-11, 2012, Seattle, WA

23. "Symposium J2: Nano/Bio Sensors," 221th Electrochemical Society (ECS) Meeting, May 6-11, 2012, Seattle, WA

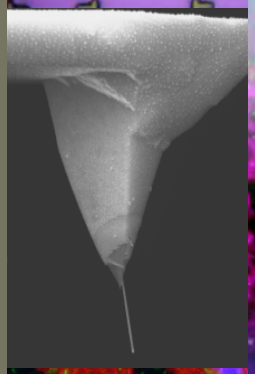
24. "Physics and Mathematics of Cancer," The Kavli Institute for Theoretical Physics, May 21 – July 13, 2012, University of California, Santa Barbara, CA

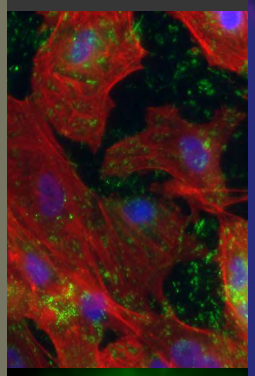
25. "MS3: Converging Clinical Oncology with Physical Sciences Based Mathematical Modeling," 2012 Society of Industrial and Applied Mathematics (SIAM) Conference on the Life Sciences, August 7-10, 2012, San Diego, CA

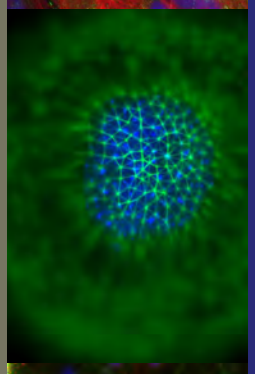


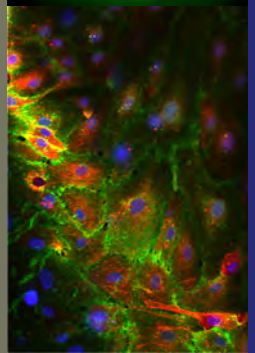
17. PS-OC Investigator Meeting Agendas

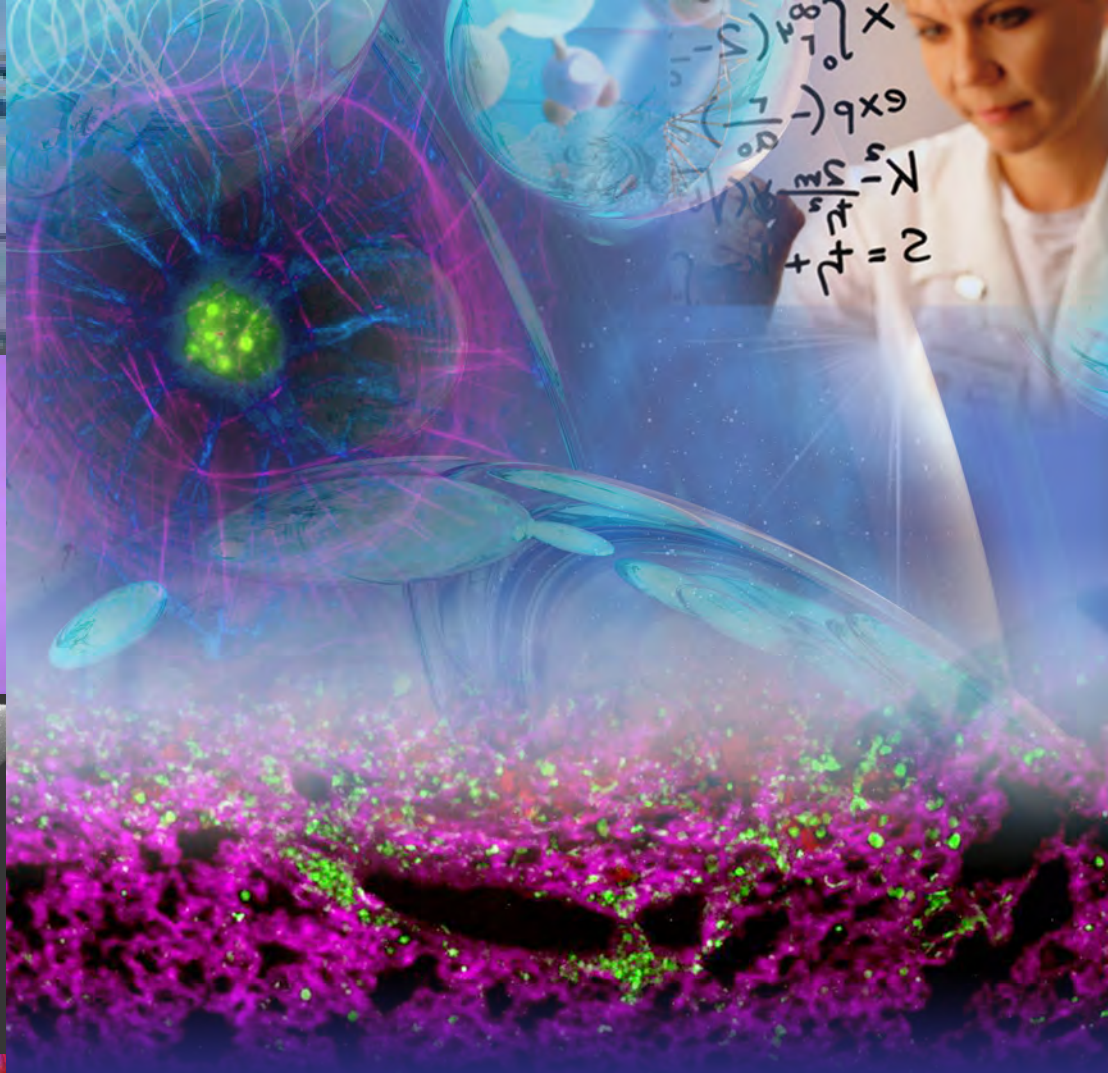
National Cancer Institute











PHYSICAL SCIENCES in ONCOLOGY

First Annual NCI Physical Sciences-Oncology Centers Network Investigators' Meeting

April 5-7, 2010

Gaylord National Resort and Convention Center
National Harbor, Maryland

Program Book

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

National Institutes of Health

17.1. First Annual Principal Investigator Meeting

Monday, April 5

7:00 a.m. - 5:00 p.m.	**Registration**	*Potomac C Lobby*
7:00 a.m. - 5:00 p.m.	**Poster Setup**	*Potomac A Lobby*
7:00 a.m. - 8:00 a.m.	**Continental Breakfast**	
8:00 a.m. - 11:30 a.m.	**Tutorial Sessions** Chair: Jan T. Liphardt, Ph.D. University of California, Berkeley University of California, Berkeley PS-OC	*Potomac C*
8:00 a.m. - 8:45 a.m.	***Understanding Transcription and Epigenetics*** Jonathan D. Licht, M.D. Robert H. Lurie Comprehensive Cancer Center Northwestern University PS-OC	
8:45 a.m. - 9:30 a.m.	***Quantifying Gene, RNA, and Protein Activity in Single Cells*** Alexander van Oudenaarden, Ph.D. Massachusetts Institute of Technology Massachusetts Institute of Technology PS-OC	
9:30 a.m. - 10:00 a.m.	***Break***	
10:00 a.m. - 10:45 a.m.	***Particle Tracking Microrheology of Living Cells: Principles and Applications*** Denis Wirtz, Ph.D. Johns Hopkins University Johns Hopkins University PS-OC	
10:45 a.m. - 11:30 a.m.	***Cellular Conversations That Control the Initiation and Progression of Cancer*** Thea D. Tlsty, Ph.D. University of California, San Francisco Princeton University PS-OC	
11:30 a.m. - 1:00 p.m.	**Lunch**	*Potomac A*

11:30 a.m. - 1:00 p.m. **Working Lunch Sessions**

PS-OC Evolution of Drug Resistance Working Group Presentation *Potomac 1-2*

Somatic Evolution in Cancer
John W. Pepper, Ph.D.
University of Arizona
University of Southern California PS-OC

Young Investigators Trans-Network Projects Information Session *Potomac C*

1:00 p.m. - 5:05 p.m. **Cell Line Exercise** *Potomac C*
Moderator: Nastaran Z. Kuhn, Ph.D.
National Cancer Institute, NIH

1:00 p.m. - 1:05 p.m. ***Opening Remarks***
Jerry S.H. Lee, Ph.D.
National Cancer Institute, NIH

1:05 p.m. - 1:15 p.m. ***Introduction***
Nastaran Z. Kuhn, Ph.D.
National Cancer Institute, NIH

1:15 p.m. - 1:30 p.m. ***Characterization of the Physical-Science-Oncology Center (PS-OC)-Specific MCF-10A and MDA-MB-231 Cells in Response to Stress***
Steve Oh, Ph.D.
University of California, San Francisco
Princeton University PS-OC

1:30 p.m. - 1:45 p.m. ***Methodology for Using PS-OC Cell Lines in Studying Tumor Microenvironment***
Arig Ibrahim Hashim, M.D.
H. Lee Moffitt Cancer Center & Research Institute
H. Lee Moffitt Cancer Center & Research Institute PS-OC

1:45 p.m. - 2:00 p.m. ***Internalization of Au Nanoparticle-phages-Multiscale Silicon Vectors Nanoassemblies Targeted to the Integrin Receptors: Study in MCF-10A and MDA-MB-231 Cells***
Biana Godin-Vilentchouk, Ph.D.
University of Texas Health Science Center at Houston
University of Texas Health Science Center at Houston PS-OC

2:00 p.m. - 2:15 p.m. ***Examining the Intracellular Physical Microenvironment in Carcinogenesis***
Veronica Estrella, M.S.
H. Lee Moffitt Cancer Center & Research Institute
H. Lee Moffitt Cancer Center & Research Institute PS-OC

2:15 p.m. - 2:30 p.m.	***Detecting Single Endogenous mRNA Molecules Using FISH*** Kevin Kung, Ph.D. Massachusetts Institute of Technology Massachusetts Institute of Technology PS-OC
2:30 p.m. - 2:45 p.m.	***Measurement of Mechanics and Internal Structure of Mitotic Chromosomes*** John Marko, Ph.D. Northwestern University Northwestern University PS-OC
2:45 p.m. - 3:05 p.m.	***Break***
3:05 p.m. - 3:20 p.m.	***Cancer Evolution in MicroFabricated Landscapes*** Guillaume Lambert, Ph.D. Princeton University Princeton University PS-OC
3:20 p.m. - 3:35 p.m.	***Characterization of Circulating Tumor Cell Dynamics in a Model of Coagulation Under Shear*** Joseph Aslan, Ph.D. Oregon Health & Science University The Scripps Research Institute PS-OC
3:35 p.m. - 3:50 p.m.	***Culturing, Assessing Physiology, Elasticity and 3D Nuclear Morphometry of Breast Cancer Cells and Controls*** Roger Johnson, Ph.D. Arizona State University Arizona State University PS-OC
3:50 p.m. - 4:05 p.m.	***Oxygen-Controlled 3D Cultures to Analyze Tumor Angiogenesis*** Claudia Fischbach, Ph.D. Cornell University Cornell University PS-OC
4:05 p.m. - 4:20 p.m.	***Migration, Proliferation and Force Generation of MCF-10A and MDA-MB-231 Cells*** Cynthia Reinhart-King, Ph.D. Cornell University Cornell University PS-OC
4:20 p.m. - 4:35 p.m.	***Mechanobiology of MCF-10A and MDA-MB-231 Cells*** Denis Wirtz, Ph.D. Johns Hopkins University Johns Hopkins University PS-OC
4:35 p.m. - 5:00 p.m.	***Discussion***

5:00 p.m. - 5:05 p.m.	***Closing Remarks*** Nastaran Z. Kuhn, Ph.D. National Cancer Institute, NIH	
5:00 p.m. - 7:00 p.m.	**Poster Session and Reception** ***ODD number posters present at this time.***	*Potomac A*

Tuesday, April 6

7:00 a.m. - 5:00 p.m.	**Registration**	*Potomac C Lobby*
7:00 a.m. - 8:00 a.m.	**Continental Breakfast**	*Potomac A Lobby*
8:00 a.m. - 8:10 a.m.	**NCI Welcome and Opening Remarks** John E. Niederhuber, M.D. National Cancer Institute, NIH	*Potomac C and D*
8:10 a.m. - 8:30 a.m.	**NCI Introduction - Meeting Objective** Anna D. Barker, Ph.D. National Cancer Institute, NIH	
8:30 a.m. - 8:40 a.m.	**Patient Advocate Perspective** Jeff Allen, Ph.D. Executive Director Friends of Cancer Research	
8:40 a.m. - 9:20 a.m.	**Plenary Talk** ***The Riddle of Cancer: Evolution, Biology, and Physics*** Donald S. Coffey, Ph.D. Johns Hopkins University Princeton University PS-OC	
9:20 a.m. - 10:10 a.m.	**Panel Discussion:** ***GBM—Think Differently*** ***Panelists:*** Eric Holland, M.D., Ph.D. Memorial Sloan-Kettering Cancer Center Memorial Sloan-Kettering Cancer Center PS-OC Chris Sander, Ph.D. Memorial Sloan-Kettering Cancer Center Memorial Sloan-Kettering Cancer Center PS-OC	

Franziska Michor, Ph.D.
Memorial Sloan-Kettering Cancer Center
Memorial Sloan-Kettering Cancer Center PS-OC

David Agus, M.D.
University of Southern California
University of Southern California PS-OC

10:10 a.m. - 10:40 a.m. **Break**

10:40 a.m. - 12:20 p.m. **Session 1: A Little Oxygen, Please!**
Moderator: Robert A. Gatenby, M.D.
H. Lee Moffitt Cancer Center & Research Institute
H. Lee Moffitt Cancer Center & Research Institute PS-OC

10:40 a.m. - 11:00 a.m. ***Investigating the Role of Hypoxia-Induced Remodeling of the Extracellular Matrix in Cancer Metastasis***
Gregg L. Semenza, M.D., Ph.D.
Johns Hopkins University
Johns Hopkins University PS-OC

11:00 a.m. - 11:20 a.m. ***Single-Cell Respiration Rates and Nuclear Morphometry in Normal and Cancer Cells***
Deirdre R. Meldrum, Ph.D.
Arizona State University
Arizona State University PS-OC

11:20 a.m. - 11:40 a.m. ***What Is the Role of the Physical Microenvironment on the Evolution and Progression of Cancers***
Robert J. Gillies, Ph.D.
H. Lee Moffitt Cancer Center & Research Institute
H. Lee Moffitt Cancer Center & Research Institute PS-OC

11:40 a.m. - 12 noon ***Three-Dimensional Modeling of Cell Deformations and Mechanics in Multicellular Assemblies***
Timothy J. Newman, Ph.D.
Arizona State University
Arizona State University PS-OC

12 noon - 12:20 p.m. ***Discussion***

12:20 p.m. - 1:50 p.m. **Lunch** *Potomac A*

12:20 p.m. - 1:50 p.m. **Working Lunch Sessions**

PS-OC Evolution of Drug Resistance Working Group Meeting *Potomac 1-2*
Clinical Drug Resistance Panel Discussion

PS-OC Physics Working Group Meeting *Potomac 3-4*

PS-OC Education and Training Working Group Meeting *Potomac 5-6*

1:50 p.m. - 3:10 p.m. **Session 2: Information Exchange – What's the Currency?** *Potomac C and D*
Moderator: Barbara Hempstead, M.D., Ph.D.
Weill Cornell Medical College
Cornell University PS-OC

1:50 p.m. - 2:10 p.m. ***A Genomic Code for Nucleosome Positioning From Archaebacteria to Man***
Jonathan Widom, Ph.D.
Northwestern University
Northwestern University PS-OC

2:10 p.m. - 2:30 p.m. ***Epigenomic Basis of Myeloid Malignancies***
Ari Melnick, Ph.D.
Cornell University
Cornell University PS-OC

2:30 p.m. - 2:50 p.m. ***Networks in The Cancer Genome Atlas***
Chris Sander, Ph.D.
Memorial Sloan-Kettering Cancer Center
Memorial Sloan-Kettering Cancer Center PS-OC

2:50 p.m. - 3:10 p.m. ***Discussion***

3:10 p.m. - 3:40 p.m. **Break**

3:40 p.m. - 5:00 p.m. **Session 3: Rare Cellular Events and Survival Prediction**
Moderator: William Daniel Hillis, Ph.D.
University of Southern California/Applied Minds, Inc.
University of Southern California PS-OC

3:40 p.m. - 4:00 p.m. ***Cell of Origin, Mathematical Model, Mouse Model***
Eric Holland, M.D., Ph.D.
Memorial Sloan-Kettering Cancer Center
Memorial Sloan-Kettering Cancer Center PS-OC

4:00 p.m. - 4:20 p.m. ***Measuring Topology of Circulating Tumor Cells in the Peripheral Blood***
Peter Kuhn, Ph.D.
The Scripps Research Institute
The Scripps Research Institute PS-OC

4:20 p.m. - 4:40 p.m. ***Darwin Meets Nano: Galapagos Islands on a Wafer***
James C. Sturm, D.Eng.
Princeton University
Princeton University PS-OC

4:40 p.m. - 5:00 p.m. ***Discussion***

5:00 p.m. - 7:00 p.m. **Poster Session and Reception** *Potomac A*
EVEN number posters present at this time.

7:00 p.m. - 9:00 p.m. **PS-OC Steering Committee Working Dinner (by invitation)** *Potomac 3-4*

Wednesday, April 7

7:00 a.m. - 2:30 p.m. **Registration** *Potomac C Lobby*

7:00 a.m. - 8:00 a.m. **Continental Breakfast** *Potomac C Lobby*

8:00 a.m. - 8:10 a.m. **PS-OC Update** *Potomac C and D*
Larry A. Nagahara, Ph.D.
National Cancer Institute, NIH

8:10 a.m. - 8:20 a.m. **PS-OC Poster and Young Investigators Trans-Network Project Awards** *Potomac C and D*
Anna M. Calcagno, R.Ph., Ph.D.
National Cancer Institute, NIH

Sean E. Hanlon, Ph.D.
National Cancer Institute, NIH

8:20 a.m. - 10:00 a.m. **Session 4: Perturbing the Spherical Cow** *Potomac C and D*
Moderator: Denis Wirtz, Ph.D.
Johns Hopkins University
Johns Hopkins University PS-OC

8:20 a.m. - 8:40 a.m. ***Coordination of Cell Growth and Division in Normal and Cancer Cells***
Scott Manalis, Ph.D.
Massachusetts Institute of Technology
Massachusetts Institute of Technology PS-OC

8:40 a.m. - 9:00 a.m. ***Physical Manipulation of EphA2 Spatial Organization Alters Cellular Response to Ephrin-A1***
Jay T. Groves, Ph.D.
University of California, Berkeley
University of California, Berkeley PS-OC

9:00 a.m. - 9:20 a.m. ***Traction Forces Exerted by Adherent Cells***
Cynthia Reinhart-King, Ph.D.
Cornell University
Cornell University PS-OC

9:20 a.m. - 9:40 a.m. ***Forcing Transformation and Metastasis***
Valerie Weaver, Ph.D.
University of California, Berkeley
University of California, Berkeley PS-OC

9:40 a.m. - 10:00 a.m. ***Discussion***

10:00 a.m. - 10:30 a.m. **Break**

10:30 a.m. - 12 noon **Session 5: A Spectrum of Niche Evolution**
Moderator: Paul Davies, Ph.D.
Arizona State University
Arizona State University PS-OC

10:30 a.m. - 10:50 a.m. ***E. coli as a Model System for Early Cancer Development***
Robert Austin, Ph.D.
Princeton University
Princeton University PS-OC

10:50 a.m. - 11:10 a.m. ***Characterizing Mutation Load of Cancer***
Leonid Mirny, Ph.D.
Massachusetts Institute of Technology
Massachusetts Institute of Technology PS-OC

11:10 a.m. - 11:30 a.m. ***Heterogeneity, Homeostasis, and Aging in Cancer Initiation and Development***
Alexander Anderson, Ph.D.
H. Lee Moffitt Cancer Center & Research Institute
H. Lee Moffitt Cancer Center & Research Institute PS-OC

11:30 a.m. - 12 noon ***Discussion***

12 noon - 1:00 p.m. **Lunch** *Potomac 1-4*

12 noon - 1:00 p.m. **Working Lunch Sessions**

PS-OC Scientific Outreach and Dissemination Working Group Meeting *Potomac 5*

PS-OC Data Integration Working Group *Potomac 6*

1:00 p.m. - 2:20 p.m. **Session 6: Where's Waldo?** *Potomac C and D*

Moderator: Mauro Ferrari, Ph.D.
University of Texas Health Science Center at Houston
University of Texas Health Science Center at Houston PS-OC

1:00 p.m. - 1:20 p.m. ***Radiofrequency Field-Induced Thermal Cancer Cell Cytotoxicity Achieved With Targeted Nanoparticles***
Steven A. Curley, M.D.
University of Texas Health Science Center at Houston
University of Texas Health Science Center at Houston PS-OC

1:20 p.m. - 1:40 p.m. ***Study of In Vivo Nanoparticle Therapy and Response Using Mathematical and Computational Tools***
Vittorio Cristini, Ph.D.
University of Texas Health Science Center at Houston
University of Southern California PS-OC and
University of Texas Health Science Center at Houston PS-OC

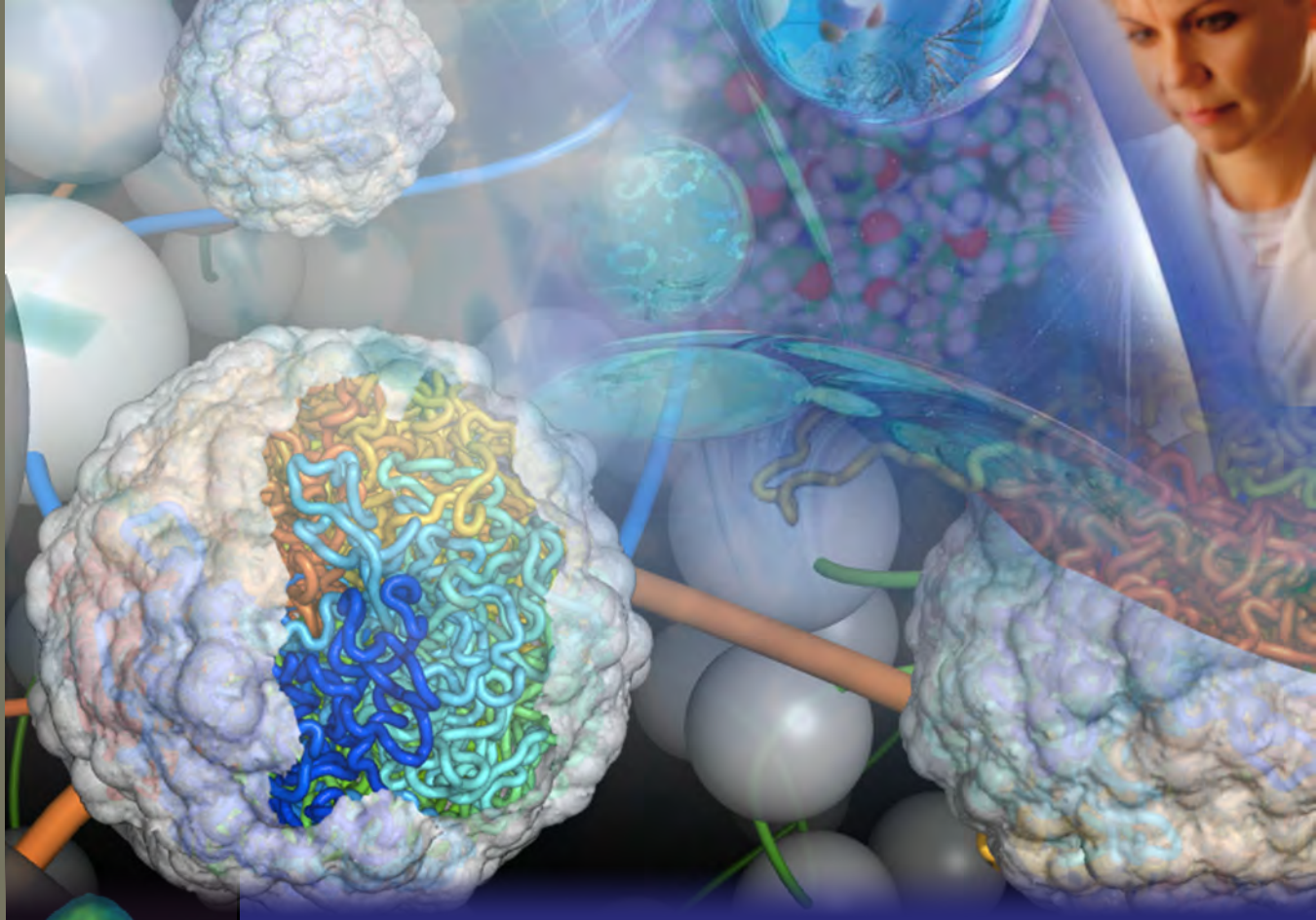
1:40 p.m. - 2:00 p.m. ***From Data Integration to Dynamics: Building a Multiscale Dynamic Model of NHL Relevant Signaling and Regulation***
Parag Mallick, Ph.D.
University of Southern California
University of Southern California PS-OC

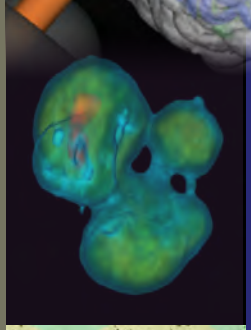
Richard Bonneau, Ph.D.
New York University
University of Southern California PS-OC

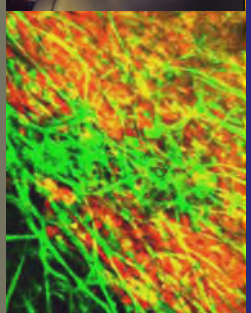
2:00 p.m. - 2:20 p.m. ***Discussion***

2:20 p.m. - 2:35 p.m. **Wrap-up and Adjournment**
Larry A. Nagahara, Ph.D.
National Cancer Institute, NIH

National Cancer Institute







PHYSICAL SCIENCES ONCOLOGY CENTERS

Second Annual NCI Physical Sciences-Oncology Centers (PS-OCs) Network Investigators' Meeting

April 10-12, 2011
Hyatt Regency La Jolla at Aventine

Program Book

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

National Institutes of Health

17.2. Second Annual Principal Investigator Meeting

Sunday, April 10

7:00 a.m. - 5:30 p.m.	**Registration**	*Grand Foyer Lobby*
7:00 a.m. - 5:30 p.m.	**Poster Setup**	*Aventine Ballroom C*
7:00 a.m. - 8:00 a.m.	**Continental Breakfast**	
8:00 a.m. -10:15 a.m.	**Pathology Boot Camp (three 45-min. sessions)**	*Scripps Clinic*
8:00 a.m. - 11:30 a.m.	**Tutorial Sessions** Moderator: Denis Wirtz, Ph.D. Johns Hopkins University Johns Hopkins University PS-OC	*Aventine Ballroom F*
8:00 a.m. - 8:30 a.m.	***An Overview of the PS-OC Bioresource Core Facility (PBCF)*** Yvonne A. Reid, Ph.D. American Type Culture Collection PS-OC Bioresource Core Facility	
8:30 a.m. - 9:15 a.m.	***Applications of Nanobiotechnology*** Michael L. Shuler, Ph.D. Cornell University Cornell University PS-OC	
9:15 a.m. - 10:00 a.m.	***An Overview of Blood Coagulation and Cancer Metastasis*** Owen McCarty, Ph.D. Oregon Health & Science University The Scripps Research Institute PS-OC	
10:00 a.m. - 10:30 a.m.	**Break**	
10:30 a.m. - 11:30 a.m.	***Show Case Tumor Board*** Jorge Nieva, M.D. Medical Oncology, Billings Clinic The Scripps Research Institute PS-OC Lyudmila Bazhenova, M.D. Thoracic Medical Oncology, University of California, San Diego The Scripps Research Institute PS-OC Kelly Bethel, M.D. Anatomical Pathology, Scripps Clinic The Scripps Research Institute PS-OC	

Arno Mundt, M.D.
Radiation Oncology, University of California, San Diego
The Scripps Research Institute PS-OC

Randolph Schaffer, M.D.
Surgery, Scripps Clinic
The Scripps Research Institute PS-OC

Robert A. Gatenby, M.D.
Clinical Imaging, H. Lee Moffitt Cancer Center & Research Institute
H. Lee Moffitt Cancer Center & Research Institute PS-OC

11:30 a.m. - 1:00 p.m. **Lunch** *Ballroom Foyer*

11:30 a.m. - 1:00 p.m. **Working Lunch Sessions**

PS-OC Young Investigators Trans-Network Projects Information Session *Aventine Ballroom F*

PS-OC Outreach and Dissemination Working Group Meeting *Portofino AB*

12 noon - 1:00 p.m. **PS-OC Trans-Network Introduction (panelists only)** *Palmero Boardroom*

1:00 p.m. - 5:30 p.m. **PS-OC Heterogeneity Trans-Network Projects** *Aventine Ballroom F*
Moderator: Sean E. Hanlon, Ph.D.
National Cancer Institute, NIH

1:00 p.m. - 1:15 p.m. ***Welcome, Background, and Introductions***
Larry A. Nagahara, Ph.D.
National Cancer Institute, NIH

1:15 p.m. - 1:35 p.m. ***Modeling Penetrance of Resistance***
Dana-Farber Cancer Institute PS-OC - Princeton University PS-OC - University of Southern California PS-OC Trans-Network Team

1:35 p.m. - 5:15 p.m. **Heterogeneity Trans-Network Proposal Team Presentations**
(assigned in random order)
(10-min. presentations; 10-min. questions and comments)

Analysis of Heterogeneity in Signaling Networks During T Cell Leukemogenesis

Assessing Cellular Heterogeneity and Its Consequences in Premalignant Lesions of Human Breast Tissue

Biophysical Investigation of Cancer Progression in Living Mice as a Function of Intratumoral Cell Heterogeneity

Emergence of Therapy Resistance in Multiple Myeloma: The Roles of Genomic and Microenvironmental Heterogeneity

Epigenetic Heterogeneity and Evolution in Leukemia

Heterogeneity of Cytoskeletal Architecture as an Indicator of Treatment Response

Heterogeneity of Tumor Cells in Primary and Metastatic Tumor Microenvironments: Assessment and Modeling of Transport Phenomena

In Vivo Analysis of Cell Cycle Progression Heterogeneity During Intestinal Tumorigenesis

In Vivo Analysis of Protein Expression Spatially Related to the Heterogeneous Physical Tumor Microenvironment During Breast Cancer Progression

Quantification of Primary Tumor Heterogeneity to Predict Phenotypes of Effluent Circulating Tumor Cells - a First Step to Understanding Metastasis

1:35 p.m. - 2:55 p.m.	***Proposal Team Presentations 1-4***	
2:55 p.m. - 3:15 p.m.	**Break**	
3:15 p.m. - 5:15 p.m.	***Proposal Team Presentations 5-10***	
5:15 p.m. - 5:30 p.m.	***Panel Comments and Wrap-up***	
5:30 p.m. - 6:00 p.m.	**PS-OC Trans-Network Proposal Debrief (panelists only)**	*Palmero Boardroom*
5:30 p.m. - 7:30 p.m.	**Poster Session and Reception** *ODD number posters present at this time.*	*Aventine Ballroom C*

Monday, April 11

7:00 a.m. - 5:00 p.m.	**Registration**	*Grand Foyer Lobby*
7:00 a.m. - 8:00 a.m.	**Continental Breakfast**	*Ballroom Foyer*
8:00 a.m. - 8:05 a.m.	**NCI Welcome**	*Aventine Ballroom F*
8:05 a.m. - 8:15 a.m.	**Opening Remarks** Peter Kuhn, Ph.D. The Scripps Research Institute The Scripps Research Institute PS-OC	
8:15 a.m. - 8:20 a.m.	**Patient Advocate Perspective** Carole L. Baas, Ph.D. NCI Patient Advocate for the PS-OC Program National Cancer Institute, NIH	

8:20 a.m. - 10:00 a.m. **Plenary Talks (45-min. talk/5-min. discussion)**

8:20 a.m. - 9:10 a.m. ***Cell Mobility and Punctuated Equilibria in Cancer Heterogeneity***
Larry Norton, M.D.
Memorial Sloan-Kettering Cancer Center

9:10 a.m. - 10:00 a.m. ***Highly Multiplexed Single-Cell Proteomics for Both Clinical Diagnostics and Fundamental Oncology Studies***
James Heath, Ph.D.
California Institute of Technology

10:00 a.m. - 10:30 a.m. **Break**

10:30 a.m. - 12:20 p.m. **Session 1: Determining if There is and/or Defining a Fundamental Equation of Cancer**
Moderator: Jonathan D. Licht, M.D.
Robert H. Lurie Comprehensive Cancer Center
Northwestern University PS-OC

10:30 a.m. - 10:50 a.m. ***Why Cancer is so Smart: The Atavism Explanation***
Paul Davies, Ph.D.
Arizona State University
Arizona State University PS-OC

10:50 a.m. - 11:10 a.m. ***Thermodynamics of Living Systems: Prokaryotes, Eukaryotes, and Cancer***
Robert A. Gatenby, M.D.
H. Lee Moffitt Cancer Center & Research Institute
H. Lee Moffitt Cancer Center & Research Institute PS-OC

11:10 a.m. - 11:30 a.m. ***Patient-Calibrated Modeling of Ductal Carcinoma In Situ (DCIS): From Microscopic Measurements to Macroscopic Predictions of Clinical Progression***
Paul Macklin, Ph.D.
University of Dundee
University of Southern California PS-OC

11:30 a.m. - 11:50 a.m. ***Experimental Tests of the Fundamental Equation of Cancer***
Robert H. Austin, Ph.D.
Princeton University
Princeton University PS-OC

11:50 a.m. - 12:20 p.m. ***Discussion***

12:20 p.m. - 1:50 p.m. **Lunch** *Ballroom Foyer*

12:20 p.m. - 1:50 p.m. **Working Lunch Sessions**

PS-OC Physics Working Group Meeting *San Remo*

PS-OC Evolution of Drug Resistance Working Group Meeting *Portofino AB*

Experimental Models in Which to Discern Clonal or Adaptive Development of Drug Resistance
Robert Getzenberg, Ph.D.
Johns Hopkins University
Princeton University PS-OC

The Importance of Stroma in Tumor Progression and Drug Resistance
Alexander Anderson, Ph.D.
H. Lee Moffitt Cancer Center & Research Institute
H. Lee Moffitt Cancer Center & Research Institute PS-OC

PS-OC Education and Training Working Group Meeting *Palatine AB*

12:30 p.m. - 3:30 p.m. **PS-OC Trans-Network Proposal Review (panelists only)** *Palmero Boardroom*

1:50 p.m. - 3:10 p.m. **Session 2: Understanding the Implications of Tumor Heterogeneity**
Moderator: Thea TIsty, Ph.D.
University of California, San Francisco
Princeton University PS-OC

1:50 p.m. - 2:10 p.m. ***Single Molecule Transcript Counting of Stem Cell Markers in the Mouse Intestine***
Alexander van Oudenaarden, Ph.D.
Massachusetts Institute of Technology
Massachusetts Institute of Technology PS-OC

2:10 p.m. - 2:30 p.m. ***Varying Microenvironmental Oxygen Tension as a Critical Regulator of Tumor Heterogeneity***
Claudia Fischbach, Ph.D.
Cornell University
Cornell University PS-OC

2:30 p.m. - 2:50 p.m. ***Metastatic Progression via Biased Random Walk on a Cancer Network***
Paul Newton, Ph.D.
University of Southern California
The Scripps Research Institute PS-OC

2:50 p.m. - 3:10 p.m. ***Discussion***

3:10 p.m. - 3:40 p.m. **Break**

3:40 p.m. - 5:00 p.m. **Session 3: Performing Physical Science Measurements**
Moderator: Kelly Bethel, M.D.
Scripps Clinic
The Scripps Research Institute PS-OC

3:40 p.m. - 4:00 p.m. ***Alterations in Nuclear Nanoscale Architecture: Optical Imaging and the Role in Early Carcinogenesis***
Vadim Backman, Ph.D.
Northwestern University
Northwestern University PS-OC

4:00 p.m. - 4:20 p.m. ***Size, Growth Rate, and Stiffness Regulation in Normal and Cancer Cells***
Scott Manalis, Ph.D.
Massachusetts Institute of Technology
Massachusetts Institute of Technology PS-OC

4:20 p.m. - 4:40 p.m. ***Towards a Novel Light Microscope Capable of Visualizing Tumor Mechanics in Living Tissues***
Jan Liphardt, Ph.D.
University of California, Berkeley
University of California, Berkeley PS-OC

4:40 p.m. - 5:00 p.m. ***Discussion***

5:00 p.m. - 7:00 p.m. **Poster Session and Reception** *Aventine Ballroom C*
EVEN number posters present at this time.

7:00 p.m. - 9:30 p.m. **PS-OC Steering Committee Working Dinner (by invitation)** *Palatine AB*

Tuesday, April 12

7:00 a.m. - 2:30 p.m. **Registration** *Grand Foyer Lobby*

7:00 a.m. - 8:00 a.m. **Continental Breakfast** *Ballroom Foyer*

8:00 a.m. - 8:20 a.m. **PS-OC Network Update** *Aventine Ballroom F*
Larry A. Nagahara, Ph.D.
National Cancer Institute, NIH

8:20 a.m. - 8:30 a.m. **PS-OC Poster and Young Investigators Trans-Network Project Awards** *Aventine Ballroom F*

8:30 a.m. - 10:10 a.m. **Plenary Talks (30-min. talk/5-min. discussion)** *Aventine Ballroom F*

8:30 a.m. - 9:05 a.m. ***Metronomics Therapy: Is It Really a New Paradigm or Rediscovering the Wheel?***
Barton A. Kamen, M.D., Ph.D.
Robert Wood Johnson Medical Center

9:05 a.m. - 9:40 a.m. ***The Challenge of Multifaceted Heterogeneity: Lessons From the Study of Microorganisms***
Herbert Levine, Ph.D.
University of California, San Diego

9:40 a.m. - 10:10 a.m. **Break**

10:10 a.m. - 11:30 a.m. **Session 4: Understanding the Role of "Seed" and "Soil" in Metastasis**
Moderator: Valerie Weaver, Ph.D.
University of California, San Francisco
University of California, Berkeley PS-OC

10:10 a.m. - 10:30 a.m. ***When Seeds Stick: Selectin-Mediated Adhesion of Circulating Tumor Cells to Vascular Endothelium***
Michael R. King, Ph.D.
Cornell University
Cornell University PS-OC

10:30 a.m. - 10:50 a.m. ***Metastasis of Low-Fitness Cells: Rare, Explosive, and Deterministic***
Timothy Newman, Ph.D.
Arizona State University
Arizona State University PS-OC

10:50 a.m. - 11:10 a.m. ***Thinking Locally: The Importance of Physical Microenvironmental Heterogeneity in Governing Tumor Cell Motility***
Sanjay Kumar, M.D., Ph.D.
University of California, Berkeley
University of California, Berkeley PS-OC

11:10 a.m. - 11:30 a.m. ***Discussion***

11:30 a.m. - 1:00 p.m. **Lunch** *Ballroom Foyer*

12 noon - 1:00 p.m. **Working Lunch Sessions**
Additional Program/Activities *Aventine Ballroom F*

NCI's Antibody Characterization Pipeline
Tara Hiltke, Ph.D.
National Cancer Institute, NIH

ARL Technology and Concepts toward Biomedical Applications
Stephen J. Kilpatrick, Ph.D.
U.S. Army Research Laboratory

NCI's Integrated Cancer Biology Program (ICBP)
Dan Gallahan, Ph.D.
National Cancer Institute, NIH

PS-OC Cell Line Project Manuscript Discussion *Palatine AB*
Nastaran Z. Kuhn, Ph.D.
National Cancer Institute, NIH

1:00 p.m. - 2:50 p.m. **Session 5: Understanding if Cancer Should Be Treated as a Curable or Manageable Disease**
Moderator: Steven A. Curley, M.D.
The University of Texas M.D. Anderson Cancer Center
The Methodist Hospital Research Institute PS-OC

1:00 p.m. - 1:20 p.m. ***Targeting the Hallmarks of Cancer***
Robert J. Gillies, Ph.D.
H. Lee Moffitt Cancer Center & Research Institute
H. Lee Moffitt Cancer Center & Research Institute PS-OC

1:20 p.m. - 1:40 p.m. ***Resistance to the Chemotherapy Paclitaxel Increases the Sensitivity to Other Microenvironmental Stresses in Prostate Cancer Cells***
Robert H. Getzenberg, Ph.D.
Johns Hopkins University
Princeton University PS-OC

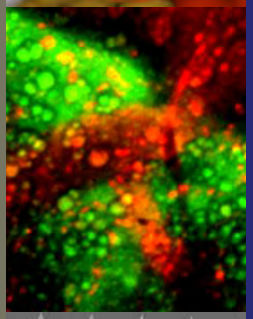
1:40 p.m. - 2:00 p.m. ***A Mathematical Framework Based on Pancreatic Cancer Autopsy Data Reveals Dynamics of Metastatic Dissemination and Suggests Optimum Treatment Strategies***
Franziska Michor, Ph.D.
Dana-Farber Cancer Institute
Dana-Farber Cancer Institute PS-OC

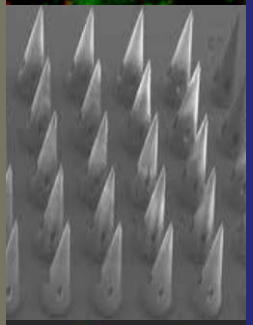
2:00 p.m. - 2:20 p.m. ***Cancer as a Complex System: Ideas on the Treatment, Clinical Course, and Behavior of Cancer, Through the Eyes of an Oncologist***
David Agus, M.D.
University of Southern California
University of Southern California PS-OC

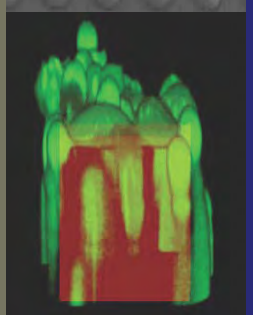
2:20 p.m. - 2:50 p.m. ***Discussion***

2:50 p.m. - 3:00 p.m. **Wrap-up and Adjournment**
Larry A. Nagahara, Ph.D.
National Cancer Institute, NIH

National Cancer Institute







PHYSICAL SCIENCES
ONCOLOGY CENTERS

Third Annual NCI Physical Sciences-Oncology Centers (PS-OCs) Network Investigators' Meeting

April 16-18, 2012

PS-OC Network Young Investigators' Meeting

April 15-16, 2012

Grand Hyatt, Tampa Bay

Program Book

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

National Institutes of Health

17.3. Third Annual Principal Investigator Meeting

Monday, April 16

12 noon - 5:30 p.m.	**Registration**	*Audubon Foyer*
12 noon - 5:30 p.m.	**Poster Setup**	*White Ibis and Audubon D*
1:00 p.m. - 1:05 p.m.	**Tutorial Introductions** Mariam Eljanne, Ph.D. National Cancer Institute, NIH	*Audubon A-C*
1:05 p.m. - 2:35 p.m.	**Using Evolutionary Principles and Mathematical Modeling to Prolong Remission Response in Metastatic Breast Cancer** Moderator: Robert Gillies, Ph.D. H. Lee Moffitt Cancer Center & Research Institute H. Lee Moffitt Cancer Center & Research Institute PS-OC	*Audubon A-C*
1:05 p.m. - 1:20 p.m.	***Treating Metastatic Breast Cancer: Why Do We Fail?*** Susan E. Minton, D.O. H. Lee Moffitt Cancer Center & Research Institute	
1:20 p.m. - 1:35 p.m.	***Evolutionary Dynamics in Cancer and Its Therapies*** Joel Brown, Ph.D. University of Illinois at Chicago H. Lee Moffitt Cancer Center & Research Institute PS-OC	
1:35 p.m. - 1:50 p.m.	***Computational Modeling as a Tool for Trial Design*** Alexander R. Anderson, Ph.D. H. Lee Moffitt Cancer Center & Research Institute H. Lee Moffitt Cancer Center & Research Institute PS-OC	
1:50 p.m. - 2:35 p.m.	***Panel Discussion***	
2:35 p.m. - 3:00 p.m.	**Break**	
3:00 p.m. - 4:45 p.m.	**Personalized Medicine** Moderator: Robert Gatenby, M.D. H. Lee Moffitt Cancer Center & Research Institute H. Lee Moffitt Cancer Center & Research Institute PS-OC	
3:00 p.m. - 3:25 p.m.	***Total Cancer Care at Moffitt*** Daniel Sullivan, M.D. H. Lee Moffitt Cancer Center & Research Institute	
3:25 p.m. - 3:50 p.m.	***Image 'omics in Cancer Diagnosis*** Robert Gillies, Ph.D. H. Lee Moffitt Cancer Center & Research Institute H. Lee Moffitt Cancer Center & Research Institute PS-OC	

3:50 p.m. - 4:15 p.m. ***Personalized Medicine 2.0: Enabling -Omics Innovations With Patient-Specific Virtual Controls***
Kristin R. Swanson, Ph.D., M.S.
University of Washington
H. Lee Moffitt Cancer Center & Research Institute PS-OC

4:15 p.m. - 4:45 p.m. ***Panel Discussion***

5:00 p.m. - 7:30 p.m. **Poster Session and Reception** *White Ibis and Audubon D*
(presenters for ODD number abstracts)

Tuesday, April 17

7:00 a.m. - 5:00 p.m. **Registration** *Audubon Foyer*

7:00 a.m. - 8:00 a.m. **Continental Breakfast** *Audubon Foyer*

8:00 a.m. - 8:05 a.m. **NCI Welcome** *Audubon A-C*
Larry A. Nagahara, Ph.D.
National Cancer Institute, NIH

8:05 a.m. - 8:10 a.m. **Opening Remarks**
Thomas A. Sellers, Ph.D., M.P.H.
H. Lee Moffitt Cancer Center & Research Institute

8:10 a.m. - 10:10 a.m. **Evolution Dynamics: Genotype Versus Phenotype**
Moderator: Robert Gatenby, M.D.
H. Lee Moffitt Cancer Center & Research Institute
H. Lee Moffitt Cancer Center & Research Institute PS-OC

8:10 a.m. - 8:50 a.m. ***Plenary: Targeting Leukemia Cells Within Their In Vivo Microenvironment***
Benjamin Ebert, M.D., Ph.D.
Brigham and Women's Hospital
Harvard Medical School

8:50 a.m. - 9:10 a.m. ***Dynamics of Chronic Myeloid Leukemia Response to Long-Term Targeted Therapy and Discontinuation Reveal Treatment Effects on Leukemic Stem Cells***
Franziska Michor, Ph.D.
Dana-Farber Cancer Institute
Dana-Farber Cancer Institute PS-OC

9:10 a.m. - 9:30 a.m. ***Bacterial Filaments: A Stem Cell Mesoscopic Crypt for Evolution***
Robert Austin, Ph.D.
Princeton University
Princeton University PS-OC

9:30 a.m. - 9:50 a.m. ***Analysis of Spatial Transcriptional Patterns in Human Breast Cancer***
Alexander van Oudenaarden, Ph.D.
Massachusetts Institute of Technology
Massachusetts Institute of Technology PS-OC

9:50 a.m. - 10:10 a.m. ***Panel Discussion***

10:10 a.m. - 10:30 a.m. **Break**

10:30 a.m. - 12:10 p.m. **Leveraging a "Watson" Perspective: Surely It's Elementary Holmes**
Moderator: Barbara L. Hempstead, M.D., Ph.D.
Cornell University
Cornell University PS-OC

10:30 a.m. - 11:10 a.m. ***Plenary: Artificial Intelligence - Watson in Health Care***
Martin Kohn, M.D.
IBM Research

11:10 a.m. - 11:30 a.m. ***The End of Illness***
David Agus, M.D.
University of Southern California
University of Southern California PS-OC

11:30 a.m. - 11:50 a.m. ***Role of the Adrenal Gland in Lung Cancer; Clinical Implication of the Markov Chain Model of Metastasis***
Lyudmila Bazhenova, M.D.
University of California, San Diego
The Scripps Research Institute PS-OC

11:50 a.m. - 12:10 p.m. ***Panel Discussion***

12:10 p.m. - 12:40 p.m. **Pathologist's View of Cancer Diagnosis, Obstacles, and Wishes**
Anthony M. Magliocco, M.D.
H. Lee Moffitt Cancer Center & Research Institute

12:40 p.m. - 1:40 p.m. **General Lunch** *Audubon Pavilion*

12:40 p.m. - 1:40 p.m. **Working Lunch Session** *Snowy Egret*

Cancer Brainstorming Club: Young Investigators' Insights Into Physical Sciences and Oncology

1:40 p.m. - 3:40 p.m. **Breakout Sessions: Integrating the PS-OC Network**
Talks for each of the breakout sessions are on pages 9-11.

Each session will have the following format: 1-hour presentation to introduce the topic and 1-hour discussion to formulate potential Trans-Network collaborations around the topic area. Breakout sessions will report back to all meeting participants on Wednesday.

Evolution of Tumor Microenvironment *Audubon Ballroom A*
Moderator: Robert Gillies, Ph.D.
H. Lee Moffitt Cancer Center & Research Institute
H. Lee Moffitt Cancer Center & Research Institute PS-OC

Cell and Tissue Mechanics *Audubon Ballroom B-C*
Moderator: Jan Liphardt, Ph.D.
University of California, Berkeley
University of California, Berkeley PS-OC

Health Disparity Through a Physical Science Perspective *Snowy Egret*
Moderator: Deborah Duran, Ph.D.
National Cancer Institute, NIH

Advancing Technologies in Cancer Research *Sandhill Crane*
Moderator: Michael L. Shuler, Ph.D.
Cornell University
Cornell University PS-OC

3:40 p.m. - 4:00 p.m. **Break**

4:00 p.m. - 5:30 p.m. **Working Group (WG) Sessions**

PS-OC Evolution of Drug Resistance WG *Audubon Ballroom A*
WG Update, Presentation, and Poster Teasers[1†]

Optimization of Dosing for EGFR-Mutant Non-Small Cell Lung Cancer With Evolutionary Cancer Modeling
Franziska Michor, Ph.D.
Dana-Farber Cancer Institute
Dana-Farber Cancer Institute PS-OC

PS-OC Outreach and Dissemination WG and Patient Advocacy *Audubon Ballroom B-C*

5:30 p.m. - 7:30 p.m. **Poster Session and Reception** *White Ibis and Audubon D*
(presenters for EVEN number abstracts)

7:00 p.m. - 9:30 p.m. **PS-OC Steering Committee Working Dinner** *Wilson's Plover Boardroom*
(invitation only) *14th Floor*

1 † Poster Teaser abstracts are denoted in the Poster Abstracts tab of the program book.

Wednesday, April 18

7:00 a.m. - 2:30 p.m. **Registration** *Audubon Foyer*

7:00 a.m. - 8:00 a.m. **Continental Breakfast** *Audubon Foyer*

8:00 a.m. - 8:15 a.m. **PS-OC Network Update** *Audubon A-C*
Larry A. Nagahara, Ph.D.
National Cancer Institute, NIH

8:15 a.m. - 8:20 a.m. **Patient Advocate Perspective**
Carole L. Baas, Ph.D.
Patient Advocate for the PS-OC Program

8:20 a.m. - 8:25 a.m. **PS-OC Poster Awards**

8:25 a.m. - 9:25 a.m. **Reports From Breakout Sessions**
Moderator: Robert H. Getzenberg, Ph.D.
Johns Hopkins University
Princeton University PS-OC

Evolution of Tumor Microenvironment
Spokesperson: Robert Gillies, Ph.D.
H. Lee Moffitt Cancer Center & Research Institute
H. Lee Moffitt Cancer Center & Research Institute PS-OC

Cell and Tissue Mechanics
Spokesperson: Jan Liphardt, Ph.D.
University of California, Berkeley
University of California, Berkeley PS-OC

Health Disparity Through a Physical Science Perspective
Spokesperson: Deborah Duran, Ph.D.
National Cancer Institute, NIH

Advancing Technologies in Cancer Research
Spokesperson: Michael L. Shuler, Ph.D.
Cornell University
Cornell University PS-OC

9:25 a.m. - 10:25 a.m. **Trans-Network and Pilot Project Updates**
Moderator: Denis Wirtz, Ph.D.
Johns Hopkins University
Johns Hopkins University PS-OC

9:25 a.m. - 9:45 a.m. ***Trans-Network: Evolution of Chemotherapy Resistance on Death Row***
Ariosto Silva, Ph.D.
H. Lee Moffitt Cancer Center & Research Institute
H. Lee Moffitt Cancer Center & Research Institute PS-OC
(in collaboration with the Princeton University PS-OC)

9:45 a.m. - 10:05 a.m.

Pilot Project: Prognostic Relevance of Integrated Genetic Profiling in Acute Myeloid Leukemia
Ross L. Levine, M.D.
Memorial Sloan-Kettering Cancer Center
Dana-Farber Cancer Institute PS-OC

10:05 a.m. - 10:25 a.m.

Trans-Network: Fluid Biopsy of Solid Tumors, Real-Time Tracking of Drug Effects in Patients With Prostate Cancer
Peter Kuhn, Ph.D.
The Scripps Research Institute
The Scripps Research Institute PS-OC
(in collaboration with the Cornell PS-OC, Moffitt PS-OC, and USC PS-OC)

10:25 a.m. - 10:40 a.m. **Break**

10:40 a.m. - 12:20 p.m. **Understanding and Targeting Chromatin Structure**
Moderator: Thomas V. O'Halloran, Ph.D.
Northwestern University
Northwestern University PS-OC

10:40 a.m. - 11:20 a.m.

Plenary: Genome-wide Dynamics of Transcription Factor Interactions with the Chromatin Landscape
Gordon L. Hager, Ph.D.
National Cancer Institute, NIH

11:20 a.m. - 11:40 a.m.

Three-Dimensional Genome Architecture Influences Partner Selection for Chromosomal Alterations in Cancer
Leonid Mirny, Ph.D.
Massachusetts Institute of Technology
Massachusetts Institute of Technology PS-OC

11:40 a.m. - 12 noon

Nucleosome Structure Propensities and TT-Photodimerization
George C. Schatz, Ph.D.
Northwestern University
Northwestern University PS-OC

12 noon - 12:20 p.m. ***Panel Discussion***

12:20 p.m. - 1:55 p.m. **Working Lunch Sessions**

PS-OC Cancer Cell Transport WG *Sandhill Crane*

PS-OC Education and Training WG *Snowy Egret*

1:55 p.m. - 3:15 p.m. **Current Cancer Translational Approaches**

Moderator: Steven A. Curley, M.D.
The Methodist Hospital Research Institute
The Methodist Hospital Research Institute PS-OC

1:55 p.m. - 2:15 p.m. ***Optimization of Radiation Scheduling in a Mouse Model of Proneural Glioma***
Eric Holland, M.D., Ph.D.
Memorial Sloan-Kettering Cancer Center
Dana-Farber Cancer Institute PS-OC

2:15 p.m. - 2:35 p.m. ***A Clinical Application of the HD-CTC "Fluid Biopsy" Technology: Circulating Epithelial Cells in Liver Transplantation for Hepatocellular Carcinoma***
Randolph L. Schaffer III, M.D.
The Scripps Research Institute
The Scripps Research Institute PS-OC

2:35 p.m. - 2:55 p.m. ***Noninvasive Radiofrequency Field Induced Hyperthermia Inhibits Homologous Recombination Mediated Repair of Gemcitabine Stalled Replication Forks***
Mustafa Raoof, M.D.
The University of Texas MD Anderson Cancer Center
The Methodist Hospital Research Institute PS-OC

2:55 p.m. - 3:15 p.m. ***Panel Discussion***

3:15 p.m. - 3:25 p.m. **Wrap-up and Adjournment**
Larry A. Nagahara, Ph.D.
National Cancer Institute, NIH

Breakout Sessions - Tuesday, April 17

1:40 p.m. - 3:40 p.m. **Evolution of Tumor Microenvironment** *Audubon Ballroom A*
Moderator: Robert Gillies, Ph.D.
H. Lee Moffitt Cancer Center & Research Institute
H. Lee Moffitt Cancer Center & Research Institute PS-OC

1:40 p.m. - 2:00 p.m. ***Engineered Culture Models to Analyze Tumor Angiogenesis and Its Therapy as a Function of Microenvironmental Heterogeneity***
Claudia Fischbach-Teschl, Ph.D.
Cornell University
Cornell University PS-OC

2:00 p.m. - 2:20 p.m. ***Explaining the Synergistic Effect of a p53 Vaccine and Chemotherapy in Lung Cancer as an Evolutionary Double Bind***
David Basanta, Ph.D.
H. Lee Moffitt Cancer Center & Research Institute
H. Lee Moffitt Cancer Center & Research Institute PS-OC

2:20 p.m. - 2:40 p.m. ***The Cellular and Molecular Landscape of Tumor Microenvironment in Breast and Lung Cancer***
Vivek Mittal, Ph.D.
Weill Cornell Medical College
Cornell University PS-OC

2:40 p.m. - 3:40 p.m. ***Roundtable Discussion***

1:40 p.m. - 3:40 p.m. **Cell and Tissue Mechanics** *Audubon Ballroom B-C*
Moderator: Jan Liphardt, Ph.D.
University of California, Berkeley
University of California, Berkeley PS-OC

1:40 p.m. - 2:00 p.m. ***Physical Confinement Alters Tumor Cell Adhesion and Migration Phenotypes***
Konstantinos Konstantopoulos, Ph.D.
Johns Hopkins University
Johns Hopkins University PS-OC

2:00 p.m. - 2:20 p.m. ***In-Depth Analysis of AFM Nanoindentation Experiments on Soft Heterogeneous Samples***
Robert Ros, Ph.D.
Arizona State University
Arizona State University PS-OC

2:20 p.m. - 2:40 p.m. ***Predictive Computation of Cell-Tissue Mechanics From First Principles***
James Sethian, Ph.D.
University of California, Berkeley
University of California, Berkeley PS-OC

2:40 p.m. - 3:40 p.m. ***Roundtable Discussion***

1:40 p.m. - 3:40 p.m. **Health Disparity Through a Physical Science Perspective** *Snowy Egret*
Moderator: Deborah Duran, Ph.D.
National Cancer Institute, NIH

1:40 p.m. - 2:00 p.m. **A P20 Trandisciplinary Research Center to Address Cancer Health Disparities: Challenges and Opportunities**
B. Lee Green, Jr., Ph.D.
H. Lee Moffitt Cancer Center & Research Institute

2:00 p.m. - 2:20 p.m. ***Addressing Cancer Health Disparities in Diverse Communities: Linking Research, Training, and Community***
Deborah Duran, Ph.D.
National Cancer Institute, NIH

2:20 p.m. - 2:40 p.m. ***Cancer Disparity: Hint of Unexpected Survival Benefits in African American Non-Small Cell Lung Cancer Patients From Combining Non-Cytotoxic Suramin With Chemotherapy***
Jessie L-S Au, Ph.D., Pharm.D.
Ohio State University

2:40 p.m. - 3:40 p.m. ***Roundtable Discussion***

1:40 p.m. - 3:40 p.m. **Advancing Technologies in Cancer Research** *Sandhill Crane*
Moderator: Michael L. Shuler, Ph.D.
Cornell University
Cornell University PS-OC

1:40 p.m. - 2:00 p.m. ***A New Tool for Cancer Biomarker Detection: Multiple Samples and Multiple Parameters on a Single Chip***
Shan X. Wang, Ph.D.
Stanford University
University of Southern California PS-OC

2:00 p.m. - 2:20 p.m. ***Computer-Assisted Gleason Grading of Prostate Cancer (CaP): Two Novel Computational Approaches Using Nuclear Shape and Texture Features to Classify Indolent and Aggressive Pathologic Gleason Grade Patterns***
Robert W. Veltri, Ph.D.
Johns Hopkins University School of Medicine
Johns Hopkins University PS-OC

2:20 p.m. - 2:40 p.m. ***Single-Cell Microfluidics for Systems Oncology***
Rong Fan, Ph.D.
Yale University
Dana-Farber Cancer Institute PS-OC

2:40 p.m. - 3:40 p.m. ***Roundtable Discussion***

17.4. Joint Meeting of Junior Investigators

INTEGRATIVE CANCER BIOLOGY PROGRAM:
CENTERS FOR CANCER SYSTEMS BIOLOGY
and the
PHYSICAL SCIENCES – ONCOLOGY CENTERS PROGRAM
Joint Meeting of Junior Investigators
September 26–28, 2012

Fred Hutchinson Cancer Research Center
1100 Fairview Avenue North, Seattle, WA 98109

Courtyard Seattle Downtown/Lake Union
925 Westlake Avenue North, Seattle, WA 98109
http://www.marriott.com/hotels/travel/seacd-courtyard-seattle-downtown-lake-union/

AGENDA

Wednesday, September 26
Meeting Location: Fred Hutchinson Cancer Research Center

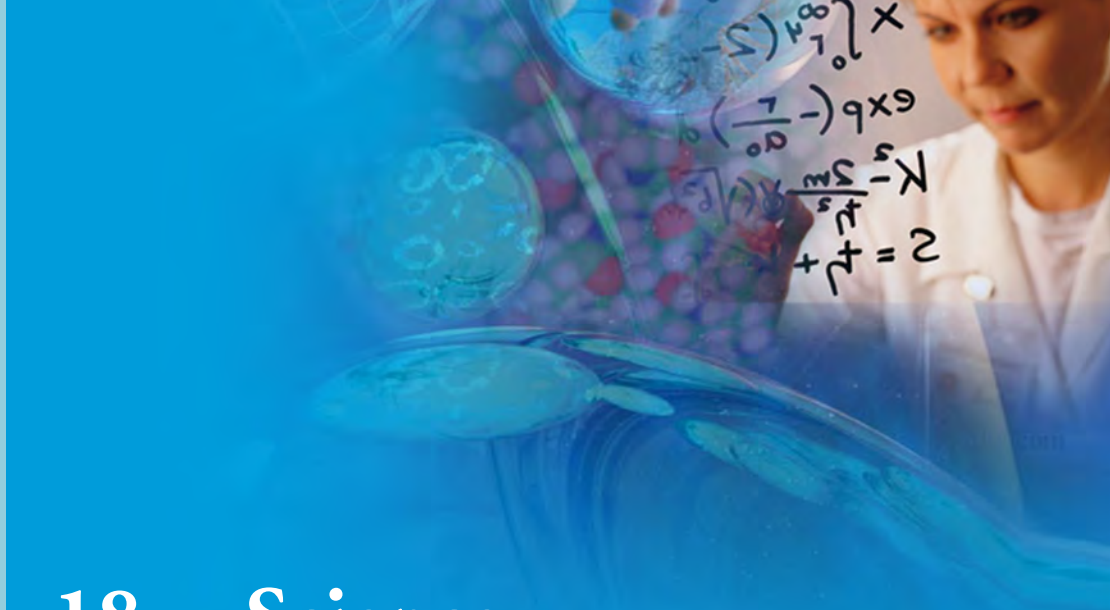
12:00–1:00 pm	**Registration**
1:00–1:30 pm	**Introductions:** Co-Chairs: Darren Tyson (Vanderbilt), Adam Margolin (Sage Bionetworks) and Shannon Mumenthaler (USC) ICBP: CCSB Welcome: Dan Gallahan (NCI) PS-OC Welcome: Nas Kuhn (NCI) Local Welcome: Stephen Friend (Sage Bionetworks)
1:30–2:00 pm	**Meeting format and goals:** Co-Chairs: Darren Tyson (Vanderbilt), Adam Margolin (Sage Bionetworks) and Shannon Mumenthaler (USC)
2:00–3:00 pm	**Speed Science (1 min presentations)** All junior investigators
3:00–3:30 pm	Break
3:30–4:10 pm	**Invited Speaker:** Jennifer Couch, NCI, "Grant Writing Dos and Don'ts" (30 min + 10 min Q/A)
4:10–5:00 pm	**Invited Speaker:** Peter Kapitein, Inspire2Live, "Cancer Advocacy" (40 min + 10 min Q/A)
5:00–6:00 pm	**Data Resources:** Larsson Omberg, Sage Bionetworks, "Synapse/TCGA" Michael Reich, Broad Institute, "ICBP Data & Analysis Portal"
6:00–7:00 pm	**Group discussion by topic (not working groups):** To define/discuss major open questions related to each topic (i.e., brainstorming): 1) drug response/resistance (*Shannon Mumenthaler*) 2) "personalized" medicine (subtype identification/molecular targets) (*Adam Margolin*) 3) tumor heterogeneity (microenvironment/tumor cell types) (*Fuhai Li*) 4) epigenetic regulation of tumor progression (*Subho De*)

Thursday, September 27
Meeting Location: Fred Hutchinson Cancer Research Center

8:00–9:00 am	**Invited Speaker:** Jonathan Irish, Vanderbilt University, "Science & Career" (50 min +10 min Q/A)
9:00–9:45 am	**Working groups**
10:00-10:15 am	Break
10:15–12:00 pm	**Working groups**
12:00–1:00 pm	Lunch on your own
1:00–2:00 pm	**Invited Speaker:** Ilya Shmulevich, The Institute for Systems Biology (ISB), "Integrative Analysis and Interactive Exploration of Data from The Cancer Genome Atlas" (50 min +10 min Q/A)
2:00–3:45 pm	**Working groups**
3:45–4:15 pm	Break
4:15–6:00 pm	**Working groups**

Friday, September 28
Meeting location: Courtyard Seattle Downtown/Lake Union

7:30–7:45 am	**Slides must be submitted no later than 7:45 am for use in oral presentations**
8:00–10:30 am	**Group presentations & Discussion (10 min presentation, 5 min Q&A)**
10:30–11:00 am	Break and checkout
11:00–11:30 pm	**Awards presentations**
11:30–12:00 pm	**Wrap-up, discussion and closing remarks** Co-Chairs: Darren Tyson (Vanderbilt), Adam Margolin (Sage Bionetworks) and Shannon Mumenthaler (USC) Stephen Friend (Sage Bionetworks)



18. Science Technology Policy Institute Memos

20. Science Technology Policy Institute Memos

STPI Memo 1: Initial Interviews

To: Jim Corrigan, Jerry Lee, NCI
From: Brian Zuckerman, STPI
CC: Christina Viola Srivastava, Mary Beth Hughes

Subject: Summary of Findings of Interviews of Physical Science – Oncology Center PIs and Senior Investigators

Date: January 6, 2010

At the request of PS-OC program staff, STPI conducted interviews with Center Principal Investigators (PI) and Senior Investigators (SI) of eight of the newly awarded PS-OCs[1] to discuss their experiences with the program so far, expectations for the future, and other issues relevant to planning for future program evaluation (interview discussion guide attached as Appendix A). This memo summarizes high-level findings from the interviews conducted.

High-Level Interview Findings

Knowledge of PS-OC Solicitation and Reasons for Applying

- Of the eight pairs interviewed, seven had either the PI or SI attend one or more of the NCI-sponsored think tank workshops on Physical Sciences in Oncology. The last pair heard about the solicitation through an email on NIH funding opportunities.
- Most interviewees who directly participated in the workshops stated that the workshops were useful for developing the application/understanding the PS-OC program or for spurring new thoughts for research agendas. Only one pair thought they were not useful, and would have preferred smaller breakout groups.
- Two of the PI/SI pairs stated that they had been funded (or had sought funding) to explore the relevance of the physical sciences to cancer biology previously. Four of the pairs had previously looked at physical science applied to biology, but had not focused on cancer systems. Two pairs stated they had never before done or even considered doing this type of work until hearing about the PS-OC program.
- Only two of the PI/SS pairs had previously collaborated with each other. The other six were brought together by the PS-OC application process, with five being introduced by a mutual colleague, or were aware of each other's work due to multi-disciplinary programs at their institutions/regions, with one pair actually meeting at the NCI-sponsored think tanks.

Approach to Putting Together Application

- In terms of choosing which projects/cores to include, six of the PI/SI pairs turned to ongoing projects or collaborators within their institutions or networks and thought about how those could be built upon to create a portfolio of projects for a Center with an overarching framework to address cancer. Two of the PI/SI pairs started from scratch as to what projects/cores they would want to include.

[1] Centers interviewed: Arizona State University; Cornell University; H. Lee Moffitt Cancer Center & Research Institute; Johns Hopkins University; Northwestern University; Princeton University; Scripps Research Institute; and University of California, Berkeley.

- One of those used physical principles to drive the application, with the physicist PI taking five commonly known physical principles and working with a cancer biologist to perform thought experiments on how they could be applied to understand the evolution of cancer resistance.
- Four of the PI/SI pairs had been previously, or are currently, involved in an interdisciplinary center or department aimed at bridging the physical sciences and biology. Of these, several stated that they believed these existing structures were useful for preparing their PS-OC applications, or that their experience as part of the previous structures would help them in managing the PS-OC.
- All Centers felt that the answering of their research questions required close collaboration between physical scientists and biologists. Three stated that they designed each of the projects to have a lead physical scientist and a lead biologist.

Application Process

- All of the pairs interviewed felt the application timeline was very rushed.
- Six of the pairs said that their proposal preparation was so rushed that they ended up leaving out projects or collaborators that they would have preferred to include.
- Most of the Centers said they would have taken the same approach towards developing their applications had they been given more time, but would have better refined their research descriptions or included those projects identified later in the application process.
- Two of the pairs said the RFA and/or NCI program staff were unclear as to what the program was actually looking for in terms of application components. One of these said the pre-application meeting in January 2009 was useful for clarifying the intent of the program.
- Two of the Centers suggested that NCI use a phased approach for Center funding in the future, with a pre-application phase that would allow for feedback to the applicants prior to submission of a full application. The National Science Foundation Science and Technology Centers were proposed as a model.

Review and Award Process

- Three of the Centers found the feedback from the review panel to be useful for knowing how to better communicate this type of research in the future; four of the Centers found the feedback to be not useful; and one stated that they did not read the review feedback. Some Centers felt the review panel was more informed than a traditional review panel might have been, while others felt they received conflicting information from different reviews of their application.
- Three of the Centers stated they believed the review process was well-designed and implemented, given the time allowed and the complexity of the subject.
- All of the Centers mentioned they had to cut their budget, with effects ranging from cutting staff time on projects to eliminating entire cores or projects. Three Centers said they will try to use existing grants or apply for new grants to help make up for the cuts.
- Four of the Centers felt the budget negotiations with NCI were unusual.

High-Level Research Questions

- Of the eight Centers interviewed, four felt their Center most closely aligned with the "Physics of Cancer" theme, one felt they aligned most closely with the "Deconvoluting the Complexity of Cancer" and one with the "Understanding the Coding, Decoding, Transfer, and Translation of Information in Cancer." Two Centers felt they aligned with more than one area.
- Most seemed to characterize their work as not entailing the exploration of new physics, but rather bringing the approaches or tools/techniques from physics to bear on questions of relevance to cancer biology. Many noted the importance of oncologists to ensure that the experiments stayed relevant to cancer.
- With respect to translation to diagnostics/therapeutics, most of the Centers stated their work was at the level of fundamental research and was not likely to have translational components within five years. One Center is already involved with clinical trials (from previous projects), and does believe they will have results with clinical applications within five years.

Approach to Facilitating Communication, Collaboration, and Outreach/Dissemination

- The interviewed Centers are taking a variety of approaches to promoting collaborations. Some of the Centers stated they believed the trick was to give smart people hard projects and that they would naturally seek out collaborations when necessary, and were leaving the collaboration decisions to each of the project leaders. Other Centers have planned a variety of meetings at all levels, from the project level to Center-wide, on a regular basis.
- Five of the Centers stated they are already exchanging students and post-docs between projects within the Center. Four Centers said they plan to exchange students and post-docs with other Centers in the PS-OC network.
- Three Centers mentioned an annual Center-wide meeting to promote knowledge sharing and collaboration within the Center.
- Three of the Centers discussed the possibility of holding a "bootcamp" for cross-training of students and post-docs.
- The Centers appear to just now be starting discussions with other Centers within the PS-OC network regarding potential collaborations.
- One Center suggested PS-OC staff hold a poster session during the annual PS-OC meeting to stimulate discussions across the Centers.

Cooperative Agreement Expectations

- All of the Centers stated that the level of administrative involvement by NCI has been intense thus far. Half felt this was an appropriate level given the new state of the program and the size of the Centers, while the other half were concerned that too much time was being spent on administration, leaving less time for science.
- Several of the Centers mentioned they would like to limit the teleconference calls, focusing directly on those matters that require PI/SI input and leaving most administrative details to be decided by the program staff and communicated to the PIs via other means.

- Most Centers felt the reporting requirements were appropriate, but several Centers stated that it was a challenge to submit a first progress report so soon after the award was received.
- Several Centers stated it was apparent that NCI program staff were committed to making the program a success.

Anticipated Challenges

- None of the interviewees anticipated any unusual challenges in their Centers beyond what is normal for multi-disciplinary centers. Issues with promoting cross-disciplinary collaboration were felt to be manageable. Several PI/SI teams cited previous success with bridging disparate fields as giving them confidence for these Centers.
- Making sure that the various projects stay focused as a Center was mentioned as a primary focus of concern.
- Most of the Centers were actively recruiting post-docs and other staff, but all feel they will be running at full capacity within six months to a year.
- Some of the Centers felt publishing this type of cross-disciplinary work would be a challenge, while others stated it would not be a problem.

Other Comments

- One interviewee who is also a clinician noted that the program seems to have unreasonable expectations with respect to the availability of Senior Investigators to travel and participate in required meetings. This interviewee felt that the challenges faced by clinician-researchers should be taken into consideration.
- Recognizing that this is a physics-driven program, some Centers would still like to see more involvement from the Senior Investigators at the PS-OC meetings. Several stated that biologists felt somewhat marginalized at the kickoff meeting.
- One Center specifically stated their hope that the PS-OC mechanism would still allow for flexibility in funds to follow research where it takes them, especially if the research is potentially high payoff. This Center said this flexibility is especially important when exploring new domains such as the bridging of physics and cancer research, where several research approaches may have to be explored.
- A few Centers mentioned that changing the paradigm in cancer research would require more investments beyond the PS-OC network. For example, NCI could create a training grant specifically to train physics students to work on cancer research, or set up a standing physical science-oncology study section. There are still barriers in place to doing this type of research, and those barriers should be examined.
- Some of the Centers stated their hope that NCI would give the Centers enough time to succeed or fail. Those that are funded for only two years were especially concerned about the level of commitment from NCI.

Appendix A: Interview Protocol for PS-OC Centers: Interviews with both PIs and Senior Investigators

1) **How did you hear about the PS-OC solicitation, and why did you decide to apply?**

For Follow Up:

- Where did the idea for the Center come from?
- Is this something you had been contemplating previously?
- Have you been funded in the past to do similar work?

2) **Once you decided to apply, what was your overall approach to putting together the application?**

For Follow Up:

- How did you develop and refine your research questions? Who had input and at what points?
- What was the process for selecting collaborators and assigning roles? Did you have pre-existing relationships with any/all collaborators?
- What was the process for deciding which projects/cores to include?
- What was the process for writing the application? Were there any issues?

3) **Do you feel that you had enough time and resources to develop a high quality application?**

For Follow Up:

- Would your application and planning process have benefited from additional time? How much?
- Do you think you would have done anything differently if additional time and/or planning grants had been available?

4) **How did the application review process for PS-OC compare with others you've experienced?**

For Follow Up:

- How, if at all, did the feedback provided by NCI on your application change your plans for the Center?
  - Feedback from study section?
  - Feedback from budget process?
- Did you find the feedback you received on your application to be useful and appropriate?
- Is there any feedback you'd like to give NCI on the workshop or application processes?

5) **Could you please briefly describe the scientific goals of your Center and the high-level research questions you intend to address?**

For Follow Up:

- Which one or more of the four NCI PS-OC themes[2] is most relevant?
- Will your research question(s) require the development of new paradigms, new datasets, or new approaches/models/techniques?
  - What's new about the biology?
  - What's new about the physics?
- Would it be possible to address these questions without involvement by both cancer biologists and physical scientists?
- How do you hope to see your research impacting cancer treatment/prevention in the future, and what do you believe is a reasonable timeframe to expect discoveries suitable for translation?

6) **How will you approach coordinating activities and facilitating communication across the Center?**

For Follow Up:

- How often will Center participants meet?
- Do you have a plan to address challenges associated with differences in scientific culture, jargon, etc?

7) **Will there be a coordinated approach to training at the Center level?**

For Follow Up:

- What do you think is the best approach to training researchers who will work across disciplines?
- What types of training and support for students/postdocs do you anticipate providing?
- Do you have plans for exchanging students, both between labs within your Center and between your and other Centers?

8) **What are your expectations with respect to the role NCI will play in managing the Cooperative agreement?**

For Follow Up:

- Do you feel that NCI's level of involvement has been appropriate so far?
- Do you feel that roles and expectations are sufficiently clear?
- Are reporting requirements appropriate and reasonable?

[2] Understanding the Physics (Physical Laws and Principles) of Cancer; Exploring and Understanding Evolution and Evolutionary Theory in Cancer; Understanding the Coding, Decoding, Transfer, and Translation of Information in Cancer; Deconvoluting the Complexity of Cancer.

9) **What challenges do you anticipate for your Center?**

For Follow Up:

- Have you encountered any barriers so far?
- How long do you think it will take to have the Center up and running at full capacity?
- Are you confident that the collaborative relationships (especially those that cross disciplines) will be successful?
- Are there aspects of the science that you would consider unusually risky?
- Do you have any concerns about the Center's ability to publish or otherwise disseminate this kind of cross-disciplinary research?

10) **Is there anything else you'd like NCI and/or the evaluation team to know at this time? Any concerns about the evaluation process or questions you'd like to see it focus on?**

STPI Memo 2: Evaluation Plan

To: Jerry Lee, Jim Corrigan, NCI
From: Brian Zuckerman, STPI
CC: Christina Viola Srivastava, Mary Beth Hughes

Subject: Draft Plan for an Outcome Evaluation of the NCI's Physical Science in Oncology Centers (PS-OC) Program

Date: March 4, 2010

The National Cancer Institute (NCI) of the National Institutes of Health (NIH) recently launched the Physical Sciences in Oncology Centers (PS-OC), a program aimed at bridging the gap between the physical sciences and oncology/cancer biology. The Science and Technology Policy Institute (STPI) has been tasked with proposing an evaluation plan for the Centers that will meet the needs of the NCI Executive Committee at Program Year 5 while informing ongoing program management. In preparation for the design task, STPI engaged in the following activities:

1. Discussions with PS-OC program staff members;
2. Review of available program documents including the pre-announcement workshop materials, RFA, summary statements, applications, and selected progress reports from the newly awarded centers;
3. Interviews with five researchers who are currently conducting cancer research involving the physical sciences in order to gain insight on the current state of the field;
4. Interviews with 8 of the 12 PS-OC senior management teams (PI and co-PI);
5. Developing a draft program logic model for the PS-OCs (attached as Appendix A).

Based on what STPI has learned to date about the program, we recommend that NCI's evaluation needs for PS-OC can best be met through three separate but interdependent evaluation components. Specifically, STPI recommends the following:

1. Prospective data collection on supported activities and key outputs to inform program management as well as future evaluation efforts;
2. Structured evaluation of program design, implementation, and preliminary outcomes by an expert panel at program year 4-5 (prior to concept renewal);
3. Summative evaluation of program outcomes at year 10 or later.

Preliminary design recommendations for each component are described below.

Component 1: Prospective Data Collection on Supported Activities and Key Outputs/Outcomes

The first recommended evaluation component is prospective data collection on activities and key outputs/outcomes. Collecting data on program activities and outputs prospectively serves several purposes: 1) activities and outputs can be monitored by program managers so that changes can be made as needed; and 2) any errors or inadequacies that are detected in the data can be addressed sooner rather than later. These advantages must be balanced against the inefficiency of collecting and analyzing information as it becomes available relative to a single retrospective data collection effort. For this reason, STPI is recommending prospective data collection for the PS-OC activities and outputs/outcomes for which data are most readily available.

Specifically, STPI recommends that information on key variables be extracted from the semi-annual Center progress reports into a more structured format as they become available. Supplementary and correlative information should also be extracted from supplementary sources (e.g. bibliometric databases) at regular intervals. The variables for which STPI recommends that data be collected prospectively are summarized in Table 1, as are the sources from which data should be extracted. These activity and output variables fall into four broad categories (knowledge generation; practice of research and collaboration; training; broader impacts) derived from the program goals and program logic (see Appendix A).

Table 1: Activity/Output/Outcome Variables for which data should be collected prospectively.

Category	Activity/Output/Outcome Variable	Data Source(s)
1. Knowledge Generation	Funded research projects by type and objectives	Progress reports
	Center publications	Progress reports; SPIRES
	Bibliometric data on center publications	Bibliometric databases
	Key discoveries/key findings	Progress reports
	Invention disclosures, patent applications, and patents	Progress reports; IP databases
	New datasets developed	Progress reports
	Other notable research outputs (e.g., datasets, software, protocols, models, etc.)	Progress reports
	Clinical studies (if any) building upon advances	Progress reports; clinicaltrials.gov
2. Practice of research and collaboration	Center activities aimed at promoting collaboration between physical scientists and cancer researchers	Progress reports
	Participating institutions	Progress reports
	Participating investigators, by institution, research project, and discipline/training	Progress reports
	Formal collaborations between Center investigators	Derive from project lists and publications
	Informal collaborations between Center investigators	Progress reports
	Cross-Center collaborations	Progress reports
	Collaborations between Center investigators and others	Progress reports
	Core resources supported, by type	Progress reports
	Use of core resources	Progress reports
3. Training and Outreach	Students and fellows supported	Progress reports
	Participants in cross-Center exchanges	Progress reports
	Course materials/training modules created	Progress reports
	Seminars/workshops conducted by Centers	Progress reports
	Other dissemination activities	Progress reports
4. Broader impacts	New solicitations for cancer research proposals using physical sciences approaches, with links to Centers (if any)	NIH administrative databases; other funder databases
	New applications to NCI for cancer research using physical sciences approaches from Center investigators, others	NIH administrative databases
	New workshops/conferences/other efforts involving physical sciences and cancer with links to Centers (if any)	NIH administrative databases; Web searches

NCI may wish to employ an independent contractor to coordinate extraction of information from progress reports and collection of supplementary data. This model has been used successfully by various Centers programs at the National Science Foundation (e.g., the Science and Technology Centers).

Component 2: Expert Panel Review at Year 4-5

The NCI Executive Committee requires evaluation prior to concept renewal at program year 5, which typically requires that evaluation efforts begin during program year 4. STPI recommends a methodologically rigorous expert panel review to assess program design, implementation, progress to date by the Centers, and potential for future success. Specifically, STPI recommends that NCI should convene a panel of experts to address the following questions:

1) Are the program's objectives and priorities being met by progress to date?
2) How should the program's priorities be changed based upon the program's experience to date?
3) Did the program design facilitate achieving the objectives?
4) Are Centers the right way to achieve the program's priorities and objectives?
5) Have there been issues with the implementation of the Centers to date?
6) Is the science being done at the Centers more innovative/multidisciplinary than most science happening elsewhere?
7) Do the relationships between physical scientists and cancer researchers appear to be appropriately collaborative, with both groups making substantive contributions to the research? Are such collaborations occurring at institutions not participating in the PS-OC program?
8) Are the training opportunities available through the Center different from training opportunities available elsewhere?
9) Overall, does the panel believe the PS-OC program is on track to meet its goals?
10) Does the panel believe that the potential for future progress merits continued investment by NCI in the PS-OCs?

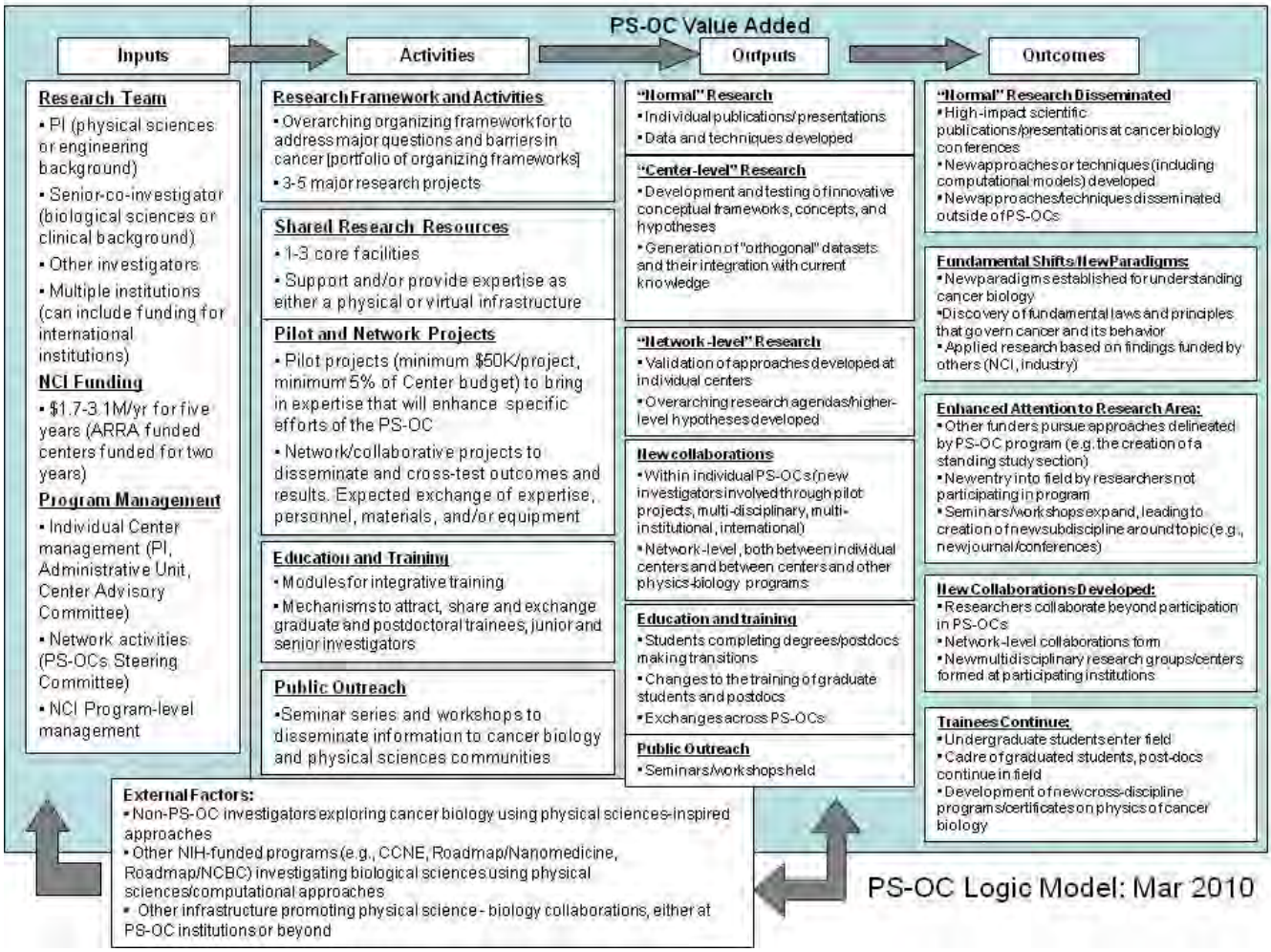
In order for the expert panel to render credible judgments, the selection of panel members is critical. Expert panel members would ideally be selected and recruited by the NCI Board of Scientific Advisors to assure scientific credibility and neutrality, though program staff could provide suggestions regarding reviewers.

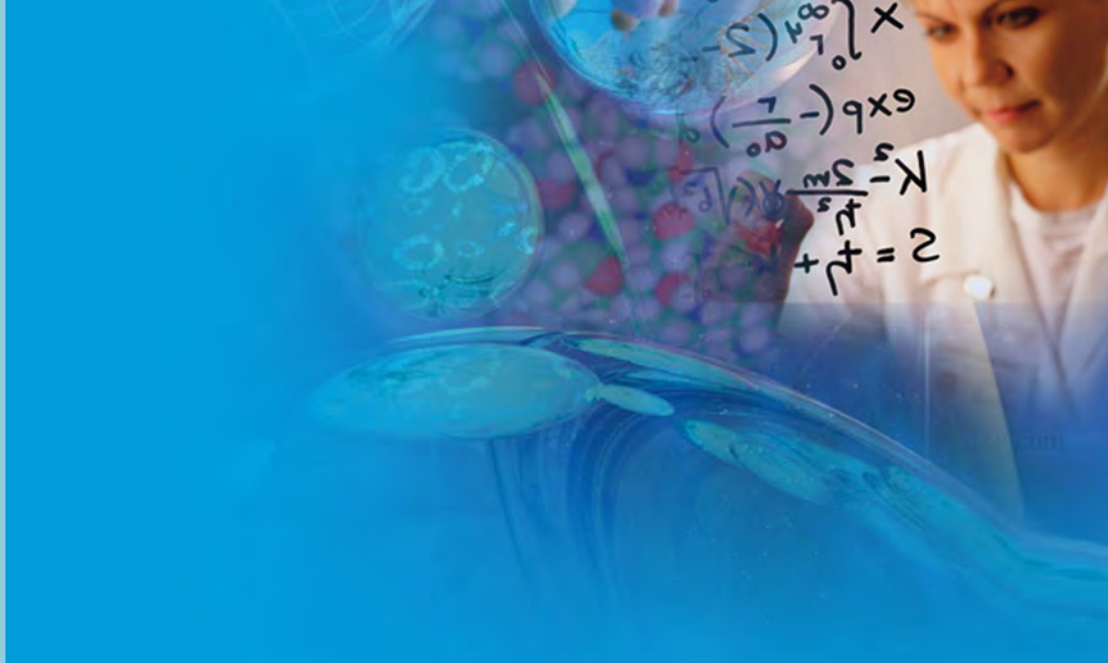
In order to facilitate the panel members becoming sufficiently familiar with the PS-OCs without making excessive demands on their time, STPI recommends that most of the Year 4 Network Meeting should be devoted to the expert panel review. With the expert panel members in attendance, the program staff and each Center should make a presentation summarizing progress to date. Following the presentations, the expert panel should meet individually with the leadership from each of the Centers to ask questions and interact one-on-one. Prior to the Network Meeting, expert panel members should also have had an opportunity to review all of the activity/output data collected as part of evaluation component 1 and the Center progress reports (as there are 12 Centers, 1 or 2 expert panel members should focus on each individual Center).

Component 3: Full Outcome Evaluation at Year 10 or Later

A full Outcome Evaluation would involve more extensive and resource-intensive collection of data on program performance and outcomes, possibly in comparison with similar efforts (although, as STPI's initial efforts to identify examples of true collaboration between physical scientists and cancer researchers were not successful, it is difficult to imagine an appropriate comparative design). If it is decided that a full Outcome Evaluation of the PS-OCs is feasible and warranted, it should not be initiated until the program is stable in terms of design and sufficiently mature for outcomes to be fully developed. Ten years is frequently used as a rule-of-thumb for maturity of Centers programs, but in reality every program is unique. In the case of the PS-OCs, it seems prudent to wait at least until after the expert panel review and concept renewal to plan an outcome evaluation, as the program design may continue to evolve.

Appendix A: Draft Logic Model for PS-OCs





19. Extended Scientific Report Template

Extended Scientific Report	
Report Date:	Center Name:
E-mail Address:	PI Name:
	Affiliation
1. PS-OC Overall Progress Summary (since last report)	
a. Progress on Center Framework	

b. New collaborations (within Center, within Network, outside Network)

2.	**Administration Unit (3-4 pages)**
a.	Status updates
	i. Status update on current PS-OC pilot projects ****For new pilot projects, in addition to the information requested, provide the rationale for selecting the project** For any additional pilot projects, follow same format and add after second project
Title of Project: Amount of Funding: Name of PI: Addional key investigators: Status Details:	
Title of Project: Amount of Funding: Name of PI: Addional key investigators: Status Details:	

ii.	Status update on current PS-OC trans-Network projects ****For new pilot projects, in addition to the information requested, provide the rationale for selecting the project** For any additional trans-Network projects, follow same format and add after second project
Title of Project: Amount of Funding: Name of PI: Addional key investigators: Status Details:	
Title of Project: Amount of Funding: Name of PI: Addional key investigators: Status Details:	

b. New leveraged funding for Center (if any since last report)
c. Plans for the next six months for the Center
d. Red flags - any current or anticipated roadblocks for the Center

e.	All Publications for the PS-OC (all projects and cores) since last report **Highlight articles from more than one PS-OC if any in each section**
i.	Published Peer-Reviewed Journal Articles (include the following information **Authors, Title, Journal name, issue, pages, and which project(s) contributed to publication**) *Note: Include only published articles - in-process articles go into next section*
ii.	Peer-Reviewed Journal Articles in Progress (include **Authors, Title, Journal name, Status (in press, accepted, or submitted), and which project(s) contributed to publication**)
iii.	Other Outputs (**Review articles, editorials, books, book chapters, etc. and which project(s) contributed to the publication**)

f.	Conference Presentations for the PS-OC (all projects and cores) since last report
	i. Past Meetings since last report (include **Presentation number, Meeting name, Authors, Title, Location of meeting, Dates of meeting, which project(s) contributed to publication**) ***Please indicate invited/plenary presentations*
	ii. Upcoming Meetings (include **Presentation number, Meeting name, Authors, Title, Location of meeting, Dates of meeting, which project(s) contributed to publication**) ***Please indicate invited/plenary presentations*
g.	Patents from Center

3.	**Research Project Progress (3-4 pages for each project)**	
a.	Project title	Names of Project Leader(s)
Collaborators:		
b.	Accomplishments during reporting period	

c. New collaborations (within Center, within Network, outside Network)
d. Plans for the next six months
e. Red flags - any current or anticipated roadblocks

f.	Publications sorted by each project **Highlight articles from more than one PS-OC if any in each section**	
	i.	Published Peer-Reviewed Journal Articles (include the following information **Authors, Title, Journal name, issue, pages, and which project(s) contributed to publication**) *Note: Include only published articles - in-process articles go into next section*
	ii.	Peer-Reviewed Journal Articles in Progress (include **Authors, Title, Journal name, Status (in press, accepted, or submitted), and which project(s) contributed to publication**)
	iii.	Other Outputs (**Review articles, editorials, books, book chapters, etc. and which project(s) contributed to the publication**)

g.	Conference Presentations sorted by each project
	i. Past Meetings since last report (include **Presentation number, Meeting name, Authors, Title, Location of meeting, Dates of meeting, which project(s) contributed to publication**) ***Please indicate invited/plenary presentations*
	ii. Upcoming Meetings (include **Presentation number, Meeting name, Authors, Title, Location of meeting, Dates of meeting, which project(s) contributed to publication**) ***Please indicate invited/plenary presentations*
h.	Patents resulting from project

4. Shared Research Resources/Cores (1-2 pages each)	
For each Core, please inlcude:	
a. Core title	Names of Core Leader(s)
Collaborators:	
b. Accomplishments during reporting period	
c. Current users and new collaborations (within Center, within Network, outside Network) **** Indicate new users**	
d. Plans for the next six months	
e. Red flags - any current or anticipated roadblocks	

f.	Publications for each core
	i. Published Peer-Reviewed Journal Articles (include the following information **Authors, Title, Journal name, issue, pages, and which project(s) contributed to publication**) *Note: Include only published articles - in-process articles go into next section*
	ii. Peer-Reviewed Journal Articles in Progress (include **Authors, Title, Journal name, Status (in press, accepted, or submitted), and which project(s) contributed to publication**)
	iii. Other Outputs (**Review articles, editorials, books, book chapters, etc. and which project(s) contributed to the publication**)

g.	Conference Presentations sorted by each core
	i. Past Meetings since last report (include **Presentation number, Meeting name, Authors, Title, Location of meeting, Dates of meeting, which project(s) contributed to publication**) ***Please indicate invited/plenary presentations*
	ii. Upcoming Meetings (include **Presentation number, Meeting name, Authors, Title, Location of meeting, Dates of meeting, which project(s) contributed to publication**) ***Please indicate invited/plenary presentations*

5. Education and Training Unit

a. Accomplishments during reporting period

i. New courses (Provide the following information):

Course number	Course name	Full course or module	Status (taught or under development)	Grad or undergrad course	Who taught course	Where taught	Which department

ii. Presented and upcoming seminars

b. Update on Training of Students and Fellows (provide the following information for each student/fellow):

Trainee name	Trainee department	Position (e.g., grad student, post-doc, undergrad)	If grad student, degree expected	Trainee mentor	Mentor department	Amount of funding received from center this year	Was training completed this year

c. Transition of trainees completed during the year (provide the following):

Trainee name	Current organization/next step (if known)	Current title (if known)

d. Update on Student/Postdoc exchanges (provide the following for each person exchanged):

Name of person exchanged	Position	Mentor	List of PS-OCs involved in exchange	Duration of exchange (months)	Goal of exchange	Specific techniques learned

6. Outreach and Dissemination Unit

a. Accomplishments during reporting period

i. Past workshops (provide the following):

Workshop name	Date	Location	Duration	Speakers	Intended audience	Attendance	Purpose	Any outcomes

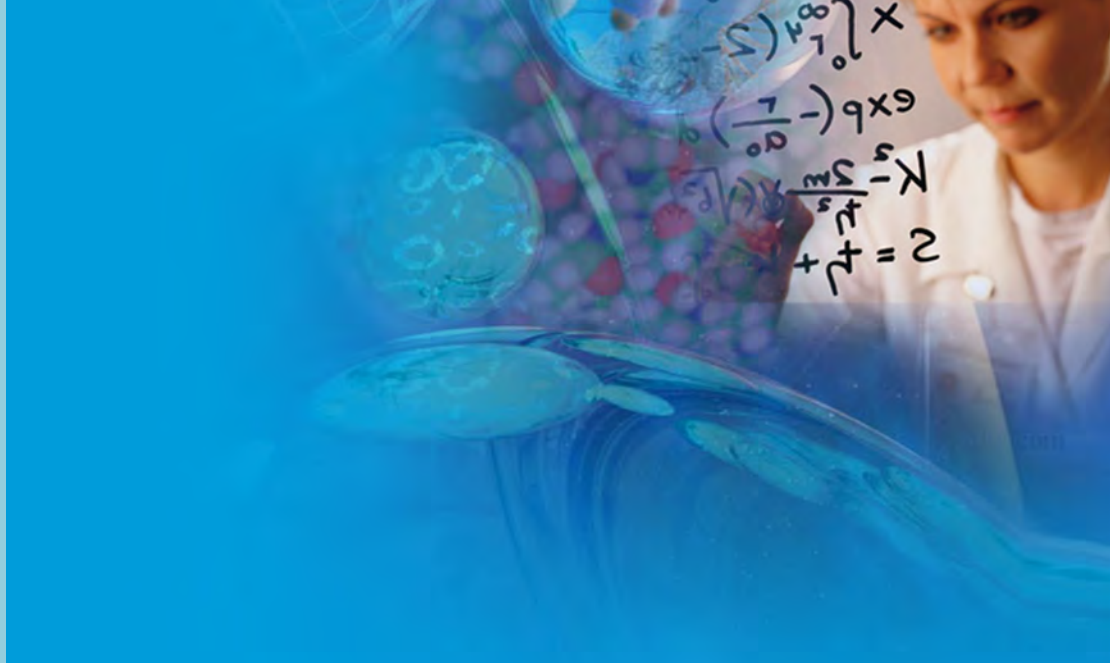
ii. Upcoming workshops and outreach efforts (provide the following):

Workshop name	Date	Location	Duration	Speakers	Intended audience	Approximate attendance	Purpose

iii. Update on personnel exchange outside of network

Name of person exchanged	Position	Mentor	Collaborating institution	Duration of exchange (month)	Goal of exchange	Specific techniques learned

iv.	Status update on current Outreach pilot projects ****For new outreach projects, in addition to the information requested, provide the rationale for selecting the project** For any additional trans-Network projects, follow same format and add after second project
Title of Project: Amount of Funding: Name of PI: Addional key investigators: Status Details:	
Title of Project: Amount of Funding: Name of PI: Addional key investigators: Status Details:	



20. Survey Questions

PS-OC Survey: Administrators (Section A)

OMB No.: 0925-0642
Expiration Date: 9/30/2014

Notification to Respondent of Estimated Burden

Public reporting burden for this collection of information is estimated to average 10 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to: NIH, Project Clearance Branch, 6705 Rockledge Drive, MSC 7974, Bethesda, MD 20892-7974, ATTN: PRA (0925-0642). Do not return the completed form to this address.

Please identify your primary affiliation with the Physical Sciences - Oncology Centers Program.

Please pick one of the answers below.

- ○ Center Principal Investigator (PI)
- ○ Center Senior Scientific Investigator (SI)
- ○ PS-OC Project/Core Investigators (i.e. project/core leader or research investigator)
- ○ PS-OC Trainee
- ○ PS-OC Advocate
- ○ PS-OC Outreach and Dissemination Unit Lead
- ○ PS-OC Education and Training Unit Lead
- ○ PS-OC Administrator
- ○ PS-OC External Advisor
- ○ I am not associated with the PS-OC Program

Section A. Please answer the following questions relevant to your role as PS-OC Administrator.

A1. How long have you been affiliated with the PS-OC Program?

Please pick one of the answers below.

- ○ less than 1 year
- ○ 1 - 2 years
- ○ Since the start of the PS-OC Program

A2. What are your roles as PS-OC Administrator? Please check all that apply.

Please check all that apply and/or add your own variant.

- ☐ Member of PS-OC Operations Sub-Group
- ☐ Member of Outreach & Dissemination Working Group
- ☐ Member of Education & Training Working Group
- ☐ Organization and Submission of Progress Reports
- ☐ Disseminating Information to PS-OC Members
- ☐ Organizing Site Visits
- ☐ Managing PS-OC Pilot Projects

Other

....

A3. Are you involved with the administration of other large NIH grants or related awards at your Institution?

Please pick one of the answers below.

- ○ Yes
- ○ No

A3b. Are you involved with any of the following NIH programs? If so, please check all that apply (if not, please skip).

Please check all that apply and/or add your own variant.

- ☐ Integrative Cancer Biology Program
- ☐ Tumor Microenvironment Network
- ☐ The Cancer Genome Atlas
- ☐ Centers of Cancer Nanotechnology Excellence
- ☐ Clinical Proteomic Tumor Analysis Consortium
- ☐ Training Programs (i.e. R25, T32)

Other

....

A3c. From your standpoint, please evaluate the PS-OC program relative to other NIH grants or related programs at your Institution for the following items.

Please mark the corresponding circle - only one per line.

	Worse			Neutral			Better
Development of trans-disciplinary teams and infrastructure	○	○	○	○	○	○	○
Training and Education	○	○	○	○	○	○	○
Community Communications and Outreach	○	○	○	○	○	○	○
Progress Reports	○	○	○	○	○	○	○
NCI Site Visits	○	○	○	○	○	○	○

A4. Please rate the effectiveness of the PS-OC Operations Subgroup teleconferences in the following areas.

Please mark the corresponding circle - only one per line.

	A	B	C	D	E	F	G	H
Disseminating information related to the PS-OC program	○	○	○	○	○	○	○	○
Providing updates to the PS-OC Administrators	○	○	○	○	○	○	○	○
Providing answers to PS-OC program questions	○	○	○	○	○	○	○	○

Legend for rank grid table: A4. Please rate the effectiveness of the PS-OC Operations Subgroup teleconferences in the following areas.

Columns:

A - I do not know
B - Ineffective
C -
D -
E - Neutral
F -
G -
H - Very Effective

A5. Within your PS-OC, how do you disseminate sharing of information to members?

Please check all that apply and/or add your own variant.

- ☐ Email
- ☐ Webpage
- ☐ Posters/Flyers
- ☐ Newsletter
- ☐ Meetings

Other

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A6. Please describe any obstacles or problems you had to overcome in administering the PS-OC?

Please write your answer in the space below.

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A7. Please describe the effectiveness of NCI program staff in the following roles.

Please mark the corresponding circle - only one per line.

	A	B	C	D	E	F	G
Faciliting interactions between PS-OC investigators	○	○	○	○	○	○	○
Answering questions about PS-OC and NCI guideline and procedures	○	○	○	○	○	○	○
Providing best practices	○	○	○	○	○	○	○
Coordinating working group teleconferences	○	○	○	○	○	○	○
Communicating with the PS-OCs about funding opportunities and resources	○	○	○	○	○	○	○

Legend for rank grid table: A7. Please describe the effectiveness of NCI program staff in the following roles.

Columns:

A - Ineffective
B -
C -
D - Neutral
E -
F -
G - Effective

A8. Do you have any additional suggestions for how NCI could enhance overall program performance?

Please write your answer in the space below.

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The following question inquires about your views on the progress the PS-OC program is making relative to the goals of the program.

From your standpoint, please evaluate the extent to which the PS-OC program has been successful in reaching the following program goals.

Please mark the corresponding circle - only one per line.

	I do not know	Very Poor	Poor	Fair	Good	Excellent
Form trans-disciplinary teams focused on establishing physical sciences-centric themes in cancer research	○	○	○	○	○	○
Build a collaborative trans-discipline research sharing network	○	○	○	○	○	○
Promote collaboration by PS-OC researchers across the PS-OC network	○	○	○	○	○	○
Educate trans-disciplinary scientists that pursue careers in the field of physical sciences in oncology	○	○	○	○	○	○
Promote collaboration by PS-OC researchers beyond the PS-OC network	○	○	○	○	○	○
Form new physical sciences in oncology programs at universities or institutions	○	○	○	○	○	○
Test dogma-challenging hypothesis on cancer initiation and progression	○	○	○	○	○	○
Bring new types of scientists to cancer research	○	○	○	○	○	○
Generate new datasets in cancer research	○	○	○	○	○	○
Generate new knowledge in cancer research	○	○	○	○	○	○

Please provide any additional comments that you would like to share about the convergence of physical sciences in oncology or the PS-OC program.

Please write your answer in the space below.

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PS-OC Survey: Advocates (Section F)

OMB No.: 0925-0642-07
Expiration Date: 9/30/2014

Notification to Respondent of Estimated Burden

Public reporting burden for this collection of information is estimated to average 15 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to: NIH, Project Clearance Branch, 6705 Rockledge Drive, MSC 7974, Bethesda, MD 20892-7974, ATTN: PRA (0925-0642). Do not return the completed form to this address.

Please identify your primary affiliation with the Physical Sciences - Oncology Centers Program.

Please pick one of the answers below.

- ○ Center Principal Investigator (PI)
- ○ Center Senior Scientific Investigator (SI)
- ○ PS-OC Project/Core Investigators (i.e. project/core leader or research investigator)
- ○ PS-OC Trainee
- ○ PS-OC Advocate
- ○ PS-OC Outreach and Dissemination Unit Lead
- ○ PS-OC Education and Training Unit Lead
- ○ PS-OC Administrator
- ○ PS-OC External Advisor
- ○ I am not associated with the PS-OC Program

Section F. The following section contains questions specific for PS-OC program advocates.

F1. What is your role as an advocate in the PS-OC program? Please check all that apply.

Please check all that apply and/or add your own variant.

- ☐ Participate in the annual meeting
- ☐ Site visits
- ☐ Scientific discussions
- ☐ Provide guidance and answer questions
- ☐ Review proposals
- ☐ Attend workshops
- ☐ Write publications (scholarly or lay)
- ☐ Present to the public

Other

....

F2. How often do you meet with the following groups?

Please mark the corresponding circle - only one per line.

	Never	Yearly	Monthly	Weekly	Daily
Other PS-OC Advocates	○	○	○	○	○
The PS-OC Network Advocate	○	○	○	○	○
The Principal Investigator of the PS-OC	○	○	○	○	○
The entire PS-OC in which you participate	○	○	○	○	○

F3. Are you involved in any other NCI programs? If yes, please list in the comment box.

Please pick one of the answers below and add your comments.

- ○ Yes
- ○ No
- ○ Other or Unsure

....

F4. How do you feel the PS-OC Network compares to the other programs?

Please mark the corresponding circle - only one per line.

	Inferior			Neutral			Superior
	○	○	○	○	○	○	○

F5. Please describe any suggestions you have for improving advocate involvement in the PS-OC Program

Please write your answer in the space below.

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The following question inquires about your views on the progress the PS-OC program is making relative to the goals of the program.

From your standpoint, please evaluate the extent to which the PS-OC program has been successful in reaching the following program goals.

Please mark the corresponding circle - only one per line.

	I do not know	Very Poor	Poor	Fair	Good	Excellent
Form trans-disciplinary teams focused on establishing physical sciences-centric themes in cancer research	○	○	○	○	○	○
Build a collaborative trans-discipline research sharing network	○	○	○	○	○	○
Promote collaboration by PS-OC researchers across the PS-OC network	○	○	○	○	○	○
Educate trans-disciplinary scientists that pursue careers in the field of physical sciences in oncology	○	○	○	○	○	○
Promote collaboration by PS-OC researchers beyond the PS-OC network	○	○	○	○	○	○
Form new physical sciences in oncology programs at universities or institutions	○	○	○	○	○	○
Test dogma-challenging hypothesis on cancer initiation and progression	○	○	○	○	○	○
Bring new types of scientists to cancer research	○	○	○	○	○	○
Generate new datasets in cancer research	○	○	○	○	○	○
Generate new knowledge in cancer research	○	○	○	○	○	○

Please provide any additional comments that you would like to share about the convergence of physical sciences in oncology or the PS-OC program.

Please write your answer in the space below.

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PS-OC Survey: Education and Training Unit Leaders (Sections A and E)

OMB No.: 0925-0642-07
Expiration Date: 9/30/2014

Notification to Respondent of Estimated Burden

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Please identify your primary affiliation with the Physical Sciences - Oncology Centers Program.

Please pick one of the answers below.

- ○ Center Principal Investigator (PI)
- ○ Center Senior Scientific Investigator (SI)
- ○ PS-OC Project/Core Investigators (i.e. project/core leader or research investigator)
- ○ PS-OC Trainee
- ○ PS-OC Advocate
- ○ PS-OC Outreach and Dissemination Unit Lead
- ○ PS-OC Education and Training Unit Lead
- ○ PS-OC Administrator
- ○ PS-OC External Advisor
- ○ I am not associated with the PS-OC Program

Section A. Please answer the following questions relevant to your role as PS-OC Administrator.

A1. How long have you been affiliated with the PS-OC Program?

Please pick one of the answers below.

- ○ less than 1 year
- ○ 1 - 2 years
- ○ Since the start of the PS-OC Program

A2. What are your roles as PS-OC Administrator? Please check all that apply.

Please check all that apply and/or add your own variant.

- ☐ Member of PS-OC Operations Sub-Group
- ☐ Member of Outreach & Dissemination Working Group
- ☐ Member of Education & Training Working Group
- ☐ Organization and Submission of Progress Reports
- ☐ Disseminating Information to PS-OC Members
- ☐ Organizing Site Visits
- ☐ Managing PS-OC Pilot Projects

Other

....

A3. Are you involved with the administration of other large NIH grants or related awards at your Institution?

Please pick one of the answers below.

- ○ Yes
- ○ No

pA3b. Are you involved with any of the following NIH programs? If so, pease check all that apply (if not, please skip).

Please check all that apply and/or add your own variant.

- ☐ Integrative Cancer Biology Program
- ☐ Tumor Microenvironment Network
- ☐ The Cancer Genome Atlas
- ☐ Centers of Cancer Nanotechnology Excellence
- ☐ Clinical Proteomic Tumor Analysis Consortium
- ☐ Training Programs (i.e. R25, T32)

Other

....

A3c. From your standpoint, please evaluate the PS-OC program relative to other NIH grants or related programs at your Institution for the following items.

Please mark the corresponding circle - only one per line.

	Worse			Neutral			Better
Development of trans-disciplinary teams and infrastructure	○	○	○	○	○	○	○
Training and Education	○	○	○	○	○	○	○
Community Communications and Outreach	○	○	○	○	○	○	○
Progress Reports	○	○	○	○	○	○	○
NCI Site Visits	○	○	○	○	○	○	○

A4. Please rate the effectiveness of the PS-OC Operations Subgroup teleconferences in the following areas.

Please mark the corresponding circle - only one per line.

	A	B	C	D	E	F	G	H
Disseminating information related to the PS-OC program	○	○	○	○	○	○	○	○
Providing updates to the PS-OC Administrators	○	○	○	○	○	○	○	○
Providing answers to PS-OC program questions	○	○	○	○	○	○	○	○

Legend for rank grid table: A4. Please rate the effectiveness of the PS-OC Operations Subgroup teleconferences in the following areas.

Columns:

A - I do not know
B - Ineffective
C -
D -
E - Neutral
F -
G -
H - Very Effective

A5. Within your PS-OC, how do you disseminate sharing of information to members?

Please check all that apply and/or add your own variant.

- ☐ Email
- ☐ Webpage
- ☐ Posters/Flyers
- ☐ Newsletter
- ☐ Meetings

Other

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A6. Please describe any obstacles or problems you had to overcome in administering the PS-OC?

Please write your answer in the space below.

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A7. Please describe the effectiveness of NCI program staff in the following roles.

Please mark the corresponding circle - only one per line.

	A	B	C	D	E	F	G
Faciliting interactions between PS-OC investigators	○	○	○	○	○	○	○
Answering questions about PS-OC and NCI guideline and procedures	○	○	○	○	○	○	○
Providing best practices	○	○	○	○	○	○	○
Coordinating working group teleconferences	○	○	○	○	○	○	○
Communicating with the PS-OCs about funding opportunities and resources	○	○	○	○	○	○	○

Legend for rank grid table: A7. Please describe the effectiveness of NCI program staff in the following roles.

Columns:

A - Ineffective
B -
C -
D - Neutral
E -
F -
G - Effective

A8. Do you have any additional suggestions for how NCI could enhance overall program performance?

Please write your answer in the space below.

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Section E. The following section contains questions that are specific for the PS-OC Education and Training Unit leaders.

E1. What are your responsibilities as an Education Leader? Please check all that apply.

Please check all that apply and/or add your own variant.

- ☐ Recruitment
- ☐ Matching trainees and mentors
- ☐ Organize workshops, courses, or symposia
- ☐ Coordinating education activities
- ☐ Promote communication between investigators and trainees

Other

....

E2. Please evaluate how your PS-OC training program is meeting the following goals.

Please mark the corresponding circle - only one per line.

	I do not know	Very Poor	Poor	Fair	Good	Excellent
Facilitate career development	○	○	○	○	○	○
Facilitate mentor-mentee relations	○	○	○	○	○	○
Teach new skills	○	○	○	○	○	○
Bring new knowledge to trainees	○	○	○	○	○	○
Initiate a new training field of physical sciences in oncology	○	○	○	○	○	○
Facilitate the interaction and sharing of ideas among trainees	○	○	○	○	○	○

E3. Is support available for PS-OC training from other sources?

Please pick one of the answers below.

- ○ Yes
- ○ No

E3b. Please list the other sources that are supporting PS-OC training.

Please write your answer in the space below.

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E4. From your standpoint, would the trainees have difficulty obtaining support for PS-OC-type activities if this program did not exist?

Please pick one of the answers below.

- ○ Yes
- ○ No
- ○ Unsure

E5. Please rate how useful you think the education and training unit has been for the trainees regarding the following:

Please mark the corresponding circle - only one per line.

	Not Useful			Neutral			Useful
Gaining experience in the field of physical sciences in oncology	○	○	○	○	○	○	○
Encouraging trainees to participate in unfamiliar research activities	○	○	○	○	○	○	○
Developing new skill sets	○	○	○	○	○	○	○
Providing trainees with access to new resources and equipment	○	○	○	○	○	○	○
Establishing new contacts	○	○	○	○	○	○	○

E6. Please describe the effectiveness of NCI program staff in the following roles.

Please mark the corresponding circle - only one per line.

	A	B	C	D	E	F	G
Facilitating interactions between PS-OC investigators	○	○	○	○	○	○	○
Answering questions about PS-OC and NCI guideline and procedures	○	○	○	○	○	○	○
Providing examples of activities and best practices	○	○	○	○	○	○	○
Coordinating working group teleconferences	○	○	○	○	○	○	○
Disseminating information about funding opportunities and resources to the PS-OCs	○	○	○	○	○	○	○

Legend for rank grid table: E6. Please describe the effectiveness of NCI program staff in the following roles.

Columns:

A - Ineffective
B -
C -
D - Neutral
E -
F -
G - Effective

E7. Do you have any additional suggestions for how NCI could enhance overall program performance?

Please write your answer in the space below.

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The following question inquires about your views on the progress the PS-OC program is making relative to the goals of the program.

From your standpoint, please evaluate the extent to which the PS-OC program has been successful in reaching the following program goals.

Please mark the corresponding circle - only one per line.

	I do not know	Very Poor	Poor	Fair	Good	Excellent
Form trans-disciplinary teams focused on establishing physical sciences-centric themes in cancer research	○	○	○	○	○	○
Build a collaborative trans-discipline research sharing network	○	○	○	○	○	○
Promote collaboration by PS-OC researchers across the PS-OC network	○	○	○	○	○	○
Educate trans-disciplinary scientists that pursue careers in the field of physical sciences in oncology	○	○	○	○	○	○
Promote collaboration by PS-OC researchers beyond the PS-OC network	○	○	○	○	○	○
Form new physical sciences in oncology programs at universities or institutions	○	○	○	○	○	○
Test dogma-challenging hypothesis on cancer initiation and progression	○	○	○	○	○	○
Bring new types of scientists to cancer research	○	○	○	○	○	○
Generate new datasets in cancer research	○	○	○	○	○	○
Generate new knowledge in cancer research	○	○	○	○	○	○

Please provide any additional comments that you would like to share about the convergence of physical sciences in oncology or the PS-OC program.

Please write your answer in the space below.

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Survey: External Advisors and Scientists Not-associated with the PS-OCs (Section G)

OMB No.: 0925-0642-07
Expiration Date: 9/30/2014

Notification to Respondent of Estimated Burden

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Please identify your primary affiliation with the Physical Sciences - Oncology Centers Program.

Please pick one of the answers below.

- ○ Center Principal Investigator (PI)
- ○ Center Senior Scientific Investigator (SI)
- ○ PS-OC Project/Core Investigators (i.e. project/core leader or research investigator)
- ○ PS-OC Trainee
- ○ PS-OC Advocate
- ○ PS-OC Outreach and Dissemination Unit Lead
- ○ PS-OC Education and Training Unit Lead
- ○ PS-OC Administrator
- ○ PS-OC External Advisor
- ○ I am not associated with the PS-OC Program

Section G. The following section contains questions specific to scientists external or not associated with the PS-OC.

G1. Research experiences may vary depending on your scientific background and the scientific background of your collaborators. For each of the following column headers, please select all types of scientists that apply.

Please fill in the answers in the table below (mark appropriate circles and squares and fill in the blank spaces).

	Your field of training and expertise	Scientists you work with currently	Scientists you would like to work with on future projects
Molecular Biologists	☐	☐	☐
Cell Biologists	☐	☐	☐
Engineers	☐	☐	☐
Biologists	☐	☐	☐
Evolutionary Biologists	☐	☐	☐
Surgeons	☐	☐	☐
Oncologists	☐	☐	☐
Pathologists	☐	☐	☐
Radiologists	☐	☐	☐
Cancer Biologists	☐	☐	☐
Chemists	☐	☐	☐
Physicists	☐	☐	☐
Mathematicians	☐	☐	☐
Theorists	☐	☐	☐
Statisticians	☐	☐	☐
Information Technologists/Computer Scientists	☐	☐	☐
Other	☐	☐	☐

G2. What is your professional title? Please select all that apply.

Please check all that apply and/or add your own variant.

- ☐ Trainee (undergrad, graduate, postdoctoral fellow, medical student)
- ☐ Research Assistant
- ☐ Research Scientist
- ☐ Assistant Professor
- ☐ Associate Professor
- ☐ Full Professor
- ☐ Department Chair
- ☐ Cancer Center Director
- ☐ Dean
- Other

....

G3. To what extent do your research interests overlap with the following scientific themes?

Please mark the corresponding circle - only one per line.

	Not at all	Very Low	Low	Somewhat	High	Very High
Physics in Cancer (i.e. Understanding the role of cell and tissue mechanics, transport phenomena, heat transfer, shear stress, or other forces in cancer phenomena)	○	○	○	○	○	○
Evolution and Evolutionary Theory in Cancer	○	○	○	○	○	○
Information Transfer and Decoding in Cancer (i.e. spatial and temporal domains of trafficking of sub-cellular components, transcription, or translation in cancer)	○	○	○	○	○	○
De-Convoluting the Complexity of Cancer (i.e. Applying mathematical simulations, 3D model systems, or game theory to understand cancer phenomena)	○	○	○	○	○	○

G4. Does your Institution have an overall strategy or mechanism for converging the fields of physical sciences and oncology?

Please pick one of the answers below.

- ○ Yes
- ○ No
- ○ Unsure

G4b. Please describe any mechanisms or sources of support that are available at your Institution for collaborative research in physical sciences and oncology. If possible, please provide links to websites or programs.

Please write your answer in the space below.

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G5. Please indicate how strongly you agree or disagree with the following statement. I have seen evidence of the formation of a new field of "Physical Sciences-Oncology" within...

Please mark the corresponding circle - only one per line.

	Disagree			Neutral			Agree
My department(s)	○	○	○	○	○	○	○
My institutions(s)	○	○	○	○	○	○	○
At scientific meetings	○	○	○	○	○	○	○
My current research	○	○	○	○	○	○	○
My future research plans	○	○	○	○	○	○	○
Publications	○	○	○	○	○	○	○
I have not seen evidence of the formation of a new field of "Physical Sciences-Oncology"	○	○	○	○	○	○	○

G6. From your standpoint, where should NCI focus its efforts in converging physical sciences and oncology? Please select all that apply.

Please check all that apply and/or add your own variant.

- ☐ Short-term research aimed at clinically testable results
- ☐ Fundamental research aimed at new advances
- ☐ Training a new generation of investigators in physical sciences and oncology
- ☐ Infrastructure/tool creation

Other

....

G7. Are you aware of other programs or efforts (non-NCI) you feel are in the same domain (converging physical sciences and oncology)?

Please pick one of the answers below.

- ○ Yes
- ○ No
- ○ Unsure

G7b. Please provide a list of these programs. If possible, please provide websites or links for these programs.

Please write your answer in the space below.

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G8. What barriers do you anticipate for integrating the fields of physical sciences and oncology? Please check all that apply.

Please check all that apply and/or add your own variant.

- ☐ Communication barriers between disciplines
- ☐ Limited funding
- ☐ Lack of physical infrastructure
- ☐ Difficulties sharing data
- ☐ Initiating collaborations
- ☐ I anticipate no barriers.

Other

....

G9. Please rate your level of familiarity with NCI's efforts to converge physical sciences and oncology, or the PS-OC Program?

Please pick one of the answers below or add your own.

- ○ I am not aware of the program.
- ○ I have heard of the program, but know little about the structure and goals.
- ○ I am familiar with the program.
- ○ I was involved in the NCI Workshops, Think Tanks, or review for this concept.
- ○ I submitted an application for this program.
- ○ I am an external advisor to a PS-OC.

Other

....

G10. Are you involved with any of the following NIH programs? If so, please check all that apply (if not, please skip).

Please check all that apply and/or add your own variant.

- ☐ Integrative Cancer Biology Program
- ☐ Tumor Microenvironment Network
- ☐ The Cancer Genome Atlas
- ☐ Centers of Cancer Nanotechnology Excellence
- ☐ Clinical Proteomic Tumor Analysis Consortium
- ☐ Training Programs (i.e. R25, T32)

Other

....

G11. From your standpoint, please rate the PS-OC program (1-5) in the following areas. "5" is the highest rating.

Please mark the corresponding circle - only one per line.

	I do not know	1	2	3	4	5
Development of trans-disciplinary teams and infrastructure	○	○	○	○	○	○
Training trans-disciplinary scientists	○	○	○	○	○	○
Disseminiating information about the program to the broader research community	○	○	○	○	○	○
Generation of new datasets in cancer research	○	○	○	○	○	○
Generation of new knowledge in cancer research	○	○	○	○	○	○
Bringing new types of scientists to cancer research	○	○	○	○	○	○

The following question inquires about your views on the progress the PS-OC program is making relative to the goals of the program.

From your standpoint, please evaluate the extent to which the PS-OC program has been successful in reaching the following program goals.

Please mark the corresponding circle - only one per line.

	I do not know	Very Poor	Poor	Fair	Good	Excellent
Form trans-disciplinary teams focused on establishing physical sciences-centric themes in cancer research	○	○	○	○	○	○
Build a collaborative trans-discipline research sharing network	○	○	○	○	○	○
Promote collaboration by PS-OC researchers across the PS-OC network	○	○	○	○	○	○
Educate trans-disciplinary scientists that pursue careers in the field of physical sciences in oncology	○	○	○	○	○	○
Promote collaboration by PS-OC researchers beyond the PS-OC network	○	○	○	○	○	○
Form new physical sciences in oncology programs at universities or institutions	○	○	○	○	○	○
Test dogma-challenging hypothesis on cancer initiation and progression	○	○	○	○	○	○
Bring new types of scientists to cancer research	○	○	○	○	○	○
Generate new datasets in cancer research	○	○	○	○	○	○
Generate new knowledge in cancer research	○	○	○	○	○	○

Please provide any additional comments that you would like to share about the convergence of physical sciences in oncology or the PS-OC program.

Please write your answer in the space below.

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PS-OC Survey: Outreach and Education Unit Leaders (Section D)

OMB No.: 0925-06-07
Expiration Date: 9/30/2014

Notification to Respondent of Estimated Burden

Public reporting burden for this collection of information is estimated to average 10 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to: NIH, Project Clearance Branch, 6705 Rockledge Drive, MSC 7974, Bethesda, MD 20892-7974, ATTN: PRA (0925-0642). Do not return the completed form to this address.

Please identify your primary affiliation with the Physical Sciences - Oncology Centers Program.

Please pick one of the answers below.

- ○ Center Principal Investigator (PI)
- ○ Center Senior Scientific Investigator (SI)
- ○ PS-OC Project/Core Investigators (i.e. project/core leader or research investigator)
- ○ PS-OC Trainee
- ○ PS-OC Advocate
- ○ PS-OC Outreach and Dissemination Unit Lead
- ○ PS-OC Education and Training Unit Lead
- ○ PS-OC Administrator
- ○ PS-OC External Advisor
- ○ I am not associated with the PS-OC Program

Section D. The following section contains questions specifically for the leader of each PS-OC Outreach and Dissemination Unit.

D1. Please rate the overall ability of your Outreach and Dissemination Unit to do the following to date:

Please mark the corresponding circle - only one per line.

	Poor			Good			Excellent
Disseminate information to the broader scientific community.	○	○	○	○	○	○	○
Disseminate information to clinicians.	○	○	○	○	○	○	○
Disseminate information to patients.	○	○	○	○	○	○	○
Disseminate information to advocates.	○	○	○	○	○	○	○

D2. To what extent are steps being taken to ensure that the following aspects of the PS-OC will be sustainable after the period of funding?

Please mark the corresponding circle - only one per line.

	Not at all	Very Low	Low	Somewhat	High	Very High
Infrastructure (ie. labs, facilities, offices)	○	○	○	○	○	○
Courses, Workshops, Seminars	○	○	○	○	○	○
Collaborations	○	○	○	○	○	○
Outreach programs	○	○	○	○	○	○

D3. Please rate the overall effectiveness of the following:

Please mark the corresponding circle - only one per line.

	A	B	C	D	E	F	G
PS-OC Newsletter	○	○	○	○	○	○	○
The Outreach and Dissemination Working Groups	○	○	○	○	○	○	○
The Annual Meeting	○	○	○	○	○	○	○
Site Visits	○	○	○	○	○	○	○

Legend for rank grid table: D3. Please rate the overall effectiveness of the following:

Columns:

A - Ineffective

B -

C -

D - Neutral

E -

F -

G - Effective

D4. Do you have any further suggestions for how NCI could enhance overall PS-OC program performance?

Please write your answer in the space below.

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The following question inquires about your views on the progress the PS-OC program is making relative to the goals of the program.

From your standpoint, please evaluate the extent to which the PS-OC program has been successful in reaching the following program goals.

Please mark the corresponding circle - only one per line.

	I do not know	Very Poor	Poor	Fair	Good	Excellent
Form trans-disciplinary teams focused on establishing physical sciences-centric themes in cancer research	○	○	○	○	○	○
Build a collaborative trans-discipline research sharing network	○	○	○	○	○	○
Promote collaboration by PS-OC researchers across the PS-OC network	○	○	○	○	○	○
Educate trans-disciplinary scientists that pursue careers in the field of physical sciences in oncology	○	○	○	○	○	○
Promote collaboration by PS-OC researchers beyond the PS-OC network	○	○	○	○	○	○
Form new physical sciences in oncology programs at universities or institutions	○	○	○	○	○	○
Test dogma-challenging hypothesis on cancer initiation and progression	○	○	○	○	○	○
Bring new types of scientists to cancer research	○	○	○	○	○	○
Generate new datasets in cancer research	○	○	○	○	○	○
Generate new knowledge in cancer research	○	○	○	○	○	○

Please provide any additional comments that you would like to share about the convergence of physical sciences in oncology or the PS-OC program.

Please write your answer in the space below.

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PS-OC Survey: Principal and Senior Scientific Investigators

OMB No.: 0925-0642-07
Expiration Date: 9/30/2014

Notification to Respondent of Estimated Burden

Public reporting burden for this collection of information is estimated to average 25 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to: NIH, Project Clearance Branch, 6705 Rockledge Drive, MSC 7974, Bethesda, MD 20892-7974, ATTN: PRA (0925-0642). Do not return the completed form to this address.

Please identify your primary affiliation with the Physical Sciences - Oncology Centers Program.

Please pick one of the answers below.

- ○ Center Principal Investigator (PI)
- ○ Center Senior Scientific Investigator (SI)
- ○ PS-OC Project/Core Investigators (i.e. project/core leader or research investigator)
- ○ PS-OC Trainee
- ○ PS-OC Advocate
- ○ PS-OC Outreach and Dissemination Unit Lead
- ○ PS-OC Education and Training Unit Lead
- ○ PS-OC Administrator
- ○ PS-OC External Advisor
- ○ I am not associated with the PS-OC Program

Section B. The following section contains questions specific for the Principal and Senior Investigators of the PS-OCs.

B1. There are a variety of different types of scientists involved in the PS-OC program. Research experiences may vary depending on your background and the background of your collaborators. For each of the following column headers, please select all types of scientists that apply.

Please fill in the answers in the table below (mark appropriate circles and squares and fill in the blank spaces).

	Your field of training and expertise	Scientists have you worked with prior to the PS-OC program	Scientists you work with currently	Scientists would like to work with in future projects
Molecular Biologists	☐	☐	☐	☐
Cell Biologists	☐	☐	☐	☐
Engineers	☐	☐	☐	☐
Biologists	☐	☐	☐	☐
Evolutionary Biologists	☐	☐	☐	☐
Surgeons	☐	☐	☐	☐
Oncologists	☐	☐	☐	☐
Pathologists	☐	☐	☐	☐
Radiologists	☐	☐	☐	☐
Cancer Biologists	☐	☐	☐	☐
Chemists	☐	☐	☐	☐
Physicists	☐	☐	☐	☐
Mathematicians	☐	☐	☐	☐
Theorists	☐	☐	☐	☐
Statisticians	☐	☐	☐	☐
Information Technologists/Computer Scientists	☐	☐	☐	☐
Other	☐	☐	☐	☐

The following questions inquire about the planning, management, and organization of your PS-OC.

B2. Which one or more of the four NCI PS-OC Themes is most relevant to your PS-OC?

Please check all that apply.

☐ The Physics of Cancer

☐ Evolution and Evolutionary Theory in Cancer

☐ De-convoluting Complexity

☐ Understanding Information Transfer and Decoding

B3. What methods do you use to coordinate activities and facilitate communication across your PS-OC?

Please check all that apply and/or add your own variant.

- ☐ Face - to - Face Meetings
- ☐ Teleconferences
- ☐ PS-OC Site Visits
- ☐ PS-OC Workshops
- ☐ Email
- ☐ Web page
- ☐ Phone Calls

Other

....

B4. Please select the choice which most closely represents the frequency of meetings for the following questions.

Please mark the corresponding circle - only one per line.

	Yearly	Every 6 months	Every 3 months	Monthly	Weekly	More than once per week	Daily
How often do you meet with your PS-OC's project leaders?	○	○	○	○	○	○	○
How often do you meet with your entire PS-OC?	○	○	○	○	○	○	○

B5. To what extent is your Center implementing the following activites recommended by NCI?

Please mark the corresponding circle - only one per line.

	Not currently implementing	Attempting to implement	Neutral	Implementing some aspects	Fully implementing
Offering PS-OC research training programs	○	○	○	○	○
Promoting multi-disciplinary collaborations within center	○	○	○	○	○
Promoting multi-disciplinary collaborations between PS-OCs	○	○	○	○	○
Ensuring day to day management and communications within the PS-OC	○	○	○	○	○
Emphasizing strategic planning within the PS-OC, including setting milestones, monitoring progress, seeking advisory or committee input	○	○	○	○	○

B6. What challenges have you encountered or do you anticipate for your PS-OC?

Please check all that apply and/or add your own variant.

- ☐ Communication barriers between disciplines
- ☐ Delay in formation of teams and collaborations
- ☐ Limited funds
- ☐ Lack of physical infrastructure support
- ☐ Difficulties sharing data and information

Other

....

The following questions inquire about the progress of your PS-OC's research, training, and outreach programs.

B7. Please rate your satisfaction with the progress you have made so far relative to the milestones you set for your PS-OC, in the following categories.

Please mark the corresponding circle - only one per line.

	A	B	C	D	E	F	G
The overall PS-OC framework	○	○	○	○	○	○	○
PS-OC Research Projects	○	○	○	○	○	○	○
PS-OC Outreach and Dissemination	○	○	○	○	○	○	○
PS-OC Education and Training	○	○	○	○	○	○	○

Legend for rank grid table: B7. Please rate your satisfaction with the progress you have made so far relative to the milestones you set for your PS-OC, in the following categories.

Columns:

A - Dissatisfied
B -
C -
D - Neutral
E -
F -
G - Satisfied

B8. Please rate the necessity of the following in achieving the research milestones of your PS-OC.

Please mark the corresponding circle - only one per line.

	A	B	C	D	E	F	G
Development of new paradigms	○	○	○	○	○	○	○
Development of new datasets	○	○	○	○	○	○	○
Development of new approaches, models, or techniques	○	○	○	○	○	○	○
Formation of trans-disciplinary collaborations between physical scientists and cancer researchers	○	○	○	○	○	○	○

Legend for rank grid table: B8. Please rate the necessity of the following in achieving the research milestones of your PS-OC.

Columns:

A - Unimportant
B -
C -
D - Neutral
E -
F -
G - Important

B9. What do you believe is a reasonable timeframe to expect PS-OC supported discoveries suitable for translation?

Please pick one of the answers below.

- ○ 0-1 year
- ○ 1-3 years
- ○ 3-5 years
- ○ 5-10 years
- ○ 10+ years

C2. Please rate your satisfaction with the progress you have made so far on your project specific aims?

Please pick one of the answers below.

- ○ Satisfied
- ○ Somewhat Satisfied
- ○ Neutral
- ○ Somewhat Dissatisfied
- ○ Dissatisfied

The following questions inquire about the status and infrastructure of the physical sciences in oncology field.

C3. I have seen evidence of the formation of a new field of "Physical Sciences-Oncology" within...

Please mark the corresponding circle - only one per line.

	Disagree			Neutral			Agree
My department(s)	○	○	○	○	○	○	○
My institutions(s)	○	○	○	○	○	○	○
At scientific meetings	○	○	○	○	○	○	○
My current research	○	○	○	○	○	○	○
My future research plans	○	○	○	○	○	○	○
Publications	○	○	○	○	○	○	○
I have not seen evidence of the formation of a new field of "Physical Sciences-Oncology"	○	○	○	○	○	○	○

C4. Does your Institution have an overall strategy for converging physical sciences and oncology outside of the PS-OC program? If yes, please provide details in comment area.

Please pick one of the answers below and add your comments.

- ○ Yes
- ○ No
- ○ Unsure

....

C5. Do any sources of support exist for phyiscal sciences in oncology research at your Institution outside of the PS-OC?

Please pick one of the answers below.

- ○ Yes
- ○ No

C5b. Please answer yes or no to the following questions about the "other" types of support offered at your Instution for converging physical sciences and oncology.

Please mark the corresponding circle - only one per line.

	Yes	No
Do PS-OC researchers recieve funding from these sources?	○	○
Do PS-OC researchers collaborate with researchers supported by these sources?	○	○
Do PS-OC researchers use equipment, materials, or infrastructure supported by these sources?	○	○

The following questions inquire about your PS-OC research advances and your participation within the PS-OC program.

C6. From your standpoint, please briefly describe the most important scientific advancement to emerge from your PS-OC to date.

Please write your answer in the space below.

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C6b. Please use the previous example to answer the following questions.

Please mark the corresponding circle - only one per line.

	Disagree			Neutral			Agree
This scientific advancement stems from projects that exisited before the PS-OC program.	○	○	○	○	○	○	○
This scientific advancement will lead to future scientific breakthroughs.	○	○	○	○	○	○	○
This advancement would not have occurred without the support of the PS-OC program.	○	○	○	○	○	○	○
There is potential for this scientific advancement to translate into the clinic.	○	○	○	○	○	○	○

C7a. Have you submitted applications for research grants based on the findings from your PS-OC supported studies?

Please pick one of the answers below.

- ○ Yes
- ○ No

C7b. What types of comments were recieved on these grants?

Please check all that apply and/or add your own variant.

- ☐ Not enough preliminary data
- ☐ Too high risk
- ☐ No clinical application
- ☐ Limited biological components
- ☐ Innovative
- ☐ I have not recieved any comments

Other

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C8. Please describe one brief example of something you know now that you didn't know before because of your involvement with the PS-OC program.

Please write your answer in the space below.

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C9. Please check all PS-OC working groups or exercises in which you have participated.

Please check all that apply.

- ☐ Evolution and Drug Resistance
- ☐ Physics
- ☐ CTC Transport
- ☐ UN of Cell Modulus
- ☐ Outreach and Dissemination
- ☐ Education and Training
- ☐ Cell line exercise
- ☐ I have not participated in any PS-OC working groups or exercises

C9b. Please rate the effectiveness of the working groups or exercises in achieving the following goals.

Please mark the corresponding circle - only one per line.

	A	B	C	D	E	F	G
Faciliate new collaborations	○	○	○	○	○	○	○
Provide new knowledge	○	○	○	○	○	○	○
Increase communication between PS-OC investigators	○	○	○	○	○	○	○
Generate PS-OC Network publications	○	○	○	○	○	○	○
Disseminate information to the broader scientific community about the PS-OC Network	○	○	○	○	○	○	○

Legend for rank grid table: C9b. Please rate the effectiveness of the working groups or exercises in achieving the following goals.

Columns:

A - Ineffective
B -
C -
D - Neutral
E -
F -
G - Effective

C9c. Please provide a suggestion for new PS-OC working groups or exercises in which you would participate.

Please write your answer in the space below.

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C10. Did the PS-OC faciliate access to equipment and infrastructure for PS-OC researchers beyond what would have been available otherwise?

Please pick one of the answers below and add your comments.

- ○ Yes
- ○ No

Comments

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C11. How effective have the following PS-OC opportunities been in encouraging you to generate innovative scientific ideas?

Please mark the corresponding circle - only one per line.

	Not Applicable	Ineffective		Effective		Very Effective
Trans-Network Projects	○	○	○	○	○	○
Young Investigator Trans-Network Projects	○	○	○	○	○	○
Pilot Projects	○	○	○	○	○	○
Outreach Pilot Projects	○	○	○	○	○	○
Student Exchanges	○	○	○	○	○	○
PS-OC Annual Meeting	○	○	○	○	○	○

C12. How have you disseminated information about the PS-OC to the broader scientific community?

Please check all that apply and/or add your own variant.

- ☐ Presentations at conferences/scientific meetings
- ☐ Invited talks
- ☐ Publications
- ☐ Webpage
- ☐ Email
- ☐ Newspaper or radio
- ☐ I have not disseminated information about the PS-OC

Other

....

C13. To what types of scientists have you presented and/or discussed your PS-OC research? Please check all that apply.

Please check all that apply and/or add your own variant.

- ☐ Molecular Biologists
- ☐ Cell Biologists
- ☐ Cancer Biologists
- ☐ Engineers
- ☐ Evolutionary Biologists
- ☐ Surgeons
- ☐ Oncologists
- ☐ Pathologists
- ☐ Radiologists
- ☐ Chemists
- ☐ Physicisits
- ☐ Mathematicians
- ☐ Theorists
- ☐ Statstaticians
- ☐ Information Technologists

Other

....

C14. From your standpoint, how effectively have the PS-OC program staff performed the following roles in the management and direction of the PS-OC program?

Please mark the corresponding circle - only one per line.

	A	B	C	D	E	F	G	H
Strategic directions	○	○	○	○	○	○	○	○
Facilitating interactions amoung PS-OC investigators	○	○	○	○	○	○	○	○
Facilitating interactions between the PS-OC Network and the broader community	○	○	○	○	○	○	○	○
Advancing research within the PS-OCs	○	○	○	○	○	○	○	○
Organizing working groups and exercises	○	○	○	○	○	○	○	○
Organizing steering committee	○	○	○	○	○	○	○	○

Legend for rank grid table: C14. From your standpoint, how effectively have the PS-OC program staff performed the following roles in the management and direction of the PS-OC program?

Columns:

A - I do not know
B - Ineffective
C -
D -
E - Neutral
F -
G -
H - Very Effective

Section J. The following questions inquire about your collaborations and their impact, methods for facilitating collaborations, and the impact of the PS-OC program in your collaborations.

J1. Without naming specific individuals, please give an example of a successful trans-disciplinary collaboration (i.e. a collaboration that integrated two or more individual disciplinary perspectives) in which you have been involved as part of the PS-OC program. Please provide a brief description of the project and how it was initiated. Please define each member's role in the collaboration.

Please write your answer in the space below.

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J1b. What are the outcomes of the collaboration described above? Please select all that apply.

Please check all that apply.

- ☐ New knowledge or skills
- ☐ Pilot project funds
- ☐ Outreach project funds
- ☐ Trans-network project funds
- ☐ NIH or NSF grant funds
- ☐ Publications
- ☐ Conference presentations or invited talks
- ☐ The collaboration is still in progress.
- ☐ Will form new collaborations
- ☐ Will pursue new aspects of the project as an extension of this work

J1c. How many researchers were involved in this trans-disciplinary collaboration?

Please pick one of the answers below.

- ○ 2
- ○ 3
- ○ 4
- ○ 5-7
- ○ 8-10
- ○ 10+

J1d. Please indicate how strongly you agree or disagree with each of the following statements pertaining to the collaboration described above. "I would have obtained these outcomes..."

Please mark the corresponding circle - only one per line.

	Disagree			Neutral			Agree
without one member of the team	○	○	○	○	○	○	○
without two members of the team	○	○	○	○	○	○	○
without a trans-disciplinary collaboration	○	○	○	○	○	○	○
without the support of the PS-OC program	○	○	○	○	○	○	○

J2. What difficulties, if any, have you experienced during your trans-disciplinary collaborations in the PS-OC program? Please rate the severity of these difficulties on a scale of 1-5. A "1" indicates that the issue did not impact the outcome(s) of the collaboration. A "5" indicates that the issue severely impacted the collaboration.

Please fill in the answers in the table below (mark appropriate circles and squares and fill in the blank spaces).

	Check all that apply	Please rate the severity of the issue
Members prioritized their personal goals before the overall team goal	☐	○1 ○2 ○3 ○4 ○5
Difficulties in sharing data	☐	○1 ○2 ○3 ○4 ○5
The team members discuss issues only at a broad level	☐	○1 ○2 ○3 ○4 ○5
Difficulties in sharing supplies, cells, tissue, or equipment	☐	○1 ○2 ○3 ○4 ○5
Responsibilities, roles, and expectations were not clear	☐	○1 ○2 ○3 ○4 ○5
Difficulties in organizing travel	☐	○1 ○2 ○3 ○4 ○5
Team members became competitive with one another	☐	○1 ○2 ○3 ○4 ○5
Difficulties in communication across scientific disciplines	☐	○1 ○2 ○3 ○4 ○5
Lack of funds	☐	○1 ○2 ○3 ○4 ○5

Power struggles	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
Sharing credit	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
The team did not meet regularly	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
The team did not establish trust	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
There is no reward structure at my institution for collaborations	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
Trouble identifying additional team members to help	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
Lack of clear vision or goals	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
No agreement on the primary spokesperson	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5

J3. Please define your role(s) in your PS-OC collaborations. Please select all that apply.

Please check all that apply and/or add your own variant.

- ☐ Provide cells or reagents
- ☐ Provide technology or skill
- ☐ Provide strategic direction
- ☐ Leader
- ☐ Combine data
- ☐ Organize team meetings and communication
- ☐ Perform data analysis
- ☐ Participant
- ☐ Advisor
- ☐ Provide training/education
- ☐ Create reports
- ☐ Communicate to stakeholders (i.e. NCI)
- ☐ Interface with Instituional leadership
- ☐ Administrative support or IT

Other

....

J4. Please answer the following questions with the approximate number of investigators (i.e. faculty level researchers).

Please mark the corresponding circle - only one per line.

	0	1 - 4	5 - 10	11 -15	16+
How many PS-OC investigators within your Center did you work with prior to the start of the PS-OC program?	○	○	○	○	○
How many PS-OC investigators within your Center do you work with now?	○	○	○	○	○
How many of these new collaborations would have started without PS-OC program funding?	○	○	○	○	○

J5. Overall, please evaluate your PS-OC supported collaborations in the following areas.

Please mark the corresponding circle - only one per line.

	Very Poor	Poor	Fair	Good	Excellent
Scientific impact	○	○	○	○	○
Productivity	○	○	○	○	○
Rewarding to all parties involved equally	○	○	○	○	○
Communication among collaborators	○	○	○	○	○
Ability to utilize the strengths of different researchers involved	○	○	○	○	○
Enabling you to reach your own research milestones faster	○	○	○	○	○
Ability to attract new collaborators to join efforts	○	○	○	○	○

J6. How effective have the following PS-OC opportunities been in encouraging you to find and/or generate collaborations?

Please mark the corresponding circle - only one per line.

	Not Applicable	Ineffective		Somewhat Effective		Very Effective
PS-OC Trans-Network Projects	○	○	○	○	○	○
PS-OC Young Investigator Trans-Network Projects	○	○	○	○	○	○
PS-OC Pilot Projects	○	○	○	○	○	○
PS-OC Outreach Pilot Projects	○	○	○	○	○	○
Student Exchanges	○	○	○	○	○	○
PS-OC Annual Meeting	○	○	○	○	○	○
PS-OC Workshops and Symposiums	○	○	○	○	○	○
PS-OC Data Jamboree	○	○	○	○	○	○

J7. From your standpoint, please evaluate the extent to which the PS-OC program has been successful in the following areas.

Please mark the corresponding circle - only one per line.

	I do not know	Very Poor	Poor	Fair	Good	Excellent
Improving leadership skills in heading a trans-disciplinary study	○	○	○	○	○	○
Mentoring junior faculty in leading and participating in a trans-disciplinary study	○	○	○	○	○	○
Increasing the discussion about team science and collaborations at your institution	○	○	○	○	○	○
Developing better policies to review and reward team science at your institution	○	○	○	○	○	○

The following question inquires about your views on the progress the PS-OC program is making relative to the goals of the program.

From your standpoint, please evaluate the extent to which the PS-OC program has been successful in reaching the following program goals.

Please mark the corresponding circle - only one per line.

	I do not know	Very Poor	Poor	Fair	Good	Excellent
Form trans-disciplinary teams focused on establishing physical sciences-centric themes in cancer research	○	○	○	○	○	○
Build a collaborative trans-discipline research sharing network	○	○	○	○	○	○
Promote collaboration by PS-OC researchers across the PS-OC network	○	○	○	○	○	○
Educate trans-disciplinary scientists that pursue careers in the field of physical sciences in oncology	○	○	○	○	○	○
Promote collaboration by PS-OC researchers beyond the PS-OC network	○	○	○	○	○	○
Form new physical sciences in oncology programs at universities or institutions	○	○	○	○	○	○
Test dogma-challenging hypothesis on cancer initiation and progression	○	○	○	○	○	○
Bring new types of scientists to cancer research	○	○	○	○	○	○
Generate new datasets in cancer research	○	○	○	○	○	○
Generate new knowledge in cancer research	○	○	○	○	○	○

Please provide any additional comments that you would like to share about the convergence of physical sciences in oncology or the PS-OC program.

Please write your answer in the space below.

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PS-OC Survey: Project Investigators (Sections C & J)

OMB No.: 0925-0642-07
Expiration Date: 9/30/2014

Notification to Respondent of Estimated Burden

Public reporting burden for this collection of information is estimated to average 20 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to: NIH, Project Clearance Branch, 6705 Rockledge Drive, MSC 7974, Bethesda, MD 20892-7974, ATTN: PRA (0925-0642). Do not return the completed form to this address.

Please identify your primary affiliation with the Physical Sciences - Oncology Centers Program.

Please pick one of the answers below.

- ○ Center Principal Investigator (PI)
- ○ Center Senior Scientific Investigator (SI)
- ○ PS-OC Project/Core Investigators (i.e. project/core leader or research investigator)
- ○ PS-OC Trainee
- ○ PS-OC Advocate
- ○ PS-OC Outreach and Dissemination Unit Lead
- ○ PS-OC Education and Training Unit Lead
- ○ PS-OC Administrator
- ○ PS-OC External Advisor
- ○ I am not associated with the PS-OC Program

Section C. The following section contains questions specific for PS-OC Investigators.

C1. There are a variety of different types of scientists involved in the PS-OC program. Research experiences may vary depending on your background and the background of your collaborators. For each of the following column headers, please select all types of scientists that apply.

Please fill in the answers in the table below (mark appropriate circles and squares and fill in the blank spaces).

	Your field of training and expertise	Scientists have you worked with prior to the PS-OC program	Scientists you work with currently	Scientists would like to work with in future projects
Molecular Biologists	☐	☐	☐	☐
Cell Biologists	☐	☐	☐	☐
Engineers	☐	☐	☐	☐
Biologists	☐	☐	☐	☐
Evolutionary Biologists	☐	☐	☐	☐
Surgeons	☐	☐	☐	☐
Oncologists	☐	☐	☐	☐
Pathologists	☐	☐	☐	☐
Radiologists	☐	☐	☐	☐
Cancer Biologists	☐	☐	☐	☐
Chemists	☐	☐	☐	☐
Physicists	☐	☐	☐	☐
Mathematicians	☐	☐	☐	☐
Theorists	☐	☐	☐	☐
Statisticians	☐	☐	☐	☐
Information Technologists/Computer Scientists	☐	☐	☐	☐
Other	☐	☐	☐	☐

C2. Please rate your satisfaction with the progress you have made so far on your project specific aims?

Please pick one of the answers below.

- ○ Satisfied
- ○ Somewhat Satisfied
- ○ Neutral
- ○ Somewhat Dissatisfied
- ○ Dissatisfied

The following questions inquire about the status and infrastructure of the physical sciences in oncology field.

C3. I have seen evidence of the formation of a new field of "Physical Sciences-Oncology" within...

Please mark the corresponding circle - only one per line.

	Disagree			Neutral			Agree
My department(s)	○	○	○	○	○	○	○
My institutions(s)	○	○	○	○	○	○	○
At scientific meetings	○	○	○	○	○	○	○
My current research	○	○	○	○	○	○	○
My future research plans	○	○	○	○	○	○	○
Publications	○	○	○	○	○	○	○
I have not seen evidence of the formation of a new field of "Physical Sciences-Oncology"	○	○	○	○	○	○	○

C4. Does your Institution have an overall strategy for converging physical sciences and oncology outside of the PS-OC program? If yes, please provide details in comment area.

Please pick one of the answers below and add your comments.

- ○ Yes
- ○ No
- ○ Unsure

....

C5. Do any sources of support exist for physical sciences in oncology research at your Institution outside of the PS-OC?

Please pick one of the answers below.

- ○ Yes
- ○ No

C5b. Please answer yes or no to the following questions about the "other" types of support offered at your institution for converging physical sciences and oncology.

Please mark the corresponding circle - only one per line.

	Yes	No
Do PS-OC researchers receive funding from these sources?	○	○
Do PS-OC researchers collaborate with researchers supported by these sources?	○	○
Do PS-OC researchers use equipment, materials, or infrastructure supported by these sources?	○	○

The following questions inquire about your PS-OC research advances and your participation within the PS-OC program.

C6. From your standpoint, please briefly describe the most important scientific advancement to emerge from your PS-OC to date.

Please write your answer in the space below.

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C6b. Please use the previous example to answer the following questions.

Please mark the corresponding circle - only one per line.

	Disagree			Neutral			Agree
This scientific advancement stems from projects that exisited before the PS-OC program.	○	○	○	○	○	○	○
This scientific advancement will lead to future scientific breakthroughs.	○	○	○	○	○	○	○
This advancement would not have occurred without the support of the PS-OC program.	○	○	○	○	○	○	○
There is potential for this scientific advancement to translate into the clinic.	○	○	○	○	○	○	○

C7a. Have you submitted applications for research grants based on the findings from your PS-OC supported studies?

Please pick one of the answers below.

- ○ Yes
- ○ No

C7b. What types of comments were received on these grants?

Please check all that apply and/or add your own variant.

- ☐ Not enough preliminary data
- ☐ Too high risk
- ☐ No clinical application
- ☐ Limited biological components
- ☐ Innovative
- ☐ I have not received any comments

Other

....

C8. Please describe one brief example of something you know now that you didn't know before because of your involvement with the PS-OC program.

Please write your answer in the space below.

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C9. Please check all PS-OC working groups or exercises in which you have participated.

Please check all that apply.

- ☐ Evolution and Drug Resistance
- ☐ Physics
- ☐ CTC Transport
- ☐ UN of Cell Modulus
- ☐ Outreach and Dissemination
- ☐ Education and Training
- ☐ Cell line exercise
- ☐ I have not participated in any PS-OC working groups or exercises

C9b. Please rate the effectiveness of the working groups or exercises in achieving the following goals.

Please mark the corresponding circle - only one per line.

	A	B	C	D	E	F	G
Faciliate new collaborations	○	○	○	○	○	○	○
Provide new knowledge	○	○	○	○	○	○	○
Increase communication between PS-OC investigators	○	○	○	○	○	○	○
Generate PS-OC Network publications	○	○	○	○	○	○	○
Disseminate information to the broader scientific community about the PS-OC Network	○	○	○	○	○	○	○

Legend for rank grid table: C9b. Please rate the effectiveness of the working groups or exercises in achieving the following goals.

Columns:

A - Ineffective
B -
C -
D - Neutral
E -
F -
G - Effective

C9c. Please provide a suggestion for new PS-OC working groups or exercises in which you would participate.

Please write your answer in the space below.

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C10. Did the PS-OC facilitate access to equipment and infrastructure for PS-OC researchers beyond what would have been available otherwise?

Please pick one of the answers below and add your comments.

- ○ Yes
- ○ No

Comments

....

C11. How effective have the following PS-OC opportunities been in encouraging you to generate innovative scientific ideas?

Please mark the corresponding circle - only one per line.

	Not Applicable	Ineffective		Effective		Very Effective
Trans-Network Projects	○	○	○	○	○	○
Young Investigator Trans-Network Projects	○	○	○	○	○	○
Pilot Projects	○	○	○	○	○	○
Outreach Pilot Projects	○	○	○	○	○	○
Student Exchanges	○	○	○	○	○	○
PS-OC Annual Meeting	○	○	○	○	○	○

C12. How have you disseminated information about the PS-OC to the broader scientific community?

Please check all that apply and/or add your own variant.

- ☐ Presentations at conferences/scientific meetings
- ☐ Invited talks
- ☐ Publications
- ☐ Webpage
- ☐ Email
- ☐ Newspaper or radio
- ☐ I have not disseminated information about the PS-OC

Other

....

C13. To what types of scientists have you presented and/or discussed your PS-OC research? Please check all that apply.

Please check all that apply and/or add your own variant.

- ☐ Molecular Biologists
- ☐ Cell Biologists
- ☐ Cancer Biologists
- ☐ Engineers
- ☐ Evolutionary Biologists
- ☐ Surgeons
- ☐ Oncologists
- ☐ Pathologists
- ☐ Radiologists
- ☐ Chemists
- ☐ Physicists
- ☐ Mathematicians
- ☐ Theorists
- ☐ Statisticians
- ☐ Information Technologists

Other

....

C14. From your standpoint, how effectively have the PS-OC program staff performed the following roles in the management and direction of the PS-OC program?

Please mark the corresponding circle - only one per line.

	A	B	C	D	E	F	G	H
Strategic directions	○	○	○	○	○	○	○	○
Facilitating interactions amoung PS-OC investigators	○	○	○	○	○	○	○	○
Facilitating interactions between the PS-OC Network and the broader community	○	○	○	○	○	○	○	○
Advancing research within the PS-OCs	○	○	○	○	○	○	○	○
Organizing working groups and exercises	○	○	○	○	○	○	○	○
Organizing steering committee	○	○	○	○	○	○	○	○

Legend for rank grid table: C14. From your standpoint, how effectively have the PS-OC program staff performed the following roles in the management and direction of the PS-OC program?

Columns:

A - I do not know
B - Ineffective
C -
D -
E - Neutral
F -
G -
H - Very Effective

Section J. The following questions inquire about your collaborations and their impact, methods for facilitating collaborations, and the impact of the PS-OC program in your collaborations.

J1. Without naming specific individuals, please give an example of a successful trans-disciplinary collaboration (i.e. a collaboration that integrated two or more individual disciplinary perspectives) in which you have been involved as part of the PS-OC program. Please provide a brief description of the project and how it was initiated. Please define each member's role in the collaboration.

Please write your answer in the space below.

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J1b. What are the outcomes of the collaboration described above? Please select all that apply.

Please check all that apply.

- ☐ New knowledge or skills
- ☐ Pilot project funds
- ☐ Outreach project funds
- ☐ Trans-network project funds
- ☐ NIH or NSF grant funds
- ☐ Publications
- ☐ Conference presentations or invited talks
- ☐ The collaboration is still in progress.
- ☐ Will form new collaborations
- ☐ Will pursue new aspects of the project as an extention of this work

J1c. How many researchers were involved in this trans-disciplinary collaboration?

Please pick one of the answers below.

- ○ 2
- ○ 3
- ○ 4
- ○ 5-7
- ○ 8-10
- ○ 10+

J1d. Please indicate how strongly you agree or disagree with each of the following statements pertaining to the collaboration described above. "I would have obtained these outcomes..."

Please mark the corresponding circle - only one per line.

	Disagree			Neutral			Agree
without one member of the team	○	○	○	○	○	○	○
without two members of the team	○	○	○	○	○	○	○
without a trans-disciplinary collaboration	○	○	○	○	○	○	○
without the support of the PS-OC program	○	○	○	○	○	○	○

J2. What difficulties, if any, have you experienced during your trans-disciplinary collaborations in the PS-OC program? Please rate the severity of these difficulties on a scale of 1-5. A "1" indicates that the issue did not impact the outcome(s) of the collaboration. A "5" indicates that the issue severely impacted the collaboration.

Please fill in the answers in the table below (mark appropriate circles and squares and fill in the blank spaces).

	Check all that apply	Please rate the severity of the issue
Members prioritized their personal goals before the overall team goal	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
Difficulties in sharing data	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
The team members discuss issues only at a broad level	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
Difficulties in sharing supplies, cells, tissue, or equipment	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
Responsibilities, roles, and expectations were not clear	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
Difficulties in organizing travel	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
Team members became competitive with one another	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
Difficulties in communication across scientific disciplines	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
Lack of funds	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5

Power struggles	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
Sharing credit	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
The team did not meet regularly	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
The team did not establish trust	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
There is no reward structure at my institution for collaborations	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
Trouble identifying additional team members to help	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
Lack of clear vision or goals	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
No agreement on the primary spokesperson	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5

J3. Please define your role(s) in your PS-OC collaborations. Please select all that apply.

Please check all that apply and/or add your own variant.

- ☐ Provide cells or reagents
- ☐ Provide technology or skill
- ☐ Provide strategic direction
- ☐ Leader
- ☐ Combine data
- ☐ Organize team meetings and communication
- ☐ Perform data analysis
- ☐ Participant
- ☐ Advisor
- ☐ Provide training/education
- ☐ Create reports
- ☐ Communicate to stakeholders (i.e. NCI)
- ☐ Interface with Institutional leadership
- ☐ Administrative support or IT

Other

....

J4. Please answer the following questions with the approximate number of investigators (i.e. faculty level researchers).

Please mark the corresponding circle - only one per line.

	0	1 - 4	5 - 10	11 -15	16+
How many PS-OC investigators within your Center did you work with prior to the start of the PS-OC program?	○	○	○	○	○
How many PS-OC investigators within your Center do you work with now?	○	○	○	○	○
How many of these new collaborations would have started without PS-OC program funding?	○	○	○	○	○

J5. Overall, please evaluate your PS-OC supported collaborations in the following areas.

Please mark the corresponding circle - only one per line.

	Very Poor	Poor	Fair	Good	Excellent
Scientific impact	○	○	○	○	○
Productivity	○	○	○	○	○
Rewarding to all parties involved equally	○	○	○	○	○
Communication among collaborators	○	○	○	○	○
Ability to utilize the strengths of different researchers involved	○	○	○	○	○
Enabling you to reach your own research milestones faster	○	○	○	○	○
Ability to attract new collaborators to join effort	○	○	○	○	○

J6. How effective have the following PS-OC opportunities been in encouraging you to find and/or generate collaborations?

Please mark the corresponding circle - only one per line.

	Not Applicable	Ineffective		Somewhat Effective		Very Effective
PS-OC Trans-Network Projects	○	○	○	○	○	○
PS-OC Young Investigator Trans-Network Projects	○	○	○	○	○	○
PS-OC Pilot Projects	○	○	○	○	○	○
PS-OC Outreach Pilot Projects	○	○	○	○	○	○
Student Exchanges	○	○	○	○	○	○
PS-OC Annual Meeting	○	○	○	○	○	○
PS-OC Workshops and Symposiums	○	○	○	○	○	○
PS-OC Data Jamboree	○	○	○	○	○	○

J7. From your standpoint, please evaluate the extent to which the PS-OC program has been successful in the following areas.

Please mark the corresponding circle - only one per line.

	I do not know	Very Poor	Poor	Fair	Good	Excellent
Improving leadership skills in heading a trans-disciplinary study	○	○	○	○	○	○
Mentoring junior faculty in leading and participating in a trans-disciplinary study	○	○	○	○	○	○
Increasing the discussion about team science and collaborations at your institution	○	○	○	○	○	○
Developing better policies to review and reward team science at your institution	○	○	○	○	○	○

The following question inquires about your views on the progress the PS-OC program is making relative to the goals of the program.

From your standpoint, please evaluate the extent to which the PS-OC program has been successful in reaching the following program goals.

Please mark the corresponding circle - only one per line.

	I do not know	Very Poor	Poor	Fair	Good	Excellent
Form trans-disciplinary teams focused on establishing physical sciences-centric themes in cancer research	○	○	○	○	○	○
Build a collaborative trans-discipline research sharing network	○	○	○	○	○	○
Promote collaboration by PS-OC researchers across the PS-OC network	○	○	○	○	○	○
Educate trans-disciplinary scientists that pursue careers in the field of physical sciences in oncology	○	○	○	○	○	○
Promote collaboration by PS-OC researchers beyond the PS-OC network	○	○	○	○	○	○
Form new physical sciences in oncology programs at universities or institutions	○	○	○	○	○	○
Test dogma-challenging hypothesis on cancer initiation and progression	○	○	○	○	○	○
Bring new types of scientists to cancer research	○	○	○	○	○	○
Generate new datasets in cancer research	○	○	○	○	○	○
Generate new knowledge in cancer research	○	○	○	○	○	○

Please provide any additional comments that you would like to share about the convergence of physical sciences in oncology or the PS-OC program.

Please write your answer in the space below.

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PS-OC Survey: Trainees (Sections H &J)

OMB No.: 0925-0642-07
Expiration Date: 9/30/2014

Notification to Respondent of Estimated Burden

Public reporting burden for this collection of information is estimated to average 10 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to: NIH, Project Clearance Branch, 6705 Rockledge Drive, MSC 7974, Bethesda, MD 20892-7974, ATTN: PRA (0925-0642). Do not return the completed form to this address.

Please identify your primary affiliation with the Physical Sciences - Oncology Centers Program.

Please pick one of the answers below.

- ○ Center Principal Investigator (PI)
- ○ Center Senior Scientific Investigator (SI)
- ○ PS-OC Project/Core Investigators (i.e. project/core leader or research investigator)
- ○ PS-OC Trainee
- ○ PS-OC Advocate
- ○ PS-OC Outreach and Dissemination Unit Lead
- ○ PS-OC Education and Training Unit Lead
- ○ PS-OC Administrator
- ○ PS-OC External Advisor
- ○ I am not associated with the PS-OC Program

Section H. The following section contains questions specific for PS-OC trainees.

H1. How have you participated as a member of the PS-OC? Please select all that apply.

Please check all that apply.

- ☐ Perform research funded by the PS-OC
- ☐ Participate in PS-OC Courses
- ☐ Attend the PS-OC Annual Meeting
- ☐ Attend the PS-OC Site Visit
- ☐ Attend PS-OC Workshops
- ☐ Attend PS-OC Bootcamps
- ☐ Attend PS-OC Seminars
- ☐ Other

H2. Please select your current research title.

Please pick one of the answers below or add your own.

- ○ Undergraduate student
- ○ Graduate student
- ○ Postdoc
- ○ Medical Student
- ○ Resident

Other

....

H3. There are a variety of different types of scientists involved in the PS-OC program. For each of the following column headers, please select all types of scientists that apply.

Please fill in the answers in the table below (mark appropriate circles and squares and fill in the blank spaces).

	Your field of training and expertise	Your mentor's field of training and expertise	The types of scientists you collaborate with currently	The types of scientists you would like to collaborate with in the future
Molecular Biologists	☐	☐	☐	☐
Cell Biologists	☐	☐	☐	☐
Engineers	☐	☐	☐	☐
Biologists	☐	☐	☐	☐
Evolutionary Biologists	☐	☐	☐	☐
Surgeons	☐	☐	☐	☐
Oncologists	☐	☐	☐	☐
Pathologists	☐	☐	☐	☐
Radiologists	☐	☐	☐	☐
Cancer Biologists	☐	☐	☐	☐
Chemists	☐	☐	☐	☐
Physicists	☐	☐	☐	☐
Mathematicians	☐	☐	☐	☐
Theorists	☐	☐	☐	☐
Statisticians	☐	☐	☐	☐
Information Technologists/Computer Scientists	☐	☐	☐	☐
Other	☐	☐	☐	☐

H4. How do you feel the PS-OC program has influenced the following for you in terms of...

Please mark the corresponding circle - only one per line.

	A	B	C	D	E	F	G
Career development	○	○	○	○	○	○	○
Learning new skills	○	○	○	○	○	○	○
Gaining a new mentor	○	○	○	○	○	○	○
Collaborations	○	○	○	○	○	○	○
Opening access to new equipment/technology	○	○	○	○	○	○	○

Legend for rank grid table: H4. How do you feel the PS-OC program has influenced the following for you in terms of...

Columns:

A - Poorly
B -
C -
D - Neutral
E -
F -
G - Extremely well

H5. How often do you interact with your PS-OC mentor?

Please mark the corresponding circle - only one per line.

	Never (One initial meeting only)	Every 6 months	Every 3 months	Monthly	Weekly	Several times per week	Daily
	○	○	○	○	○	○	○

H6. Did you apply for a young investigator trans-network award?

Please pick one of the answers below.

○ Yes

○ No

H6b. To the best of your knowledge, please rate how well the young investigator trans-network process is achieving the following goals:

Please mark the corresponding circle - only one per line.

	A	B	C	D	E	F	G
Increasing collaborations among centers in general	○	○	○	○	○	○	○
Increasing discussions/collaborations between young investigators	○	○	○	○	○	○	○
Advancing the convergence of physical science and oncology in cancer research	○	○	○	○	○	○	○
Making advances in cancer research	○	○	○	○	○	○	○

Legend for rank grid table: H6b. To the best of your knowledge, please rate how well the young investigator trans-network process is achieving the following goals:

Columns:

A - Poorly
B -
C -
D - Neutral
E -
F -
G - Extremely well

H7. Do you plan to conduct research in the field of physical sciences-oncology in the future?

Please pick one of the answers below.

- ○ Yes
- ○ No
- ○ Maybe/Unsure

H8. What do you consider to be the most important scientific advances to emerge from your PS-OC supported research to date? Please describe any promising lines of inquiries for future breakthroughs.

Please write your answer in the space below.

....

....

....

....

H9. How effective have the following PS-OC opportunities been in encouraging you to generate innovative scientific ideas?

Please mark the corresponding circle - only one per line.

	A	B	C	D	E	F	G	H
Trans-Network Projects	○	○	○	○	○	○	○	○
Young Investigator Trans-Network	○	○	○	○	○	○	○	○
Pilot Projects	○	○	○	○	○	○	○	○
Outreach Pilot Projects	○	○	○	○	○	○	○	○
Student Exchanges	○	○	○	○	○	○	○	○
PS-OC Data Jamboree	○	○	○	○	○	○	○	○
PS-OC Annual Meeting	○	○	○	○	○	○	○	○
PS-OC Workshops, Bootcamps, and Symposium	○	○	○	○	○	○	○	○

Legend for rank grid table: H9. How effective have the following PS-OC opportunities been in encouraging you to generate innovative scientific ideas?

Columns:

A - I do not know
B - Ineffective
C -
D -
E - Neutral
F -
G -
H - Very Effective

H10. Have you participated in a student exchange or otherwise worked in another PS-OC Investigator's lab?

Please pick one of the answers below.

○ Yes

○ No

H10b. How many exchanges or other PS-OC Investigator's labs have you participated in?

Please pick one of the answers below.

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5+

H10c. Please rate the overall usefulness of the exchanges in which you have participated.

Please mark the corresponding circle - only one per line.

	Useless			Neutral			Useful
	○	○	○	○	○	○	○

H10d. What was the reason for the exchange? Please select all that apply.

Please check all that apply and/or add your own variant.

- ☐ Trans-network project
- ☐ Learn a new skill
- ☐ Immersion program

Other

....

H10e. Do you think this exchange could have occurred without the PS-OC program?

Please pick one of the answers below or add your own.

- ○ Yes
- ○ No
- ○ Unsure

Other

....

Section J. The following questions inquire about your collaborations and their impact, methods for facilitating collaborations, and the impact of the PS-OC program in your collaborations.

J1. Without naming specific individuals, please give an example of a successful trans-disciplinary collaboration (i.e. a collaboration that integrated two or more individual disciplinary perspectives) in which you have been involved as part of the PS-OC program. Please provide a brief description of the project and how it was initiated. Please define each member's role in the collaboration.

Please write your answer in the space below.

....

....

....

....

J1b. What are the outcomes of the collaboration described above? Please select all that apply.

Please check all that apply.

- ☐ New knowledge or skills
- ☐ Pilot project funds
- ☐ Outreach project funds
- ☐ Trans-network project funds
- ☐ NIH or NSF grant funds
- ☐ Publications
- ☐ Conference presentations or invited talks
- ☐ The collaboration is still in progress.
- ☐ Will form new collaborations
- ☐ Will pursue new aspects of the project as an extension of this work

J1c. How many researchers were involved in this trans-disciplinary collaboration?

Please pick one of the answers below.

- ○ 2
- ○ 3
- ○ 4
- ○ 5-7
- ○ 8-10
- ○ 10+

J1d. Please indicate how strongly you agree or disagree with each of the following statements pertaining to the collaboration described above. "I would have obtained these outcomes..."

Please mark the corresponding circle - only one per line.

	Disagree			Neutral			Agree
without one member of the team	○	○	○	○	○	○	○
without two members of the team	○	○	○	○	○	○	○
without a trans-disciplinary collaboration	○	○	○	○	○	○	○
without the support of the PS-OC program	○	○	○	○	○	○	○

J2. What difficulties, if any, have you experienced during your trans-disciplinary collaborations in the PS-OC program? Please rate the severity of these difficulties on a scale of 1-5. A "1" indicates that the issue did not impact the outcome(s) of the collaboration. A "5" indicates that the issue severely impacted the collaboration.

Please fill in the answers in the table below (mark appropriate circles and squares and fill in the blank spaces).

	Check all that apply	Please rate the severity of the issue
Members prioritized their personal goals before the overall team goal	☐	○1 ○2 ○3 ○4 ○5
Difficulties in sharing data	☐	○1 ○2 ○3 ○4 ○5
The team members discuss issues only at a broad level	☐	○1 ○2 ○3 ○4 ○5
Difficulties in sharing supplies, cells, tissue, or equipment	☐	○1 ○2 ○3 ○4 ○5
Responsibilities, roles, and expectations were not clear	☐	○1 ○2 ○3 ○4 ○5
Difficulties in organizing travel	☐	○1 ○2 ○3 ○4 ○5
Team members became competitive with one another	☐	○1 ○2 ○3 ○4 ○5
Difficulties in communication across scientific disciplines	☐	○1 ○2 ○3 ○4 ○5
Lack of funds	☐	○1 ○2 ○3 ○4 ○5

Power struggles	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
Sharing credit	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
The team did not meet regularly	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
The team did not establish trust	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
There is no reward structure at my institution for collaborations	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
Trouble identifying additional team members to help	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
Lack of clear vision or goals	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5
No agreement on the primary spokesperson	☐	○ 1 ○ 2 ○ 3 ○ 4 ○ 5

J3. Please define your role(s) in your PS-OC collaborations. Please select all that apply.

Please check all that apply and/or add your own variant.

- ☐ Provide cells or reagents
- ☐ Provide technology or skill
- ☐ Provide strategic direction
- ☐ Leader
- ☐ Combine data
- ☐ Organize team meetings and communication
- ☐ Perform data analysis
- ☐ Participant
- ☐ Advisor
- ☐ Provide training/education
- ☐ Create reports
- ☐ Communicate to stakeholders (i.e. NCI)
- ☐ Interface with Institutional leadership
- ☐ Administrative support or IT

Other

....

J4. Please answer the following questions with the approximate number of investigators (i.e. faculty level researchers).

Please mark the corresponding circle - only one per line.

	0	1 - 4	5 - 10	11 -15	16+
How many PS-OC investigators within your Center did you work with prior to the start of the PS-OC program?	○	○	○	○	○
How many PS-OC investigators within your Center do you work with now?	○	○	○	○	○
How many of these new collaborations would have started without PS-OC program funding?	○	○	○	○	○

J5. Overall, please evaluate your PS-OC supported collaborations in the following areas.

Please mark the corresponding circle - only one per line.

	Very Poor	Poor	Fair	Good	Excellent
Scientific impact	○	○	○	○	○
Productivity	○	○	○	○	○
Rewarding to all parties involved equally	○	○	○	○	○
Communication among collaborators	○	○	○	○	○
Ability to utilize the strengths of different researchers involved	○	○	○	○	○
Enabling you to reach your own research milestones faster	○	○	○	○	○
Ability to attract new collaborators to join efforts	○	○	○	○	○

J6. How effective have the following PS-OC opportunities been in encouraging you to find and/or generate collaborations?

Please mark the corresponding circle - only one per line.

	Not Applicable	Ineffective		Somewhat Effective		Very Effective
PS-OC Trans-Network Projects	○	○	○	○	○	○
PS-OC Young Investigator Trans-Network Projects	○	○	○	○	○	○
PS-OC Pilot Projects	○	○	○	○	○	○
PS-OC Outreach Pilot Projects	○	○	○	○	○	○
Student Exchanges	○	○	○	○	○	○
PS-OC Annual Meeting	○	○	○	○	○	○
PS-OC Workshops and Symposiums	○	○	○	○	○	○
PS-OC Data Jamboree	○	○	○	○	○	○

J7. From your standpoint, please evaluate the extent to which the PS-OC program has been successful in the following areas.

Please mark the corresponding circle - only one per line.

	I do not know	Very Poor	Poor	Fair	Good	Excellent
Improving leadership skills in heading a trans-disciplinary study	○	○	○	○	○	○
Mentoring junior faculty in leading and participating in a trans-disciplinary study	○	○	○	○	○	○
Increasing the discussion about team science and collaborations at your institution	○	○	○	○	○	○
Developing better policies to review and reward team science at your institution	○	○	○	○	○	○

The following question inquires about your views on the progress the PS-OC program is making relative to the goals of the program.

From your standpoint, please evaluate the extent to which the PS-OC program has been successful in reaching the following program goals.

Please mark the corresponding circle - only one per line.

	I do not know	Very Poor	Poor	Fair	Good	Excellent
Form trans-disciplinary teams focused on establishing physical sciences-centric themes in cancer research	○	○	○	○	○	○
Build a collaborative trans-discipline research sharing network	○	○	○	○	○	○
Promote collaboration by PS-OC researchers across the PS-OC network	○	○	○	○	○	○
Educate trans-disciplinary scientists that pursue careers in the field of physical sciences in oncology	○	○	○	○	○	○
Promote collaboration by PS-OC researchers beyond the PS-OC network	○	○	○	○	○	○
Form new physical sciences in oncology programs at universities or institutions	○	○	○	○	○	○
Test dogma-challenging hypothesis on cancer initiation and progression	○	○	○	○	○	○
Bring new types of scientists to cancer research	○	○	○	○	○	○
Generate new datasets in cancer research	○	○	○	○	○	○
Generate new knowledge in cancer research	○	○	○	○	○	○

Please provide any additional comments that you would like to share about the convergence of physical sciences in oncology or the PS-OC program.

Please write your answer in the space below.

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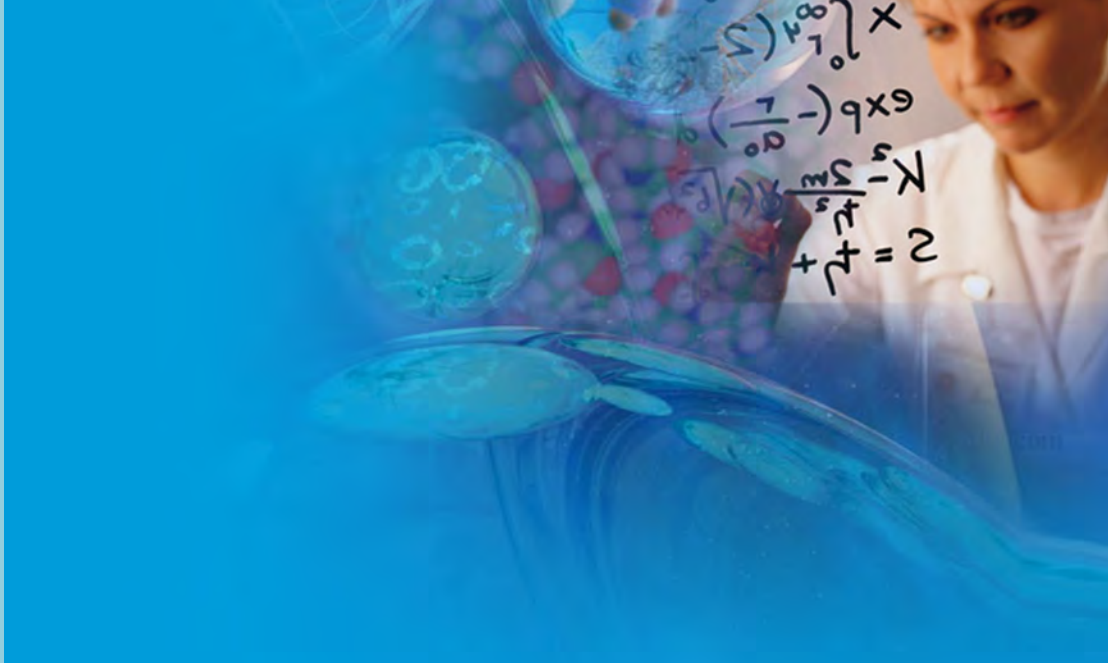

21. Survey Results

Q1

OMB No.: 0925-0642 Expiration Date: 9/30/2014 Notification to Respondent of Estimated Burden Public reporting burden for this collection of information is estimated to average 10 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to: NIH, Project Clearance Branch, 6705 Rockledge Drive, MSC 7974, Bethesda, MD 20892-7974, ATTN: PRA (0925-0642). Do not return the completed form to this address.

Q2

Please identify your primary affiliation with the Physical Sciences - Oncology Centers Program.	**Response percent**	**Response total**
Center Principal Investigator (PI)	0.00%	0
Center Senior Scientific Investigator (SI)	0.00%	0
PS-OC Project/Core Investigators (i.e. project/core leader or research investigator)	0.00%	0
PS-OC Trainee	0.00%	0
PS-OC Advocate	0.00%	0
PS-OC Outreach and Dissemination Unit Lead	0.00%	0
PS-OC Education and Training Unit Lead	0.00%	0
PS-OC Administrator	100.00%	13
PS-OC External Advisor	0.00%	0
I am not associated with the PS-OC Program	0.00%	0
Total of respondents	13	
Statistics based number of response	13	
Filtered	0	
Skipped	0	

Q3

Section A. Please answer the following questions relevant to your role as PS-OC Administrator.

Q4

A1. How long have you been affiliated with the PS-OC Program?	**Response percent**	**Response total**
less than 1 year	0.00%	0
1 - 2 years	30.77%	4
Since the start of the PS-OC Program	69.23%	9
Total of respondents	13	
Statistics based number of response	13	
Filtered	0	
Skipped	0	

Q5

A2. What are your roles as PS-OC Administrator? Please check all that apply.	**Response percent**	**Response total**
Member of PS-OC Operations Sub-Group	84.62%	11
Member of Outreach & Dissemination Working Group	30.77%	4
Member of Education & Training Working Group	30.77%	4
Organization and Submission of Progress Reports	84.62%	11
Disseminating Information to PS-OC Members	92.31%	12
Organizing Site Visits	100.00%	13
Managing PS-OC Pilot Projects	76.92%	10
Other	46.15%	6
Total of respondents	13	
Statistics based number of response	13	

Filtered	0
Skipped	0

Q6

A3. Are you involved with the administration of other large NIH grants or related awards at your Institution?

	Response percent	Response total
Yes	69.23%	9
No	30.77%	4

Total of respondents	13
Statistics based number of response	13
Filtered	0
Skipped	0

Q7

A3b. Are you involved with any of the following NIH programs? If so, please check all that apply (if not, please skip).

	Response percent	Response total
Integrative Cancer Biology Program	11.11%	1
Tumor Microenvironment Network	0.00%	0
The Cancer Genome Atlas	0.00%	0
Centers of Cancer Nanotechnology Excellence	55.56%	5
Clinical Proteomic Tumor Analysis Consortium	0.00%	0
Training Programs (i.e. R25, T32)	22.22%	2
Other	55.56%	5

Total of respondents	13
Statistics based number of response	9
Filtered	0
Skipped	4

Q8

A3c. From your standpoint, please evaluate the PS-OC program relative to other NIH grants or related programs at your Institution for the following items.

Response percent	**1. Worse**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Better**
Development of trans-disciplinary teams and infrastructure	0.00%	0.00%	0.00%	44.44%	0.00%	33.33%	22.22%
Training and Education	0.00%	0.00%	11.11%	22.22%	11.11%	22.22%	33.33%
Community Communications and Outreach	0.00%	0.00%	11.11%	33.33%	22.22%	11.11%	22.22%
Progress Reports	11.11%	0.00%	22.22%	22.22%	33.33%	0.00%	11.11%
NCI Site Visits	0.00%	0.00%	0.00%	44.44%	0.00%	33.33%	22.22%

Response total	**1. Worse**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Better**
Development of trans-disciplinary teams and infrastructure	0	0	0	4	0	3	2
Training and Education	0	0	1	2	1	2	3
Community Communications and Outreach	0	0	1	3	2	1	2
Progress Reports	1	0	2	2	3	0	1
NCI Site Visits	0	0	0	4	0	3	2

Total of respondents	13
Statistics based number of response	9
Filtered	0
Skipped	4

Q9

A4. Please rate the effectiveness of the PS-OC Operations Subgroup teleconferences in the following areas.

Response percent	**1. I do not know**	**2. Ineffective**	**3.**	**4.**	**5. Neutral**	**6.**	**7.**	**8. Very Effective**

Disseminating information related to the PS-OC program	15.38%	0.00%	0.00%	0.00%	0.00%	23.08%	38.46%	23.08%
Providing updates to the PS-OC Administrators	15.38%	0.00%	0.00%	0.00%	0.00%	15.38%	38.46%	30.77%
Providing answers to PS-OC program questions	15.38%	0.00%	0.00%	0.00%	7.69%	23.08%	30.77%	23.08%

Response total	**1. I do not know**	**2. Ineffective**	**3.**	**4.**	**5. Neutral**	**6.**	**7.**	**8. Very Effective**
Disseminating information related to the PS-OC program	2	0	0	0	0	3	5	3
Providing updates to the PS-OC Administrators	2	0	0	0	0	2	5	4
Providing answers to PS-OC program questions	2	0	0	0	1	3	4	3

Total of respondents	13
Statistics based number of response	13
Filtered	0
Skipped	0

Q10

A5. Within your PS-OC, how do you disseminate sharing of information to members?	**Response percent**	**Response total**
Email	100.00%	13
Webpage	69.23%	9
Posters/Flyers	38.46%	5
Newsletter	23.08%	3
Meetings	100.00%	13
Other	7.69%	1

Total of respondents	13
Statistics based number of response	13
Filtered	0
Skipped	0

Q11

A6. Please describe any obstacles or problems you had to overcome in administering the PS-OC?	**Response total**
	9

Total of respondents	13
Statistics based number of response	9
Filtered	0
Skipped	4

Q12

A7. Please describe the effectiveness of NCI program staff in the following roles.

Response percent	**1. Ineffective**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Effective**
Faciliting interactions between PS-OC investigators	0.00%	0.00%	7.69%	30.77%	15.38%	23.08%	23.08%
Answering questions about PS-OC and NCI guideline and procedures	0.00%	0.00%	15.38%	0.00%	30.77%	30.77%	23.08%
Providing best practices	0.00%	0.00%	7.69%	38.46%	23.08%	23.08%	7.69%
Coordinating working group teleconferences	0.00%	0.00%	7.69%	7.69%	23.08%	30.77%	30.77%
Communicating with the PS-OCs about funding opportunities and resources	0.00%	0.00%	7.69%	30.77%	15.38%	15.38%	30.77%

Response total	**1. Ineffective**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Effective**
Faciliting interactions between PS-OC investigators	0	0	1	4	2	3	3
Answering questions about PS-OC and NCI guideline and procedures	0	0	2	0	4	4	3
Providing best practices	0	0	1	5	3	3	1
Coordinating working group teleconferences	0	0	1	1	3	4	4
Communicating with the PS-OCs about funding opportunities and resources	0	0	1	4	2	2	4

Total of respondents	13
Statistics based number of response	13

Filtered	0
Skipped	0

Q13

A8. Do you have any additional suggestions for how NCI could enhance overall program performance?

Response total
7

Total of respondents	13
Statistics based number of response	7
Filtered	0
Skipped	6

Q14

The following question inquires about your views on the progress the PS-OC program is making relative to the goals of the program.

Q15

From your standpoint, please evaluate the extent to which the PS-OC program has been successful in reaching the following program goals.

Response percent	**1. I do not know**	**2. Very Poor**	**3. Poor**	**4. Fair**	**5. Good**	**6. Excellent**
Form trans-disciplinary teams focused on establishing physical sciences-centric themes in cancer research	7.69%	0.00%	0.00%	0.00%	53.85%	38.46%
Build a collaborative trans-discipline research sharing network	0.00%	0.00%	0.00%	38.46%	38.46%	23.08%
Promote collaboration by PS-OC researchers across the PS-OC network	0.00%	0.00%	0.00%	23.08%	46.15%	30.77%
Educate trans-disciplinary scientists that pursue careers in the field of physical sciences in oncology	7.69%	0.00%	0.00%	7.69%	53.85%	30.77%
Promote collaboration by PS-OC researchers beyond the PS-OC network	15.38%	0.00%	0.00%	23.08%	46.15%	15.38%
Form new physical sciences in oncology programs at universities or institutions	38.46%	0.00%	0.00%	15.38%	38.46%	7.69%
Test dogma-challenging hypothesis on cancer initiation and progression	38.46%	0.00%	0.00%	0.00%	46.15%	15.38%
Bring new types of scientists to cancer research	30.77%	0.00%	0.00%	0.00%	15.38%	53.85%
Generate new datasets in cancer research	38.46%	0.00%	0.00%	15.38%	7.69%	38.46%
Generate new knowledge in cancer research	15.38%	0.00%	0.00%	7.69%	38.46%	38.46%

Response total	**1. I do not know**	**2. Very Poor**	**3. Poor**	**4. Fair**	**5. Good**	**6. Excellent**
Form trans-disciplinary teams focused on establishing physical sciences-centric themes in cancer research	1	0	0	0	7	5
Build a collaborative trans-discipline research sharing network	0	0	0	5	5	3
Promote collaboration by PS-OC researchers across the PS-OC network	0	0	0	3	6	4
Educate trans-disciplinary scientists that pursue careers in the field of physical sciences in oncology	1	0	0	1	7	4
Promote collaboration by PS-OC researchers beyond the PS-OC network	2	0	0	3	6	2
Form new physical sciences in oncology programs at universities or institutions	5	0	0	2	5	1
Test dogma-challenging hypothesis on cancer initiation and progression	5	0	0	0	6	2
Bring new types of scientists to cancer research	4	0	0	0	2	7
Generate new datasets in cancer research	5	0	0	2	1	5
Generate new knowledge in cancer research	2	0	0	1	5	5

Total of respondents	13
Statistics based number of response	13
Filtered	0
Skipped	0

Q16

Please provide any additional comments that you would like to share about the convergence of physical sciences in oncology or the PS-OC program.

Response total
1

Total of respondents	13

Statistics based number of response	1
Filtered	0
Skipped	12

Q1

OMB No.: 0925-0642-07 Expiration Date: 9/30/2014 Notification to Respondent of Estimated Burden Public reporting burden for this collection of information is estimated to average 15 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to: NIH, Project Clearance Branch, 6705 Rockledge Drive, MSC 7974, Bethesda, MD 20892-7974, ATTN: PRA (0925-0642). Do not return the completed form to this address.

Q2

Please identify your primary affiliation with the Physical Sciences - Oncology Centers Program.	Response percent	Response total
Center Principal Investigator (PI)	0.00%	0
Center Senior Scientific Investigator (SI)	0.00%	0
PS-OC Project/Core Investigators (i.e. project/core leader or research investigator)	0.00%	0
PS-OC Trainee	0.00%	0
PS-OC Advocate	100.00%	7
PS-OC Outreach and Dissemination Unit Lead	0.00%	0
PS-OC Education and Training Unit Lead	0.00%	0
PS-OC Administrator	0.00%	0
PS-OC External Advisor	0.00%	0
I am not associated with the PS-OC Program	0.00%	0
Total of respondents	7	
Statistics based number of response	7	
Filtered	0	
Skipped	0	

Q3

Section F. The following section contains questions specific for PS-OC program advocates.

Q4

F1. What is your role as an advocate in the PS-OC program? Please check all that apply.	Response percent	Response total
Participate in the annual meeting	85.71%	6
Site visits	57.14%	4
Scientific discussions	42.86%	3
Provide guidance and answer questions	71.43%	5
Review proposals	14.29%	1
Attend workshops	85.71%	6
Write publications (scholarly or lay)	57.14%	4
Present to the public	71.43%	5
Other	42.86%	3
Total of respondents	7	
Statistics based number of response	7	
Filtered	0	
Skipped	0	

Q5

F2. How often do you meet with the following groups?

Response percent	1. Never	2. Yearly	3. Monthly	4. Weekly	5. Daily

Other PS-OC Advocates	14.29%	42.86%	28.57%	0.00%	14.29%
The PS-OC Network Advocate	42.86%	14.29%	14.29%	14.29%	14.29%
The Principal Investigator of the PS-OC	0.00%	42.86%	42.86%	14.29%	0.00%
The entire PS-OC in which you participate	14.29%	28.57%	42.86%	0.00%	14.29%

Response total	**1. Never**	**2. Yearly**	**3. Monthly**	**4. Weekly**	**5. Daily**
Other PS-OC Advocates	1	3	2	0	1
The PS-OC Network Advocate	3	1	1	1	1
The Principal Investigator of the PS-OC	0	3	3	1	0
The entire PS-OC in which you participate	1	2	3	0	1

Total of respondents	7
Statistics based number of response	7
Filtered	0
Skipped	0

Q6

F3. Are you involved in any other NCI programs? If yes, please list in the comment box.	**Response percent**	**Response total**
Yes	57.14%	4
No	42.86%	3
Other or Unsure	0.00%	0
		4

Total of respondents	7
Statistics based number of response	7
Filtered	0
Skipped	0

Q7

F4. How do you feel the PS-OC Network compares to the other programs?

Response percent	**1. Inferior**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Superior**
	0.00%	0.00%	0.00%	0.00%	50.00%	50.00%	0.00%

Response total	**1. Inferior**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Superior**
	0	0	0	0	2	2	0

Total of respondents	7
Statistics based number of response	4
Filtered	0
Skipped	3

Q8

F5. Please describe any suggestions you have for improving advocate involvement in the PS-OC Program	**Response total**
	4

Total of respondents	7
Statistics based number of response	4
Filtered	0
Skipped	3

Q9

The following question inquires about your views on the progress the PS-OC program is making relative to the goals of the program.

Q10

From your standpoint, please evaluate the extent to which the PS-OC program has been successful in reaching the following program goals.

Response percent	1. I do not know	2. Very Poor	3. Poor	4. Fair	5. Good	6. Excellent
Form trans-disciplinary teams focused on establishing physical sciences-centric themes in cancer research	28.57%	0.00%	0.00%	0.00%	28.57%	42.86%
Build a collaborative trans-discipline research sharing network	28.57%	0.00%	0.00%	0.00%	57.14%	14.29%
Promote collaboration by PS-OC researchers across the PS-OC network	28.57%	0.00%	0.00%	0.00%	42.86%	28.57%
Educate trans-disciplinary scientists that pursue careers in the field of physical sciences in oncology	57.14%	0.00%	0.00%	0.00%	0.00%	42.86%
Promote collaboration by PS-OC researchers beyond the PS-OC network	42.86%	0.00%	0.00%	14.29%	0.00%	42.86%
Form new physical sciences in oncology programs at universities or institutions	42.86%	0.00%	0.00%	28.57%	0.00%	28.57%
Test dogma-challenging hypothesis on cancer initiation and progression	42.86%	0.00%	14.29%	0.00%	14.29%	28.57%
Bring new types of scientists to cancer research	28.57%	0.00%	0.00%	0.00%	14.29%	57.14%
Generate new datasets in cancer research	42.86%	0.00%	0.00%	0.00%	14.29%	42.86%
Generate new knowledge in cancer research	42.86%	0.00%	0.00%	0.00%	0.00%	57.14%

Response total	1. I do not know	2. Very Poor	3. Poor	4. Fair	5. Good	6. Excellent
Form trans-disciplinary teams focused on establishing physical sciences-centric themes in cancer research	2	0	0	0	2	3
Build a collaborative trans-discipline research sharing network	2	0	0	0	4	1
Promote collaboration by PS-OC researchers across the PS-OC network	2	0	0	0	3	2
Educate trans-disciplinary scientists that pursue careers in the field of physical sciences in oncology	4	0	0	0	0	3
Promote collaboration by PS-OC researchers beyond the PS-OC network	3	0	0	1	0	3
Form new physical sciences in oncology programs at universities or institutions	3	0	0	2	0	2
Test dogma-challenging hypothesis on cancer initiation and progression	3	0	1	0	1	2
Bring new types of scientists to cancer research	2	0	0	0	1	4
Generate new datasets in cancer research	3	0	0	0	1	3
Generate new knowledge in cancer research	3	0	0	0	0	4

Total of respondents	7
Statistics based number of response	7
Filtered	0
Skipped	0

Q11

Please provide any additional comments that you would like to share about the convergence of physical sciences in oncolo	Response total
	4

Total of respondents	7
Statistics based number of response	4
Filtered	0
Skipped	3

Q1

OMB No.: 0925-0642-07 Expiration Date: 9/30/2014 Notification to Respondent of Estimated Burden Public reporting burden for this collection of information is estimated to average 15 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to: NIH, Project Clearance Branch, 6705 Rockledge Drive, MSC 7974, Bethesda, MD 20892-7974, ATTN: PRA (0925-0642). Do not return the completed form to this address.

Q2

Please identify your primary affiliation with the Physical Sciences - Oncology Centers Program.	Response percent	Response total
Center Principal Investigator (PI)	0.00%	0
Center Senior Scientific Investigator (SI)	0.00%	0
PS-OC Project/Core Investigators (i.e. project/core leader or research investigator)	25.00%	1
PS-OC Trainee	0.00%	0
PS-OC Advocate	0.00%	0
PS-OC Outreach and Dissemination Unit Lead	0.00%	0
PS-OC Education and Training Unit Lead	50.00%	2
PS-OC Administrator	25.00%	1
PS-OC External Advisor	0.00%	0
I am not associated with the PS-OC Program	0.00%	0
Total of respondents	4	
Statistics based number of response	4	
Filtered	0	
Skipped	0	

Q3

Section A. Please answer the following questions relevant to your role as PS-OC Administrator.

Q4

A1. How long have you been affiliated with the PS-OC Program?	Response percent	Response total
less than 1 year	25.00%	1
1 - 2 years	25.00%	1
Since the start of the PS-OC Program	50.00%	2
Total of respondents	4	
Statistics based number of response	4	
Filtered	0	
Skipped	0	

Q5

A2. What are your roles as PS-OC Administrator? Please check all that apply.	Response percent	Response total
Member of PS-OC Operations Sub-Group	0.00%	0
Member of Outreach & Dissemination Working Group	50.00%	2
Member of Education & Training Working Group	75.00%	3
Organization and Submission of Progress Reports	75.00%	3
Disseminating Information to PS-OC Members	50.00%	2
Organizing Site Visits	75.00%	3
Managing PS-OC Pilot Projects	25.00%	1
Other	0.00%	0
Total of respondents	4	
Statistics based number of response	4	
Filtered	0	
Skipped	0	

Q6

A3. Are you involved with the administration of other large NIH grants or related awards at your Institution?	Response percent	Response total

Yes	75.00%	3
No	25.00%	1

Total of respondents	4
Statistics based number of response	4
Filtered	0
Skipped	0

Q7

pA3b. Are you involved with any of the following NIH programs? If so, pease check all that apply (if not, please skip).

	Response percent	Response total
Integrative Cancer Biology Program	0.00%	0
Tumor Microenvironment Network	0.00%	0
The Cancer Genome Atlas	0.00%	0
Centers of Cancer Nanotechnology Excellence	50.00%	1
Clinical Proteomic Tumor Analysis Consortium	0.00%	0
Training Programs (i.e. R25, T32)	50.00%	1
Other	0.00%	0

Total of respondents	4
Statistics based number of response	2
Filtered	0
Skipped	2

Q8

A3c. From your standpoint, please evaluate the PS-OC program relative to other NIH grants or related programs at your Institution for the following items.

Response percent	**1. Worse**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Better**
Development of trans-disciplinary teams and infrastructure	0.00%	0.00%	25.00%	25.00%	25.00%	25.00%	0.00%
Training and Education	0.00%	0.00%	0.00%	25.00%	50.00%	25.00%	0.00%
Community Communications and Outreach	0.00%	0.00%	25.00%	25.00%	25.00%	25.00%	0.00%
Progress Reports	0.00%	0.00%	0.00%	25.00%	75.00%	0.00%	0.00%
NCI Site Visits	0.00%	0.00%	0.00%	50.00%	0.00%	50.00%	0.00%

Response total	**1. Worse**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Better**
Development of trans-disciplinary teams and infrastructure	0	0	1	1	1	1	0
Training and Education	0	0	0	1	2	1	0
Community Communications and Outreach	0	0	1	1	1	1	0
Progress Reports	0	0	0	1	3	0	0
NCI Site Visits	0	0	0	2	0	2	0

Total of respondents	4
Statistics based number of response	4
Filtered	0
Skipped	0

Q9

A4. Please rate the effectiveness of the PS-OC Operations Subgroup teleconferences in the following areas.

Response percent	**1. I do not know**	**2. Ineffective**	**3.**	**4.**	**5. Neutral**	**6.**	**7.**	**8. Very Effective**
Disseminating information related to the PS-OC program	50.00%	0.00%	0.00%	0.00%	25.00%	25.00%	0.00%	0.00%
Providing updates to the PS-OC Administrators	25.00%	0.00%	0.00%	0.00%	50.00%	25.00%	0.00%	0.00%
Providing answers to PS-OC program questions	25.00%	0.00%	0.00%	0.00%	25.00%	50.00%	0.00%	0.00%

Response total	**1. I do not know**	**2. Ineffective**	**3.**	**4.**	**5. Neutral**	**6.**	**7.**	**8. Very Effective**
Disseminating information related to the PS-OC program	2	0	0	0	1	1	0	0
Providing updates to the PS-OC Administrators	1	0	0	0	2	1	0	0

Providing answers to PS-OC program questions	1	0	0	0	1	2	0	0

Total of respondents 4
Statistics based number of response 4
Filtered 0
Skipped 0

Q10

A5. Within your PS-OC, how do you disseminate sharing of information to members?	**Response percent**	**Response total**
Email	100.00%	4
Webpage	75.00%	3
Posters/Flyers	50.00%	2
Newsletter	0.00%	0
Meetings	50.00%	2
Other	0.00%	0

Total of respondents 4
Statistics based number of response 4
Filtered 0
Skipped 0

Q11

A6. Please describe any obstacles or problems you had to overcome in administering the PS-OC?	**Response total**
	1

Total of respondents 4
Statistics based number of response 1
Filtered 0
Skipped 3

Q12

A7. Please describe the effectiveness of NCI program staff in the following roles.

Response percent	**1. Ineffective**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Effective**
Faciliting interactions between PS-OC investigators	0.00%	25.00%	25.00%	50.00%	0.00%	0.00%	0.00%
Answering questions about PS-OC and NCI guideline and procedures	0.00%	0.00%	0.00%	50.00%	25.00%	25.00%	0.00%
Providing best practices	0.00%	0.00%	25.00%	50.00%	25.00%	0.00%	0.00%
Coordinating working group teleconferences	0.00%	0.00%	0.00%	25.00%	50.00%	0.00%	25.00%
Communicating with the PS-OCs about funding opportunities and resources	0.00%	0.00%	0.00%	25.00%	25.00%	25.00%	25.00%

Response total	**1. Ineffective**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Effective**
Faciliting interactions between PS-OC investigators	0	1	1	2	0	0	0
Answering questions about PS-OC and NCI guideline and procedures	0	0	0	2	1	1	0
Providing best practices	0	0	1	2	1	0	0
Coordinating working group teleconferences	0	0	0	1	2	0	1
Communicating with the PS-OCs about funding opportunities and resources	0	0	0	1	1	1	1

Total of respondents 4
Statistics based number of response 4
Filtered 0
Skipped 0

Q13

A8. Do you have any additional suggestions for how NCI could enhance overall program performance?	**Response total**
	1

Total of respondents 4

Statistics based number of response	1
Filtered	0
Skipped	3

Q14

Section E. The following section contains questions that are specific for the PS-OC Education and Training Unit leaders.

Q15

E1. What are your responsibilities as an Education Leader? Please check all that apply.	**Response percent**	**Response total**
Recruitment	50.00%	2
Matching trainees and mentors	25.00%	1
Organize workshops, courses, or symposia	75.00%	3
Coordinating education activities	75.00%	3
Promote communication between investigators and trainees	100.00%	4
Other	0.00%	0

Total of respondents	4
Statistics based number of response	4
Filtered	0
Skipped	0

Q16

E2. Please evaluate how your PS-OC training program is meeting the following goals.

Response percent	**1. I do not know**	**2. Very Poor**	**3. Poor**	**4. Fair**	**5. Good**	**6. Excellent**
Facilitate career development	25.00%	0.00%	0.00%	50.00%	25.00%	0.00%
Facilitate mentor-mentee relations	25.00%	0.00%	0.00%	50.00%	25.00%	0.00%
Teach new skills	25.00%	0.00%	0.00%	25.00%	50.00%	0.00%
Bring new knowledge to trainees	25.00%	0.00%	0.00%	25.00%	50.00%	0.00%
Initiate a new training field of physical sciences in oncology	25.00%	0.00%	0.00%	50.00%	25.00%	0.00%
Facilitate the interaction and sharing of ideas among trainees	25.00%	0.00%	0.00%	0.00%	75.00%	0.00%

Response total	**1. I do not know**	**2. Very Poor**	**3. Poor**	**4. Fair**	**5. Good**	**6. Excellent**
Facilitate career development	1	0	0	2	1	0
Facilitate mentor-mentee relations	1	0	0	2	1	0
Teach new skills	1	0	0	1	2	0
Bring new knowledge to trainees	1	0	0	1	2	0
Initiate a new training field of physical sciences in oncology	1	0	0	2	1	0
Facilitate the interaction and sharing of ideas among trainees	1	0	0	0	3	0

Total of respondents	4
Statistics based number of response	4
Filtered	0
Skipped	0

Q17

E3. Is support available for PS-OC training from other sources?	**Response percent**	**Response total**
Yes	75.00%	3
No	25.00%	1

Total of respondents	4
Statistics based number of response	4
Filtered	0
Skipped	0

Q18

E3b. Please list the other sources that are supporting PS-OC training.	**Response total**

Total of respondents	4
Statistics based number of response	1
Filtered	0
Skipped	3

Q19

E4. From your standpoint, would the trainees have difficulty obtaining support for PS-OC-type activities if this program did not exist?

	Response percent	Response total
Yes	75.00%	3
No	0.00%	0
Unsure	25.00%	1

Total of respondents	4
Statistics based number of response	4
Filtered	0
Skipped	0

Q20

E5. Please rate how useful you think the education and training unit has been for the trainees regarding the following:

Response percent	**1. Not Useful**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Useful**
Gaining experience in the field of physical sciences in oncology	0.00%	0.00%	0.00%	25.00%	50.00%	25.00%	0.00%
Encouraging trainees to participate in unfamiliar research activities	0.00%	0.00%	0.00%	25.00%	25.00%	50.00%	0.00%
Developing new skill sets	0.00%	0.00%	0.00%	25.00%	25.00%	50.00%	0.00%
Providing trainees with access to new resources and equipment	0.00%	0.00%	0.00%	25.00%	25.00%	50.00%	0.00%
Establishing new contacts	0.00%	0.00%	0.00%	50.00%	0.00%	50.00%	0.00%

Response total	**1. Not Useful**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Useful**
Gaining experience in the field of physical sciences in oncology	0	0	0	1	2	1	0
Encouraging trainees to participate in unfamiliar research activities	0	0	0	1	1	2	0
Developing new skill sets	0	0	0	1	1	2	0
Providing trainees with access to new resources and equipment	0	0	0	1	1	2	0
Establishing new contacts	0	0	0	2	0	2	0

Total of respondents	4
Statistics based number of response	4
Filtered	0
Skipped	0

Q21

E6. Please describe the effectiveness of NCI program staff in the following roles.

Response percent	**1. Ineffective**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Effective**
Facilitating interactions between PS-OC investigators	0.00%	25.00%	25.00%	25.00%	25.00%	0.00%	0.00%
Answering questions about PS-OC and NCI guideline and procedures	0.00%	0.00%	0.00%	50.00%	25.00%	0.00%	25.00%
Providing examples of activities and best practices	0.00%	0.00%	25.00%	50.00%	25.00%	0.00%	0.00%
Coordinating working group teleconferences	0.00%	0.00%	0.00%	25.00%	50.00%	0.00%	25.00%
Disseminating information about funding opportunities and resources to the PS-OCs	0.00%	0.00%	0.00%	25.00%	25.00%	25.00%	25.00%

Response total	**1. Ineffective**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Effective**
Facilitating interactions between PS-OC investigators	0	1	1	1	1	0	0
Answering questions about PS-OC and NCI guideline and procedures	0	0	0	2	1	0	1
Providing examples of activities and best practices	0	0	1	2	1	0	0
Coordinating working group teleconferences	0	0	0	1	2	0	1
Disseminating information about funding opportunities and resources to the PS-OCs	0	0	0	1	1	1	1

Total of respondents	4
Statistics based number of response	4
Filtered	0
Skipped	0

Q22

E7. Do you have any additional suggestions for how NCI could enhance overall program performance?

Response total
0

Total of respondents	4
Statistics based number of response	0
Filtered	0
Skipped	4

Q23

The following question inquires about your views on the progress the PS-OC program is making relative to the goals of the program.

Q24

From your standpoint, please evaluate the extent to which the PS-OC program has been successful in reaching the following program goals.

Response percent	**1. I do not know**	**2. Very Poor**	**3. Poor**	**4. Fair**	**5. Good**	**6. Excellent**
Form trans-disciplinary teams focused on establishing physical sciences-centric themes in cancer research	25.00%	0.00%	0.00%	25.00%	50.00%	0.00%
Build a collaborative trans-discipline research sharing network	25.00%	0.00%	25.00%	50.00%	0.00%	0.00%
Promote collaboration by PS-OC researchers across the PS-OC network	25.00%	0.00%	25.00%	50.00%	0.00%	0.00%
Educate trans-disciplinary scientists that pursue careers in the field of physical sciences in oncology	25.00%	0.00%	0.00%	75.00%	0.00%	0.00%
Promote collaboration by PS-OC researchers beyond the PS-OC network	25.00%	0.00%	25.00%	50.00%	0.00%	0.00%
Form new physical sciences in oncology programs at universities or institutions	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Test dogma-challenging hypothesis on cancer initiation and progression	75.00%	0.00%	0.00%	25.00%	0.00%	0.00%
Bring new types of scientists to cancer research	50.00%	0.00%	0.00%	25.00%	25.00%	0.00%
Generate new datasets in cancer research	75.00%	0.00%	0.00%	25.00%	0.00%	0.00%
Generate new knowledge in cancer research	25.00%	0.00%	0.00%	50.00%	25.00%	0.00%

Response total	**1. I do not know**	**2. Very Poor**	**3. Poor**	**4. Fair**	**5. Good**	**6. Excellent**
Form trans-disciplinary teams focused on establishing physical sciences-centric themes in cancer research	1	0	0	1	2	0
Build a collaborative trans-discipline research sharing network	1	0	1	2	0	0
Promote collaboration by PS-OC researchers across the PS-OC network	1	0	1	2	0	0
Educate trans-disciplinary scientists that pursue careers in the field of physical sciences in oncology	1	0	0	3	0	0
Promote collaboration by PS-OC researchers beyond the PS-OC network	1	0	1	2	0	0
Form new physical sciences in oncology programs at universities or institutions	4	0	0	0	0	0
Test dogma-challenging hypothesis on cancer initiation and progression	3	0	0	1	0	0
Bring new types of scientists to cancer research	2	0	0	1	1	0
Generate new datasets in cancer research	3	0	0	1	0	0
Generate new knowledge in cancer research	1	0	0	2	1	0

Total of respondents	4
Statistics based number of response	4
Filtered	0
Skipped	0

Q25

Please provide any additional comments that you would like to share about the convergence of physical sciences in oncology or the PS-OC program.

Response total
0

Total of respondents	4

Statistics based number of response	0
Filtered	0
Skipped	4

Q1

OMB No.: 0925-0642-07 Expiration Date: 9/30/2014 Notification to Respondent of Estimated Burden Public reporting burden for this collection of information is estimated to average 15 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to: NIH, Project Clearance Branch, 6705 Rockledge Drive, MSC 7974, Bethesda, MD 20892-7974, ATTN: PRA (0925-0642). Do not return the completed form to this address.

Q2

Please identify your primary affiliation with the Physical Sciences - Oncology Centers Program.	Response percent	Response total
Center Principal Investigator (PI)	0.00%	0
Center Senior Scientific Investigator (SI)	2.08%	2
PS-OC Project/Core Investigators (i.e. project/core leader or research investigator)	4.17%	4
PS-OC Trainee	3.13%	3
PS-OC Advocate	1.04%	1
PS-OC Outreach and Dissemination Unit Lead	0.00%	0
PS-OC Education and Training Unit Lead	0.00%	0
PS-OC Administrator	1.04%	1
PS-OC External Advisor	9.38%	9
I am not associated with the PS-OC Program	79.17%	76
Total of respondents	96	
Statistics based number of response	96	
Filtered	0	
Skipped	0	

Q3

Section G. The following section contains questions specific to scientists external or not associated with the PS-OC.

Q4

G1. Research experiences may vary depending on your scientific background and the scientific background of your collaborators. For each of the following column headers, please select all types of scientists that apply.

Response percent	Your field of training and expertise	Scientists you work with currently	Scientists you would like to work with on future projects
Molecular Biologists	26.04%	58.33%	26.04%
Cell Biologists	32.29%	62.50%	28.13%
Engineers	35.42%	52.08%	25.00%
Biologists	19.79%	47.92%	15.63%
Evolutionary Biologists	7.29%	19.79%	25.00%
Surgeons	2.08%	34.38%	25.00%
Oncologists	6.25%	42.71%	37.50%
Pathologists	1.04%	29.17%	28.13%
Radiologists	1.04%	16.67%	17.71%
Cancer Biologists	18.75%	55.21%	35.42%
Chemists	12.50%	45.83%	19.79%
Physicists	25.00%	46.88%	34.38%

Mathematicians	8.33%	44.79%	26.04%
Theorists	21.88%	39.58%	30.21%
Statisticians	4.17%	31.25%	28.13%
Information Technologists/Computer Scientists	8.33%	38.54%	27.08%
Other	2.08%	5.21%	8.33%

Response total	**Your field of training and expertise**	**Scientists you work with currently**	**Scientists you would like to work with on future projects**
Molecular Biologists	25	56	25
Cell Biologists	31	60	27
Engineers	34	50	24
Biologists	19	46	15
Evolutionary Biologists	7	19	24
Surgeons	2	33	24
Oncologists	6	41	36
Pathologists	1	28	27
Radiologists	1	16	17
Cancer Biologists	18	53	34
Chemists	12	44	19
Physicists	24	45	33
Mathematicians	8	43	25
Theorists	21	38	29
Statisticians	4	30	27
Information Technologists/Computer Scientists	8	37	26
Other	2	5	8

Total of respondents	96
Statistics based number of response	96
Filtered	0
Skipped	0

Q5

G2. What is your professional title? Please select all that apply.	**Response percent**	**Response total**
Trainee (undergrad, graduate, postdoctoral fellow, medical student)	3.13%	3
Research Assistant	0.00%	0
Research Scientist	2.08%	2
Assistant Professor	11.46%	11
Associate Professor	10.42%	10
Full Professor	61.46%	59
Department Chair	10.42%	10
Cancer Center Director	1.04%	1
Dean	1.04%	1
Other	14.58%	14

Total of respondents	96
Statistics based number of response	96
Filtered	0
Skipped	0

Q6

G3. To what extent do your research interests overlap with the following scientific themes?

Response percent	1. Not at all	2. Very Low	3. Low	4. Somewhat	5. High	6. Very High
Physics in Cancer (i.e. Understanding the role of cell and tissue mechanics, transport phenomena, heat transfer, shear stress, or other forces in cancer phenomena)	13.54%	6.25%	7.29%	20.83%	20.83%	31.25%
Evolution and Evolutionary Theory in Cancer	37.63%	13.98%	12.90%	18.28%	8.60%	8.60%
Information Transfer and Decoding in Cancer (i.e. spatial and temporal domains of trafficking of sub-cellular components, transcription, or translation in cancer)	18.95%	14.74%	7.37%	27.37%	21.05%	10.53%
De-Convoluting the Complexity of Cancer (i.e. Applying mathematical simulations, 3D model systems, or game theory to understand cancer phenomena)	20.21%	12.77%	8.51%	22.34%	19.15%	17.02%

Response total	1. Not at all	2. Very Low	3. Low	4. Somewhat	5. High	6. Very High
Physics in Cancer (i.e. Understanding the role of cell and tissue mechanics, transport phenomena, heat transfer, shear stress, or other forces in cancer phenomena)	13	6	7	20	20	30
Evolution and Evolutionary Theory in Cancer	35	13	12	17	8	8
Information Transfer and Decoding in Cancer (i.e. spatial and temporal domains of trafficking of sub-cellular components, transcription, or translation in cancer)	18	14	7	26	20	10
De-Convoluting the Complexity of Cancer (i.e. Applying mathematical simulations, 3D model systems, or game theory to understand cancer phenomena)	19	12	8	21	18	16

Total of respondents	96
Statistics based number of response	96
Filtered	0
Skipped	0

Q7

G4. Does your Institution have an overall strategy or mechanism for converging the fields of physical sciences and oncology?	Response percent	Response total
Yes	34.38%	33
No	50.00%	48
Unsure	15.63%	15

Total of respondents	96
Statistics based number of response	96
Filtered	0
Skipped	0

Q8

G4b. Please describe any mechanisms or sources of support that are available at your institution for collaborative research in physical sciences and oncology. If possible, please provide links to websites or programs.	Response total
	18

Total of respondents	96
Statistics based number of response	18
Filtered	0
Skipped	78

Q9

G5. Please indicate how strongly you agree or disagree with the following statement. I have seen evidence of the formation of a new field of "Physical Sciences-Oncology" within...

Response percent	1. Disagree	2.	3.	4. Neutral	5.	6.	7. Agree

My department(s)	46.88%	7.29%	3.13%	13.54%	9.38%	10.42%	9.38%
My institutions(s)	33.33%	8.33%	3.13%	9.38%	18.75%	14.58%	12.50%
At scientific meetings	8.33%	4.17%	4.17%	11.46%	27.08%	30.21%	14.58%
My current research	9.38%	5.21%	1.04%	19.79%	14.58%	21.88%	28.13%
My future research plans	7.29%	3.13%	2.08%	10.42%	18.75%	21.88%	36.46%
Publications	4.17%	3.13%	5.21%	18.75%	29.17%	23.96%	15.63%
I have not seen evidence of the formation of a new field of "Physical Sciences-Oncology"	53.13%	13.54%	10.42%	8.33%	4.17%	3.13%	7.29%

Response total	**1. Disagree**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Agree**
My department(s)	45	7	3	13	9	10	9
My institutions(s)	32	8	3	9	18	14	12
At scientific meetings	8	4	4	11	26	29	14
My current research	9	5	1	19	14	21	27
My future research plans	7	3	2	10	18	21	35
Publications	4	3	5	18	28	23	15
I have not seen evidence of the formation of a new field of "Physical Sciences-Oncology"	51	13	10	8	4	3	7

Total of respondents	96
Statistics based number of response	96
Filtered	0
Skipped	0

Q10

G6. From your standpoint, where should NCI focus its efforts in converging physical sciences and oncology? Please select all that apply.	**Response percent**	**Response total**
Short-term research aimed at clinically testable results	22.92%	22
Fundamental research aimed at new advances	87.50%	84
Training a new generation of investigators in physical sciences and oncology	77.08%	74
Infrastructure/tool creation	33.33%	32
Other	8.33%	8

Total of respondents	96
Statistics based number of response	96
Filtered	0
Skipped	0

Q11

G7. Are you aware of other programs or efforts (non-NCI) you feel are in the same domain (converging physical sciences and oncology)?	**Response percent**	**Response total**
Yes	21.88%	21
No	55.21%	53
Unsure	22.92%	22

Total of respondents	96
Statistics based number of response	96
Filtered	0
Skipped	0

Q12

G7b. Please provide a list of these programs. If possible, please provide websites or links for these programs.	**Response total**
	19

Total of respondents	96
Statistics based number of response	19
Filtered	0
Skipped	77

Q13

G8. What barriers do you anticipate for integrating the fields of physical sciences and oncology? Please check all that apply.	**Response percent**	**Response total**
Communication barriers between disciplines	79.17%	76
Limited funding	80.21%	77
Lack of physical infrastructure	25.00%	24
Difficulties sharing data	29.17%	28
Initiating collaborations	46.88%	45
I anticipate no barriers.	2.08%	2
Other	15.63%	15

Total of respondents	96
Statistics based number of response	96
Filtered	0
Skipped	0

Q14

G9. Please rate your level of familiarity with NCI's efforts to converge physical sciences and oncology, or the PS-OC Program?	**Response percent**	**Response total**
I am not aware of the program.	2.08%	2
I have heard of the program, but know little about the structure and goals.	20.83%	20
I am familiar with the program.	22.92%	22
I was involved in the NCI Workshops, Think Tanks, or review for this concept.	35.42%	34
I submitted an application for this program.	8.33%	8
I am an external advisor to a PS-OC.	7.29%	7
Other	3.13%	3

Total of respondents	96
Statistics based number of response	96
Filtered	0
Skipped	0

Q15

G10. Are you involved with any of the following NIH programs? If so, please check all that apply (if not, please skip).	**Response percent**	**Response total**
Integrative Cancer Biology Program	7.87%	7
Tumor Microenvironment Network	5.62%	5
The Cancer Genome Atlas	1.12%	1
Centers of Cancer Nanotechnology Excellence	17.98%	16
Clinical Proteomic Tumor Analysis Consortium	1.12%	1
Training Programs (i.e. R25, T32)	17.98%	16
Other	64.04%	57

Total of respondents	96
Statistics based number of response	89
Filtered	0

Skipped	7

Q16

G11. From your standpoint, please rate the PS-OC program (1-5) in the following areas. "5" is the highest rating.

Response percent	**1. I do not know**	**2. 1**	**3. 2**	**4. 3**	**5. 4**	**6. 5**
Development of trans-disciplinary teams and infrastructure	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Training trans-disciplinary scientists	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Disseminiating information about the program to the broader research community	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Generation of new datasets in cancer research	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Generation of new knowledge in cancer research	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Bringing new types of scientists to cancer research	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Response total	**1. I do not know**	**2. 1**	**3. 2**	**4. 3**	**5. 4**	**6. 5**
Development of trans-disciplinary teams and infrastructure	0	0	0	0	0	0
Training trans-disciplinary scientists	0	0	0	0	0	0
Disseminiating information about the program to the broader research community	0	0	0	0	0	0
Generation of new datasets in cancer research	0	0	0	0	0	0
Generation of new knowledge in cancer research	0	0	0	0	0	0
Bringing new types of scientists to cancer research	0	0	0	0	0	0

Total of respondents	96
Statistics based number of response	0
Filtered	0
Skipped	96

Q17

The following question inquires about your views on the progress the PS-OC program is making relative to the goals of the program.

Q18

From your standpoint, please evaluate the extent to which the PS-OC program has been successful in reaching the following program goals.

Response percent	**1. I do not know**	**2. Very Poor**	**3. Poor**	**4. Fair**	**5. Good**	**6. Excellent**
Form trans-disciplinary teams focused on establishing physical sciences-centric themes in cancer research	32.29%	2.08%	3.13%	17.71%	33.33%	11.46%
Build a collaborative trans-discipline research sharing network	44.79%	4.17%	3.13%	20.83%	21.88%	5.21%
Promote collaboration by PS-OC researchers across the PS-OC network	45.83%	2.08%	7.29%	19.79%	22.92%	2.08%
Educate trans-disciplinary scientists that pursue careers in the field of physical sciences in oncology	44.79%	3.13%	4.17%	26.04%	19.79%	2.08%
Promote collaboration by PS-OC researchers beyond the PS-OC network	45.83%	10.42%	10.42%	22.92%	8.33%	2.08%
Form new physical sciences in oncology programs at universities or institutions	38.54%	11.46%	9.38%	14.58%	21.88%	4.17%
Test dogma-challenging hypothesis on cancer initiation and progression	39.58%	8.33%	9.38%	17.71%	19.79%	5.21%
Bring new types of scientists to cancer research	28.13%	9.38%	4.17%	15.63%	30.21%	12.50%
Generate new datasets in cancer research	57.29%	2.08%	4.17%	15.63%	14.58%	6.25%
Generate new knowledge in cancer research	39.58%	9.38%	3.13%	18.75%	19.79%	9.38%

Response total	**1. I do not know**	**2. Very Poor**	**3. Poor**	**4. Fair**	**5. Good**	**6. Excellent**
Form trans-disciplinary teams focused on establishing physical sciences-centric themes in cancer research	31	2	3	17	32	11
Build a collaborative trans-discipline research sharing network	43	4	3	20	21	5
Promote collaboration by PS-OC researchers across the PS-OC network	44	2	7	19	22	2

Educate trans-disciplinary scientists that pursue careers in the field of physical sciences in oncology	43	3	4	25	19	2
Promote collaboration by PS-OC researchers beyond the PS-OC network	44	10	10	22	8	2
Form new physical sciences in oncology programs at universities or institutions	37	11	9	14	21	4
Test dogma-challenging hypothesis on cancer initiation and progression	38	8	9	17	19	5
Bring new types of scientists to cancer research	27	9	4	15	29	12
Generate new datasets in cancer research	55	2	4	15	14	6
Generate new knowledge in cancer research	38	9	3	18	19	9

Total of respondents	96
Statistics based number of response	96
Filtered	0
Skipped	0

Q19

Please provide any additional comments that you would like to share about the convergence of physical sciences in oncology or the PS-OC program.

Response total
34

Total of respondents	96
Statistics based number of response	34
Filtered	0
Skipped	62

Q1

OMB No.: 0925-06-07 Expiration Date: 9/30/2014 Notification to Respondent of Estimated Burden Public reporting burden for this collection of information is estimated to average 10 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to: NIH, Project Clearance Branch, 6705 Rockledge Drive, MSC 7974, Bethesda, MD 20892-7974, ATTN: PRA (0925-0642). Do not return the completed form to this address.

Q2

Please identify your primary affiliation with the Physical Sciences - Oncology Centers Program.	Response percent	Response total
Center Principal Investigator (PI)	0.00%	0
Center Senior Scientific Investigator (SI)	0.00%	0
PS-OC Project/Core Investigators (i.e. project/core leader or research investigator)	0.00%	0
PS-OC Trainee	0.00%	0
PS-OC Advocate	0.00%	0
PS-OC Outreach and Dissemination Unit Lead	33.33%	1
PS-OC Education and Training Unit Lead	66.67%	2
PS-OC Administrator	0.00%	0
PS-OC External Advisor	0.00%	0
I am not associated with the PS-OC Program	0.00%	0

Total of respondents	3
Statistics based number of response	3
Filtered	0
Skipped	0

Q3

Section D. The following section contains questions specifically for the leader of each PS-OC Outreach and Dissemination Unit.

Q4

D1. Please rate the overall ability of your Outreach and Dissemination Unit to do the following to date:

Response percent	1. Poor	2.	3.	4. Good	5.	6.	7. Excellent
Disseminate information to the broader scientific community.	0.00%	0.00%	0.00%	0.00%	0.00%	33.33%	66.67%
Disseminate information to clinicians.	0.00%	0.00%	0.00%	0.00%	33.33%	33.33%	33.33%
Disseminate information to patients.	0.00%	0.00%	0.00%	66.67%	0.00%	0.00%	33.33%
Disseminate information to advocates.	0.00%	0.00%	0.00%	33.33%	0.00%	33.33%	33.33%

Response total	1. Poor	2.	3.	4. Good	5.	6.	7. Excellent
Disseminate information to the broader scientific community.	0	0	0	0	0	1	2
Disseminate information to clinicians.	0	0	0	0	1	1	1
Disseminate information to patients.	0	0	0	2	0	0	1
Disseminate information to advocates.	0	0	0	1	0	1	1

Total of respondents	3
Statistics based number of response	3
Filtered	0
Skipped	0

Q5

D2. To what extent are steps being taken to ensure that the following aspects of the PS-OC will be sustainable after the period of funding?

Response percent	1. Not at all	2. Very Low	3. Low	4. Somewhat	5. High	6. Very High
Infrastructure (ie. labs, facilities, offices)	0.00%	0.00%	0.00%	33.33%	33.33%	33.33%
Courses, Workshops, Seminars	0.00%	0.00%	0.00%	33.33%	33.33%	33.33%
Collaborations	0.00%	0.00%	0.00%	33.33%	33.33%	33.33%
Outreach programs	0.00%	0.00%	0.00%	66.67%	33.33%	0.00%

Response total	1. Not at all	2. Very Low	3. Low	4. Somewhat	5. High	6. Very High
Infrastructure (ie. labs, facilities, offices)	0	0	0	1	1	1
Courses, Workshops, Seminars	0	0	0	1	1	1
Collaborations	0	0	0	1	1	1
Outreach programs	0	0	0	2	1	0

Total of respondents	3
Statistics based number of response	3
Filtered	0
Skipped	0

Q6

D3. Please rate the overall effectiveness of the following:

Response percent	1. Ineffective	2.	3.	4. Neutral	5.	6.	7. Effective
PS-OC Newsletter	0.00%	0.00%	0.00%	0.00%	66.67%	33.33%	0.00%
The Outreach and Dissemination Working Groups	0.00%	0.00%	0.00%	33.33%	0.00%	33.33%	33.33%
The Annual Meeting	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
Site Visits	0.00%	0.00%	0.00%	0.00%	0.00%	66.67%	33.33%

Response total	1. Ineffective	2.	3.	4. Neutral	5.	6.	7. Effective
PS-OC Newsletter	0	0	0	0	2	1	0
The Outreach and Dissemination Working Groups	0	0	0	1	0	1	1
The Annual Meeting	0	0	0	0	0	0	3
Site Visits	0	0	0	0	0	2	1

Total of respondents	3
Statistics based number of response	3
Filtered	0
Skipped	0

Q7

D4. Do you have any further suggestions for how NCI could enhance overall PS-OC program performance?	Response total
	2

Total of respondents	3
Statistics based number of response	2
Filtered	0
Skipped	1

Q8

The following question inquires about your views on the progress the PS-OC program is making relative to the goals of the program.

Q9

From your standpoint, please evaluate the extent to which the PS-OC program has been successful in reaching the following program goals.

Response percent	1. I do not know	2. Very Poor	3. Poor	4. Fair	5. Good	6. Excellent
Form trans-disciplinary teams focused on establishing physical sciences-centric themes in cancer research	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
Build a collaborative trans-discipline research sharing network	0.00%	0.00%	0.00%	0.00%	33.33%	66.67%
Promote collaboration by PS-OC researchers across the PS-OC network	0.00%	0.00%	0.00%	33.33%	0.00%	66.67%
Educate trans-disciplinary scientists that pursue careers in the field of physical sciences in oncology	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
Promote collaboration by PS-OC researchers beyond the PS-OC network	0.00%	0.00%	0.00%	0.00%	66.67%	33.33%
Form new physical sciences in oncology programs at universities or institutions	33.33%	0.00%	0.00%	0.00%	33.33%	33.33%
Test dogma-challenging hypothesis on cancer initiation and progression	0.00%	0.00%	0.00%	0.00%	33.33%	66.67%
Bring new types of scientists to cancer research	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
Generate new datasets in cancer research	33.33%	0.00%	0.00%	0.00%	33.33%	33.33%
Generate new knowledge in cancer research	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%

Response total	1. I do not know	2. Very Poor	3. Poor	4. Fair	5. Good	6. Excellent
Form trans-disciplinary teams focused on establishing physical sciences-centric themes in cancer research	0	0	0	0	0	3
Build a collaborative trans-discipline research sharing network	0	0	0	0	1	2
Promote collaboration by PS-OC researchers across the PS-OC network	0	0	0	1	0	2
Educate trans-disciplinary scientists that pursue careers in the field of physical sciences in oncology	0	0	0	0	0	3
Promote collaboration by PS-OC researchers beyond the PS-OC network	0	0	0	0	2	1
Form new physical sciences in oncology programs at universities or institutions	1	0	0	0	1	1
Test dogma-challenging hypothesis on cancer initiation and progression	0	0	0	0	1	2
Bring new types of scientists to cancer research	0	0	0	0	0	3
Generate new datasets in cancer research	1	0	0	0	1	1
Generate new knowledge in cancer research	0	0	0	0	0	3

Total of respondents	3
Statistics based number of response	3
Filtered	0
Skipped	0

Q10

Please provide any additional comments that you would like to share about the convergence of physical sciences in oncology	Response total
	1

Total of respondents	3
Statistics based number of response	1
Filtered	0
Skipped	2

Q1

OMB No.: 0925-0642-07 Expiration Date: 9/30/2014 Notification to Respondent of Estimated Burden Public reporting burden for this collection of information is estimated to average 25 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to: NIH, Project Clearance Branch, 6705 Rockledge Drive, MSC 7974, Bethesda, MD 20892-7974, ATTN: PRA (0925-0642). Do not return the completed form to this address.

Q2

Please identify your primary affiliation with the Physical Sciences - Oncology Centers Program.	Response percent	Response total
Center Principal Investigator (PI)	47.06%	8
Center Senior Scientific Investigator (SI)	41.18%	7
PS-OC Project/Core Investigators (i.e. project/core leader or research investigator)	11.76%	2
PS-OC Trainee	0.00%	0
PS-OC Advocate	0.00%	0
PS-OC Outreach and Dissemination Unit Lead	0.00%	0
PS-OC Education and Training Unit Lead	0.00%	0
PS-OC Administrator	0.00%	0
PS-OC External Advisor	0.00%	0
I am not associated with the PS-OC Program	0.00%	0
Total of respondents	17	
Statistics based number of response	17	
Filtered	0	
Skipped	0	

Q3

Section B. The following section contains questions specific for the Principal and Senior Investigators of the PS-OCs.

Q4

B1. There are a variety of different types of scientists involved in the PS-OC program. Research experiences may vary depending on your background and the background of your collaborators. For each of the following column headers, please select all types of scientists that apply.

Response percent	Your field of training and expertise	Scientists have you worked with prior to the PS-OC program	Scientists you work with currently	Scientists would like to work with in future projects
Molecular Biologists	35.29%	82.35%	76.47%	58.82%
Cell Biologists	29.41%	76.47%	64.71%	47.06%
Engineers	11.76%	41.18%	76.47%	52.94%
Biologists	23.53%	47.06%	41.18%	29.41%
Evolutionary Biologists	11.76%	23.53%	70.59%	41.18%
Surgeons	5.88%	41.18%	64.71%	47.06%
Oncologists	23.53%	47.06%	82.35%	58.82%
Pathologists	5.88%	52.94%	70.59%	47.06%
Radiologists	5.88%	29.41%	52.94%	41.18%
Cancer Biologists	23.53%	64.71%	82.35%	58.82%
Chemists	11.76%	41.18%	47.06%	47.06%
Physicists	29.41%	41.18%	76.47%	64.71%
Mathematicians	11.76%	41.18%	82.35%	58.82%
Theorists	11.76%	52.94%	76.47%	41.18%
Statisticians	0.00%	41.18%	47.06%	47.06%
Information Technologists/Computer Scientists	5.88%	35.29%	58.82%	52.94%
Other	5.88%	11.76%	11.76%	11.76%

Response total	Your field of training and expertise	Scientists have you worked with prior to the PS-OC program	Scientists you work with currently	Scientists would like to work with in future projects
Molecular Biologists	6	14	13	10
Cell Biologists	5	13	11	8
Engineers	2	7	13	9
Biologists	4	8	7	5
Evolutionary Biologists	2	4	12	7
Surgeons	1	7	11	8
Oncologists	4	8	14	10
Pathologists	1	9	12	8
Radiologists	1	5	9	7
Cancer Biologists	4	11	14	10
Chemists	2	7	8	8
Physicists	5	7	13	11
Mathematicians	2	7	14	10
Theorists	2	9	13	7
Statisticians	0	7	8	8
Information Technologists/Computer Scientists	1	6	10	9
Other	1	2	2	2
Total of respondents	17			
Statistics based number of response	17			
Filtered	0			
Skipped	0			

Q5

The following questions inquire about the planning, management, and organization of your PS-OC.

Q6

B2. Which one or more of the four NCI PS-OC Themes is most relevant to your PS-OC?	Response percent	Response total
The Physics of Cancer	64.71%	11
Evolution and Evolutionary Theory in Cancer	29.41%	5
De-convoluting Complexity	17.65%	3
Understanding Information Transfer and Decoding	11.76%	2
Total of respondents	17	
Statistics based number of response	17	
Filtered	0	
Skipped	0	

Q7

B3. What methods do you use to coordinate activities and facilitate communication across your PS-OC?	Response percent	Response total
Face - to - Face Meetings	94.12%	16
Teleconferences	94.12%	16
PS-OC Site Visits	82.35%	14
PS-OC Workshops	58.82%	10
Email	100.00%	17
Web page	29.41%	5
Phone Calls	76.47%	13
Other	11.76%	2
Total of respondents	17	
Statistics based number of response	17	
Filtered	0	
Skipped	0	

Q8

B4. Please select the choice which most closely represents the frequency of meetings for the following questions.

Response percent	1. Yearly	2. Every 6 months	3. Every 3 months	4. Monthly	5. Weekly	6. More than once per week	7. Daily
How often do you meet with your PS-OC's project leaders?	5.88%	0.00%	17.65%	52.94%	23.53%	0.00%	0.00%
How often do you meet with your entire PS-OC?	11.76%	58.82%	5.88%	11.76%	11.76%	0.00%	0.00%

Response total	1. Yearly	2. Every 6 months	3. Every 3 months	4. Monthly	5. Weekly	6. More than once per week	7. Daily
How often do you meet with your PS-OC's project leaders?	1	0	3	9	4	0	0
How often do you meet with your entire PS-OC?	2	10	1	2	2	0	0

Total of respondents	17
Statistics based number of response	17
Filtered	0
Skipped	0

Q9

B5. To what extent is your Center implementing the following activites recommended by NCI?

Response percent	1. Not currently implementing	2. Attempting to implement	3. Neutral	4. Implementing some aspects	5. Fully implementing
Offering PS-OC research training programs	0.00%	5.88%	0.00%	23.53%	70.59%
Promoting multi-disciplinary collaborations within center	0.00%	0.00%	0.00%	0.00%	100.00%
Promoting multi-disciplinary collaborations between PS-OCs	0.00%	0.00%	0.00%	11.76%	88.24%
Ensuring day to day management and communications within the PS-OC	0.00%	0.00%	5.88%	29.41%	64.71%
Emphasizing strategic planning within the PS-OC, including setting milestones, monitoring progress, seeking advisory or committee input	0.00%	0.00%	17.65%	35.29%	47.06%

Response total	1. Not currently implementing	2. Attempting to implement	3. Neutral	4. Implementing some aspects	5. Fully implementing
Offering PS-OC research training programs	0	1	0	4	12
Promoting multi-disciplinary collaborations within center	0	0	0	0	17
Promoting multi-disciplinary collaborations between PS-OCs	0	0	0	2	15
Ensuring day to day management and communications within the PS-OC	0	0	1	5	11
Emphasizing strategic planning within the PS-OC, including setting milestones, monitoring progress, seeking advisory or committee input	0	0	3	6	8
Total of respondents	17				
Statistics based number of response	17				
Filtered	0				
Skipped	0				

Q10

B6. What challenges have you encountered or do you anticipate for your PS-OC?	Response percent	Response total
Communication barriers between disciplines	64.71%	11
Delay in formation of teams and collaborations	41.18%	7
Limited funds	64.71%	11

Lack of physical infrastructure support	23.53%	4
Difficulties sharing data and information	5.88%	1
Other	11.76%	2

Total of respondents	17
Statistics based number of response	17
Filtered	0
Skipped	0

Q11

The following questions inquire about the progress of your PS-OC's research, training, and outreach programs.

Q12

B7. Please rate your satisfaction with the progress you have made so far relative to the milestones you set for your PS-OC, in the following categories.

Response percent	**1. Dissatisfied**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Satisfied**
The overall PS-OC framework	0.00%	0.00%	0.00%	11.76%	11.76%	35.29%	41.18%
PS-OC Research Projects	0.00%	0.00%	0.00%	0.00%	17.65%	23.53%	58.82%
PS-OC Outreach and Dissemination	0.00%	0.00%	0.00%	23.53%	23.53%	23.53%	29.41%
PS-OC Education and Training	0.00%	0.00%	5.88%	5.88%	11.76%	41.18%	35.29%

Response total	**1. Dissatisfied**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Satisfied**
The overall PS-OC framework	0	0	0	2	2	6	7
PS-OC Research Projects	0	0	0	0	3	4	10
PS-OC Outreach and Dissemination	0	0	0	4	4	4	5
PS-OC Education and Training	0	0	1	1	2	7	6

Total of respondents	17
Statistics based number of response	17
Filtered	0
Skipped	0

Q13

B8. Please rate the necessity of the following in achieving the research milestones of your PS-OC.

Response percent	**1. Unimportant**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Important**
Development of new paradigms	0.00%	5.88%	0.00%	17.65%	5.88%	11.76%	58.82%
Development of new datasets	0.00%	0.00%	5.88%	5.88%	29.41%	5.88%	52.94%
Development of new approaches, models, or techniques	0.00%	0.00%	0.00%	5.88%	5.88%	29.41%	58.82%
Formation of trans-disciplinary collaborations between physical scientists and cancer researchers	0.00%	0.00%	0.00%	5.88%	0.00%	23.53%	70.59%

Response total	**1. Unimportant**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Important**
Development of new paradigms	0	1	0	3	1	2	10
Development of new datasets	0	0	1	1	5	1	9
Development of new approaches, models, or techniques	0	0	0	1	1	5	10
Formation of trans-disciplinary collaborations between physical scientists and cancer researchers	0	0	0	1	0	4	12

Total of respondents	17
Statistics based number of response	17
Filtered	0
Skipped	0

Q14

B9. What do you believe is a reasonable timeframe to expect PS-OC supported discoveries suitable for translation?	**Response percent**	**Response total**
0-1 year	0.00%	0
1-3 years	5.88%	1
3-5 years	41.18%	7
5-10 years	47.06%	8
10+ years	5.88%	1

Total of respondents	17
Statistics based number of response	17
Filtered	0
Skipped	0

Q15

C2. Please rate your satisfaction with the progress you have made so far on your project specific aims?	**Response percent**	**Response total**
Satisfied	53.85%	7
Somewhat Satisfied	30.77%	4
Neutral	0.00%	0
Somewhat Dissatisfied	15.38%	2
Dissatisfied	0.00%	0

Total of respondents	17
Statistics based number of response	13

Filtered	0
Skipped	4

Q16

The following questions inquire about the status and infrastructure of the physical sciences in oncology field.

Q17

C3. I have seen evidence of the formation of a new field of "Physical Sciences-Oncology" within...

Response percent	**1. Disagree**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Agree**
My department(s)	16.67%	8.33%	0.00%	25.00%	8.33%	16.67%	25.00%
My institutions(s)	7.69%	15.38%	0.00%	0.00%	7.69%	46.15%	23.08%
At scientific meetings	7.69%	0.00%	15.38%	0.00%	15.38%	23.08%	38.46%
My current research	0.00%	0.00%	0.00%	0.00%	7.69%	15.38%	76.92%
My future research plans	0.00%	0.00%	0.00%	0.00%	7.69%	7.69%	84.62%
Publications	7.69%	0.00%	0.00%	0.00%	23.08%	7.69%	61.54%
I have not seen evidence of the formation of a new field of "Physical Sciences-Oncology"	70.00%	10.00%	20.00%	0.00%	0.00%	0.00%	0.00%

Response total	**1. Disagree**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Agree**
My department(s)	2	1	0	3	1	2	3
My institutions(s)	1	2	0	0	1	6	3
At scientific meetings	1	0	2	0	2	3	5
My current research	0	0	0	0	1	2	10
My future research plans	0	0	0	0	1	1	11
Publications	1	0	0	0	3	1	8
I have not seen evidence of the formation of a new field of "Physical Sciences-Oncology"	7	1	2	0	0	0	0

Total of respondents	17
Statistics based number of response	13
Filtered	0
Skipped	4

Q18

C4. Does your institution have an overall strategy for converging physical sciences and oncology outside of the PS-OC program? If yes, please provide details in comment area.	**Response percent**	**Response total**
Yes	23.08%	3
No	61.54%	8
Unsure	15.38%	2
		3

Total of respondents	17
Statistics based number of response	13
Filtered	0
Skipped	4

Q19

C5. Do any sources of support exist for phyiscal sciences in oncology research at your Institution outside of the PS-OC?	**Response percent**	**Response total**
Yes	30.77%	4
No	69.23%	9

Total of respondents	17
Statistics based number of response	13
Filtered	0
Skipped	4

Q20

C5b. Please answer yes or no to the following questions about the "other" types of support offered at your Instution for converging physical sciences and oncology.

Response percent	**1. Yes**	**2. No**
Do PS-OC researchers recieve funding from these sources?	75.00%	25.00%
Do PS-OC researchers collaborate with researchers supported by these sources?	100.00%	0.00%
Do PS-OC researchers use equipment, materials, or infrastructure supported by these sources?	100.00%	0.00%

Response total	**1. Yes**	**2. No**
Do PS-OC researchers recieve funding from these sources?	3	1
Do PS-OC researchers collaborate with researchers supported by these sources?	4	0
Do PS-OC researchers use equipment, materials, or infrastructure supported by these sources?	4	0

Total of respondents	17
Statistics based number of response	4
Filtered	0
Skipped	13

Q21

The following questions inquire about your PS-OC research advances and your participation within the PS-OC program.

Q22

C6. From your standpoint, please briefly describe the most important scientific advancement to emerge from your PS-OC to date.

	Response total
	13

Total of respondents	17
Statistics based number of response	13
Filtered	0
Skipped	4

Q23

C6b. Please use the previous example to answer the following questions.

Response percent	1. Disagree	2.	3.	4. Neutral	5.	6.	7. Agree
This scientific advancement stems from projects that exisited before the PS-OC program.		53.85%	15.38%	0.00%	7.69%	15.38%	0.00%	7.69%
This scientific advancement will lead to future scientific breakthroughs.		0.00%	0.00%	0.00%	0.00%	7.69%	15.38%	76.92%
This advancement would not have occurred without the support of the PS-OC program.		0.00%	0.00%	0.00%	0.00%	7.69%	15.38%	76.92%
There is potential for this scientific advancement to translate into the clinic.		0.00%	0.00%	0.00%	0.00%	7.69%	7.69%	84.62%

Response total	1. Disagree	2.	3.	4. Neutral	5.	6.	7. Agree
This scientific advancement stems from projects that exisited before the PS-OC program.		7	2	0	1	2	0	1
This scientific advancement will lead to future scientific breakthroughs.		0	0	0	0	1	2	10
This advancement would not have occurred without the support of the PS-OC program.		0	0	0	0	1	2	10
There is potential for this scientific advancement to translate into the clinic.		0	0	0	0	1	1	11

Total of respondents	17
Statistics based number of response	13
Filtered	0
Skipped	4

Q24

C7a. Have you submitted applications for research grants based on the findings from your PS-OC supported studies?

	Response percent	Response total
Yes	76.92%	10
No	23.08%	3

Total of respondents	17
Statistics based number of response	13
Filtered	0
Skipped	4

Q25

C7b. What types of comments were recieved on these grants?

	Response percent	Response total
Not enough preliminary data	20.00%	2
Too high risk	60.00%	6
No clinical application	10.00%	1
Limited biological components	10.00%	1
Innovative	40.00%	4
I have not recieved any comments	10.00%	1
Other	10.00%	1

Total of respondents	17
Statistics based number of response	10
Filtered	0
Skipped	7

Q26

C8. Please describe one brief example of something you know now that you didn't know before because of your involvement with the PS-OC program.

	Response total
	10

Total of respondents	17
Statistics based number of response	10
Filtered	0
Skipped	7

Q27

C9. Please check all PS-OC working groups or exercises in which you have participated.

	Response percent	Response total
Evolution and Drug Resistance	46.15%	6
Physics	46.15%	6
CTC Transport	23.08%	3
UN of Cell Modulus	15.38%	2
Outreach and Dissemination	61.54%	8
Education and Training	69.23%	9
Cell line exercise	69.23%	9
I have not participated in any PS-OC working groups or exercises	0.00%	0

Total of respondents	17
Statistics based number of response	13

Filtered	0
Skipped	4

Q28

C9b. Please rate the effectiveness of the working groups or exercises in achieving the following goals.

Response percent	**1. Ineffective**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Effective**
Faciliate new collaborations	7.69%	0.00%	0.00%	7.69%	38.46%	15.38%	30.77%
Provide new knowledge	7.69%	0.00%	7.69%	23.08%	30.77%	0.00%	30.77%
Increase communication between PS-OC investigators	7.69%	0.00%	0.00%	0.00%	38.46%	15.38%	38.46%
Generate PS-OC Network publications	7.69%	15.38%	15.38%	15.38%	15.38%	0.00%	30.77%
Disseminate information to the broader scientific community about the PS-OC Network	7.69%	0.00%	23.08%	23.08%	23.08%	0.00%	23.08%

Response total	**1. Ineffective**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Effective**
Faciliate new collaborations	1	0	0	1	5	2	4
Provide new knowledge	1	0	1	3	4	0	4
Increase communication between PS-OC investigators	1	0	0	0	5	2	5
Generate PS-OC Network publications	1	2	2	2	2	0	4
Disseminate information to the broader scientific community about the PS-OC Network	1	0	3	3	3	0	3

Total of respondents	17
Statistics based number of response	13
Filtered	0
Skipped	4

Q29

C9c. Please provide a suggestion for new PS-OC working groups or exercises in which you would participate.

	Response total
	0

Total of respondents	17
Statistics based number of response	0
Filtered	0
Skipped	17

Q30

C10. Did the PS-OC facilitate access to equipment and infrastructure for PS-OC researchers beyond what would have been available otherwise?	**Response percent**	**Response total**
Yes	76.92%	10
No	23.08%	3
Comments		3

Total of respondents	17
Statistics based number of response	13
Filtered	0
Skipped	4

Q31

C11. How effective have the following PS-OC opportunities been in encouraging you to generate innovative scientific ideas?

Response percent	**1. Not Applicable**	**2. Ineffective**	**3.**	**4. Effective**	**5.**	**6. Very Effective**
Trans-Network Projects	7.69%	7.69%	0.00%	15.38%	23.08%	46.15%
Young Investigator Trans-Network Projects	7.69%	7.69%	0.00%	38.46%	30.77%	15.38%
Pilot Projects	7.69%	7.69%	7.69%	7.69%	23.08%	46.15%
Outreach Pilot Projects	15.38%	7.69%	15.38%	0.00%	30.77%	30.77%
Student Exchanges	15.38%	0.00%	15.38%	30.77%	23.08%	15.38%
PS-OC Annual Meeting	0.00%	0.00%	0.00%	38.46%	30.77%	30.77%

Response total	**1. Not Applicable**	**2. Ineffective**	**3.**	**4. Effective**	**5.**	**6. Very Effective**
Trans-Network Projects	1	1	0	2	3	6
Young Investigator Trans-Network Projects	1	1	0	5	4	2
Pilot Projects	1	1	1	1	3	6
Outreach Pilot Projects	2	1	2	0	4	4
Student Exchanges	2	0	2	4	3	2
PS-OC Annual Meeting	0	0	0	5	4	4

Total of respondents	17
Statistics based number of response	13
Filtered	0
Skipped	4

Q32

C12. How have you disseminated information about the PS-OC to the broader scientific community?	**Response percent**	**Response total**
Presentations at conferences/scientific meetings	92.31%	12
Invited talks	100.00%	13
Publications	100.00%	13
Webpage	76.92%	10

Email	69.23%	9
Newspaper or radio	53.85%	7
I have not disseminated information about the PS-OC	0.00%	0
Other	7.69%	1

Total of respondents	17
Statistics based number of response	13
Filtered	0
Skipped	4

Q33

C13. To what types of scientists have you presented and/or discussed your PS-OC research? Please check all that apply.

	Response percent	**Response total**
Molecular Biologists	76.92%	10
Cell Biologists	61.54%	8
Cancer Biologists	92.31%	12
Engineers	92.31%	12
Evolutionary Biologists	61.54%	8
Surgeons	69.23%	9
Oncologists	100.00%	13
Pathologists	61.54%	8
Radiologists	46.15%	6
Chemists	53.85%	7
Physicisits	92.31%	12
Mathematicians	61.54%	8
Theorists	69.23%	9
Statstaticians	30.77%	4
Information Technologists	38.46%	5
Other	0.00%	0

Total of respondents	17
Statistics based number of response	13
Filtered	0
Skipped	4

Q34

C14. From your standpoint, how effectively have the PS-OC program staff performed the following roles in the management and direction of the PS-OC program?

Response percent	**1. I do not know**	**2. Ineffective**	**3.**	**4.**	**5. Neutral**	**6.**	**7.**	**8. Very Effective**
Strategic directions	0.00%	7.69%	0.00%	0.00%	15.38%	7.69%	38.46%	30.77%
Facilitating interactions amoung PS-OC investigators	0.00%	7.69%	0.00%	0.00%	7.69%	7.69%	30.77%	46.15%
Facilitating interactions between the PS-OC Network and the broader community	0.00%	7.69%	7.69%	7.69%	15.38%	7.69%	23.08%	30.77%
Advancing research within the PS-OCs	0.00%	7.69%	0.00%	0.00%	15.38%	15.38%	23.08%	38.46%
Organizing working groups and exercises	0.00%	7.69%	7.69%	0.00%	7.69%	30.77%	23.08%	23.08%
Organizing steering committee	0.00%	0.00%	7.69%	0.00%	15.38%	7.69%	38.46%	30.77%

Response total	**1. I do not know**	**2. Ineffective**	**3.**	**4.**	**5. Neutral**	**6.**	**7.**	**8. Very Effective**
Strategic directions	0	1	0	0	2	1	5	4
Facilitating interactions amoung PS-OC investigators	0	1	0	0	1	1	4	6
Facilitating interactions between the PS-OC Network and the broader community	0	1	1	1	2	1	3	4
Advancing research within the PS-OCs	0	1	0	0	2	2	3	5
Organizing working groups and exercises	0	1	1	0	1	4	3	3
Organizing steering committee	0	0	1	0	2	1	5	4

Total of respondents	17
Statistics based number of response	13
Filtered	0
Skipped	4

Q35

Section J. The following questions inquire about your collaborations and their impact, methods for facilitating collaborations, and the impact of the PS-OC program in your collaborations.

Q36

J1. Without naming specific individuals, please give an example of a successful trans-disciplinary collaboration (i.e. a collaboration that integrated two or more individual disciplinary perspectives) in which you have been involved as part of the PS-OC program. Please provide a brief description of the project and how it was initiated. Please define each member's role in the collaboration.

Response total
17

Total of respondents	17
Statistics based number of response	17
Filtered	0
Skipped	0

Q37

J1b. What are the outcomes of the collaboration described above? Please select all that apply.	**Response percent**	**Response total**
New knowledge or skills	88.24%	15

Pilot project funds	17.65%	3
Outreach project funds	5.88%	1
Trans-network project funds	41.18%	7
NIH or NSF grant funds	11.76%	2
Publications	58.82%	10
Conference presentations or invited talks	70.59%	12
The collaboration is still in progress.	94.12%	16
Will form new collaborations	35.29%	6
Will pursue new aspects of the project as an extension of this work	70.59%	12

Total of respondents	17
Statistics based number of response	17
Filtered	0
Skipped	0

Q38

J1c. How many researchers were involved in this trans-disciplinary collaboration?	**Response percent**	**Response total**
2	5.88%	1
3	0.00%	0
4	17.65%	3
5-7	52.94%	9
8-10	17.65%	3
10+	5.88%	1

Total of respondents	17
Statistics based number of response	17
Filtered	0
Skipped	0

Q39

J1d. Please indicate how strongly you agree or disagree with each of the following statements pertaining to the collaboration described above. "I would have obtained these outcomes..."

Response percent	**1. Disagree**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Agree**
without one member of the team	41.18%	5.88%	0.00%	35.29%	0.00%	5.88%	11.76%
without two members of the team	58.82%	11.76%	11.76%	17.65%	0.00%	0.00%	0.00%
without a trans-disciplinary collaboration	82.35%	11.76%	0.00%	5.88%	0.00%	0.00%	0.00%
without the support of the PS-OC program	94.12%	0.00%	0.00%	5.88%	0.00%	0.00%	0.00%

Response total	**1. Disagree**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Agree**
without one member of the team	7	1	0	6	0	1	2
without two members of the team	10	2	2	3	0	0	0
without a trans-disciplinary collaboration	14	2	0	1	0	0	0
without the support of the PS-OC program	16	0	0	1	0	0	0

Total of respondents	17
Statistics based number of response	17
Filtered	0
Skipped	0

Q40

J2. What difficulties, if any, have you experienced during your trans-disciplinary collaborations in the PS-OC program? Please rate the severity of these difficulties on a scale of 1-5. A "1" indicates that the issue did not impact the outcome(s) of the collaboration. A "5" indicates that the issue severely impacted the collaboration.

Response percent	**Check all that apply**	**Please rate the severity of the issue: 1**	**Please rate the severity of the issue: 2**	**Please rate the severity of the issue: 3**	**Please rate the severity of the issue: 4**	**Please rate the severity of the issue: 5**
Members prioritized their personal goals before the overall team goal	29.41%	33.33%	33.33%	33.33%	0.00%	0.00%
Difficulties in sharing data	5.88%	50.00%	50.00%	0.00%	0.00%	0.00%
The team members discuss issues only at a broad level	23.53%	40.00%	20.00%	40.00%	0.00%	0.00%
Difficulties in sharing supplies, cells, tissue, or equipment	17.65%	25.00%	25.00%	50.00%	0.00%	0.00%
Responsibilities, roles, and expectations were not clear	29.41%	16.67%	50.00%	33.33%	0.00%	0.00%
Difficulties in organizing travel	17.65%	25.00%	50.00%	0.00%	25.00%	0.00%
Team members became competitive with one another	17.65%	25.00%	50.00%	0.00%	25.00%	0.00%
Difficulties in communication across scientific disciplines	47.06%	33.33%	22.22%	33.33%	11.11%	0.00%
Lack of funds	58.82%	11.11%	22.22%	55.56%	11.11%	0.00%
Power struggles	17.65%	50.00%	50.00%	0.00%	0.00%	0.00%
Sharing credit	17.65%	75.00%	25.00%	0.00%	0.00%	0.00%
The team did not meet regularly	11.76%	33.33%	0.00%	33.33%	33.33%	0.00%
The team did not establish trust	5.88%	50.00%	0.00%	50.00%	0.00%	0.00%
There is no reward structure at my institution for collaborations	17.65%	25.00%	0.00%	50.00%	25.00%	0.00%
Trouble identifying additional team members to help	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%
Lack of clear vision or goals	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%
No agreement on the primary spokesperson	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%

Response total	**Check all that apply**	**Please rate the severity of the issue: 1**	**Please rate the severity of the issue: 2**	**Please rate the severity of the issue: 3**	**Please rate the severity of the issue: 4**	**Please rate the severity of the issue: 5**
Members prioritized their personal goals before the overall team goal	5	2	2	2	0	0
Difficulties in sharing data	1	1	1	0	0	0

The team members discuss issues only at a broad level	4	2	1	2	0	0
Difficulties in sharing supplies, cells, tissue, or equipment	3	1	1	2	0	0
Responsibilities, roles, and expectations were not clear	5	1	3	2	0	0
Difficulties in organizing travel	3	1	2	0	1	0
Team members became competitive with one another	3	1	2	0	1	0
Difficulties in communication across scientific disciplines	8	3	2	3	1	0
Lack of funds	10	1	2	5	1	0
Power struggles	3	2	2	0	0	0
Sharing credit	3	3	1	0	0	0
The team did not meet regularly	2	1	0	1	1	0
The team did not establish trust	1	1	0	1	0	0
There is no reward structure at my institution for collaborations	3	1	0	2	1	0
Trouble identifying additional team members to help	0	1	0	0	0	0
Lack of clear vision or goals	0	1	0	0	0	0
No agreement on the primary spokesperson	0	1	0	0	0	0

Total of respondents	17
Statistics based number of response	17
Filtered	0
Skipped	0

Q41

J3. Please define your role(s) in your PS-OC collaborations. Please select all that apply.	**Response percent**	**Response total**
Provide cells or reagents	29.41%	5
Provide technology or skill	64.71%	11
Provide strategic direction	82.35%	14
Leader	70.59%	12
Combine data	23.53%	4
Organize team meetings and communication	70.59%	12
Perform data analysis	35.29%	6
Participant	17.65%	3
Advisor	52.94%	9
Provide training/education	35.29%	6
Create reports	52.94%	9
Communicate to stakeholders (i.e. NCI)	52.94%	9
Interface with Instituional leadership	47.06%	8
Administrative support or IT	0.00%	0
Other	5.88%	1

Total of respondents	17
Statistics based number of response	17
Filtered	0
Skipped	0

Q42

J4. Please answer the following questions with the approximate number of investigators (i.e. faculty level researchers).

Response percent	**1. 0**	**2. 1 - 4**	**3. 5 - 10**	**4. 11 -15**	**5. 16+**
How many PS-OC investigators within your Center did you work with prior to the start of the PS-OC program?	23.53%	58.82%	5.88%	11.76%	0.00%
How many PS-OC investigators within your Center do you work with now?	0.00%	23.53%	29.41%	17.65%	29.41%
How many of these new collaborations would have started without PS-OC program funding?	58.82%	35.29%	5.88%	0.00%	0.00%

Response total	**1. 0**	**2. 1 - 4**	**3. 5 - 10**	**4. 11 -15**	**5. 16+**
How many PS-OC investigators within your Center did you work with prior to the start of the PS-OC program?	4	10	1	2	0
How many PS-OC investigators within your Center do you work with now?	0	4	5	3	5
How many of these new collaborations would have started without PS-OC program funding?	10	6	1	0	0

Total of respondents	17
Statistics based number of response	17
Filtered	0
Skipped	0

Q43

J5. Overall, please evaluate your PS-OC supported collaborations in the following areas.

Response percent	**1. Very Poor**	**2. Poor**	**3. Fair**	**4. Good**	**5. Excellent**
Scientific impact	0.00%	0.00%	11.76%	29.41%	58.82%
Productivity	0.00%	0.00%	11.76%	23.53%	64.71%
Rewarding to all parties involved equally	0.00%	0.00%	23.53%	41.18%	35.29%
Communication among collaborators	0.00%	0.00%	17.65%	52.94%	29.41%
Ability to utilize the strengths of different researchers involved	0.00%	0.00%	0.00%	47.06%	52.94%
Enabling you to reach your own research milestones faster	0.00%	5.88%	11.76%	35.29%	47.06%
Ability to attract new collaborators to join efforts	0.00%	0.00%	5.88%	35.29%	58.82%

Response total	**1. Very Poor**	**2. Poor**	**3. Fair**	**4. Good**	**5. Excellent**
Scientific impact	0	0	2	5	10

Productivity	0	0	2	4	11
Rewarding to all parties involved equally	0	0	4	7	6
Communication among collaborators	0	0	3	9	5
Ability to utilize the strengths of different researchers involved	0	0	0	8	9
Enabling you to reach your own research milestones faster	0	1	2	6	8
Ability to attract new collaborators to join efforts	0	0	1	6	10

Total of respondents	17
Statistics based number of response	17
Filtered	0
Skipped	0

Q44

J6. How effective have the following PS-OC opportunities been in encouraging you to find and/or generate collaborations?

Response percent	**1. Not Applicable**	**2. Ineffective**	**3.**	**4. Somewhat Effective**	**5.**	**6. Very Effective**
PS-OC Trans-Network Projects	11.76%	5.88%	11.76%	11.76%	23.53%	35.29%
PS-OC Young Investigator Trans-Network Projects	5.88%	0.00%	17.65%	41.18%	23.53%	11.76%
PS-OC Pilot Projects	17.65%	0.00%	17.65%	17.65%	29.41%	17.65%
PS-OC Outreach Pilot Projects	29.41%	5.88%	5.88%	29.41%	29.41%	0.00%
Student Exchanges	25.00%	0.00%	18.75%	25.00%	18.75%	12.50%
PS-OC Annual Meeting	0.00%	0.00%	5.88%	35.29%	29.41%	29.41%
PS-OC Workshops and Symposiums	0.00%	11.76%	23.53%	17.65%	35.29%	11.76%
PS-OC Data Jamboree	23.53%	23.53%	29.41%	17.65%	5.88%	0.00%

Response total	**1. Not Applicable**	**2. Ineffective**	**3.**	**4. Somewhat Effective**	**5.**	**6. Very Effective**
PS-OC Trans-Network Projects	2	1	2	2	4	6
PS-OC Young Investigator Trans-Network Projects	1	0	3	7	4	2
PS-OC Pilot Projects	3	0	3	3	5	3
PS-OC Outreach Pilot Projects	5	1	1	5	5	0
Student Exchanges	4	0	3	4	3	2
PS-OC Annual Meeting	0	0	1	6	5	5
PS-OC Workshops and Symposiums	0	2	4	3	6	2
PS-OC Data Jamboree	4	4	5	3	1	0

Total of respondents	17
Statistics based number of response	17
Filtered	0
Skipped	0

Q45

J7. From your standpoint, please evaluate the extent to which the PS-OC program has been successful in the following areas.

Response percent	**1. I do not know**	**2. Very Poor**	**3. Poor**	**4. Fair**	**5. Good**	**6. Excellent**
Improving leadership skills in heading a trans-disciplinary study	0.00%	0.00%	0.00%	17.65%	52.94%	29.41%
Mentoring junior faculty in leading and participating in a trans-disciplinary study	0.00%	0.00%	0.00%	11.76%	47.06%	41.18%
Increasing the discussion about team science and collaborations at your institution	0.00%	0.00%	5.88%	11.76%	35.29%	47.06%
Developing better policies to review and reward team science at your institution	17.65%	0.00%	11.76%	11.76%	41.18%	17.65%

Response total	**1. I do not know**	**2. Very Poor**	**3. Poor**	**4. Fair**	**5. Good**	**6. Excellent**
Improving leadership skills in heading a trans-disciplinary study	0	0	0	3	9	5
Mentoring junior faculty in leading and participating in a trans-disciplinary study	0	0	0	2	8	7
Increasing the discussion about team science and collaborations at your institution	0	0	1	2	6	8
Developing better policies to review and reward team science at your institution	3	0	2	2	7	3

Total of respondents	17
Statistics based number of response	17
Filtered	0
Skipped	0

Q46

The following question inquires about your views on the progress the PS-OC program is making relative to the goals of the program.

Q47

From your standpoint, please evaluate the extent to which the PS-OC program has been successful in reaching the following program goals.

Response percent	**1. I do not know**	**2. Very Poor**	**3. Poor**	**4. Fair**	**5. Good**	**6. Excellent**
Form trans-disciplinary teams focused on establishing physical sciences-centric themes in cancer research	0.00%	0.00%	0.00%	0.00%	29.41%	70.59%
Build a collaborative trans-discipline research sharing network	0.00%	0.00%	0.00%	5.88%	41.18%	52.94%
Promote collaboration by PS-OC researchers across the PS-OC network	0.00%	0.00%	0.00%	17.65%	41.18%	41.18%
Educate trans-disciplinary scientists that pursue careers in the field of physical sciences in oncology	0.00%	0.00%	0.00%	5.88%	47.06%	47.06%
Promote collaboration by PS-OC researchers beyond the PS-OC network	0.00%	0.00%	0.00%	17.65%	35.29%	47.06%
Form new physical sciences in oncology programs at universities or institutions	5.88%	5.88%	0.00%	23.53%	29.41%	35.29%
Test dogma-challenging hypothesis on cancer initiation and progression	0.00%	0.00%	5.88%	5.88%	52.94%	35.29%
Bring new types of scientists to cancer research	0.00%	0.00%	0.00%	5.88%	17.65%	76.47%

Generate new datasets in cancer research	5.88%	0.00%	5.88%	5.88%	29.41%	52.94%
Generate new knowledge in cancer research	0.00%	0.00%	11.76%	0.00%	29.41%	58.82%

Response total	1. I do not know	2. Very Poor	3. Poor	4. Fair	5. Good	6. Excellent	
Form trans-disciplinary teams focused on establishing physical sciences-centric themes in cancer research		0	0	0	0	5	12
Build a collaborative trans-discipline research sharing network		0	0	0	1	7	9
Promote collaboration by PS-OC researchers across the PS-OC network		0	0	0	3	7	7
Educate trans-disciplinary scientists that pursue careers in the field of physical sciences in oncology		0	0	0	1	8	8
Promote collaboration by PS-OC researchers beyond the PS-OC network		0	0	0	3	6	8
Form new physical sciences in oncology programs at universities or institutions		1	1	0	4	5	6
Test dogma-challenging hypothesis on cancer initiation and progression		0	0	1	1	9	6
Bring new types of scientists to cancer research		0	0	0	1	3	13
Generate new datasets in cancer research		1	0	1	1	5	9
Generate new knowledge in cancer research		0	0	2	0	5	10

Total of respondents	17
Statistics based number of response	17
Filtered	0
Skipped	0

Q48

Please provide any additional comments that you would like to share about the convergence of physical sciences in oncology or the PS-OC program.

Response total
7

Total of respondents	17
Statistics based number of response	7
Filtered	0
Skipped	10

Q1

OMB No.: 0925-0642-07 Expiration Date: 9/30/2014 Notification to Respondent of Estimated Burden Public reporting burden for this collection of information is estimated to average 20 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to: NIH, Project Clearance Branch, 6705 Rockledge Drive, MSC 7974, Bethesda, MD 20892-7974, ATTN: PRA (0925-0642). Do not return the completed form to this address.

Q2

Please identify your primary affiliation with the Physical Sciences - Oncology Centers Program.	Response percent	Response total
Center Principal Investigator (PI)	6.38%	3
Center Senior Scientific Investigator (SI)	10.64%	5
PS-OC Project/Core Investigators (i.e. project/core leader or research investigator)	78.72%	37
PS-OC Trainee	0.00%	0
PS-OC Advocate	0.00%	0
PS-OC Outreach and Dissemination Unit Lead	0.00%	0
PS-OC Education and Training Unit Lead	0.00%	0
PS-OC Administrator	0.00%	0
PS-OC External Advisor	4.26%	2
I am not associated with the PS-OC Program	0.00%	0
Total of respondents	47	
Statistics based number of response	47	
Filtered	0	
Skipped	0	

Q3

Section C. The following section contains questions specific for PS-OC Investigators.

Q4

C1. There are a variety of different types of scientists involved in the PS-OC program. Research experiences may vary depending on your background and the background of your collaborators. For each of the following column headers, please select all types of scientists that apply.

Response percent	Your field of training and expertise	Scientists have you worked with prior to the PS-OC program	Scientists you work with currently	Scientists would like to work with in future projects
Molecular Biologists	34.04%	53.19%	59.57%	44.68%
Cell Biologists	34.04%	57.45%	63.83%	48.94%
Engineers	36.17%	55.32%	61.70%	44.68%
Biologists	29.79%	51.06%	55.32%	42.55%
Evolutionary Biologists	0.00%	8.51%	17.02%	38.30%
Surgeons	2.13%	29.79%	34.04%	34.04%
Oncologists	19.15%	48.94%	65.96%	57.45%
Pathologists	0.00%	36.17%	53.19%	48.94%
Radiologists	4.26%	17.02%	19.15%	31.91%
Cancer Biologists	42.55%	61.70%	80.85%	59.57%
Chemists	8.51%	27.66%	40.43%	42.55%
Physicists	25.53%	34.04%	59.57%	51.06%
Mathematicians	8.51%	25.53%	40.43%	40.43%
Theorists	10.64%	25.53%	42.55%	36.17%
Statisticians	0.00%	29.79%	40.43%	38.30%
Information Technologists/Computer Scientists	10.64%	25.53%	38.30%	40.43%
Other	0.00%	0.00%	4.26%	6.38%

Response total	Your field of training and expertise	Scientists have you worked with prior to the PS-OC program	Scientists you work with currently	Scientists would like to work with in future projects
Molecular Biologists	16	25	28	21
Cell Biologists	16	27	30	23
Engineers	17	26	29	21
Biologists	14	24	26	20
Evolutionary Biologists	0	4	8	18
Surgeons	1	14	16	16
Oncologists	9	23	31	27

Pathologists	0	17	25	23
Radiologists	2	8	9	15
Cancer Biologists	20	29	38	28
Chemists	4	13	19	20
Physicists	12	16	28	24
Mathematicians	4	12	19	19
Theorists	5	12	20	17
Statisticians	0	14	19	18
Information Technologists/Computer Scientists	5	12	18	19
Other	0	0	2	3

Total of respondents	47
Statistics based number of response	47
Filtered	0
Skipped	0

Q5

C2. Please rate your satisfaction with the progress you have made so far on your project specific aims?	**Response percent**	**Response total**
Satisfied	51.06%	24
Somewhat Satisfied	36.17%	17
Neutral	6.38%	3
Somewhat Dissatisfied	6.38%	3
Dissatisfied	0.00%	0

Total of respondents	47
Statistics based number of response	47
Filtered	0
Skipped	0

Q6

The following questions inquire about the status and infrastructure of the physical sciences in oncology field.

Q7

C3. I have seen evidence of the formation of a new field of "Physical Sciences-Oncology" within...

Response percent	**1. Disagree**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Agree**
My department(s)	18.18%	11.36%	2.27%	20.45%	9.09%	13.64%	25.00%
My institutions(s)	6.67%	8.89%	2.22%	11.11%	13.33%	20.00%	37.78%
At scientific meetings	2.22%	4.44%	4.44%	22.22%	22.22%	17.78%	26.67%
My current research	0.00%	0.00%	4.26%	6.38%	23.40%	14.89%	51.06%
My future research plans	0.00%	2.13%	2.13%	4.26%	19.15%	8.51%	63.83%
Publications	0.00%	6.38%	2.13%	10.64%	17.02%	19.15%	44.68%
I have not seen evidence of the formation of a new field of "Physical Sciences-Oncology"	50.00%	10.00%	17.50%	12.50%	7.50%	0.00%	2.50%

Response total	**1. Disagree**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Agree**
My department(s)	8	5	1	9	4	6	11
My institutions(s)	3	4	1	5	6	9	17
At scientific meetings	1	2	2	10	10	8	12
My current research	0	0	2	3	11	7	24
My future research plans	0	1	1	2	9	4	30
Publications	0	3	1	5	8	9	21
I have not seen evidence of the formation of a new field of "Physical Sciences-Oncology"	20	4	7	5	3	0	1

Total of respondents	47
Statistics based number of response	47
Filtered	0
Skipped	0

Q8

C4. Does your Institution have an overall strategy for converging physical sciences and oncology outside of the PS-OC program? If yes, please provide details in comment area.	**Response percent**	**Response total**
Yes	31.91%	15
No	34.04%	16
Unsure	34.04%	16

Total of respondents	47
Statistics based number of response	47
Filtered	0
Skipped	0

Q9

C5. Do any sources of support exist for physical sciences in oncology research at your Institution outside of the PS-OC?

	Response percent	Response total
Yes	38.30%	18
No	61.70%	29

Total of respondents	47
Statistics based number of response	47
Filtered	0
Skipped	0

Q10

C5b. Please answer yes or no to the following questions about the "other" types of support offered at your institution for converging physical sciences and oncology.

Response percent	**1. Yes**	**2. No**
Do PS-OC researchers receive funding from these sources?	83.33%	16.67%
Do PS-OC researchers collaborate with researchers supported by these sources?	94.44%	5.56%
Do PS-OC researchers use equipment, materials, or infrastructure supported by these sources?	94.44%	5.56%

Response total	**1. Yes**	**2. No**
Do PS-OC researchers receive funding from these sources?	15	3
Do PS-OC researchers collaborate with researchers supported by these sources?	17	1
Do PS-OC researchers use equipment, materials, or infrastructure supported by these sources?	17	1

Total of respondents	47
Statistics based number of response	18
Filtered	0
Skipped	29

Q11

The following questions inquire about your PS-OC research advances and your participation within the PS-OC program.

Q12

C6. From your standpoint, please briefly describe the most important scientific advancement to emerge from your PS-OC to date.

Response total
47

Total of respondents	47
Statistics based number of response	47
Filtered	0
Skipped	0

Q13

C6b. Please use the previous example to answer the following questions.

Response percent	**1. Disagree**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Agree**
This scientific advancement stems from projects that exisited before the PS-OC program.	21.28%	12.77%	17.02%	23.40%	12.77%	6.38%	6.38%
This scientific advancement will lead to future scientific breakthroughs.	0.00%	0.00%	0.00%	0.00%	12.77%	21.28%	65.96%
This advancement would not have occurred without the support of the PS-OC program.	2.17%	2.17%	2.17%	6.52%	13.04%	19.57%	54.35%
There is potential for this scientific advancement to translate into the clinic.	0.00%	2.13%	2.13%	2.13%	19.15%	21.28%	53.19%

Response total	**1. Disagree**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Agree**
This scientific advancement stems from projects that exisited before the PS-OC program.	10	6	8	11	6	3	3
This scientific advancement will lead to future scientific breakthroughs.	0	0	0	0	6	10	31
This advancement would not have occurred without the support of the PS-OC program.	1	1	1	3	6	9	25
There is potential for this scientific advancement to translate into the clinic.	0	1	1	1	9	10	25

Total of respondents	47

Statistics based number of response	47
Filtered	0
Skipped	0

Q14

C7a. Have you submitted applications for research grants based on the findings from your PS-OC supported studies?	**Response percent**	**Response total**
Yes	55.32%	26
No	44.68%	21

Total of respondents	47
Statistics based number of response	47
Filtered	0
Skipped	0

Q15

C7b. What types of comments were received on these grants?	**Response percent**	**Response total**
Not enough preliminary data	26.92%	7
Too high risk	11.54%	3
No clinical application	3.85%	1
Limited biological components	3.85%	1
Innovative	38.46%	10
I have not received any comments	30.77%	8
Other	26.92%	7

Total of respondents	47
Statistics based number of response	26
Filtered	0
Skipped	21

Q16

C8. Please describe one brief example of something you know now that you didn't know before because of your involvement with the PS-OC program.	**Response total**
	47

Total of respondents	47
Statistics based number of response	47
Filtered	0
Skipped	0

Q17

C9. Please check all PS-OC working groups or exercises in which you have participated.	**Response percent**	**Response total**
Evolution and Drug Resistance	25.53%	12
Physics	21.28%	10
CTC Transport	12.77%	6
UN of Cell Modulus	0.00%	0
Outreach and Dissemination	27.66%	13
Education and Training	36.17%	17
Cell line exercise	31.91%	15
I have not participated in any PS-OC working groups or exercises	34.04%	16

Total of respondents	47
Statistics based number of response	47
Filtered	0
Skipped	0

Q18

C9b. Please rate the effectiveness of the working groups or exercises in achieving the following goals.

Response percent	**1. Ineffective**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Effective**
Faciliate new collaborations	3.13%	0.00%	0.00%	9.38%	21.88%	34.38%	31.25%
Provide new knowledge	0.00%	0.00%	3.13%	3.13%	25.00%	31.25%	37.50%
Increase communication between PS-OC investigators	3.13%	0.00%	3.13%	9.38%	9.38%	37.50%	37.50%
Generate PS-OC Network publications	3.13%	3.13%	3.13%	15.63%	31.25%	18.75%	25.00%
Disseminate information to the broader scientific community about the PS-OC Network	3.13%	3.13%	0.00%	25.00%	28.13%	25.00%	15.63%

Response total	1. Ineffective	2.	3.	4. Neutral	5.	6.	7. Effective
Faciliate new collaborations	1	0	0	3	7	11	10
Provide new knowledge	0	0	1	1	8	10	12
Increase communication between PS-OC investigators	1	0	1	3	3	12	12
Generate PS-OC Network publications	1	1	1	5	10	6	8
Disseminate information to the broader scientific community about the PS-OC Network	1	1	0	8	9	8	5

Total of respondents	47
Statistics based number of response	32
Filtered	0
Skipped	15

Q19

C9c. Please provide a suggestion for new PS-OC working groups or exercises in which you would participate.	Response total
	8

Total of respondents	47
Statistics based number of response	8
Filtered	0
Skipped	39

Q20

C10. Did the PS-OC facilitate access to equipment and infrastructure for PS-OC researchers beyond what would have been available otherwise?	Response percent	Response total
Yes	82.98%	39
No	17.02%	8
Comments		5

Total of respondents	47
Statistics based number of response	47
Filtered	0
Skipped	0

Q21

C11. How effective have the following PS-OC opportunities been in encouraging you to generate innovative scientific ideas?

Response percent	1. Not Applicable	2. Ineffective	3.	4. Effective	5.	6. Very Effective
Trans-Network Projects	19.57%	2.17%	15.22%	26.09%	15.22%	21.74%
Young Investigator Trans-Network Projects	32.61%	0.00%	10.87%	30.43%	13.04%	13.04%
Pilot Projects	17.39%	0.00%	4.35%	28.26%	26.09%	23.91%
Outreach Pilot Projects	32.56%	2.33%	13.95%	25.58%	13.95%	11.63%
Student Exchanges	26.09%	0.00%	17.39%	30.43%	13.04%	13.04%
PS-OC Annual Meeting	8.51%	0.00%	14.89%	19.15%	31.91%	25.53%

Response total	1. Not Applicable	2. Ineffective	3.	4. Effective	5.	6. Very Effective
Trans-Network Projects	9	1	7	12	7	10
Young Investigator Trans-Network Projects	15	0	5	14	6	6
Pilot Projects	8	0	2	13	12	11
Outreach Pilot Projects	14	1	6	11	6	5
Student Exchanges	12	0	8	14	6	6
PS-OC Annual Meeting	4	0	7	9	15	12

Total of respondents	47
Statistics based number of response	47
Filtered	0
Skipped	0

Q22

C12. How have you disseminated information about the PS-OC to the broader scientific community?	Response percent	Response total
Presentations at conferences/scientific meetings	87.23%	41
Invited talks	72.34%	34
Publications	82.98%	39
Webpage	31.91%	15
Email	34.04%	16

Newspaper or radio	6.38%	3
I have not disseminated information about the PS-OC	4.26%	2
Other	2.13%	1
Total of respondents	47	
Statistics based number of response	47	
Filtered	0	
Skipped	0	

Q23

C13. To what types of scientists have you presented and/or discussed your PS-OC research? Please check all that apply.	**Response percent**	**Response total**
Molecular Biologists	68.09%	32
Cell Biologists	74.47%	35
Cancer Biologists	80.85%	38
Engineers	61.70%	29
Evolutionary Biologists	12.77%	6
Surgeons	27.66%	13
Oncologists	55.32%	26
Pathologists	38.30%	18
Radiologists	17.02%	8
Chemists	29.79%	14
Physicists	48.94%	23
Mathematicians	29.79%	14
Theorists	25.53%	12
Statisticians	25.53%	12
Information Technologists	10.64%	5
Other	8.51%	4
Total of respondents	47	
Statistics based number of response	47	
Filtered	0	
Skipped	0	

Q24

C14. From your standpoint, how effectively have the PS-OC program staff performed the following roles in the management and direction of the PS-OC program?

Response percent	**1. I do not know**	**2. Ineffective**	**3.**	**4.**	**5. Neutral**	**6.**	**7.**	**8. Very Effective**
Strategic directions	12.77%	0.00%	2.13%	0.00%	12.77%	14.89%	38.30%	19.15%
Facilitating interactions amoung PS-OC investigators	10.64%	0.00%	0.00%	2.13%	8.51%	14.89%	27.66%	36.17%
Facilitating interactions between the PS-OC Network and the broader community	10.64%	2.13%	0.00%	4.26%	12.77%	14.89%	29.79%	25.53%
Advancing research within the PS-OCs	14.89%	0.00%	0.00%	2.13%	6.38%	12.77%	38.30%	25.53%
Organizing working groups and exercises	23.40%	0.00%	0.00%	0.00%	12.77%	8.51%	29.79%	25.53%
Organizing steering committee	31.91%	0.00%	0.00%	2.13%	10.64%	12.77%	21.28%	21.28%

Response total	**1. I do not know**	**2. Ineffective**	**3.**	**4.**	**5. Neutral**	**6.**	**7.**	**8. Very Effective**
Strategic directions	6	0	1	0	6	7	18	9
Facilitating interactions amoung PS-OC investigators	5	0	0	1	4	7	13	17
Facilitating interactions between the PS-OC Network and the broader community	5	1	0	2	6	7	14	12
Advancing research within the PS-OCs	7	0	0	1	3	6	18	12
Organizing working groups and exercises	11	0	0	0	6	4	14	12
Organizing steering committee	15	0	0	1	5	6	10	10

Total of respondents	47
Statistics based number of response	47
Filtered	0
Skipped	0

Q25

Section J. The following questions inquire about your collaborations and their impact, methods for facilitating collaborations, and the impact of the PS-OC program in your collaborations.

Q26

J1. Without naming specific individuals, please give an example of a successful trans-disciplinary collaboration (i.e. a collaboration that integrated two or more individual disciplinary perspectives) in which you have been involved as part of the PS-OC program. Please provide a brief description of the project and how it was initiated. Please define each member's role in the collaboration.	Response total
	47

Total of respondents	47
Statistics based number of response	47
Filtered	0
Skipped	0

Q27

J1b. What are the outcomes of the collaboration described above? Please select all that apply.	Response percent	Response total
New knowledge or skills	78.72%	37
Pilot project funds	25.53%	12
Outreach project funds	10.64%	5
Trans-network project funds	21.28%	10
NIH or NSF grant funds	10.64%	5
Publications	57.45%	27
Conference presentations or invited talks	42.55%	20
The collaboration is still in progress.	80.85%	38
Will form new collaborations	36.17%	17
Will pursue new aspects of the project as an extention of this work	44.68%	21

Total of respondents	47
Statistics based number of response	47
Filtered	0
Skipped	0

Q28

J1c. How many researchers were involved in this trans-disciplinary collaboration?	Response percent	Response total
2	19.15%	9
3	17.02%	8
4	34.04%	16
5-7	21.28%	10
8-10	6.38%	3
10+	2.13%	1

Total of respondents	47
Statistics based number of response	47
Filtered	0
Skipped	0

Q29

J1d. Please indicate how strongly you agree or disagree with each of the following statements pertaining to the collaboration described above. "I would have obtained these outcomes..."

Response percent	1. Disagree	2.	3.	4. Neutral	5.	6.	7. Agree
without one member of the team	55.32%	8.51%	2.13%	21.28%	2.13%	4.26%	6.38%
without two members of the team	63.83%	6.38%	10.64%	14.89%	2.13%	0.00%	2.13%
without a trans-disciplinary collaboration	65.96%	6.38%	4.26%	8.51%	0.00%	10.64%	4.26%
without the support of the PS-OC program	61.70%	14.89%	6.38%	6.38%	2.13%	6.38%	2.13%

Response total	1. Disagree	2.	3.	4. Neutral	5.	6.	7. Agree
without one member of the team	26	4	1	10	1	2	3
without two members of the team	30	3	5	7	1	0	1
without a trans-disciplinary collaboration	31	3	2	4	0	5	2
without the support of the PS-OC program	29	7	3	3	1	3	1

Total of respondents	47
Statistics based number of response	47
Filtered	0
Skipped	0

Q30

J2. What difficulties, if any, have you experienced during your trans-disciplinary collaborations in the PS-OC program? Please rate the severity of these difficulties on a scale of 1-5. A "1" indicates that the issue did not impact the outcome(s) of the collaboration. A "5" indicates that the issue severely impacted the collaboration.

Response percent	Check all that apply	Please rate the severity of the issue: 1	Please rate the severity of the issue: 2	Please rate the severity of the issue: 3	Please rate the severity of the issue: 4	Please rate the severity of the issue: 5
Members prioritized their personal goals before the overall team goal	36.17%	31.58%	26.32%	15.79%	5.26%	21.05%
Difficulties in sharing data	17.02%	36.36%	36.36%	27.27%	0.00%	0.00%
The team members discuss issues only at a broad level	19.15%	41.67%	8.33%	8.33%	25.00%	16.67%
Difficulties in sharing supplies, cells, tissue, or equipment	19.15%	36.36%	9.09%	27.27%	18.18%	9.09%
Responsibilities, roles, and expectations were not clear	29.79%	47.06%	23.53%	17.65%	11.76%	0.00%
Difficulties in organizing travel	8.51%	16.67%	33.33%	16.67%	0.00%	33.33%
Team members became competitive with one another	12.77%	37.50%	12.50%	37.50%	0.00%	12.50%
Difficulties in communication across scientific disciplines	23.40%	33.33%	33.33%	8.33%	16.67%	8.33%
Lack of funds	57.45%	21.43%	17.86%	17.86%	25.00%	17.86%
Power struggles	6.38%	40.00%	0.00%	20.00%	0.00%	40.00%
Sharing credit	6.38%	40.00%	40.00%	0.00%	0.00%	20.00%
The team did not meet regularly	14.89%	33.33%	44.44%	11.11%	11.11%	0.00%
The team did not establish trust	6.38%	40.00%	40.00%	0.00%	0.00%	20.00%
There is no reward structure at my institution for collaborations	8.51%	33.33%	16.67%	33.33%	16.67%	0.00%
Trouble identifying additional team members to help	4.26%	50.00%	50.00%	0.00%	0.00%	0.00%
Lack of clear vision or goals	14.89%	22.22%	11.11%	55.56%	0.00%	11.11%
No agreement on the primary spokesperson	6.38%	60.00%	0.00%	0.00%	0.00%	40.00%

Response total	Check all that apply	Please rate the severity of the issue: 1	Please rate the severity of the issue: 2	Please rate the severity of the issue: 3	Please rate the severity of the issue: 4	Please rate the severity of the issue: 5
Members prioritized their personal goals before the overall team goal	17	6	5	3	1	4
Difficulties in sharing data	8	4	4	3	0	0
The team members discuss issues only at a broad level	9	5	1	1	3	2
Difficulties in sharing supplies, cells, tissue, or equipment	9	4	1	3	2	1
Responsibilities, roles, and expectations were not clear	14	8	4	3	2	0
Difficulties in organizing travel	4	1	2	1	0	2
Team members became competitive with one another	6	3	1	3	0	1
Difficulties in communication across scientific disciplines	11	4	4	1	2	1
Lack of funds	27	6	5	5	7	5
Power struggles	3	2	0	1	0	2
Sharing credit	3	2	2	0	0	1
The team did not meet regularly	7	3	4	1	1	0
The team did not establish trust	3	2	2	0	0	1
There is no reward structure at my institution for collaborations	4	2	1	2	1	0
Trouble identifying additional team members to help	2	2	2	0	0	0
Lack of clear vision or goals	7	2	1	5	0	1
No agreement on the primary spokesperson	3	3	0	0	0	2

Total of respondents	47
Statistics based number of response	47
Filtered	0
Skipped	0

Q31

J3. Please define your role(s) in your PS-OC collaborations. Please select all that apply.	Response percent	Response total
Provide cells or reagents	42.55%	20
Provide technology or skill	72.34%	34
Provide strategic direction	68.09%	32
Leader	36.17%	17
Combine data	23.40%	11
Organize team meetings and communication	36.17%	17
Perform data analysis	38.30%	18
Participant	51.06%	24
Advisor	38.30%	18
Provide training/education	34.04%	16
Create reports	27.66%	13
Communicate to stakeholders (i.e. NCI)	17.02%	8

Interface with Institutional leadership	17.02%	8
Administrative support or IT	0.00%	0
Other	0.00%	0

Total of respondents	47
Statistics based number of response	47
Filtered	0
Skipped	0

Q32

J4. Please answer the following questions with the approximate number of investigators (i.e. faculty level researchers).

Response percent	**1. 0**	**2. 1 - 4**	**3. 5 - 10**	**4. 11 -15**	**5. 16+**
How many PS-OC investigators within your Center did you work with prior to the start of the PS-OC program?	40.43%	55.32%	4.26%	0.00%	0.00%
How many PS-OC investigators within your Center do you work with now?	0.00%	48.94%	42.55%	0.00%	8.51%
How many of these new collaborations would have started without PS-OC program funding?	65.91%	34.09%	0.00%	0.00%	0.00%

Response total	**1. 0**	**2. 1 - 4**	**3. 5 - 10**	**4. 11 -15**	**5. 16+**
How many PS-OC investigators within your Center did you work with prior to the start of the PS-OC program?	19	26	2	0	0
How many PS-OC investigators within your Center do you work with now?	0	23	20	0	4
How many of these new collaborations would have started without PS-OC program funding?	29	15	0	0	0

Total of respondents	47
Statistics based number of response	47
Filtered	0
Skipped	0

Q33

J5. Overall, please evaluate your PS-OC supported collaborations in the following areas.

Response percent	**1. Very Poor**	**2. Poor**	**3. Fair**	**4. Good**	**5. Excellent**
Scientific impact	0.00%	4.26%	8.51%	42.55%	44.68%
Productivity	0.00%	2.13%	14.89%	53.19%	29.79%
Rewarding to all parties involved equally	0.00%	4.26%	19.15%	46.81%	29.79%
Communication among collaborators	0.00%	2.13%	14.89%	48.94%	34.04%
Ability to utilize the strengths of different researchers involved	0.00%	2.13%	2.13%	44.68%	51.06%
Enabling you to reach your own research milestones faster	0.00%	6.38%	14.89%	44.68%	34.04%
Ability to attract new collaborators to join effort	0.00%	6.38%	17.02%	36.17%	40.43%

Response total	**1. Very Poor**	**2. Poor**	**3. Fair**	**4. Good**	**5. Excellent**
Scientific impact	0	2	4	20	21
Productivity	0	1	7	25	14
Rewarding to all parties involved equally	0	2	9	22	14
Communication among collaborators	0	1	7	23	16
Ability to utilize the strengths of different researchers involved	0	1	1	21	24
Enabling you to reach your own research milestones faster	0	3	7	21	16
Ability to attract new collaborators to join effort	0	3	8	17	19

Total of respondents	47
Statistics based number of response	47
Filtered	0
Skipped	0

Q34

J6. How effective have the following PS-OC opportunities been in encouraging you to find and/or generate collaborations?

Response percent	**1. Not Applicable**	**2. Ineffective**	**3.**	**4. Somewhat Effective**	**5.**	**6. Very Effective**
PS-OC Trans-Network Projects	34.78%	2.17%	10.87%	15.22%	17.39%	19.57%
PS-OC Young Investigator Trans-Network Projects	50.00%	2.17%	15.22%	6.52%	17.39%	8.70%
PS-OC Pilot Projects	26.09%	0.00%	6.52%	26.09%	23.91%	17.39%
PS-OC Outreach Pilot Projects	50.00%	2.27%	18.18%	15.91%	4.55%	9.09%
Student Exchanges	45.65%	2.17%	13.04%	17.39%	13.04%	8.70%
PS-OC Annual Meeting	10.64%	2.13%	12.77%	21.28%	31.91%	21.28%

PS-OC Workshops and Symposiums	22.22%	2.22%	15.56%	24.44%	22.22%	13.33%
PS-OC Data Jamboree	48.89%	4.44%	20.00%	20.00%	2.22%	4.44%

Response total	**1. Not Applicable**	**2. Ineffective**	**3.**	**4. Somewhat Effective**	**5.**	**6. Very Effective**
PS-OC Trans-Network Projects	16	1	5	7	8	9
PS-OC Young Investigator Trans-Network Projects	23	1	7	3	8	4
PS-OC Pilot Projects	12	0	3	12	11	8
PS-OC Outreach Pilot Projects	22	1	8	7	2	4
Student Exchanges	21	1	6	8	6	4
PS-OC Annual Meeting	5	1	6	10	15	10
PS-OC Workshops and Symposiums	10	1	7	11	10	6
PS-OC Data Jamboree	22	2	9	9	1	2

Total of respondents	47
Statistics based number of response	47
Filtered	0
Skipped	0

Q35

J7. From your standpoint, please evaluate the extent to which the PS-OC program has been successful in the following areas.

Response percent	**1. I do not know**	**2. Very Poor**	**3. Poor**	**4. Fair**	**5. Good**	**6. Excellent**
Improving leadership skills in heading a trans-disciplinary study	25.53%	2.13%	2.13%	4.26%	40.43%	25.53%
Mentoring junior faculty in leading and participating in a trans-disciplinary study	25.53%	2.13%	2.13%	17.02%	23.40%	29.79%
Increasing the discussion about team science and collaborations at your institution	12.77%	0.00%	2.13%	10.64%	40.43%	34.04%
Developing better policies to review and reward team science at your institution	17.78%	2.22%	2.22%	40.00%	15.56%	22.22%

Response total	**1. I do not know**	**2. Very Poor**	**3. Poor**	**4. Fair**	**5. Good**	**6. Excellent**
Improving leadership skills in heading a trans-disciplinary study	12	1	1	2	19	12
Mentoring junior faculty in leading and participating in a trans-disciplinary study	12	1	1	8	11	14
Increasing the discussion about team science and collaborations at your institution	6	0	1	5	19	16
Developing better policies to review and reward team science at your institution	8	1	1	18	7	10

Total of respondents	47
Statistics based number of response	47
Filtered	0
Skipped	0

Q36

The following question inquires about your views on the progress the PS-OC program is making relative to the goals of the program.

Q37

From your standpoint, please evaluate the extent to which the PS-OC program has been successful in reaching the following program goals.

Response percent	**1. I do not know**	**2. Very Poor**	**3. Poor**	**4. Fair**	**5. Good**	**6. Excellent**
Form trans-disciplinary teams focused on establishing physical sciences-centric themes in cancer research	6.38%	0.00%	4.26%	4.26%	29.79%	55.32%
Build a collaborative trans-discipline research sharing network	6.38%	0.00%	2.13%	14.89%	38.30%	38.30%
Promote collaboration by PS-OC researchers across the PS-OC network	10.64%	2.13%	2.13%	10.64%	31.91%	42.55%
Educate trans-disciplinary scientists that pursue careers in the field of physical sciences in oncology	12.77%	0.00%	0.00%	10.64%	42.55%	34.04%
Promote collaboration by PS-OC researchers beyond the PS-OC network	12.77%	0.00%	4.26%	12.77%	31.91%	38.30%
Form new physical sciences in oncology programs at universities or institutions	19.15%	2.13%	2.13%	27.66%	17.02%	31.91%
Test dogma-challenging hypothesis on cancer initiation and progression	6.38%	2.13%	2.13%	17.02%	36.17%	36.17%
Bring new types of scientists to cancer research	6.38%	0.00%	0.00%	6.38%	27.66%	59.57%
Generate new datasets in cancer research	10.64%	0.00%	2.13%	2.13%	46.81%	38.30%
Generate new knowledge in cancer research	4.26%	0.00%	0.00%	4.26%	36.17%	55.32%

Response total	**1. I do not know**	**2. Very Poor**	**3. Poor**	**4. Fair**	**5. Good**	**6. Excellent**
Form trans-disciplinary teams focused on establishing physical sciences-centric themes in cancer research	3	0	2	2	14	26
Build a collaborative trans-discipline research sharing network	3	0	1	7	18	18
Promote collaboration by PS-OC researchers across the PS-OC network	5	1	1	5	15	20
Educate trans-disciplinary scientists that pursue careers in the field of physical sciences in oncology	6	0	0	5	20	16
Promote collaboration by PS-OC researchers beyond the PS-OC network	6	0	2	6	15	18

Form new physical sciences in oncology programs at universities or institutions	9	1	1	13	8	15
Test dogma-challenging hypothesis on cancer initiation and progression	3	1	1	8	17	17
Bring new types of scientists to cancer research	3	0	0	3	13	28
Generate new datasets in cancer research	5	0	1	1	22	18
Generate new knowledge in cancer research	2	0	0	2	17	26

Total of respondents	47
Statistics based number of response	47
Filtered	0
Skipped	0

Q38

Please provide any additional comments that you would like to share about the convergence of physical sciences in oncology or the PS-OC program.	**Response total**
	16

Total of respondents	47
Statistics based number of response	16
Filtered	0
Skipped	31

Q1

OMB No.: 0925-0642-07 Expiration Date: 9/30/2014 Notification to Respondent of Estimated Burden Public reporting burden for this collection of information is estimated to average 10 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to: NIH, Project Clearance Branch, 6705 Rockledge Drive, MSC 7974, Bethesda, MD 20892-7974, ATTN: PRA (0925-0642). Do not return the completed form to this address.

Q2

Please identify your primary affiliation with the Physical Sciences - Oncology Centers Program.	Response percent	Response total
Center Principal Investigator (PI)	0.00%	0
Center Senior Scientific Investigator (SI)	1.33%	1
PS-OC Project/Core Investigators (i.e. project/core leader or research investigator)	6.67%	5
PS-OC Trainee	90.67%	68
PS-OC Advocate	0.00%	0
PS-OC Outreach and Dissemination Unit Lead	0.00%	0
PS-OC Education and Training Unit Lead	0.00%	0
PS-OC Administrator	0.00%	0
PS-OC External Advisor	0.00%	0
I am not associated with the PS-OC Program	1.33%	1
Total of respondents	75	
Statistics based number of response	75	
Filtered	0	
Skipped	0	

Q3

Section H. The following section contains questions specific for PS-OC trainees.

Q4

H1. How have you participated as a member of the PS-OC? Please select all that apply.	Response percent	Response total
Perform research funded by the PS-OC	92.00%	69
Participate in PS-OC Courses	13.33%	10
Attend the PS-OC Annual Meeting	76.00%	57
Attend the PS-OC Site Visit	77.33%	58
Attend PS-OC Workshops	42.67%	32
Attend PS-OC Bootcamps	6.67%	5
Attend PS-OC Seminars	64.00%	48
Other	2.67%	2
Total of respondents	75	
Statistics based number of response	75	
Filtered	0	
Skipped	0	

Q5

H2. Please select your current research title.	Response percent	Response total
Undergraduate student	1.33%	1
Graduate student	46.67%	35
Postdoc	40.00%	30
Medical Student	0.00%	0
Resident	0.00%	0
Other	12.00%	9
Total of respondents	75	
Statistics based number of response	75	
Filtered	0	
Skipped	0	

Q6

H3. There are a variety of different types of scientists involved in the PS-OC program. For each of the following column headers, please select all types of scientists that apply.

Response percent	Your field of training and expertise	Your mentor's field of training and expertise	The types of scientists you collaborate with currently	The types of scientists you would like to collaborate with in the future
Molecular Biologists	42.67%	25.33%	46.67%	28.00%
Cell Biologists	30.67%	21.33%	52.00%	30.67%
Engineers	29.33%	22.67%	32.00%	26.67%
Biologists	26.67%	20.00%	46.67%	24.00%
Evolutionary Biologists	4.00%	6.67%	8.00%	21.33%
Surgeons	0.00%	1.33%	17.33%	22.67%

Oncologists	5.33%	12.00%	26.67%	37.33%
Pathologists	1.33%	4.00%	29.33%	24.00%
Radiologists	0.00%	4.00%	12.00%	12.00%
Cancer Biologists	18.67%	24.00%	48.00%	32.00%
Chemists	9.33%	9.33%	24.00%	24.00%
Physicists	14.67%	25.33%	37.33%	26.67%
Mathematicians	16.00%	17.33%	26.67%	20.00%
Theorists	9.33%	6.67%	16.00%	21.33%
Statisticians	2.67%	5.33%	21.33%	28.00%
Information Technologists/Computer Scientists	8.00%	4.00%	22.67%	34.67%
Other	1.33%	0.00%	2.67%	1.33%

Response total	**Your field of training and expertise**	**Your mentor's field of training and expertise**	**The types of scientists you collaborate with currently**	**The types of scientists you would like to collaborate with in the future**
Molecular Biologists	32	19	35	21
Cell Biologists	23	16	39	23
Engineers	22	17	24	20
Biologists	20	15	35	18
Evolutionary Biologists	3	5	6	16
Surgeons	0	1	13	17
Oncologists	4	9	20	28
Pathologists	1	3	22	18
Radiologists	0	3	9	9
Cancer Biologists	14	18	36	24
Chemists	7	7	18	18
Physicists	11	19	28	20
Mathematicians	12	13	20	15
Theorists	7	5	12	16
Statisticians	2	4	16	21
Information Technologists/Computer Scientists	6	3	17	26
Other	1	0	2	1

Total of respondents	75
Statistics based number of response	75
Filtered	0
Skipped	0

Q7

H4. How do you feel the PS-OC program has influenced the following for you in terms of...

Response percent	**1. Poorly**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Extremely well**
Career development	4.00%	0.00%	1.33%	24.00%	20.00%	33.33%	17.33%
Learning new skills	2.67%	1.33%	0.00%	10.67%	22.67%	41.33%	21.33%
Gaining a new mentor	8.00%	1.33%	4.00%	36.00%	16.00%	16.00%	18.67%
Collaborations	2.67%	0.00%	1.33%	14.67%	16.00%	29.33%	36.00%
Opening access to new equipment/technology	2.67%	1.33%	2.67%	16.00%	14.67%	37.33%	25.33%

Response total	**1. Poorly**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Extremely well**
Career development	3	0	1	18	15	25	13
Learning new skills	2	1	0	8	17	31	16
Gaining a new mentor	6	1	3	27	12	12	14
Collaborations	2	0	1	11	12	22	27
Opening access to new equipment/technology	2	1	2	12	11	28	19

Total of respondents	75
Statistics based number of response	75
Filtered	0
Skipped	0

Q8

H5. How often do you interact with your PS-OC mentor?

Response percent	**1. Never (One initial meeting only)**	**2. Every 6 months**	**3. Every 3 months**	**4. Monthly**	**5. Weekly**	**6. Several times per week**	**7. Daily**
	0.00%	2.67%	6.67%	14.67%	33.33%	22.67%	20.00%

Response total	**1. Never (One initial meeting only)**	**2. Every 6 months**	**3. Every 3 months**	**4. Monthly**	**5. Weekly**	**6. Several times per week**	**7. Daily**
	0	2	5	11	25	17	15

Total of respondents	75
Statistics based number of response	75
Filtered	0
Skipped	0

Q9

H6. Did you apply for a young investigator trans-network award? **Response percent** **Response total**

Yes	25.33%	19
No	74.67%	56

Total of respondents	75
Statistics based number of response	75
Filtered	0
Skipped	0

Q10

H6b. To the best of your knowledge, please rate how well the young investigator trans-network process is achieving the following goals:

Response percent	**1. Poorly**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Extremely well**	
Increasing collaborations among centers in general	0.00%	0.00%	5.26%	0.00%	15.79%	63.16%	15.79%	
Increasing discussions/collaborations between young investigators	0.00%	0.00%	0.00%	5.26%	15.79%	52.63%	26.32%	
Advancing the convergence of physical science and oncology in cancer research	0.00%	0.00%	5.26%	5.26%	21.05%	47.37%	21.05%	
Making advances in cancer research	0.00%	0.00%	5.26%	5.26%	36.84%	47.37%	5.26%	

Response total	**1. Poorly**	**2.**	**3.**	**4. Neutral**	**5.**	**6.**	**7. Extremely well**	
Increasing collaborations among centers in general	0	0	1	0	3	12	3	
Increasing discussions/collaborations between young investigators	0	0	0	1	3	10	5	
Advancing the convergence of physical science and oncology in cancer research	0	0	1	1	4	9	4	
Making advances in cancer research	0	0	1	1	7	9	1	

Total of respondents	75
Statistics based number of response	19
Filtered	0
Skipped	56

Q11

H7. Do you plan to conduct research in the field of physical sciences-oncology in the future?	**Response percent**	**Response total**
Yes	57.33%	43
No	5.33%	4
Maybe/Unsure	37.33%	28

Total of respondents	75
Statistics based number of response	75
Filtered	0
Skipped	0

Q12

H8. What do you consider to be the most important scientific advances to emerge from your PS-OC supported research to date? Please describe any promising lines of inquiries for future breakthroughs.	**Response total**
	75

Total of respondents	75
Statistics based number of response	75
Filtered	0
Skipped	0

Q13

H9. How effective have the following PS-OC opportunities been in encouraging you to generate innovative scientific ideas?

Response percent	**1. I do not know**	**2. Ineffective**	**3.**	**4.**	**5. Neutral**	**6.**	**7.**	**8. Very Effective**
Trans-Network Projects	21.62%	6.76%	1.35%	4.05%	18.92%	16.22%	16.22%	14.86%
Young Investigator Trans-Network	29.17%	5.56%	1.39%	5.56%	18.06%	13.89%	16.67%	9.72%
Pilot Projects	26.76%	4.23%	0.00%	4.23%	22.54%	18.31%	11.27%	12.68%
Outreach Pilot Projects	34.72%	5.56%	0.00%	4.17%	29.17%	13.89%	6.94%	5.56%
Student Exchanges	28.17%	7.04%	0.00%	0.00%	23.94%	12.68%	21.13%	7.04%
PS-OC Data Jamboree	40.28%	2.78%	0.00%	1.39%	25.00%	16.67%	9.72%	4.17%
PS-OC Annual Meeting	6.94%	2.78%	2.78%	0.00%	8.33%	23.61%	33.33%	22.22%
PS-OC Workshops, Bootcamps, and Symposium	18.06%	2.78%	0.00%	1.39%	12.50%	19.44%	30.56%	15.28%

Response total	**1. I do not know**	**2. Ineffective**	**3.**	**4.**	**5. Neutral**	**6.**	**7.**	**8. Very Effective**
Trans-Network Projects	16	5	1	3	14	12	12	11
Young Investigator Trans-Network	21	4	1	4	13	10	12	7
Pilot Projects	19	3	0	3	16	13	8	9
Outreach Pilot Projects	25	4	0	3	21	10	5	4
Student Exchanges	20	5	0	0	17	9	15	5
PS-OC Data Jamboree	29	2	0	1	18	12	7	3
PS-OC Annual Meeting	5	2	2	0	6	17	24	16
PS-OC Workshops, Bootcamps, and Symposium	13	2	0	1	9	14	22	11

Total of respondents	75
Statistics based number of response	75
Filtered	0
Skipped	0

Q14

H10. Have you participated in a student exchange or otherwise worked in another PS-OC Investigator's lab?	Response percent	Response total
Yes	14.67%	11
No	85.33%	64

Total of respondents	75
Statistics based number of response	75
Filtered	0
Skipped	0

Q15

H10b. How many exchanges or other PS-OC investigator's labs have you participated in?	Response percent	Response total
1	54.55%	6
2	27.27%	3
3	9.09%	1
4	0.00%	0
5+	9.09%	1

Total of respondents	75
Statistics based number of response	11
Filtered	0
Skipped	64

Q16

H10c. Please rate the overall usefulness of the exchanges in which you have participated.

Response percent	1. Useless	2.	3.	4. Neutral	5.	6.	7. Useful
	0.00%	0.00%	0.00%	9.09%	9.09%	9.09%	72.73%

Response total	1. Useless	2.	3.	4. Neutral	5.	6.	7. Useful
	0	0	0	1	1	1	8

Total of respondents	75
Statistics based number of response	11
Filtered	0
Skipped	64

Q17

H10d. What was the reason for the exchange? Please select all that apply.	Response percent	Response total
Trans-network project	27.27%	3
Learn a new skill	54.55%	6
Immersion program	18.18%	2
Other	18.18%	2

Total of respondents	75
Statistics based number of response	11
Filtered	0
Skipped	64

Q18

H10e. Do you think this exchange could have occurred without the PS-OC program?	Response percent	Response total
Yes	9.09%	1
No	63.64%	7
Unsure	27.27%	3
Other	0.00%	0

Total of respondents	75
Statistics based number of response	11
Filtered	0
Skipped	64

Q19

Section J: The following questions inquire about your collaborations and their impact, methods for facilitating collaborations, and the impact of the PS-OC program in your collaborations.

Q20

successful trans-disciplinary collaboration (i.e. a collaboration that integrated two or more individual disciplinary perspectives) in which you have been involved as part of the PS-OC program. Please provide a brief description of the project and how it was initiated. Please define each member's role in the collaboration.

	Response total
	75

Total of respondents	75
Statistics based number of response	75
Filtered	0
Skipped	0

Q21

J1b. What are the outcomes of the collaboration described above? Please select all that apply.

Response percent	Response total
New knowledge or skills	77.33%	58
Pilot project funds	10.67%	8
Outreach project funds	1.33%	1
Trans-network project funds	12.00%	9
NIH or NSF grant funds	6.67%	5
Publications	42.67%	32
Conference presentations or invited talks	36.00%	27
The collaboration is still in progress.	66.67%	50
Will form new collaborations	24.00%	18
Will pursue new aspects of the project as an extension of this work	36.00%	27

Total of respondents	75
Statistics based number of response	75
Filtered	0
Skipped	0

Q22

J1c. How many researchers were involved in this trans-disciplinary collaboration?

Response percent	Response total
2	21.33%	16
3	12.00%	9
4	25.33%	19
5-7	32.00%	24
8-10	6.67%	5
10+	2.67%	2

Total of respondents	75
Statistics based number of response	75
Filtered	0
Skipped	0

Q23

J1d. Please indicate how strongly you agree or disagree with each of the following statements pertaining to the collaboration described above. "I would have obtained these outcomes..."

Response percent	1. Disagree	2.	3.	4. Neutral	5.	6.	7. Agree
without one member of the team	41.33%	8.00%	6.67%	24.00%	5.33%	8.00%	6.67%
without two members of the team	50.67%	6.67%	9.33%	25.33%	0.00%	4.00%	4.00%
without a trans-disciplinary collaboration	54.67%	10.67%	8.00%	16.00%	0.00%	2.67%	8.00%
without the support of the PS-OC program	54.67%	13.33%	2.67%	20.00%	1.33%	2.67%	5.33%

Response total	1. Disagree	2.	3.	4. Neutral	5.	6.	7. Agree
without one member of the team	31	6	5	18	4	6	5
without two members of the team	38	5	7	19	0	3	3
without a trans-disciplinary collaboration	41	8	6	12	0	2	6
without the support of the PS-OC program	41	10	2	15	1	2	4

Total of respondents	75
Statistics based number of response	75
Filtered	0
Skipped	0

Q24

J2. What difficulties, if any, have you experienced during your trans-disciplinary collaborations in the PS-OC program? Please rate the severity of these difficulties on a scale of 1-5. A "1" indicates that the issue did not impact the outcome(s) of the collaboration. A "5" indicates that the issue severely impacted the collaboration.

Response percent	Check all that apply	Please rate the severity of the issue: 1	Please rate the severity of the issue: 2	Please rate the severity of the issue: 3	Please rate the severity of the issue: 4	Please rate the severity of the issue: 5
Members prioritized their personal goals before the overall team goal	28.00%	29.17%	8.33%	29.17%	12.50%	20.83%

Difficulties in sharing data	22.67%	57.89%	15.79%	5.26%	5.26%	15.79%
The team members discuss issues only at a broad level	12.00%	54.55%	0.00%	18.18%	9.09%	18.18%
Difficulties in sharing supplies, cells, tissue, or equipment	10.67%	54.55%	9.09%	27.27%	0.00%	9.09%
Responsibilities, roles, and expectations were not clear	29.33%	33.33%	25.00%	20.83%	4.17%	16.67%
Difficulties in organizing travel	13.33%	53.85%	30.77%	7.69%	0.00%	7.69%
Team members became competitive with one another	8.00%	55.56%	0.00%	11.11%	11.11%	22.22%
Difficulties in communication across scientific disciplines	26.67%	43.48%	13.04%	21.74%	13.04%	8.70%
Lack of funds	24.00%	26.32%	15.79%	31.58%	15.79%	10.53%
Power struggles	8.00%	50.00%	10.00%	20.00%	10.00%	10.00%
Sharing credit	6.67%	62.50%	12.50%	0.00%	0.00%	25.00%
The team did not meet regularly	30.67%	38.46%	30.77%	23.08%	3.85%	3.85%
The team did not establish trust	6.67%	50.00%	0.00%	25.00%	12.50%	12.50%
There is no reward structure at my institution for collaborations	8.00%	33.33%	22.22%	0.00%	33.33%	11.11%
Trouble identifying additional team members to help	6.67%	87.50%	12.50%	0.00%	0.00%	0.00%
Lack of clear vision or goals	17.33%	43.75%	18.75%	25.00%	6.25%	6.25%
No agreement on the primary spokesperson	2.67%	60.00%	0.00%	40.00%	0.00%	0.00%

Response total	Check all that apply		Please rate the severity of the issue: 1	Please rate the severity of the issue: 2	Please rate the severity of the issue: 3	Please rate the severity of the issue: 4	Please rate the severity of the issue: 5	
Members prioritized their personal goals before the overall team goal		24	7	2	7	3	5	24
Difficulties in sharing data		19	11	3	1	1	3	19
The team members discuss issues only at a broad level		11	6	0	2	1	2	11
Difficulties in sharing supplies, cells, tissue, or equipment		11	6	1	3	0	1	11
Responsibilities, roles, and expectations were not clear		24	8	6	5	1	4	24
Difficulties in organizing travel		13	7	4	1	0	1	13
Team members became competitive with one another		9	5	0	1	1	2	9
Difficulties in communication across scientific disciplines		23	10	3	5	3	2	23
Lack of funds		19	5	3	6	3	2	19
Power struggles		10	5	1	2	1	1	10
Sharing credit		8	5	1	0	0	2	8
The team did not meet regularly		26	10	8	6	1	1	26
The team did not establish trust		8	4	0	2	1	1	8
There is no reward structure at my institution for collaborations		9	3	2	0	3	1	9
Trouble identifying additional team members to help		8	7	1	0	0	0	8
Lack of clear vision or goals		16	7	3	4	1	1	16
No agreement on the primary spokesperson		5	3	0	2	0	0	5

Total of respondents	75
Statistics based number of response	75
Filtered	0
Skipped	0

Q25

J3. Please define your role(s) in your PS-OC collaborations. Please select all that apply.

	Response percent	Response total
Provide cells or reagents	29.33%	22
Provide technology or skill	64.00%	48
Provide strategic direction	32.00%	24
Leader	8.00%	6
Combine data	30.67%	23
Organize team meetings and communication	14.67%	11
Perform data analysis	60.00%	45
Participant	62.67%	47
Advisor	0.00%	0
Provide training/education	12.00%	9
Create reports	26.67%	20
Communicate to stakeholders (i.e. NCI)	5.33%	4
Interface with Institutional leadership	4.00%	3
Administrative support or IT	0.00%	0
Other	5.33%	4

Total of respondents	75
Statistics based number of response	75
Filtered	0
Skipped	0

Q26

J4. Please answer the following questions with the approximate number of investigators (i.e. faculty level researchers).

Response percent	1. 0	2. 1 - 4	3. 5 - 10	4. 11 -15	5. 16+
How many PS-OC investigators within your Center did you work with prior to the start of the PS-OC program?	44.00%	53.33%	2.67%	0.00%	0.00%
How many PS-OC investigators within your Center do you work with now?	8.00%	66.67%	21.33%	2.67%	1.33%
How many of these new collaborations would have started without PS-OC program funding?	60.81%	35.14%	4.05%	0.00%	0.00%

Response total	1. 0	2. 1 - 4	3. 5 - 10	4. 11 -15	5. 16+	
How many PS-OC investigators within your Center did you work with prior to the start of the PS-OC program?		33	40	2	0	0
How many PS-OC investigators within your Center do you work with now?		6	50	16	2	1
How many of these new collaborations would have started without PS-OC program funding?		45	26	3	0	0

Total of respondents	75
Statistics based number of response	75
Filtered	0
Skipped	0

Q27

J5. Overall, please evaluate your PS-OC supported collaborations in the following areas.

Response percent	1. Very Poor	2. Poor	3. Fair	4. Good	5. Excellent
Scientific impact	0.00%	0.00%	12.00%	57.33%	30.67%
Productivity	1.33%	0.00%	20.00%	49.33%	29.33%
Rewarding to all parties involved equally	1.33%	1.33%	20.00%	56.00%	21.33%
Communication among collaborators	2.67%	1.33%	21.33%	56.00%	18.67%
Ability to utilize the strengths of different researchers involved	1.33%	1.33%	14.67%	46.67%	36.00%
Enabling you to reach your own research milestones faster	1.33%	2.67%	18.67%	58.67%	18.67%
Ability to attract new collaborators to join efforts	5.33%	1.33%	25.33%	45.33%	22.67%

Response total	1. Very Poor	2. Poor	3. Fair	4. Good	5. Excellent
Scientific impact	0	0	9	43	23
Productivity	1	0	15	37	22
Rewarding to all parties involved equally	1	1	15	42	16
Communication among collaborators	2	1	16	42	14
Ability to utilize the strengths of different researchers involved	1	1	11	35	27
Enabling you to reach your own research milestones faster	1	2	14	44	14
Ability to attract new collaborators to join efforts	4	1	19	34	17

Total of respondents	75
Statistics based number of response	75
Filtered	0
Skipped	0

Q28

J6. How effective have the following PS-OC opportunities been in encouraging you to find and/or generate collaborations?

Response percent	1. Not Applicable	2. Ineffective	3.	4. Somewhat Effective	5.	6. Very Effective
PS-OC Trans-Network Projects	42.67%	4.00%	9.33%	17.33%	17.33%	9.33%
PS-OC Young Investigator Trans-Network Projects	44.59%	5.41%	5.41%	14.86%	13.51%	16.22%
PS-OC Pilot Projects	53.33%	5.33%	5.33%	16.00%	8.00%	12.00%
PS-OC Outreach Pilot Projects	62.16%	5.41%	12.16%	10.81%	4.05%	5.41%
Student Exchanges	49.32%	5.48%	9.59%	13.70%	9.59%	12.33%
PS-OC Annual Meeting	12.00%	5.33%	5.33%	21.33%	32.00%	24.00%
PS-OC Workshops and Symposiums	30.67%	1.33%	2.67%	24.00%	26.67%	14.67%
PS-OC Data Jamboree	53.33%	1.33%	5.33%	18.67%	14.67%	6.67%

Response total	1. Not Applicable	2. Ineffective	3.	4. Somewhat Effective	5.	6. Very Effective
PS-OC Trans-Network Projects	32	3	7	13	13	7
PS-OC Young Investigator Trans-Network Projects	33	4	4	11	10	12
PS-OC Pilot Projects	40	4	4	12	6	9
PS-OC Outreach Pilot Projects	46	4	9	8	3	4
Student Exchanges	36	4	7	10	7	9
PS-OC Annual Meeting	9	4	4	16	24	18
PS-OC Workshops and Symposiums	23	1	2	18	20	11
PS-OC Data Jamboree	40	1	4	14	11	5

Total of respondents	75
Statistics based number of response	75
Filtered	0
Skipped	0

Q29

J7. From your standpoint, please evaluate the extent to which the PS-OC program has been successful in the following areas.

Response percent	1. I do not know	2. Very Poor	3. Poor	4. Fair	5. Good	6. Excellent
Improving leadership skills in heading a trans-disciplinary study	25.33%	2.67%	2.67%	10.67%	37.33%	21.33%
Mentoring junior faculty in leading and participating in a trans-disciplinary study	38.67%	1.33%	4.00%	8.00%	36.00%	12.00%
Increasing the discussion about team science and collaborations at your institution	16.00%	2.67%	1.33%	13.33%	40.00%	26.67%
Developing better policies to review and reward team science at your institution	28.00%	2.67%	5.33%	20.00%	30.67%	13.33%

Response total	1. I do not know	2. Very Poor	3. Poor	4. Fair	5. Good	6. Excellent	
Improving leadership skills in heading a trans-disciplinary study		19	2	2	8	28	16
Mentoring junior faculty in leading and participating in a trans-disciplinary study		29	1	3	6	27	9
Increasing the discussion about team science and collaborations at your institution		12	2	1	10	30	20
Developing better policies to review and reward team science at your institution		21	2	4	15	23	10

Total of respondents	75
Statistics based number of response	75
Filtered	0
Skipped	0

Q30

The following question inquires about your views on the progress the PS-OC program is making relative to the goals of the program.

Q31

From your standpoint, please evaluate the extent to which the PS-OC program has been successful in reaching the following program goals.

Response percent	1. I do not know	2. Very Poor	3. Poor	4. Fair	5. Good	6. Excellent	
Form trans-disciplinary teams focused on establishing physical sciences-centric themes in cancer research		14.67%	4.00%	0.00%	10.67%	38.67%	32.00%
Build a collaborative trans-discipline research sharing network		10.67%	2.67%	1.33%	12.00%	36.00%	37.33%
Promote collaboration by PS-OC researchers across the PS-OC network		10.67%	4.00%	2.67%	9.33%	36.00%	37.33%
Educate trans-disciplinary scientists that pursue careers in the field of physical sciences in oncology		14.67%	4.00%	2.67%	8.00%	38.67%	32.00%
Promote collaboration by PS-OC researchers beyond the PS-OC network		21.33%	1.33%	1.33%	17.33%	36.00%	22.67%
Form new physical sciences in oncology programs at universities or institutions		28.00%	4.00%	5.33%	4.00%	34.67%	24.00%
Test dogma-challenging hypothesis on cancer initiation and progression		18.67%	0.00%	4.00%	9.33%	41.33%	26.67%
Bring new types of scientists to cancer research		8.00%	0.00%	0.00%	8.00%	34.67%	49.33%
Generate new datasets in cancer research		18.67%	1.33%	0.00%	8.00%	36.00%	36.00%
Generate new knowledge in cancer research		9.33%	0.00%	1.33%	5.33%	40.00%	44.00%

Response total	1. I do not know	2. Very Poor	3. Poor	4. Fair	5. Good	6. Excellent	
Form trans-disciplinary teams focused on establishing physical sciences-centric themes in cancer research		11	3	0	8	29	24
Build a collaborative trans-discipline research sharing network		8	2	1	9	27	28
Promote collaboration by PS-OC researchers across the PS-OC network		8	3	2	7	27	28
Educate trans-disciplinary scientists that pursue careers in the field of physical sciences in oncology		11	3	2	6	29	24
Promote collaboration by PS-OC researchers beyond the PS-OC network		16	1	1	13	27	17
Form new physical sciences in oncology programs at universities or institutions		21	3	4	3	26	18
Test dogma-challenging hypothesis on cancer initiation and progression		14	0	3	7	31	20
Bring new types of scientists to cancer research		6	0	0	6	26	37
Generate new datasets in cancer research		14	1	0	6	27	27
Generate new knowledge in cancer research		7	0	1	4	30	33

Total of respondents	75
Statistics based number of response	75
Filtered	0
Skipped	0

Q32

Please provide any additional comments that you would like to share about the convergence of physical sciences in oncology or the PS-OC program.	Response total
	18

Total of respondents	75
Statistics based number of response	18
Filtered	0
Skipped	57

C6. From your standpoint, please briefly describe the most important scientific advancement to emerge from your PS-OC to date.

PI/SIs

Successful delivery of targeted nanoparticles for thermal and multimodality therapy, significant increase in activity with minimal toxicities.

The development of a testable theory of cancer and its place in the evolution of multicellular life.

I thought this is blinded/anonymous? (1) clinical utility of the fluid biopsy is multiple carcinomas at the time of disease diagnosis. (2) equations of metastasis to motivate a clinical trial in non-small-cell lung cancer.

A completely new view of cancer cell migration.

Opportunity to collaborate on a novel project with investigators who bring technical and intellectual expertise in an area that I am not familiar with....willingness to try to test a very unique/novel question using trans-network funds that would otherwise NEVER be funded and therefore never get done.

Understanding mechanisms generating mutations in cancer genomes optimized dosing strategies for lung and brain cancers

Critical role of extracellular matrix stiffening by collagen fiber formation/crosslinking in breast cancer metastasis.

Further Definition of Nucleosomal Positions, Definition of Global Chromatin Dysfunction

I think we established that there are some strong physics principles that direct evolution in complex environments under stress. PS: What is a paradigm?

Short Term—CTC capture and characterization for use in therapy—I'll use this one to answer C^b. Medium Term; Rapid analysis of a cell's epigeniome Longer Term: Understanding How matrix Characteristics Influences cancer Development

new multiscale model for cancer

Our most important scientific advancement has been to integrate a multitude of apparently disparate results from various fields, all relating to the role of mechanics in tumor progression and metastasis. This integrated view of tumor mechanics is now allowing us to (1) calculate how cells and tumors respond to altered tissue mechanics, (2) develop new ways of detecting and quantifying altered tissue mechanics in human tissue, (3) identify fundamentally new extracellular targets for clinical intervention.

Support for acid-mediated invasion and its inhibition by buffers

Project Investigators

High throughput proteomics on individual cells, used to build advanced signaling models.

Getting scientists, physicians, and engineers to work together effectively to attack a new problem in a new way. they not only have to meld their various skills but also learn to understand the language of their separate fields.

-new devices to study angiogenesis -new biomaterials and modified surfaces -novel computational approaches

The ability to collaborate with senior cancer biologists is the most valuable aspect of this grant.

Broaden the network of collaboration with biologists and other physicists working at the interface between biology and physics.

High resolution mapping of nucleosomes.

High resolution nucleosome mapping techniques (experiment design, high-throughput data acquisition, large-scale statistical analysis) that will be important to analysis of gene regulation in cancer cells. Development of methods for analysis of higher-order chromatin structure in cancer vs normal cells; demonstration that those methods have potential for clinical diagnostic use. Adaptation of single-molecule approaches to biophysics to analysis of problems of chromatin structure and regulated protein degradation relevant to analysis of gene regulation in cancer cells.

We have built a computational methodology for coupling fluid, elastic, mechanical, and geometric solvers to model cell growth, division and interactions, analyzing structural and mechanics forces and stabilities. Our solvers rely on first principles, and include second order projection methods for incompressible fluid flow, non-linear Eulerian reference map elasticity solvers, and multiphase multi-interfaces coupled dynamics solvers. The development and application of these techniques to cancer modeling has occurred because of the PS-OC, and the newly formed close working relationships with scientists from significantly different disciplines, including molecular and cell biology, physic imaging experts, oncologists, and cancer specialists.

finding of tumor cell clusters. development of fluid biopsy technology mathematical model of metastasis

It's difficult for me to make this statement for the center as a whole, but I can certainly say that the most exciting result to come from my own portion of the PSOC has been to develop strategies to dissect tensional homeostasis between tumor cells and the ECM using biophotonics approaches. We have developed strategies to measure the mechanical properties of contractile structures in different portions of living cells, relate these properties to specific myosin activation pathways, and combine them with FRET probes to connect cytoskeletal exertion of tensile forces to tension experienced at the cell-matrix interface.

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(1) The importance of evolution in drug resistance. (2) The assessment of drug resistance mechanisms and ways to circumvent drug resistance. (3) The use of engineering and mathematical tools to study nuclear and tissue structure in cancer. (4) The use of micro-engineering of miniature devises to study cancer cell and microorganism behaviors. (5) Working directly with engineers and physicists to solve cancer biology problems.

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We are integrating multiple types of data collected from the same cancer cells, and a comprehensive picture is emerging of how these cells are proliferating both in vitro and in vivo. From my end, we have shown the DNA methylation may be used to identify putative resistance genes, and are currently validating our findings.

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See published work.

We're currently investigating adhesion of cancer cells through an over-expressed ligand to its endogenous inhibitor that is expressed in the endothelium using in vitro systems. If successful, this can show that these over-expressed ligands can aid metastasis by promoting adhesion in the vasculature.

Not Sure

realistic computer model of invasive tumors

Accurately quantifying nuclear morphology and the non-random organization of chromatin, genes, and proteins in 3D nuclear space by physical science methods will provide: (a) insights into functional consequences such as gene/protein expression and their alterations in cancer, (b) reliable signatures for early detection and response to therapy.

Capacity to map chromatin at high resolution in model organisms that would be relevant for cancer and development.

My work investigates how extracellular matrix mechanics influence angiogenic blood vessel formation and stability. We have found that changing the mechanical properties of the matrix modulate endothelial cell network morphology.

with the former PI (Jonathan Widom), we developed a new experiment and related algorithm to locate nucleosome positions in unprecedented detail and accuracy. The paper of these results has been accepted by the journal "Nature".

Most of my advances have been with learning new techniques and sharing and receiving ideas with other collaborators.

We have been able to see different perspective towards DNA methylation Leading to gene silencing and hope to extend this to the real cells Study.

Looking at cancer from an evolutionary perspective

the tissue engineering study of the tumor microenvironment and hypoxia and that connection with clinical studies

We have found that metastatic cancer cells exert higher forces than non-metastatic cells, which may have significant implications for the mechanism which some cancer cells use to metastasize in vivo.

mathematical modeling of forces on surface of CTC attached to blood vessel mathematical modeling of procoagulant CTCs expressing tissue factor

We have developed genetic tools to investigate the role of cellular mechanical properties (for example, cell stiffness, contractility, shape) on cell motility. We will be using these genetic tools to manipulate the mechanical properties of glioblastoma cells in mice models and to evaluate the effects on tumor size and invasiveness. These studies have the potential to reveal novel therapeutic targets for treating glioblastoma.

We found that simple changes to cell morphology by changing the physical environment can induce over-expression of an important cytokine involved in cancer. This finding is significant because cells that normally express very little or none of this cytokine when grown under normal tissue culture conditions can also be induced to over-express this cytokine, an indication that the physical environment is important for the expression of this protein. This marker belongs to the TGFbeta superfamily and has been implicated in many cancers, in which metastatic patients have elevated levels of this cytokine. Our in vitro findings coupled with the clinical findings of this cytokine presents a change in how it shold be employed as a biomarker. We believe that this marker should be used prospectively to determine when a tumor in a patient starts to metastasize.

We have made progress on understanding the relationship between sequence and bendability in nucleosome formation and other biological contexts

Transcription Factor Activity Arrays in applications to breast cancer

Cancer stiffness associate integrin and oncogene signaling

combining biologists, mathematicians, engineers and computer scientists to understanding cancer. i think this integrated approach will one day lead us to a much more better understanding of this disease to the point of possible conquer.

Multiscale modeling of various omics data (genomics, transcriptomic, and proteomic) has lead the identification of a novel pathway that may be involved in the resistance of B-cell lymphoma.

The most important scientific advance in our PS-OC research is to study how spatial heterogeneity drives cancer evolution. We need more collaborations with biologists for genetic and epigenetic characterization of the dynamic process.

I don't know

The collaboration that has been set with the PS-OC physics lab is stellar and has allowed us to start to develop an assay that could yield previously unmeasureable information about our system. We are very grateful for that. Without the PS-OC, these collaborations might be more difficult to start.

We developed a novel technology to measure the profiles of isotypes of immunoglobulins. With this technology, we might address some questions on class switching and immune response study.

I am an applied mathematician, and I am interested in developing computation methods for carrying out mechanical simulations of materials. Prior to being involved in the PS-OC, I have been involved in a number of collaborative projects with engineers and physicists, aimed at using simulations to understand the behavior of complex materials. The PS-OC has been an excellent environment in which seek out similar collaborative projects. I have worked with several of the groups in the Bay Area PS-OC, and I currently have three projects underway in which I have been able to apply mechanical simulations to better understand experimental results. These collaborations, where I have been in direct communication with experimentalists, would have been very difficult to nurture without the PS-OC.

We are learning about what kinds of materials produce heat when exposed to an external radiofrequency field and are currently investigating the heating mechanism.

Our part in the project has mainly been to develop murine cancer model systems, which can then be analyzed by other groups. The combination of cutting-edge tumor models, large-scale analysis methods (-omics) and mathematical integration of the data to form predictive theoretical models has been a major advance so far. One of the models was focused on malignant lymphoma. Using genomic, proteomic, epigenetic and expression data as well as data from the host response, a framework for the understanding of therapy resistance has been developed. In a series of experiments, we plan to test and refine these models, with a particular emphasis on comparing the model to human disease.

Ideas on how to optimize drug delivery/scheduling. However, our PSOC is very dysfunctional and the PIs don't get along and this impacts our work tremendously.

potential new target for cancer therapy

Pushing the limits of standard microscopes to yield quantitative information such as cellular mass, volume, and density. These quantities might help make pathology a quantitative science.

polyA

Nothing as of yet.

Collaborations between mathematicians and cancer biologists

In vitro experimental model for cancer motility heterogeneity through single cell analysis

cooperation

The consequences of previously ignored electrokinetics in biology on a whole. This is a true intersect of physical sciences and biology.

I got a small award from NU-PSOC, which allowed me to buy computer time from QUEST server (in NU). The resources are used on genetic triplet disease research where I collaborate with Prof. Matthew D. Disney from Scripps Research Institute, FL. Computational analysis on the conformational preference of AA basepairs in RNA CAG repeats (causing Huntington Disease) show specific conformational modes with unique properties. The results will be important on how binding of small molecules to

AA basepairs in CAG triplet repeats. Inhibition of musclebind protein binding to CAG repeats can be achieved if we can find the best small molecule binding to these repeats.

I have potentially identified new components in the piRNA pathway that silences transposable elements in the eukaryotic genome.

As a younger graduate student, I benefited greatly from attending the PS-OC annual meeting and seeing other perspectives in cancer research, specifically those from pathology and the clinic.

enhance collaboration from different fields

We have been able to combine theory and experiments in order to explain new phenomena regarding cell migration.

A better understanding of cancer development and cancer biology by combining biology, physics and medicine research

Establishing collaborations with researchers from other fields.

Mapping of human nucleosomes, and developing a model that is evolutionarily higher than the current yeast in vitro model

developing new methods to quantify and analyze biological data and suggest better experiments.

Utilizing the multidisciplinary framework to achieve hypothesis driven results.

applying new imaging methods and microscopy in cancer. Also developing new mathematical models and bioinformatic method for easier and faster analysis.

The most scientific advances that has emerged from my research to date, is the ability to calibrate various force fields with quantum mechanical theory.

correlation of biology and physics with the technique that we use

The increased collaboration between various labs on our campus. Although we are a cancer biology/molecular biology lab we communicate weekly with labs across campus that include statisticians and mathematicians to help us in our analyses and studies.

The most important scientific advances to emerge from my PS-OC supported research is the better understanding of cancer metabolism through mathematical modeling. This modeling framework provides opportunities to identify drug targets for cancer therapy.

There is ready access to clinical centers which can/do provide patient samples/data to apply to benchtop models. Access to state-of-the-art technologies for acquisition of physical sciences data is superb.

I am still generating the data but I hope significant information will come from examining the three dimensional architecture I the chromatin in several cancerous cell lines in collaboration with the Dana Farber PSOC

nano devices could be used to molecular field with great advantage in sample processing.

identify changes in extracellular matrix via multiphoton microscopy

n/a

Ongoing work into understanding behavior in gene networks through characterizations of network structure

We developed the Pathway Commons database, which integrates cellular pathway data from several resources. We developed the Paxtools software for working with pathway data in BioPAX format. We developed ChiBE for visualization of pathways. We developed graph query algorithms to be able to follow signaling events on the network. We are currently working on the integration of omics data with cellular networks so that we can identify patient specific events and links between events which would help developing a cure.

We had a some nice research on nucleosomes and nucleosome positioning.

Collaborative work with experimental labs.

The notion and supporting evidence showing the importance of cancer microenvironment and mechanics.

Understanding the mechanism of controlling the directionality of transcription factor activation

I work for the bioinformatics core, we cooperate with the project 2 and developed a chemical approach with an advanced statistical algorithm, and achieve nucleosome mapping with single-base-pair accuracy. the results will be published on the top journal "Nature" (published online on June 3). We continue this project for different species now.

I think that the most promising advances involve using Partial Wave Spectroscopy to analyze nuclear disorder in cells.

C6. From your standpoint, please briefly describe the most important scientific advancement to emerge from your PS-OC to date.

PI/SIs

Successful delivery of targeted nanoparticles for thermal and multimodality therapy, significant increase in activity with minimal toxicities.

The development of a testable theory of cancer and its place in the evolution of multicellular life.

I thought this is blinded/anonymous? (1) clinical utility of the fluid biopsy is multiple carcinomas at the time of disease diagnosis. (2) equations of metastasis to motivate a clinical trial in non-small-cell lung cancer.

A completely new view of cancer cell migration.

Opportunity to collaborate on a novel project with investigators who bring technical and intellectual expertise in an area that I am not familiar with....willingness to try to test a very unique/novel question using trans-network funds that would otherwise NEVER be funded and therefore never get done....

understanding mechanisms generating mutations in cancer genomes optimized dosing strategies for lung and brain cancers

Critical role of extracellular matrix stiffening by collagen fiber formation/crosslinking in breast cancer metastasis.

Further Definition of Nucleosomal Positions, Defintition of Global Chromatin Dysfucntion

I think we established that there are some strong physics principles that direct evolution in complex environments under stress. PS: What is a paradigm?

Short Term—CTC capture and characterization for use in therapy—I'll use this one to answer C^b. Medium Term; Rapid analysis of a cell's epigenome Longer Term: Understanding How matrix Characteristics Influences cancer Development

new multiscale model for cancer

Our most important scientific advancement has been to integrate a multitude of apparently disparate results from various fields, all relating to the role of mechanics in tumor progression and metastasis. This integrated view of tumor mechanics is now allowing us to (1) calculate how cells and tumors respond to altered tissue mechanics, (2) develop new ways of detecting and quantifying altered tissue mechanics in human tissue, (3) identify fundamentally new extracellular targets for clinical intervention.

Support for acid-mediated invasion and its inhibition by buffers

Project Investigators

High throughput proteomics on individual cells, used to build advanced signaling models.

Getting scientists, physicians, and engineers to work together effectively to attack a new problem in a new way. they not only have to meld their various skills but also learn to understand the language of their separate fields.

-new devices to study angiogenesis -new biomaterials and modified surfaces -novel computational approaches

The ability to collaborate with senior cancer biologists is the most valuable aspect of this grant.

Broaden the network of collaboration with biologists and other physicists working at the interface between biology and physics.

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My work investigates how extracellular matrix mechanics influence angiogenic blood vessel formation and stability. We have found that changing the mechanical properties of the matrix modulate endothelial cell network morphology.

with the former PI (Jonathan Widom), we developed a new experiment and related algorithm to locate nucleosome positions in unprecedented detail and accuracy. The paper of these results has been accepted by the journal "Nature".

Most of my advances have been with learning new techniques and sharing and receiving ideas with other collaborators.

We have been able to see different perspective towards DNA methylation Leading to gene silencing and hope to extend this to the real cells Study.

Looking at cancer from an evolutionary perspective

the tissue engineering study of the tumor microenvironment and hypoxia and that connection with clinical studies

We have found that metastatic cancer cells exert higher forces than non-metastatic cells, which may have significant implications for the mechanism which some cancer cells use to metastasize in vivo.

mathematical modeling of forces on surface of CTC attached to blood vessel mathematical modeling of procoagulant CTCs expressing tissue factor

We have developed genetic tools to investigate the role of cellular mechanical properties (for example, cell stiffness, contractility, shape) on cell motility. We will be using these genetic tools to manipulate the mechanical properties of glioblastoma cells in mice models and to evaluate the effects on tumor size and invasiveness. These studies have the potential to reveal novel therapeutic targets for treating glioblastoma.

We found that simple changes to cell morphology by changing the physical environment can induce over-expression of an important cytokine involved in cancer. This finding is significant because cells that normally express very little or none of this cytokine when grown under normal tissue culture conditions can also be induced to over-express this cytokine, an indication that the physical environment is important for the expression of this protein. This marker belongs to the TGFbeta superfamily and has been implicated in many cancers, in which metastatic patients have elevated levels of this cytokine. Our in vitro findings coupled with the clinical findings of this cytokine presents a change in how it should be employed as a biomarker. We believe that this marker should be used prospectively to determine when a tumor in a patient starts to metastasize.

We have made progress on understanding the relationship between sequence and bendability in nucleosome formation and other biological contexts

Transcription Factor Activity Arrays in applications to breast cancer

Cancer stiffness associate integrin and oncogene signaling

combining biologists, mathematicians, engineers and computer scientists to understanding cancer. i think this integrated approach will one day lead us to a much more better understanding of this disease to the point of possible conquer.

Multiscale modeling of various omics data (genomics, transcriptomic, and proteomic) has lead the the identification of a novel pathway that may be involved in the resistance of B-cell lymphoma.

The most important scientific advance in our PS-OC research is to study how spatial heterogeneity drives cancer evolution. We need more collaborations with biologists for genetic and epigenetic characterization of the dynamic process.

i don't know

The collaboration that has been set with the PS-OC physics lab is stellar and has allowed us to start to develop an assay that could yield previously unmeasureable information about our system. We are very grateful for that. Without the PS-OC, these collaborations might be more difficult to start.

We developed a novel technology to measure the profiles of isotypes of immunoglobulins. With this technology, we might address some questions on class switching and immune response study.

I am an applied mathematician, and I am interested in developing computation methods for carrying out mechanical simulations of materials. Prior to being involved in the PS-OC, I have been involved in a number of collaborative projects with engineers and physicists, aimed at using simulations to understand the behavior of complex materials. The PS-OC has been an excellent environment in which seek out similar collaborative projects. I have worked with several of the groups in the Bay Area PS-OC, and I currently have three projects underway in which I have been able to apply mechanical simulations to better understand experimental results. These collaborations, where I have been in direct communication with experimentalists, would have been very difficult to nurture without the PS-OC.

We are learning about what kinds of materials produce heat when exposed to an external radiofrequency field and are currently investigating the heating mechanism.

Our part in the project has mainly been to develop murine cancer model systems, which can then be analyzed by other groups. The combination of cutting-edge tumor models, large-scale analysis methods (-omics) and mathematical integration of the data to form predictive theoretical models has been a major advance so far. One of the models was focused on malignant lymphoma. Using genomic, proteomic, epigenetic and expression data as well as data from the host response, a framework for the understanding of therapy resistance has been developed. In a series of experiments, we plan to test and refine these models, with a particular emphasis on comparing the model to human disease.

Ideas on how to optimize drug delivery/scheduling. However, our PSOC is very dysfunctional and the PIs don't get along and this impacts our work tremendously.

potential new target for cancer therapy

Pushing the limits of standard microscopes to yield quantitative information such as cellular mass, volume, and density. These quantities might help make pathology a quantitative science.

polyA

Nothing as of yet.

Collaborations between mathematicians and cancer biologists

In vitro experimental model for cancer motility heterogeneity through single cell analysis

cooperation

The consequences of previously ignored electrokinetics in biology on a whole. This is a true intersect of physical sciences and biology.

I got a small award from NU-PSOC, which allowed me to buy computer time from QUEST server (in NU). The resources are used on genetic triplet disease research where I collaborate with Prof. Matthew D. Disney from Scripps Research Institute, FL. Computational analysis on the conformational preference of AA basepairs in RNA CAG repeats (causing Huntington Disease) show specific conformational modes with unique properties. The results will be important on how binding of small molecules to

AA base pairs in CAG triplet repeats. Inhibition of musclebind protein binding to CAG repeats can be achieved if we can find the best small molecule binding to these repeats.

I have potentially identified new components in the piRNA pathway that silences transposable elements in the eukaryotic genome.

As a younger graduate student, I benefited greatly from attending the PS-OC annual meeting and seeing other perspectives in cancer research, specifically those from pathology and the clinic.

enhance collaboration from different fields

We have been able to combine theory and experiments in order to explain new phenomena regarding cell migration.

A better understanding of cancer development and cancer biology by combining biology, physics and medicine research

Establishing collaborations with researchers from other fields.

Mapping of human nucleosomes, and developing a model that is evolutionarily higher than the current yeast in vitro model

developing new methods to quantify and analyze biological data and suggest better experiments.

Utilizing the multidisciplinary framework to achieve hypothesis driven results.

applying new imaging methods and microscopy in cancer. Also developing new mathematical models and bioinformatic method for easier and faster analysis.

The most scientific advances that has emerged from my research to date, is the ability to calibrate various force fields with quantum mechanical theory.

correlation of biology and physics with the technique that we use

The increased collaboration between various labs on our campus. Although we are a cancer biology/molecular biology lab we communicate weekly with labs across campus that include statisticians and mathematicians to help us in our analyses and studies.

The most important scientific advances to emerge from my PS-OC supported research is the better understanding of cancer metabolism through mathematical modeling. This modeling framework provides opportunities to identify drug targets for cancer therapy.

There is ready access to clinical centers which can/do provide patient samples/data to apply to bench top models. Access to state-of-the-art technologies for acquisition of physical sciences data is superb.

I am still generating the data but I hope significant information will come from examining the three dimensional architecture I the chromatin in several cancerous cell lines in collaboration with the Dana Farber PSOC

Nano devices could be used to molecular field with great advantage in sample processing.

identify changes in extracellular matrix via multiphoton microscopy

n/a

Ongoing work into understanding behavior in gene networks through characterizations of network structure

We developed the Pathway Commons database, which integrates cellular pathway data from several resources. We developed the Paxtools software for working with pathway data in BioPAX format. We developed ChiBE for visualization of pathways. We developed graph query algorithms to be able to follow signaling events on the network. We are currently working on the integration of omics data with cellular networks so that we can identify patient specific events and links between events which would help developing a cure.

We had a some nice research on nucleosomes and nucleosome positioning.

Collaborative work with experimental labs.

The notion and supporting evidence showing the importance of cancer microenvironment and mechanics.

Understanding the mechanism of controlling the directionality of transcription factor activation

I work for the bioinformatics core, we cooperate with the project 2 and developed a chemical approach with an advanced statistical algorithm, and achieve nucleosome mapping with single-base-pair accuracy. results will be published on the top journal "Nature" (published online on June 3). We continue this project for different species now.

I think that the most promising advances involve using Partial Wave Spectroscopy to analyze nuclear disorder in cells.

C8: Something you know now that you didn't pre-PS-OC:

PI/SIs

Role of physics in understanding biologic systems

Cancer cells change their physical properties.

the fluid phase of solid tumors is an accurate reflection of the disease in the patient.

The importance of epigenetics in cancer cell phenotype

chromatin organization/structure/function and mechanical force.....interplay between microenvironment and gene expression/networks as well as epigenetics -

How Gradients of Stress Drive Evolution

Chemotherapy basically doesn't work.

The relative value of CTC in diagnosis/treatment of certain cancers

(1) Cells are in contact with the ECM, which provides mechanical integrity to tissues and also chemical and mechanical signals to cells, influencing differentiation, development, and pathogenesis. (2) Tissue hardening due to changes in collagen crosslinking status and composition has been causally implicated in tumor progression in mice. (3) Normalizing tissue mechanics reduces the rate with which tumors grow and significantly reduces the probability of metastasis.

I have come to appreciate the genetic heterogeneity of tumors and its evolutionary ramifications

Project Investigators

Learned much more about role of epigenetics, which appears more and more to play a greater role than genetics.

It has been a slow process to coordinate the contributions of the various groups within the project. they are geographically separated, and each is working on other things as well as this particular PSOC. Communication has had its spotty aspects, which have led to delays in interpretation of new results and in the implementation of new experiments and models that take advantage of those results.

Problems with patient derived primary tumor endothelial cells

Reversion of 3D cell culture

How physical approaches help to advance the field of cancer nanomedicine

Systems approach to the tumor phenotype

Importance of link between large-scale chromosome structure, nucleosome modifications, and cancer gene regulation programs.

We have a much better handle on the interplay between fluid, mechanical, elastic, and geometric forces in cell cluster stability, interactions with basement membranes, and the role that these forces play in creating and maintaining organized structures.

How probablistic models work.

The most important thing I've learned is how open-minded "traditional" cancer biologists/oncologists can be to physical sciences and engineering-based approaches to studying and treating cancer if you just take the time to talk to them and explain your interests. I've also been awakened to how sophisticated cell culture models have become in a variety of cancer systems—in many cases it's possible to obtain cancer stem cells from individual patients, fully sequence these cells, "bank" them in culture, and recapitulate the tumor by implanting them into mice, such that one has full access to genotype, phenotype, and clinical history. The potential to relate in vitro cell biophysics to cell biology to clinical course has never been greater.

Different primary cancers have different modes of stepwise progression.

Better mathematical understanding of cancer

I now know how to work with and design experiments utilizing patient samples, rather than solely relying on cell-line based data.

Growth rate in budding yeast changes dramatically during the cell cycle.

I have a greater appreciation for the interface between cancer biology and bioengineering.

That drug resistance may be a molecular evolutionary problem that involves mutation, selection and survival of the resistant cancer cell.

I was unaware of the process that oncology, surgery and pathology use to diagnose and treat cancer. This has been essential in guiding the motivation and translational potential of our studies.

contribution of microenvironment-driven metabolic changes and their role in tumor evolutionary processes

The potential role of DNA mechanics in gene regulation and cancer.

That epigenetic heterogeneity within tumors stems from disruption of specific barrier mechanisms and is a major determinant of clinical outcomes in patients with cancer.

A lot of information regarding cancer pathology, diagnosis, sample collection, staging etc.

Quantitative grading of cancer is still in its infancy and progress toward helping to make grading more precise will aid in prognosis.

Mechano-sensing can result from adhesion molecule dynamics.

The necessity of considering that the tumor itself is a complex adaptive system on top of the challenge that individual cells themselves are complex adaptive systems.

The existence of the bioinformatics cores

The depth and breadth of research that is being performed. I learn something new from other investigators all the time - I cannot focus on one thing.

I am much more familiar with new technologies for assessing cancer and with mathematical modeling approaches to understand cancer. I am also much more aware of a more systems based approach to cancer - a more holistic view - than I had had before participating here. A key element of PSOC is that it gets away from the very focused boutique approach to cancer and

starts to address the disease as a higher level. It brings a much more multidisciplinary toolkit to answer questions that simply cannot get answered by reductionist approaches.

Microfluidics Mathematical models of cellular processes

I was not familiar with some of the parameters that can be modeled in cell culture to create an accurate model of the tumor microenvironment, including matrix rigidity and number of integrin binding cites as independent factors that can be manipulated separately.

Oncology research is overall far more complex and less quantitative than traditional physical science research. Physical science approaches can make a huge difference.

Modeling of metastasis

During differentiation of tumor cells induced by retinoic acid, there is a self sustaining hyperactivated MAPK feed back loop involving CXCR5 that involves at least another potential receptor or signaling molecule but is relatively self contained.

I didn't know that oncologists have very limited knowledge of cell biology, or even care about cellular mechanisms in general. The field would broadly benefit from MORE FUNDAMENTAL SCIENCE in all respects. Cell biology is a rapidly evolving field with new discoveries everyday. Oncologist can benefit from the knowledge and methods of cell biologists.

I was not familiar with Cytof mass cytometry and would like to incorporate this broadly into our work

We didn't know whether DNA methylation varied across cancer cells, and whether this variability changed in response to drug treatments

I have learned that looking at cancer from a physical sciences perspective will be the only way to cure this disease. The reason is that cancer is a complex system spanning multiple time and physical length scales (from the DNA to the patient). Physics, Mathematics, and Engineering provide the tools and the frameworks to properly analyze such complex systems. In contrast, the biological sciences are descriptive by nature and cannot provide this multi-scale analysis.

I can do animal experiments to study cancer in my own lab; my involvement in the PS-OC enabled me to branch out into this.

the important physical differences in cancer cells as they become more malignant

(1) How to have physist work with biologist (2) How easy is to use nanodevices and nanofabrication facility

The existence of methodologies for visualizing the expression of individual RNAs in single cells

Overall, the most compelling new findings relates to the potential to translate cell/tissue based biomechanical studies to clinical relevance in caring for cancer patients.

How much people doesn't understand physical science approach in oncology!

I wasn't aware that healthy immune responsive cells actively and unwittingly support the growth of cancer and that targeting these interactions may a viable adjuvant therapy and possibly an effective primary therapy

(1) That even adult cells behave like an embryos to form the correct architecture of a tissue but they need to move using a coherent angular motion and that tumor cells do not perform this movement. We are beginning to study the pathway which thus can become a target for therapy.(partial PSOC funding) (2) In the dormancy model (totally PSOC funding)we also have discovered a new pathway for dormancy and also possible pathway that wake up the dormant tumor cell and thus cause malignancy. I do

not understand c-9 below!. I have been to Washington meetings and think have participated on some of the below but probably by phone?

The tumor board education in the annual PS-OC meeting in La Jolla was very helpful. I learned how a tumor board works, which is extremely helpful in putting things in context.

Interdependency of cell types involved in malignancy

n/a

J1. Without naming specific individuals, please give an example of a successful trans-disciplinary collaboration (i.e. a collaboration that integrated two or more individual disciplinary perspectives) in which you have been involved as part of the PS-OC program. Please provide a brief description of the project and how it was initiated. Please define each member's role in the collaboration.

PI/SIs

Surgeon in clinical practice without a significant research component heard a Grand Rounds presentation at the hospital from a member of the PSOC describing the general research area. Surgeon approached PSOC for opportunity to become involved, a team was assembled, the surgeon was assimilated into the PSOC, and the project pursued, initially on a small scale, but now has achieved additional outside funding and is a fairly big project with early data emerging and clinical follow up data (i.e. translatable) expected in 2-3 years. A similar pattern is currently in its early stage, with a GI doctor from the clinic who heard about the research and approached the PSOC about endoscopic ultrasound-guided biopsies of pancreatic masses. This project is already enrolling patients and additional funding is expected in the near future.

Facilitating delivery of tumor specimens (by the Department of Pathology, with dedicated staff) to physical scientists for physical measurements. Designing new devices to effectively capture rare cells from cancer patients, that will permit evaluation of specific mutations that confer resistance to conventional chemotherapy.

In a project developed over the past year, we have obtained technical expertise and advanced microfluidic technology from on PSOC site and added it to a multidisciplinary team (including computational modelers, clinical oncologists, and tumor biologists) at our site. The technology has been successfully adapted and integrated into a clinical trial. Currently, tumor cells from bone marrow aspirates of patients with multiple myeloma are being placed in the microfluidics chamber to assess their response to gradients of a variety of drugs. These data are then incorporated into computational models of each patient's bone marrow (based additionally on morphologic and immunohistochemical features of the bone marrow biopsy and data from flow cytometry of bone marrow aspirates). These models are then used to predict the outcomes (within the bone marrow) of therapy to be employed in that patient. These predictions will be tested based on morpholigal and immunohistochemical data from follow up bone marrow biopsies. Through this iterative method it is hoped that the computation model ("virtual bone marrow") can be used to design optimal therapeutic approaches in individual patients.

Collaboration that will correlate physical structure of chromatin in nucleus of cell with molecular alterations in the DNA (e.g., mutations in tumor suppressor genes, etc.).

Worked with another SI who developed an antibody that targets pancreatic cancer, they purified and we conjugated to our nanoparticles and performed stability and RF treatment studies in vitro, soon to perform in vivo.

The new theory of cancer I have developed arose from my interaction with a range of cancer biologists.

most of our pilot projects are effectively trans-network projects.

Thanks to PSOC, a group of expert in oncology, pathology, surgeons, biostatisticians, and engineers have developed a novel and versatile microsocpy-based high-throughput cell phenotyping assay that is being applied to determine combined epigenetic/genetic/phenotypic signatures of drug responses, resistance, survival, and metastatic disease in ovarian and pancreatic cancer. Cells from biopsies or sections of tissues are digitized and analyzed to extract thousands of molecular, structural parameters at single-cell resolution.

New trans-network initiative - very cutting edge with extremely high potential to move the field in a major way forward....to identify novel concepts and has very high potential for clinical translation - involves 4 different PSOC centers....revolves around

assessing the interplay between epigenetics and chromatin remodeling/nuclear structure and tissue structure and extracellular matrix tension.....will be exploring impact of ECM tension on higher order chromatin organization.....as well as epigenetics and gene expression.....generation of very unique information.....that can easily be incorporated into clinical scenario....also has incredible potential for fundamental insight into tissue specific development....as well as tumor heterogeneity....seriously if this works...this will literally blow open the whole area....i have never been this excited about a project before...have wanted to do this for at least a decade...and funds from the PSOC will now allow this to happen, but more importantly...I have met and begun to collaborate with the type of scientist that will enable me to do this work....very excited...lets just hope that we obtain further support for this project...because i know that it will literally change things...

Year 1 trans-network project between Dana-Farber, USC, and Princeton Initiated the project

We have collaborated with physical scientists to connect molecular changes in cancers with physical changes and biological consequences.

With Michor, Melcnika, and Levine we are investigating how IDH1 mutations in AML change DNA methyaltion patterns and the three dimensional configuration of chromatin- extensive mathematical modeling and analysis is involved

The work with the Moffitt center on the evolution dynamics of MM cells in a death galaxy configuration has been very fruitful and I think it shows rapid evolution at work under the presence of chemotherapy. PI's of Centers: Did initial negotiations Post-doc (Moffitt): provided initial technical guidance, helped write proposal, gave talks Grad-student (PU): has performed experiments and traveled to Moffitt.

Clinical Oncologist and microfabrication/mechanical engineer—The engineer had almost no prior bio experience—he spent a year sabbatical based in part on encouragement from the PS-OC at the Medical School where he developed several interactions with clinical scientists The clinician had seen a special opportunity for a device and together with the engineer constructed a system now in clinical trials

new approach to data for modeling

We have brought together a cancer biologist, a mathematician, and a polymer physicist to investigate how mammary acini remodel their extracellular matrix. We discovered that Ras-transformed mammary acini can mechanically interact via lines of aligned collagen that form between them due to acinar contractility and the nonlinearity of collagen mechanics. These collagen lines are as much as 8-fold stiffer than the undisturbed material around them and can extend for more than 1 mm, mechanically linking acini over long distances. Gradually, a planar network forms, in which contractile acini are connected along geodesics by stiff collagen cables. Disorganization of mechanically interconnected acini is more likely, rapid, and extensive than of isolated acini, showing that groups of mammary acini can mechanically cooperate through their substrate, accelerating their disorganization. Thus, collagen matrices can participate in the generation of inappropriate biological signals and support their directional mm-scale propagation, influencing the organization and stability of groups of multicellular structures. This result has been submitted to Science. The cancer biologist provided the basic model system and the cancer context, the mathematician developed a computational framework for calculating how collagen responds to contractile acini, and the polymer physicist clarified the dynamics of the resultant emergent phenomenon, consisting of mechanically coordinated, collective disorganization of groups of acini.

We have worked with MIT and NYU to investigate genetic effects of the microenvironment that would not have been otherwise possible. We have also worked with Cornell on a number of projects, including cranial windows and plans for matching dorsal windows to engineered bioreactors.

Project Investigators

I have been involved in a joint project between modelers, oncologists, pathologists, cell biologists, and bioengineers, to develop well-calibrated computational models of micrometastases in bioengineered liver organoids. The bioengineered organoids provide a novel, controllable platform for physical measurements and computational model validation. This platform is combined with more traditional in vitro 2-D monolayer experiments for computational cell calibration. The computational model allows a broader exploration of the parameter space (beyond what is feasible by experiments alone), allows extrapolation of the results beyond the 2-3 week organoid lifetime, and allows extrapolation of the results to human in vivo conditions by changing the simulated organ geometry.

When it turned out that the number of lymphoma cells inject was too high, there was an immediate and effective response to agree on a lower dose, which required a modification of all the previously agreed on protocols. This cut across a wide swath of the entire program. When it turned out that there was as immunological response to the use of luciferase as a labeling agent, there had to be an overall agreement ton controls that allowed the separation of this effect form the effects of treatment agents. Again, this had unforeseen impacts on the use of controls and procedures. When it was discovered that the injected lymphoma cells did not immediately go to the lymph nodes but went to the spleen and bone marrow and then subsequently were ejected after a rise in the angiotensin level, an opportunity to capitalize on this discovery required reordering some to the sample measurement protocols across the project.

Collaboration with fluid mechanics expert. Collaboration with biomaterials expert. Collaboration with Colloidal Microstructures expert.

Because of limited funding for my group under the PSOC, one very successful interaction has been with members of the ICBP program. We have a collaboration based on both sources of funding's, allowing us to make advancement in our modeling effort by combining experiments and computer models. This has been initiated by the director of this ICBP program who showed keen interest in our simulations. This director has been investing in our group to help on providing more mathematical support to continue our modeling work. This has freed some of our time and effort to dedicate in the acquisition of experimental data. In addition, another PI (experimentalist) from our PSOC has also been instrumental in acquiring more data. This has created an interesting scientific trio, merging mathematics (ICBP), Physics/modeling (my group) and 3D biology (other PI). We have generated one publication under this arrangement and are in the process of submitting another one.

Built understanding of each other's expertise through multiple visits. Exchange researchers were effective.

Analysis of proteome for proteins that are partially proteolyzed by the proteasome. Came out of conversations with PS-OC members and outside collaborators. Development of a compound that targets the Gli transcription factor. Came out of discussions with faculty inside and outside the PS-OC.

Analysis of higher-order chromosome structure and role in cancer gene regulation. We brought together experienced oncologists/cancer biologists with expertise in regulation of DNA replication and nucleosome modifications, together with physicists and engineers working on methods to analyze chromosome structure. The result is a convergence of research methods and cell systems that I believe will lead to a series of excellent publications illustrating the connection between these different aspects of the gene regulation anomalies that are associated with disease. The project was initiated largely because of the PS-OC project organization scheme, which brought the different groups together.

We have built a computational methodology for studying cell cluster structural stability. The project only came into existence because of the PSOC and the leadership within the program. We are able to build and develop these technologies in part by taking existing expertise in computational fluids, mechanics, and elasticity, and part by inventing brand-new computational methodologies necessary to pursue the goals of a robust, reliable, predictive computational environment. Keys aspects of ensure

that the developing mathematical and algorithmic technologies are biologically relevant have come from close collaboration with cell biologists, imaging physicists, and laboratory experimentalists to measure key quantities.

Developing a mathematical model of metastasis with the mathematician doing most of the modeling and the clinician providing guidance and "reality checks" on the model and guiding clinical applications.

I've collaborated with a small-molecule synthesis person to develop new materials with photoswitchable mechanical properties.

Collaboration between mathematicians and oncologists

This project brought together three units that would not have otherwise worked together

We have developed a technology to characterize the procoagulant phenotpe of leukemic cells from patient samples. This is a collaboration between engineers, cell biologists, cancer biologists and oncologists. This was initiated as part of the CTC transport group.

Our program officer was very effective and involved.

As part of our Outreach Pilot Project, we were able to accomplish a tumor study with live in vivo imaging that will potentially help the other members of the PS-OC in monitoring tumor formation in a living animal.

Lance Armstrong's impressive response to therapy for advanced metastatic testicular cancer was typical, but in stark contrast to the dismal results with pancreatic cancers. Why are some metastatic cancers curable whereas others are not? Our goal is to identify differences of chromatin structure and dynamics between curable and non-curable cancers. We have two specific hypotheses: (1) Nuclear structure plays a key role in determining the aggressiveness and the curability of cancer. (2) There are significant alterations in chromatin organization and dynamics in curable compared to incurable cancers. (3) Protein components of the nuclear structure play a central role in chromatin organization and may be differentially expressed between curable and incurable cancers.

There is a recent project that was initiated to look at blood vessel formation in cancer. It integrates PSOCs with characterization of human samples, incorporation of animal models and construction of in vitro models. It was initiated in discussions regarding trans-network projects. The strength of this team is that it incorporates in vivo, ex vivo and in vitro approaches to understand the physical properties of a tumor that guide angiogenesis.

initiation: trans-network proposal calls project: development of biologically relevant cell culture models to study cell-microenvironment interactions and their role in tumorigenesis role in collaboration: cell biologist/oncologist: provided biological material and access to animal models; engineer: design and adaption of cell culture models; physicist/engineer: computational analysis of related transport phenomena and signaling networks

I participate in a TN project that was initiated through the interaction between three PSOCs with convergent cross-disciplinary interest in modeling how tumor clonal heterogeneity effects the clinical behavior of cancers. It includes a member with expertise in evolutionary biology and mathematical modeling, another with leukemia biology expertise, another in genetics and another in epigenetics.

I have aided in the design of molecular biology experiments for captured CTCs. These interactions were driven through the PI at our center and interaction between myself and the post-doctoral fellow doing the CTC capture and molecular biology.

I have worked with a pathologist to analyze and characterize for the first time images of healthy and cancer glial cells using sophisticated descriptors used in statistical physics.

We developed a model for mechanosensing that involved aspects from physics, engineering, mathematics, and cell biology.

Development of models for penetrance of resistance. Project came about initially through discussions about lacking data for generating models that my lab might be able to readily generate. Then, after several exciting discussions, we submitted a trans-network pilot which was funded. We have subsequently had one paper published, are writing a second and have submitted two related proposals.

Collaboration with Drs. Joseph Scandura, Sina Rabbany, and Pouneh Kermani

The project was to create a microvascular model of cancer metastasis - adhesion of CTC and growth at the metastatic site. It was between a biologist (myself) and an engineer and has since extended to include another person in mechanical engineering.

All of the experiments we have done with PSOC have been transdisciplinary collaborative projects. In every case we are working with someone that we have not worked with before. In one case, we are testing drug sensitive vs. resistant cells with a lab that measures changes in the cells membrane physical membrane characteristics in response to drug treatment. In another, we are measuring the immune response developed during the course of cancer formation against 10,000 possible antigens in the proteome. This has required working with scientists who have developed solid mouse models and with mathematicians capable of developing solid statistical models based on pathway analysis.

Working in studying CTCs; developed out of common interests and goals with different technology.

Collaboration between biomedical engineer and molecular biologist. The engineer has created systems for 3-D cell culture and the molecular biologist has conducted assays comparing cell behavior under 2-D vs. 3-D conditions.

As an engineer, I now collaborate with MDs, biostatisticians, molecular imaging experts, and chemists.

we collaborated with a computational engineer to test models of cell differentiation

Collaboration between a theorist and a cell biophysicist on cell migration in confined space. This combines mathematical modeling, microfluidics and cell biology.

began broader collaborations based on technology and biological interests related to but beyond PSOC goals

We are currently involved in a project to study the chromatin structure of cancer cells. This project involves theorists and experimentalists within multiple PSOCs.

A transdisciplinary collaboration between an imaging scientist and a biomedical engineer led to the quantitative analysis of drug delivered via nanoparticles into tumor tissue, involving both high-resolution imaging of particles (by the imaging scientist) as well as computational simulation of tumor growth (by the biomedical engineer). This project was initiated as part of a Young Investigators Trans-network Award. The results suggest that we are on the cusp of being able to deliver sufficient drug with a single injection of particles to produce tumor regression. This study also yielded several other interesting findings, including the need for slow drug release rather than a burst release, and a non-linear relationship between drug dose and treatment response. Although this work raises many more questions than it answers, the results suggest that particles designed through integrated empirical methods and quantitative modeling approaches have the potential to revolutionize cancer treatment.

A pilot project brought together a bioengineer (in Network), a cancer cell biologist (out of Network) and a clinical oncologist (in Network) to address a specific scientific question related to understanding the mechanism of cancer metastasis to bone. This project could not have been accomplished, or at least not nearly as effectively, by any of these investigators alone. The bioengineer integrated ideas into an outside-the-box hypothesis, the biologist provided experimental tools, and the clinician provided insights and patient samples.

Collaborations of my colleagues with investigators at MIT to model signaling networks and measure RNA expression in immature hematopoietic cells.

Communications between and among members of the PSOC network have been particularly productive. As one of a few "clinicians in the room," I have been excited about presenting real-world clinical problems with physical sciences colleagues and amazed and gratified by the novel approaches and vitality they have applied to these issues. The most striking example for my own research concerns networking initiated at one of the PSOC kick off meeting which transitioned into a preliminary correlative science project (supported by outside funds) and then finally to a Trans-Network project supported from PSOC funds.

Professor in civil engineering proposed an approach to study actin network rheology using method applied in the civil engineering field. I am involved in discuss some specific properties of proteins in the actin network to make the parameters more close to real.

The collaborations that I have become affiliated with have only recently begun. Among these is a collaboration that will use morphological and other cell based immunoflourescence measurements to create an algorithm which can predict which individual cells in a population of cancer cells will become resistant to therapy. This collaboration was initiated during the previous meeting in Tampa and has progressed from planning to obtaining the cell lines which will be studied.

A project on evolution of metastasis and the role of exosomes: Approved two years ago, with small funding, which was quite delayed for various reasons. But encouraged us to go for larger funding. The project was initiated in the collaborators laboratory and one of the fellows became involved even before PSOC and have published a very important paper that is just out. But we got involved because of the funding from PSOC. So the next paper would have acknowledgment to the PSOC. They have the patient data and we are developing 3D culture models, and will be studying the mechanism of transfer.

The Houston (Methodist Hospital Research Institute)- Cornell PS-OC workshop was very effective in bringing clinicians and engineers together. There are exchange of primary cell lines, and advanced engineering tools between the two sites.

I am just now starting a trans-disciplinary collaboration, so cannot address how successful it will be. The collaboration started by word-of-mouth, two labs working on different aspects of the same project.

Trainees

Hard to explain without identifying members.

I am a physics grad student and I visited a cancer research center for two days, during which time I was trained by a post-doc cancer biologist how to grow breast cancer cells in 3D using Matrigel. This hands-on training was useful for my research project. The lab I visited was within my PSOC but as a satellite.

Studying the role of the physical microenvironment in driving the evolution of glioblastomas. Thanks to a Moffitt-PSOC pilot project I started collaborating with a physician-scientist at the department of radiation oncology in Moffitt where mathematical and biological experiments produced an integrated understanding of the evolutionary dynamics of glioblastomas. The experimental part includes now a cranial window mouse model that we learned thanks to collaborators at the Cornell-PSOC.

I combined my background in cancer biology, imaging, and engineering with experts in optics and mathematical modeling to develop novel intravital microscopy techniques for studying and quantifying single particle dynamics in live mice. This work has led to 3 publications (2 published, 1 submitted) and well as several new ongoing research directions. As a direct result of this work, I have formed several new collaborations across Centers as well as outside the Centers.

team A: microfluidic devices with various 3D matrix gels team B: stem cell biology

PS-OC Data Jamboree. collecting data and analyze them. it was initiated in the first PSOC meeting .we had several members to collect , and then analyze and write a manuscript.

Research project using a Markov chain dynamical system was used to characterize the progression of lung cancer. Collaborators were able to give a clinician's view on the subject and validated the results that were found from the research. They were also able to offer new ideas and information to keep the project moving forward steadily.

I have worked with a mathematician a biophysicist and another engineer in a PS-OC collaboration. We met at a seminar series and realized we had complementary skill sets. Mathematician - theoretical analysis of mechanical behavior, incorporation of experimental data into mathematical model Me (bioengineer) - work out 3D cellular extraction protocol, do some of the mechanical testing and analysis Other engineer - mechanical testing and analysis Biophysicist - mechanical testing

Provided helpful techniques and ideas for my own research.

We are participating in a successful collaboration with a PS-OC, but I think there were inter-disciplinary problems that took us some time to hash out. From our perspective, we had a theoretically sound hypothesis that cancer was hurt by its mutational load and began our collaboration in order to test this hypothesis in in vitro and mouse models. To develop the cell lines, we had a local collaborator who ran a lab that studied cancer cell biology and didn't believe in our idea—it was quite 'out of the box' and experimentally untested, and he was too polite to say so. Instead, at first, he wanted to use the collaboration to test an entirely alternate hypothesis of his. When I first brought our model to another PS-OC to begin a trans-network study to test our shared ideas in a mouse model, the mathematicians gobbled up our model. They asked so many good, probing questions that my half-hour talk ended up taking 3 hours. When I gave the same talk to biologists, I received very little interest—1 question. Unfortunately, the other theorists were unable and uninterested in testing our theory experimentally (our goal), but instead more interested in integrating our theoretical model with their models. We felt that was premature at this point. We had a cool dogma-challenging model that already showed theoretical promise, but desperately needed to be tested experimentally before we could faithfully argue that the paradigms of cancer mutations needed revision. It took some arm twisting, a period of familiarization and trust-building, and major outsourcing, to get our experiments underway, since the biologists were less intrigued in our research. Perhaps, this is just a reality of collaborative research, but the issue is particularly pronounced between cell biologists and physical scientists. For example, we've recently had discussions with a physicist-turn-biologist who has been much easier to work with from the beginning because of our shared language. Unfortunately, talking with other physical scientists is less useful to us than talking to biologists who have far more complimentary approaches and knowledge.

Environmental interaction.

My PI and I were interested in looking at interactions between different cell types and how that can affect metastasis. At a site visit, we heard a presentation by another PI, who uses collagen for co-culture of different cells. We talked to that PI, and discovered that they were using the model to study glioblastoma, while we were interested in studying brain metastasis. We were very interested to start collaborating with them and uses their system for our study. The collaboration is now underway - we're currently meeting to discuss how we can collaborate.

The feedback between modeling and experimentation was really great in our collaborations, and the insights from the biology side helped a lot in guiding our designs.

Project: revisit the Gleason grading scheme for prostate cancer (Princeton and JHU). JHU team: provide data and images; Princeton team: apply tools in statistical physics and materials science to analyze the data and sample.

One of the trans-network projects awarded by the PSOC office enabled biologists and biochemists to work with physical scientists and engineers to determine whether and how nuclear organization varied in nuclei of curable and incurable cancer

cells. Fittingly, the biologists and the physical scientists reached out to each other simultaneously to set up the collaboration. The engineers and physical scientists are responsible for 3D quantitative imaging of cells, the biologists are in charge of the hypotheses and interpreting the results, and the biochemists perform assays to determine expression levels of genes and proteins associated with nuclear organization.

Combining molecular biology techniques with statistics and modeling.

We have integrated new imaging modalities and techniques as a result of collaborations with our microscopy core. The data we have collected has helped to move our project forward and has stimulated new project directions.

I have been working in Bioinformatics Core. In 2010 the Project 2 produced a data set with a novel experiment. The experiment data includes nucleosome positioning signals genome-wide, but these signals are entangled intensively. We developed a statistical model and applied an advanced statistical algorithm (dynamic simulation method) to de-convolute the signals. The model and algorithm are successful, the de-convoluted nucleosome signals locate nucleosome positions genome-wide in unprecedented detail and accuracy. It reveals novel aspects of the in vivo nucleosome organization that are linked to transcription factor binding, RNA polymerase pausing, and the higher order structure of the chromatin fiber. The paper describes the experiment and the biology results has been accepted by "Nature". The developed statistical model and related algorithm are also very interesting and useful, we are preparing a statistical methodology paper about our model, the algorithm, their applications and further modification, etc., members: Kristin Broggard[1], Liqun Xi[2] (me), Ji-Ping Wang[2], and Jonathan Widom[1] [1]Department of Molecular Biosciences and Department of Chemistry, Northwestern University, Evanston, IL, 60208, USA [2]Department of Statistics, Northwestern University, Evanston, IL, 60208, USA K.B. did all experimental work. X. L. and J.P.W. developed the algorithm and performed the analyses. K.B., J.P.W. and J.W. wrote the paper. J.W directed the project.

We worked with a physics lab that had taken our matched cell lines (cancer and malignant) and our currently using them to study the tensil strength of the chromatin as well as chromatin accessibility.

We collaborated to learn how to extract chromatin and are utilizing it in our current research.

collaboration with cancer biologist doing research in the lab and with oncologists bringing insights in from the field

i was able to get advice on how to analyze histology of the lung samples I am analyzing for circulating tumor cells. I have also learned more about gliomblastoma from people who perform modeling

I worked with a cancer biologist from another PS-OC on a young investigator trans-network project initiated at the PS-OC annual meeting two years ago. We studied the effects of hypoxia on the force generation and migration behavior of cancer cells with respect to substrate stiffness. My collaborator ran migration experiments, and I ran force experiments on the cells.

Unfortunately, I have not yet had the chance to participate in a successful trans-disciplinary collaboration. I do hope to though in the next year.

We worked together with physicists and engineers to construct a microfabricated chip as a model of studying invasive capability of cancer cells and the work was published as a result of this collaboration. This collaboration was started as a direct collaboration between our two PIs and particularly successful because each side brought their respective skill sets to the table. The physicists were responsible for construction of the chips while we were responsible for generating the cell lines that were used in the study.

We were involved with a molecular biology/biochemistry lab that had more experience making certain DNAs than we did, while we had unique biophysical tools to study them with. This project began through a friendship between my advisor and another PI that was deepened through the PS-OC connection.

Unfortunately I have not been involved in any role of focal adhesion in 3D culture. role of alpha catenin and beta catenin in E-cadherin mediated cell junction. my role is to generate all shRNA transduced cell lines. mentors to conceive the projects. collaborators perform functional assays.

CornelI-USC collaboration CornelI with expertise in 3D tissue culture provides cell lysates prepared from different cell culture conditions and USC runs analysis of the samples

Integrating quantitative proteomic data and transcriptional regulatory networks into a single model.

As a physical scientist, we create functional microenvironment for cancer cell lines to study effect of environmental heterogeneity on cancer. Our biological/clinical collaborators study intrinsic genetic heterogeneity of cancer and apply our designed microenvironment for patient samples. Then we approach the topic of cancer evolution from both scientific and technological perspectives.

Physics and Molecular Biology/Biochemistry collaboration studying protein degradation. We are trying to characterize, on a mechanistic, microscopic level, the proteasome's interaction with substrates in an effort to understand differential processing of substrates. This is very important in regard to cancer because some of the known physiological protein substrates are involved in many different types of cancer. Knowing what signals result in their differential processing by the proteasome will likely result in understanding how we can remove them more efficiently or keep them around so that cells can use these proteins. Our physical characterization will be key to understanding the proteasome mechanism and could be a huge step forward in disease research and also will be in the protein degradation field. Physics part provides instrument expertise, with data analysis expertise, while the Biology/biochemistry provides the proteasome biology expertise and also data analysis expertise.

One found that tumor cells go into lymph nodes several days after they are injected into a mouse model by imaging techniques, and the timing is pretty reproducible. Based on their results, people working on molecular detection try to plan their sampling points to measure changes of cytokines. Also, collaborators in simulation field try to build up a model to understand and predict their results.

One of the groups in our PS-OC carried out experiments designed to understand long-range interactions between acini from the MCF10A progression series, when placed on a collagen gel. The experiments showed the formation of lines of higher density collagen between the acini. Once these lines formed, they would act as "highways", with cells moving along them, providing a mechanism for cells to communicate over long distances. There was a lot of debate within out PS-OC about how these lines could form. Some of the people suggested that there was a biological reason behind them. However, I was able to construct a computational mechanical model of the collagen that demonstrated that the line formation of the lines could be explained entirely in terms of the particular mechanical properties of the gel. The simulations were able to make predictions that matched the experimental data. The project involved collaboration between several PIs in mathematics, physics, and biology. Experiments were carried out by postdocs with a biology/physics background, and I carried out the computational simulations.

In collaboration with a surgeon, we have studied the synergistic effect of combining radiofrequency induced hyperthermia of cancer cells lines with the use of nanoparticles that have been conjugated with targeting moieties as well as therapeutic agents.

We have established a murine model of chemotherapy resistance in which some of the mice respond the therapy, whereas other mice do not due to specific genetic changes in one cohort of lymphoma cells. We then collected serum samples from mice during treatment and sent it to collaborators, who analyzed it using protein arrays and other approaches to measure specific immune responses during lymphoma development and therapy. The data from this analysis was then integrated into a mathematical model by a third group, allowing to run pathway analyses and generating predictions on important nodes in the response to therapy by either sensitive or resistant cells. We are now in the process of perturbing these predicted critical

nodes using RNAi to functionally validate the mathematical model, and also to generate additional biological data to refine the predictions.

Metronomics project initiated by a physicist that joined our lab and in which I do all the experimental part. We have learned on how to optimize dosing.

For me the primary example has been the mission of our PSOC. I have been able to perform first-ever optical measurements on CTCs. The project was initiated through our original PSOC grant.

cloning

We work with bioinformaticists to analyze large data sets we generate.

My work with a bio-statistician allowed my work to progress at a much faster rate

We introduced our in vitro technology to cancer biologists and they suggested a collaboration. We have used different cell types from them and performed experiments using our tools. My advisor initiated the collaboration and is keeping the collaboration through meetings. I perform experiments, analyze and report them. The collaborators provide other suggestions and they perform their experiments for the collaboration. The collaborators provide cells for us.

There is currently work being done with experts from three very separate fields: oncology, mathematics, evolutionary ecology. It is a great team that uses evology principles that have been around for decades and applies to them oncology. Having a math/computer scientist on the team allows for math models to be used to better illustrate the ecology principles and how they relate to cancer research.

My mentor knew what type of research gets my interest. Moreover, I gave him some names in NU that would be a good match for me to collaborate with. He knew these groups and their interests; so a meeting was held between the two groups to exchange ideas. Later, the collaboration started. My role is to do computational and theoretical calculations on their system while they do experimental work.

Large set of data was generated from Next generation sequencing project I carried. Data analysis in collaboration within the PS-OC was extremely helpful.

Project involves isolating circulating tumor cells from the blood. A graduate student in another lab initiated the project after making some interesting observations about how particles deflect over grooved surfaces. He initiated the collaboration with my advisor and his advisor, bringing together physics, fluid mechanics, cancer biology, and molecular biology teams. I was chosen by my advisor to work on the project. I have been responsible for running some of the experiments and doing the necessary cell culture work. The other graduate student fabricates the devices and built the experimental setup. Our advisors help provide direction for the project.

The goal of my project is to understand how mechanical property of cancer cells affects their migration and invasion. Two PS-OC labs having well developed technology on measuring stiffness of cells and analyzing cell migratory behavior respectively work together and have published the results.

I am currently working on a trans-disciplinary collaboration between my postdoc mentor (training in engineering and cancer biology) and another group (led by a physicist). We are actively working to combine experimental data generated by our lab with a theoretical framework developed by our collaborators. This project began last year before I began my postdoc position, so I am unsure of how the project was initiated. My role - experiments My PI's role - Cancer biology and engineering perspective Collaborating PI - Theoretical perspective Collaborating postdoc - Theoretical model development

We investigated the use of partial wave spectroscopic (PWS) microscopy interrogation of different normal and cancer cell lines cell lines to assess their disorder strength. This project (still at its beginning) may help us to globally assess changes in local nanoscale architecture (influenced by higher-order chromatin structure) of the cell lines and to correlate the results with levels of histone modifications.

A group of researchers from PSOC is helping our lab to analyze some chip-seq and RNA-seq data

My project involved mapping human nucleosomes (molecular biology). We collaborated with a computational scientist in order to develop a model that can predict where nucleosomes prefer to be based on the DNA sequence.

Our group compose of two mathematicians and two biologists. Mathematicians have developed three types of models based on biological findings from our biologists. While the model is developing, we regularly meet to show and discuss simulation results. After 1 year of discussion, we finally agree to test hypothesis generated from model simulations. We first carried out in vitro experiment and then we performed immnohistochemistry analysis in human samples. Currently, we are writing up a paper.

Engineering devices furthering biologic scientific discovery

I just joined the PSOC and don't know that much.

I helped to design novel protocols to images cancer cells with a new microscopy technique. I primarily focused on the cell aspect and helped with preparation, another trainee (from a different lab) did the protocol development and imaging, where another trainee analyzed the data.

Our lab is interested in using next generation sequencing to profile histone modification, nucleosome, and mRNA expression changes genome-wide. We have the cell lines, tools, and ability to effectively do the biological assays for the experiments. As part of the PS-OC program, we have now been able to include statisticians and mathematicians to help us in the analysis of the data. Without these collaborations we would not have the ability to effectively analyze the data or generate new hypothesis that we can test at the bench.

I have proposed a trans-network grant for young investigators this year. This was initiated when I met one of my collaborators at the PSOC symposium at MSKCC October last year. This was an outstanding opportunity to talk to PSOC investigators because the small size of the symposium provided an intimate environment to approach other researchers. Earlier this year, I have attended two conferences to present my results from the PSOC project, both of them were held in the cities where my collaborators' institutions are located. The idea generated from the initial meeting with the collaborator has elaborated in the course of our interactions during these symposiums and conferences, resulting in the proposal for the young investigators. The team composed of two computational researchers and two experimental researchers put our expertise from different disciplines to investigate an unexplored area of cancer research. The role of each member of the team is bioinformatics, computational modeling, immonu-FISH, and Hi-C experiment, respectively, any single item of which is indispensable to accomplish the goal of the proposal.

We have received funding to investigate the role of astrocyte signaling and extracellular matrix remodeling in the pathogenesis of glioblastoma. The collaboration provides us with 1) engineered models to mimic the brain parenchyma where these events occur, thus allowing controlled study of cancer cell migration as a function of extracellular matrix conditions and cell-cell interactions; 2) multiphoton imaging capabilities to track cancer cell migration longitudinally in vivo; and 3) genetic rodent inducible models of glioblastoma which provide tumor- and non-tumor associated cell populations to apply to 1) and 2). This project was initiated from conversations held at PS-OC annual meetings, and funded through a young-investigator trans-network award. The collaboration is from three labs, two at Cornell University (Ithaca) and one at Memorial Sloan Kettering.

I am part of a young investigators trans network project proposal which we hope will be funded. A graduate student with a background in computational biology has taken the lead and brought in another computational biologist as well as two biologists including myself. Our goal is to use both existing data sets as well as new data sets to examine three dimensional chromatin architecture.

we are having the collaborations of developing new method for genomic wide study based on nano technology. We were from two very different labs and making use of our advantages respectively in the projects. Though it's tough in the developing step, the future of the project is quite nice and would benefit both researchers and cancer patients.

suggestions from collaborators regarding transfection of lysyl oxidase in cells; as a result of suggestions, new collaboration with stem cell center to produce viral vector of lysyl oxidase

Mathematicians and cancer biologists working together to analyze gene expression data from cancer cells in an effort to infer the presence/absence of gene interactions between all pairs of genes.

We developed software collaborating with a team of software engineers in Turkey. This is a visualization software for cellular pathway data. Both parties were involved in design and development.

We wrote some theory to describe experiments of a PSOC member. As a result we had nice discussions about the subject.

Our collaborators got the data on growth and death rates of glioma cell lines under different concentrations of drug by experiments. We analyze the data and estimate the quantitative relationship between the drug concentration and tumor growth and death rates. We got these data for both drug-sensitive and drug-resistant clones. We are going to infer optimal treatment schedule for glioma by using these data. This study was initiated by PIs' communication.

I work for bioinformatics core. The project 2 developed a chemical approach for nucleosome mapping with potential single-base-pair accuracy. But the nucleosome signals produced from the approach are intensively convoluted genome-wide. We developed an advanced statistical model and the related algorithm, successively de-convoluted the entangled nucleosome signals and achieve true single-base-pair accuracy. The results will be published on the journal "Nature" (published online on June 3). there are four members, the leader of the project 2 directed all the process. The director of the bioinformatics core directed the math and statistics part. The graduate student (supported by PS-OC) did all the experiment work. I did all the calculation work including co-developed models and algorithms. Four of us communicated very frequently, almost every day during the period.

We have been in collaboration with a nanotech lab to develop nanoparticle targeting ligands for analyzing chromatin structure. Our lab does all of the cell work and treatment, while the other lab provides the functionalized nanoparticles.

Please provide any additional comments that you would like to share about the convergence of physical sciences in oncology or the PS-OC program.

Admins

The umbrella of the Physical Sciences-Oncology Network has lowered the "energy of activation" required to introduce physical scientists to cancer research and has created an environment that is conducive to new insights into cancer. This concentrated and concerted effort could not be replicated in the context of an R01, nor would this unique training environment for the next generation of researchers be possible without Center support. This U54 mechanism has spurred unexpected collaborations and given rise to important discoveries on the molecular level that significantly our knowledge of how cells manage information and how this process is altered in cancer.

Advocates

I've heard that some PS-OCs are focusing on the specific tools or furthering existing projects rather than developing new concepts on the physical aspects of cancer. I think the concepts are most important to create a whole new way of approaching cancer that is focused on getting results to patients.

I believe in this program; if I didn't, I wouldn't devote so much of my time to this effort. Transdisciplinary, collaborative research is the future of science, and the PS-OC is instrumental in bringing this approach to cancer. The PS-OC has enabled scientists who have never worked in cancer research before to explore this area, and I believe it is through efforts such as this that true breakthroughs will be made.

having been to one meeting, I was impressed with the attention given by other disciplines to each other during presentations.

This is a very innovative program and should serve as a model for future efforts to promote transdisciplinary research beyond cancer research. Important ripple effect for participating investigators to "spread the gospel."

External

As I mentioned before, leadership positions should be given to those who have strong understanding and experience in both physics and biology. There are such people, and they should be funded - not those who are strong physicists with little knowledge or experience with biology or biologists with little knowledge or experience of physics.

I believe this is a worthy area of exploration however, I think it may have been better idea to begin with individual grants instead of these centers—they plain and simply do not collaborate—I have tried. I believe pairings of scientists across disciplines, facilitated by the program would be highly beneficial.

Only 2 of the 12 (Princeton and ASU) are run by physicists. Fully 6 are at medical schools. These results are not consistent with the stated goal of a new theory of cancer.

I only heard about the first awards and the goals of those who received funding, but nothing of the accomplishments so far.

(1) I hadn't heard that the program was off the ground, despite having been at one of the ThinkTanks, so evidently the PR and networking aspect of the program is nil. (2) The PR problem may have two inherent problems: a) Physics, evolution, and integrative biology seem like 3 unrelated subjects, rather than a single new field. So to their publications support, e.g., "the tumor evolution field", rather than "the field of PS-OC". b) PS-OC is more of a mouthful than "Oncology Physics". But I know your goal was something like physical tools + physics-like mathematical analyses, and I can't think of something more

precise. "Soft-matter physics of cancer"? (Taking the name from the new subjournal of Physical Review.) (3) I'm glad the idea of "testing dogma-challenging hypotheses" made it into the list of important aspects of the program. But I'm dubious that any such application would survive, especially if the application is handed off to programs like R21 or Eureka. I believe the only solution will be to have a Study Section devoted to dogma-challenging and risky projects, with members chosen for having done such things in the past and for having some physics background. There are two reasons: a) The well-known risk-averseness of regular Study Sections and b) The idea of identifying and testing a crucial point is central to physics, whereas biology is focused on saturating a small area of research with reliable measurements.

It has been difficult to get "senior" people to take this convergence seriously. The "physics" revolution in the early 1900's was initiate by very junior investigators with some very radical ideas. Would be useful to somehow recruit much younger physics types into this program.

More funding and education programs in this field will be more appreciated.

My Take Major Home from the Meeting: I did not feel that a unification of physical science and oncology was evident during this meeting. It seemed to me that the physical scientists and the oncologists were speaking different languages and simply coexisted because of the funding glue. In many cases they seemed even unaware what exactly their collaborator was doing. Possible one or two of these projects will yield new insights. Perhaps the most successful in my view was the one led by Denis Wirtz, where they are investigating morphological parameters related to cancer and gaining insights from the correlation. A UNIFYING THEORY: the ECM inhibits the expression of genes for cell migration and proliferation and induces those for differentiation. We've known this for years by the work of Mina Bissell and others. But now I'm thinking that it may be the primary effector, rather than gene expression, in contrast to the model that cancer can be simply explained by genes gone rogue. ECM ages and therefore provides a direct correlation between aging and cancer. For instance, the model would be that the ECM breaks down, the cells associated with it become less adhesive, released from these constraints, they can proliferate or migrate. In a discussion with Larry Norton he told me that one of the best predictors of breast cancer is the density of collagen. Can the physical chemistry of ECM aging be characterized? Therefore I think that a deeper investigation of the ECM is the most fruitful approach rather than more genetic oriented studies.

I was a reviewer, and I strongly support the NCI and the program directors' efforts in this direction. Indeed, I believe it is crucial beyond what is advertised, from my own research in Angiogenesis supported by an NIH RC4 NEI targeting predictive modeling of diabetic retinopathy (which has a strong cancer direction, mainly due to the experience of the NCI review panel, and the realization of the transdisciplinary influences.) As I learn more about reprogramming in health and disease, I read more cancer research/survey articles to find my way around my own research which is not officially cancer research, but clearly overlapping in a major way with questions from cancer biology due to the approach that I have from integrating my background from the physical sciences and biomedicine. The complexity of what we call cancer is surely far beyond what present biomedical scientists realize, unless they could get solidly grounded or closely connected with the physical sciences for a sustained period of time. I have not personally applied to NCI, but I find the directions of PA at NCI to be far reaching to the roots of cancer and related biology in unquantifiable, but quite clear manner. Maybe there is need for strong funding of physical-science based research on cancer+XYZ diseases, where XYZ are other diseases that arise due to similar biological/mechanistic/genomic processes. Such a research sounds more challenging, but its success will require "seeing the forest beyond the trees", as history of science in physics, mathematics and engineering reveals....

I have been invited to the workshop at NIH several times but the invitation comes so late (6 weeks before) that I already have plans.

It seems the PS-OC aims are laudable, but the teams and Centers I have seen established did not really have an impact and failed to meet the original goals. It might be better to have individual projects rather than centers in the future.

The entire effort emphasizes too much on technology and too little on ideas and intellectual exchanges.

here are some additional questions that I don't know the answers to: 1. how many PS-OC investigators had never before received NIH or NCI funding? 2. Why was a U54 mechanism chosen? Why not start with something smaller (R21 or R01)?

My primary knowledge/experience is derived from nanoscale science and engineering opportunities, so I have important but somewhat limited perspective.

PS-OC program is more focused on the centers they have. And the centers are located in the proximity of well-established Cancer centers where the researchers from the Cancer centers are already well-funded and have collaborators. I would like to see PS-OC program give small 300k-400k funds like NSF to new researchers.

The new conceptual framework of somatic cell evolution needs to be revolutionized. The genome theory of cancer evolution is the key.

In the US, molecular biologists are obstructing most efforts in this regard under the claim that they, and only they, "understand" Cancer. After a century of searching for those "f....." mutations that "cause" cancer and 200 billion dollars plus of investment they have come up with zilch. This means that the somatic mutation theory has been a failure. Unless the NCI cut significantly the funds now being used to find those mutations and what they may be doing in cancer cells, your efforts will go nowhere. The incorporation of the physical sciences is promoted under a different paradigm that proposes that cancer is a tissue-based disease (like development). To accept this notion, you know who will have to go from the NIH/NCI. This change will happen over their dead bodies. As probably you, I also know how politics works... But unless the ideas about carcinogenesis change to center on the physical sciences (as proposed by the Tissue Organization Field Theory), your impact will be minimal no matter how much datasets you incorporate into your program.

It is important to build up this field and strengthen transdisciplinary collaborations. Also, clear language communications with health professionals, scientists, and research university leaders who are not directly involved needs to be improved.

I participated in one of the think tanks. I thought that there were many participants had no clue that a new theoretical framework was needed. The main assumption was that just putting together physicists with biologists was enough to tackle the problem of biological complexity, while what we need is a new theoretical framework. In spite of this, we formed a stellar team and applied. The review process was dismal. They told us that our theory was unproven...Well, if it was proven, why would we apply? In the informational meeting we attended, it was made clear that the review criteria would be different from those of regular study sections. However, the SS showed the same reductionistic, molecular bias that the NCI was explicitly trying to avoid. The NCI should make an effort to bring theoretical biologists into the picture.

I have not come across a definition of the PS-OC program. Have not noticed evidence for much enthusiasm for PS-OC among colleagues. Have not been approached by PS-OC for input, collaboration, or participation in workshop. Could be due entirely to my lack of reaching out to them.

We are still early in the process of understanding how the physical sciences impact on cancer understanding.

Up until 3 months ago, I was unaware that this program existed. And now that I am aware of it and have looked into it, it's clear it was pointed to a few sites only. I can tell you in the world of stem cells and in the tumor microenvironment, the integration of physical scientists w/ current cancer biologists is very foreign, I just attended the TMEN meeting, and did not see one presentation or poster that integrated any form of physical science into it.

I applaud the effort since cancer is really a disease of improper sensing of the microenvironment and little is known about that aspect of the disease. The issue now is showing some success in the understanding of the disease or treatments so that

people will take it seriously and will devote effort to understanding how the cells actually respond to their microenvironment in both the normal and cancer cases.

Quite a few research areas within PSOC are only somewhat physical. Some just use physical methods, but for standard cancer cell biology studies. Biologists even within PSOC have not always committed to learning enough math or mechanics to be optimal collaborators. This will likely come with time, and this is one of many reasons why PSOC's need to be sustained and increased.

The area has the opportunity to be very important, but the basic idea behind it of "let the community come up with the ideas" will not—I think work. The problem is that the cancer biology community seems only to collect genomic data (since that's easy to do, and everything else is hard and requires difficult new programs—which will probably be rejected by the peer review community), and physicists simply cannot handle a data/fact-rich field, and basically spend their time making physical measurements of familiar sorts. All this activity is the familiar "sausage-making" that the field of science is so comfortable with. Based on limited understanding of the field, it does not seem to be making much progress in coming up with new approaches. The view of "cancer" has shifted dramatically in the last decade: from "cure" to "management," from "intervention" to "informed choice," from "tumor" to "metastases," from "genomics" to "epigenetics," and so on. There are very important problems in these new areas that combine physical science, biomedical science, and the clinic, but I simply don't see how new ideas are possibly going to emerge in any finite time from the conventional NIH process. "Business as usual" is simply not going to produce radical change. Competent, well-meaning, conventional scientists are going to require that new ideas be generated (somewhere, by smart, broad, imaginative people) and then forced on them. DARPA may be a better model than the RO1 (which has ceased, in my view, to be an effective way of doing anything *really* new).

The PS-OC has been hijacked by the molecular biologists and geneticists. Unsurprising, but has largely undone the novelty of the work funded. Too much of an old-boys network (a few sterling exceptions like Moffitt).

The lack of top notch expertise at the NIH program director level, paired with a less than entrepreneurial mindset for the majority of the midlevel administrators, forces the admin people to heavily rely on the results of the peer review. However, cutting edge research - such as PSOC - by definition has few peers, hence the very notion of peer review in these emergent areas is ill conceived as almost everybody in the nascent field applies for the few programs available and thus only few capable are left to review these important applications. The NIH should hire, retain & promote expertise and then administer the program along the lines of DARPA which assigns more power to program directors; to incentivize administrators to educate themselves and take risks, promotions should depend on research portfolio performance metrics (not unlike in private industry). As to external reviewers - any NIH grantee should, as a condition to his/her award, sign on to serving on say 3 review boards - together, this would reinvigorate review - in addition to providing more such programs. The NIH should ask for matching commitments - in funding, i.e., dollars, not space - from the submitting institutions. This would force a concerted team building effort prior to an application ever hitting an NIH desk (- thus likely facilitating the take off at post-award and also accelerating cross-award collaborations), and demonstrate commitment from the institutions' admin to support the program in addition & beyond the lifetime of the grant. It is inevitable that this research is funded exclusively through taxpayer money without any commitment from the very institutions which would then own & monetize the intellectual property derived from this work. No wonder the institutions encourage their investigators to send volume instead of quality as their is no risk involved for them ... The NIH generally does a good job on meetings, workshops and to some degrees on fellowships (although we need more of them). However, the NIH does an - awful - job in supporting infrastructure tool development long-term. For many of the PSOC (and similar) projects, integrative databases & repositories are needed which must be supported longterm if the community should thrive. The peer review process is the wrong mechanism to provide support for tool development and maintenance. Rather, the NIH needs to do this through contracts. Work with industry should be even more encouraged - we have to do a better job in public-private partnerships to ensure that the translational phase for the innovation coming out of these programs is smoother.

Finally, there has to be something like the R21s that is dedicated for high-risk projects, attached/not-attached to larger grants, such as these centers, and that is reviewed expedited - beyond of what the NIH is capable now. Innovation thrives on speed to execution. The original idea behind the R21s was excellent - unfortunately, as RO1s became increasingly difficult and random to get, everybody applied for R21s with the consequence that they were reviewed as RO1s. The NIH needs an expedited mechanism for high-risk/high-reward to go proof-of-concept - milestone driven - and reviewed as such. I am sure there is much more - but tackling some of what I listed above would be an important start.

We need to define the problems of intellectual interests. I believe that there are opportunities. I involved with the generation of computational biology. I like to partner with someone to work on physical cancer biology.

I suggest broadening the view to more explicitly encompass engineering, which focuses on analysis and control of complex processes within the context of physical constraints and laws.

From the early work of Mina Bissell, Don Ingber, and their students I've been aware of the connection between physical mechanics and oncology but had not been aware of the efforts of the PS-OC until the last year.

I am not convinced that distributing funds to a few large collaborations is the most successful way to grow a successful Physics-sciences-oncology interface. I think that it would be better to grow the field through an evolutionary mechanism which starts with initially numerous small (maybe R21) grants, subsequent evaluation and further funding of the most successful projects and so on. This way the program would reach more scientists, generate more new ideas and directions, and award ingenuity versus large scale complex operations with a small or no track record in the field.

As an evolutionary biologist/population geneticist, I feel that by classifying evolutionary biology as part of the "physical sciences" creates a very serious barrier - evolutionary biologists will naturally assume that the program has nothing to do with them. I would argue that the integration of evolution into the study of cancer is so important that a much more appropriate name would be "physical sciences and evolutionary biology"-OC program. When I started this survey, I was not certain that evolution was still being considered as part of the program - and I had attended one of the workshops!

look into information theory: http://alum.mit.edu/www/toms/

Outreach and Dissemination

The network needs to be given time to develop and grow. The weak ties that were formed by setting up the network as a collaborative/cooperative superset, rather than a collection of competing teams, were extremely valuable in ways that aren't necessarily being counted by the various trans-network reporting metrics. Moreover, a particular centers tendency towards collaborating within itself shouldn't be seen as a reflection on the long term value of the network.

PI/SIs

I think that the PS-OC is only now beginning to gel, and its true output will be meaningful in the next 5-10 years. The difficulties in speaking with one another across disciplinary boundaries was far more significant than initially appreciated. In retrospect, the physical scientists needed a 3 or 4 day intensive primer on cancer biology (by experts not related to the PS-OC, rather than hour long talks of individual projects by PS-OC SIs), and the cancer biologists needed a 3- 4 day course on physical/statistical methods, taught at a graduate school level. The modes of "educating" the PS-OC faculty was suboptimal, with didactic seminars for the PIs and SIs that rarely trickled down to the faculty and staff doing the experiments. Also, the continual "tinkering" with format (three different forms of competition for trans-network projects, including a "speed-dating" approach in the first year), undermined credibility, and it was difficult for cross-disciplinary teams to form, mature and produce

effectively, because each time the rules were different. The turnover of dedicated NCI staff, and emphasis on process also made it more difficult for faculty at different PS-OC to be able to plan large scale collaborative and longer term experiments, and to propose and complete really inventive science that takes advantage of the unique attributes of the PS-OC, i.e., putting thought leaders in the physical sciences together with strong cancer biologists. I think that the productivity within each PS-OC is beginning to blossom, as individual investigators become more comfortable with each other's styles and skills. This model (scientists of different disciplines, and in different locales) would never have been possible 10 years ago; there are still some challenges of conducting science at different sites, and more movement of faculty (not just students) for short sabbaticals should be encouraged. However, during the last 3 years we learned a tremendous amount, and I think that the real pay-off is in the near future, as we have now begun to communicate and effectively plan experiments together. The Trans-network approach is invaluable in promoting truly game-changing science, and this is to be applauded; however, there needs to be consistency so that faculty will commit themselves to proposing and carrying out these cross-disciplinary studies.

This is the most stimulating and enjoyable program I have ever worked within or with, it must continue!

By focusing on physical science, the program has missed the opportunity to involve stronger insights from astrobiology, developmental biology, ecology and evolutionary biology. The program was flawed by setting overly-defined experimental goals at the outset, before sufficient attention had been given to formulating the much-touted new hypotheses, new techniques and "out-of-the-box" thinking on which the program's concept was founded. There are too few radically new ideas being pursued, and too much data-gathering and curve-fitting for its own sake.

I have been highly committed to this transdisciplinary approach for more than a decade...so the PS-OC concept is not a new one...but it has made a serious impact on the next generation of scientists.....I can see this at my own institution and also at other institutions...and i have experienced a greater and greater level of excitement for this type of team science whenever i travel and give talks at meetings and institutions....this I can see increasing every year...this type of endeavor takes time....my biggest compliant with the network...is the extent to which it is micro managed....to the point that it gets in the way of executing the science...that and the incredible frustration with the nitpicking of reports....funding justifications... etc...huge amount of calls and busy work.....this only serves to frustrate folks....that and the level of science is very un even. With some scientists being superb and others very mediocre.....personally I have decided rather than be busy busy busy with a dozen collaborations that I will pick and choose carefully to collaborate with those scientists i seriously respect and whom I can work with to truly change cancer paradigms....and this is finally happening. And for that I am quite grateful

Princeton University has basically ignored this program. This is my greatest regret; as far as the University is concerned we don't exist.

The diverse centers represent a broad patchwork of disciplines and it is impossible to expect that they would converge around single themes. However, stochastic interactions among the younger members have greatly increased the potential for trans-disciplinary studies. Because the younger members of the Centers are most likely to generate tangible benefits from this program, i.e., by developing new language and new paradigms, this will take time to develop.

Project Investigators

Need better research funding opportunities for emerging scientists in these fields. Can be difficult for a young Co-I level scientist to obtain funding in traditional fields (e.g., mathematics or biology) for team-based science where the young scientist is the leader. Joint, multi-institution proposals often require very senior co-PIs (one high-level PI per institution), leaving the young emerging scientists with little *formal* / *recognized* leadership opportunities. Single-institution and smaller-scale grants can have a junior scientist as a Co-PI, but it is much more difficult for a young "integrative" type of scientist who wants to lead a joint biology-pathology-modeling-clinical sciences effort.

I think this program is a great initiative and has open the door to new collaborations. Unfortunately, our group suffered from isolation and lack of interest from the main PI, making us look for collaborations outside our network. I would recommend the NIH and the program managers to have a stronger control on where they want those programs to focus their attention to and limit the power that PIs currently have. This tends to create a hierarchy that is counterproductive for team work, especially when multiple expertise are being mixed.

Most serious problem has been instability resulting from uncertainty in next-year budgets which has forced prioritizing of support. Reducing the budget by a few percent per year is a poor way for the funding organization run the program. It is much better to plan ahead of time to permit predictable funding of multi-year projects, especially when they are obviously highly productive.

It has been a very interesting and productive experience to be part of a PS-OC. I hope that the program is continued and that our PS-OC continues to receive support.

Since I have started working with Dr. Robert Getzenberg on the PS-OC project I have opened up new research collaborations with Dr. CC Li at UPITT department of Electrical Engineering and Dr. Anant Madabhushi of the department of Biomedical Engineering at Rutgers University working on computer-assisted Gleason grading using automated imaging technologies. We have used two approaches to resolve tissue and nuclear structure utilized a variational adaptive contour segmentation model (AdACM) from the Rutgers group and the cardinal Multiridgelet transform (CMRT) based texture analysis from the University of Pittsburgh group

This program has given a very significant boost to engineering in cancer. Prior to this program, it was difficult as an engineer to receive cancer funding unless that research was for drug delivery applications. I believe this has opened up an entirely new field of research which can be seen in the rising popularity of cancer at the MRS, BMES, and APS meetings in addition to many engineering journals.

I would like to see an increase in the pilot projects.

The intentions of this program were great and the program staff are invested and enthusiastic. Although not apparent from my answers, I benefitted substantially from this program, through interacting with other researchers and new investigators at my own PSOC. I learnt a ton and hope to establish new collaborations in the near future, but I currently only have one graduate student working on a PSOC funded project, so one cannot expect the world with that type of resource. I personally find trans-network projects difficult to accomplish because I only have a 50% research appointment and this requires substantial time, which I wish I had to invest in making these collaborations work (or the people to put on projects so they can progress). The biggest frustration for me was lack of funding and the budget being cut all the time. Insufficient funds were given to investigators for the studies - research needs time and people and people cost money and the funds were not provided for fledgling investigators like me (who need people and money to do the research more than anything) to make the progress, establish collaborations, get preliminary data - all of this required people and supplemental funding from other sources, which I just did not have. I also think the expectations were phenomenally high for this program. Things take far longer to come to fruition than one would hope for (good work can be agonizingly slow) and I think you need to invest far more time and money into the research for this program to be the success you would hope for.

The PS-OC program represents a revolutionary approach that holds out the best promise of elucidating the complexity of cancer. Without the expertise and tools from the physical sciences, the field of cancer research would revert to a biologically-focused approach that has proven insufficient to integrate this complexity into a system-level understanding.

we have built strong bridges between Mayo and ASU that will have effects far beyond the PSOC - that in itself is remarkable. Our lab staff feel the same way.

There are not many funding mechanisms like PSOC exist outside PSOC. Even though some of them disorganized exist, the reviewers are usually out of expertise and have no idea how to review. Therefore, it would be difficult to push this type of effort efficiency outside PSOC. However, the Physical Science approaches are extremely critical for the cancer research. Without this type of research to balance out the general view of cancer research, the development of successful, comprehensive cancer research won't be optimal.

I have worked in labs that were on the fore front of developing targeted therapies for CML and other cancers and though targeted therapy is very successful, resistance to therapies has been an ongoing problem. While understanding specific drug/protein interactions is important understanding the wider signaling networks and learning how to interfere with dysfunctional signaling in cancer cells seems the most logical effective method to achieve real results for cancer patients. To better understand the signaling pathways and their effects, systems biology and model building must occur. These network signaling systems are highly complex and overlapping and often appear to give us contradictory results. The staggering amount of data that has been generated in recent years seems to highlight the point that the systems biology approach to complex problems requires larger collaborations with well thought out projects and focused goals. Partnering physical scientists with cancer researchers and oncologists makes great sense since after 50 years using the same old methods has not succeeded. If we were trying to build an automobile for fifty years with very little success would we continue using the methods to build that automobile? I have seen in the literature other labs that are beginning to adopt similar methods of building and testing in silico models of cancer as well as forming larger hypothesis driven collaborations to attempt to solve otherwise intractable problems. I have lost many family members to cancer and have a stake in helping to find the best fastest solutions to this dysfunctional aspect of evolution and from my experience the PSOC seems to make a great deal of sense. I am glad and excited to be participating in this cutting edge experiment and new approach to science. Supporting the collaborative and community wide approach to solving the big complex problem of cancer makes much more sense to me than hoping that the isolated super genius will figure it out on their own in a lab funded by competitive grants that create a more hostile approach to collaboration. While competition is critical and conducive to pushing progress forward it is clear that this approach has failed cancer patients in the wider community. Our ancestors eventually learned to hunt together for survival. We now need to work together and use all our technologies and resources to find real and meaningful solutions to the problem of cancer. The PSOC is a step in the right direction.

I wish that the biology colleagues would be more open and willing to share their perspectives with the physicists and engineers.

I think collaboratory projects may have been better picked if there were outside reviewers.

Trainees

Don't kill it!!

This has been an excellent program and really has opened up many new opportunities and research directions for me, as well as crystallized the research I would like to pursue as future independent faculty.

more funding is imperative

Our center comprises 3 huge institutions (Berkeley, LBNL, UCSF). If I can find collaborations at these places, I'm not likely to go all the way to Boston for a collaboration. I can get work done much faster and effectively if I can physically meet with the people I'm working with on a regular basis. People don't do things for you when you're a grad student and they are in a lab all the way across the country.

While I'm very enthused about the PS-OC, I think extra attention needs to be paid to how the many 'out of the box' and exciting ideas generated by physical scientists in oncology are perceived by cancer biologists. My impression is that biologists perceive ideas from the physical sciences far more dubiously than is appreciated publicly or by physical scientists; or at least, when the disagreement is realized both sides decide to politely ignore the other's opinion and think the solution will be to just see which horse wins the race. Behind the scenes, I think biologists believe physical models are fundamentally wrong because they rely on imperfect assumptions and ignore both the complexity and long history of biological research in cancer, while physicists, behind the scenes, believe that biologists are destine to fail because they study only the most specific pathways, cancer types, and properties of cancer without formulating principles that can generalize beyond their cell lines or mouse models. In reality, if our theories aren't both grounded in reality and generalizable, physicists and biologists will fail. This negative attitude of our peers is missed in grant writing and at conferences because both biologists and physicists know they'll catch more flies with honey than vinegar. We use a conciliatory tone: biology is becoming one great collaborative confluence of faster sequencing, more powerful computers, new imagining, smarter minds, better theories, and new biological techniques; hence, "we're on the precipice of great things, please fund and cite us." The ideas and techniques that we distrust are conspicuously missing from our writing because pessimism doesn't attract money or newcomers. If we're not collaborating with someone in our own field, who uses complimentary approaches, its often not because of a lack of awareness or incentives, it's because we disagree. But don't take my word for it: compare a typical publication or grant received with a peer-review or a typical after hours conversation about the research of a scientist's peer (If these recourses are obtainable). The first two invariably have a positive tone, while the latter discourses are far more negative. Disagreement is good for science, but we do ourselves no good if it is a secret. I think the PS-OC could do a few things to help. First, the PS-OC should challenge biologists and physical scientists to publicly air, perhaps at this conference in April, their main criticism and solutions to physical approaches and likewise challenge physical scientists to attack biological methodology in a similar fashion. Criticisms could be either specific or general concerns, but the argument should be a Socratic debate rather than veiled grudges. I think a general request to audiences to speak their concerns, or even a specific session on only this issue would be awesome. Secondly, I'd place a specific onus on biologists and physicists to address the criticisms of their counterparts and enlist their support. Physicists lack the time to learn every biological detail out there and biologists weren't trained to critique esoteric equations; we can't just deride each side's finite knowledge, good ideas transcend this problem.

It has been a very enriching experience for me. Besides helping me understand cancer better, the program has definitely helped broaden my knowledge base and skillset. Thus, the program has molded me into a competitive interdisciplinary researcher.

We really did not encounter the problem in J2, but I have to enter something in order to submit.

I think the program is great to bring scientists from very different areas together to work on a particular problem. There is a learning curve required for everyone involved to understand the different approaches and how to optimally use them for the PSOC project and beyond, which makes them at least initially less efficient than single center projects on a non-transdisciplinary problem. But overall the collaboration is very fruitful and inspiring and enables projects which would be impossible to do for a single researcher.

I work in a very dysfunctional PSOC group (Princeton PSOC) were PI's don't get along. There are major issues on how PI's communicate with each other and how they work together. This affects the work of postdocs and grad students as we are not allowed to share information about experiments or projects. Even if we want to work together (students and postdocs) we're not given the freedom to do so. There are other major issues in my lab too, such as lack of good mentorship and restricted access to proposals in which my name has been listed as participant.

From a research standpoint, I think the PS-OC initiative is awe inspiring. However, I think the biggest break throughs in the treatment of cancer are reliant on changing the way new drugs are developed for use in clinical trials. As a physical scientist

taking in all the points of view at the annual meeting, the most helpful things are the evolutionary models of drug resistance and the CTC detection/monitoring in patients. I am not convinced that the biophysical cell assays on hard surfaces are providing new insights as evidenced by the seminal literature produced by other PSOC members on the role of the ECM in cancer. The main success of the PS-OC is putting cancer research on the map for physical scientists and providing a new means to predict things like drug resistance and the potential for the real time monitoring of metastasis through the vasculature.

Most of our project leaders are assistant professors, whose primary concern is tenure. Therefore, all the collaboration seems to connect through them. I think that senior professors should get involved in encouraging other collaboration. For postdocs over 5 years, who are not qualified for young investigators, it is still challenging to initiate collaborative work.

I believe that there has been a disconnect in the definition of physical sciences within the PSOC community. At the recent annual meeting there were very few projects that were truly utilizing physical sciences. I saw three types of projects presented: medical physics, systems biology, and occasionally the true physical sciences biology. Many of the projects that were presented were systems biology where pure biology projects were supported by mathematical models and systems approaches. Another large set of presentations were utilizing medical physics where new micro and nano technology is applied to biology. Both of these sciences, systems biology and medical physics, while obviously important are not what I believe to be physical sciences biology. I only point this out because of the monetary component of research today. Money is obviously tight and getting high risk new idea research funded can be very difficult. In this light, there is a relatively large amount of available grant money for genetics research, pure biochemical research, systems biology, and medical physics. On the other hand there is very little available money for the brand new concepts of integrating physical sciences with biology. Acquiring the money for the PSOC was an amazing accomplishment in the way of getting money for previously unheard of research. In this way, I do not think that the money from the PSOC is being utilized correctly. We should not be using the PSOC money to fund the "more of the same" research projects just because they are now using math models or nano technology. The money should be allotted for true physical sciences research: Newtonian biology, biological thermodynamics, electromagnetism and electrokenetics, biological physical mechanics, etc... I just hope that this unique monetary opportunity will not be exhausted on not unique research.

Thank you for the opportunity to participate.

I feel the program has been very effective to date. In addition to the collaborations already established, the annual meeting has been extremely educational to introduce me to existing resources which may provide value in future research.

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