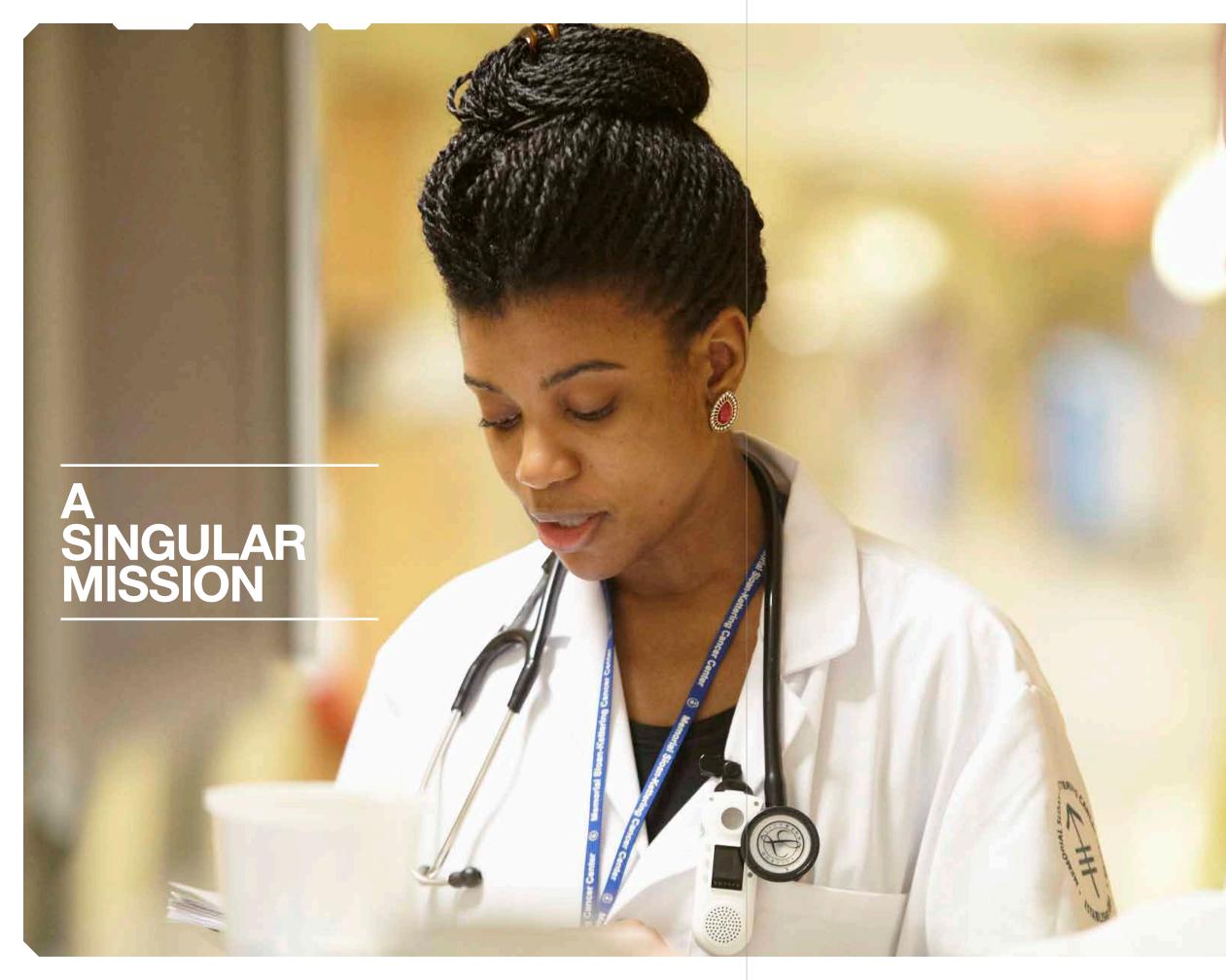
Memorial Sloan-Kettering Cancer Center





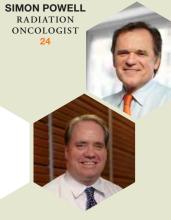
Nurse practitioner Naomi Cazeau, of the Adult Bone Marrow Transplant Service.

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The clinicians and scientists of **Memorial Sloan-Kettering share a vision and** a singular mission – to conquer cancer.

They are experts united against a complex disease. Each type of cancer is different, each tumor is unique. Set free in surroundings that invite the sharing of ideas and resources, they attack the complexity of cancer from every angle and every discipline.





SCOTT ARMSTRONG PEDIATRIC ONCOLOGIST

TO CONQUER CANCER

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A complete version of this report which includes lists of our donors, doctors, and scientists is available on our website at www.mskcc.org/annualreport.





ALEXANDER RUDENSKY IMMUNOLOGIST



STEPHEN LONG STRUCTURAL BIOLOGIST 20

> ETHEL LAW NURSE PRACTITIONER

CHRISTINA LESLIE COMPUTATIONAL BIOLOGIST

JORGE REIS-FILHO EXPERIMENTAL PATHOLOGIST

Letter from the Chairman and the President

In 2012 the leadership of Memorial Sloan-Kettering endorsed a \$2.2 billion investment in a clinical expansion that will set the stage for a changing care paradigm into the next decade and beyond.

This decision occurred against a backdrop of strong financial results, new clinical leadership, and new collaborative relationships. These actions position Memorial Sloan-Kettering for a future in which we have every reason to believe we will witness historic progress against the complex set of diseases we know as cancer.

There are several tangible components of the clinical strategic plan, among them an outpatient cancer care building that we plan to develop along the FDR Drive at East 74th Street in conjunction with Hunter College of the City University of New York. The project, currently under review by city planning authorities, would enable us to provide cancer care in a facility designed to adapt to the ways in which cancer will be diagnosed and treated in the coming decades. We will provide leading-edge treatment for patients with hematologic cancers such as leukemia and lymphoma, head and neck cancers, and thoracic cancers. In addition, the facility will support our efforts to provide bone marrow transplants in the outpatient setting and provide a focused environment for early-stage clinical trials. The MSKCC building would be located next to the future home of Hunter College's new Science and Health Professions building and its School of Nursing. The acquisition contract is contingent upon the necessary land use and zoning actions required for construction of the two proposed buildings.

Other elements of the capital program include the Josie Robertson Surgical Center on York Avenue, which will feature 12 operating rooms equipped to provide technologically sophisticated surgical care on an outpatient basis. The certificate of need was approved in 2012, the structure that was on the site has been demolished, and construction has begun. Also close to the main campus, MSKCC is planning a new facility that will house a clinical laboratory and research building and will accommodate all specialized testing, along with a cell bank, a cell therapy facility, and tumor procurement services. Regional investments include a 114,000-square-foot ambulatory care facility in Harrison, New York, that will offer advanced cancer care to area residents, closer to home. A "topping-off" ceremony took place on December 20 as the final steel beam of the structure was hoisted into place.

Douglas A. Warner III



Boards of Overseers and Manage

Craig B. Thompson



These programmatic investments require leadership and vision. Our new Physician-in-Chief, José Baselga, joined us on January 1, 2013. An internationally recognized physician-scientist, he comes to us from Massachusetts General Hospital (MGH) where he was Chief of the Division of Hematology/Oncology and Associate Director of the MGH Cancer Center. Dr. Baselga is no stranger to MSKCC. He completed a medical oncology fellowship at Memorial Hospital and remained as a faculty member on the Breast/Gynecology Service from 1994 through 1996, after which he returned to his native Spain. His responsibilities include the management of patient care delivery in Memorial Hospital as well as at MSKCC clinics and regional sites. Dr. Baselga will also focus on clinical strategic planning and will oversee clinical and translational research. He succeeds Physician-in-Chief Robert E. Wittes, who stepped down after a decade of exemplary service.

Thomas J. Kelly, Director of the Sloan-Kettering Institute for the past 11 years, announced that he would be stepping down as of March 1, 2013. He is returning to full-time research and will remain an SKI faculty member. Dr. Kelly joined MSKCC in early 2002 and led the largest expansion in SKI's history to broaden the scope of its basic and translational research activities and focus on the most promising areas of biomedical research as they relate to cancer. A search committee is actively recruiting his successor.

We are pleased with our financial results for 2012, particularly because our operating results for 2011 included non-recurring prior year gains. Our clinical volume continues to expand and, in a sign of our strength as an organization, MSKCC was able to issue 40-year taxable debt at attractive rates — the first such issuance by a not-for-profit. These and other bond financings will be used for the major clinical expansion program that is currently under way.

At MSKCC's 33rd annual Academic Convocation in May, we celebrated an important milestone when the first four graduates of the Louis V. Gerstner, Jr. Graduate School of Biomedical Sciences received their PhD degrees. The school admitted its first class of six students in 2006 and has become one of the premier training grounds for cancer biology and a model for training biomedical scientists. Today, more than 50 students are engaged in thesis work in the laboratories of our faculty. Six more students will graduate in May 2013.



The dedication, energy, compassion, and creative spirits of the men and women of Memorial Sloan-Kettering are what power this extraordinary institution and make us thrive." In a striking example of the integration of clinical studies and fundamental laboratory discoveries at MSKCC, the US Food and Drug Administration announced in August that the drug enzalutamide had been approved for the treatment of men with metastatic prostate cancer. The results of a large, multicenter phase III study, led by an MSKCC physicianscientist, showed that enzalutamide significantly increased survival in men with advanced disease. Investigators led by Howard I. Scher, Chief of MSKCC's Genitourinary Oncology Service, first presented these findings at the American Society of Clinical Oncology's Genitourinary Cancers Symposium in February 2012. Laboratory work conducted by Charles L. Sawyers, Chair of our Human Oncology and Pathogenesis Program, and colleagues was instrumental in the development of this novel therapy. The basic research that resulted in its development, and the collaborative efforts to bring that discovery into a clinical setting, will serve as a model for future drug development at academic institutions.

The excellence of our researchers and research community received a ringing endorsement from The Starr Foundation, which provided renewed support for The Starr Cancer Consortium and Tri-Institutional Stem Cell Initiative totaling \$105 million. The Starr Cancer Consortium is a collaboration among MSKCC, the Broad Institute of Harvard and MIT, The Rockefeller University, Weill Cornell Medical College, and Cold Spring Harbor Laboratory. The Tri-Institutional Stem Cell Initiative is a collaboration among MSKCC, The Rockefeller University, and Weill Cornell Medical College.

Our clinicians and scientists received numerous awards and honors in 2012, far more than we could ever mention here, so we will single out just a few of the most significant. Structural Biology Program Chair Nikola Pavletich and Immunology Program Chair Alexander Rudensky were named members of the National Academy of Sciences (NAS). The NAS is one of our country's most prestigious scientific societies and election to its membership is one of the highest honors given to scientists working in the United States. Drs. Pavletich and Rudensky join the ten MSKCC researchers who were already NAS members.

In addition, neuro-oncologist Lisa M. DeAngelis was elected to the Institute of Medicine (IOM). Dr. DeAngelis is Chair of MSKCC's Department of Neurology and Co-Executive Director of the Brain Tumor Center. Election to the IOM is considered one of the highest honors in the fields of health and medicine. She joins MSKCC's 17 other IOM members.



John R. Gunn Executive Vice President



Robert E. Wittes Physician-in-Chief, Memorial Hospital



Thomas J. Kelly Director, Sloan-Kettering Institute



James D. Robinson III Honorary Chairman, Boards of Overseers and Managers In December, President Obama appointed Charles Sawyers as one of six new members of the National Cancer Advisory Board (NCAB). Dr. Sawyers will serve on a body that advises on some of our nation's most pressing issues in cancer research and treatment. In yet another honor, Dr. Sawyers was elected President of the American Association for Cancer Research, the world's oldest and largest professional organization dedicated to advancing cancer research.

And Clifford A. Hudis, Chief of the Breast Cancer Medicine Service, was elected President of the American Society of Clinical Oncology, the world's leading professional organization representing more than 30,000 physicians who care for people with cancer.

The many achievements and successes over the past year would have been impossible without the support of our staff, who performed exceptionally in every important area. The dedication, energy, compassion, and creative spirits of the men and women of Memorial Sloan-Kettering are what power this extraordinary institution and make us thrive.

In the pages that follow, you will meet ten MSKCC researchers — basic scientists and clinicians — all of whom are working to answer critical questions about cancer. Each one is making seminal contributions to the development of new and innovative therapies that will improve and prolong the lives of the patients we see today and those we will care for tomorrow.

Warner

Douglas A. Warner III Chairman, Boards of Overseers and Managers

Craig B. Thompson President and Chief Executive Officer



MEDICAL ONCOLOGIST, MELANOMA AND SARCOMA SERVICE

CANCER BIOLOGIST, HUMAN ONCOLOGY AND PATHOGENESIS PROGRAM

GEOFFREY BEENE JUNIOR FACULTY CHAIR



<u></u> Dr. Chi meets with a patient.

When I began looking for a place to start my career, I was drawn to Memorial Sloan-Kettering's Human Oncology and Pathogenesis Program [HOPP] because I believed it would give me sufficient time to focus on my lab research without having to give up caring for patients.

HOPP was founded to bring together a diverse group of physician-scientists who could advance scientific knowledge while moving laboratory discoveries more rapidly into the clinic.

HOPP researchers tend to ask questions about the molecular causes of cancer. And although we work primarily in the lab, we meet regularly with our physician colleagues to discuss new cases, so we never lose sight of the practical and clinical considerations that go in to making decisions about patient care.

As a clinician, I see patients with melanoma and many different types of sarcomas. [Sarcomas are a

diverse group of tumors that arise in soft tissues such as muscle, fat, and cartilage, and in bones.]

I am looking at genetic changes such as mutations, which affect the sequence of DNA [our genetic code], and also epigenetic changes, which do not involve alterations in our genetic code but can control whether a gene is turned on or off. I also study the cellular context in which genetic and epigenetic changes occur. This is important in my research because sometimes—depending on the signals that are activated by nearby

cells-such changes can lead to

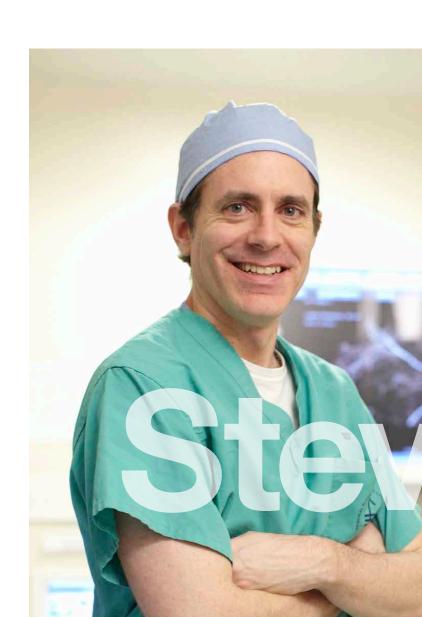


cancer and may represent a specific Achilles' heel for a certain cancer type that we may be able to target with drugs.

My lab is using many different approaches to look for novel diagnostic and prognostic biomarkers and targets in sarcomas. These include mapping epigenetic changes, studying the cells of different types of sarcomas and the formation of disease in mouse models, and using high-throughput screens, which can evaluate gene expression signatures in thousands of samples at the same time. Even though we have come very far with targeted therapy, we still have a poor understanding of the biology of many types of sarcoma, and we don't have a lot of treatment options.

A new focus of my lab is studying something called malignant peripheral nerve sheath tumors. The only treatment that can cure these tumors is surgery, and the surgery is very difficult because the tumors often surround crucial nerves. So I'm trying to identify ways to develop targeted therapy for advanced tumors. Understanding their genetic alterations could lead to the development of clinical trials in which drugs or combinations of drugs are selected to work against a particular target.

One of my goals is to get more involved with early-stage clinical trials that exploit the same molecular mechanisms I'm studying in the lab. In particular, for patients with a rare gastrointestinal tumor called GIST, there is a new treatment strategy that targets a gene called *ETV1* and potentially could be used as an alternative to and a more effective therapy than the current therapy, a drug called imatinib (Gleevec[®]), which targets a different gene. My colleagues and I hope to start a clinical trial for this new treatment strategy sometime in 2013. ••



Stephen B. Solomon, MD

CHIEF, INTERVENTIONAL RADIOLOGY SERVICE

DIRECTOR, CENTER FOR IMAGE-GUIDED INTERVENTIONS

Interventional radiology (IR) is an increasingly common approach to diagnosing and treating cancer. The use of image-guided interventions at MSKCC has grown to approximately 12,000 cases annually, and my colleagues and I are engaged in numerous multidisciplinary, image-guided clinical and research initiatives.



Dr. Solomon with his colleague, interventional radiologist Constantinos I. Sofocleous (foreground), in an interventional radiology control room during an IR procedure.

Interventional radiologists are physicians who use image guidance—including CT and PET scans, ultrasound, x-rays, and MRI scans—to perform minimally invasive procedures that diagnose and treat disease and provide relief from symptoms.

Thermal ablation of a tumor is among the procedures we do routinely. The technique involves placing a needle into a tumor and applying extreme heat or cold to kill the cancer while preserving surrounding healthy tissue. This has traditionally been done under CT guidance, which allows us to visualize the tumor and know where to place the needle. But the CT image can't tell us whether we have fully destroyed a tumor.

A method that could provide real-time, image-based monitoring of tumor ablation would be a valuable tool. MSKCC is one of the only hospitals in the world with an interventional PET-CT, which is housed in our Center for Image-Guided Interventions. We're investigating a novel, MSKCC-developed way to use PET scans to assess—while a patient is still on the table—whether we have completely ablated a tumor.

In addition to destroying tumors, thermal ablation may also help activate tumor-specific T cells [a type of immune cell]. When we ablate a tumor, we create an inflammatory reaction in which these cells are recruited to clean up the dead cancer cells. In the process, the T cells have the opportunity to learn that the cancer has certain markers that they might be able to recognize in order to fight cancer that has spread to other parts of the body. Generally, though, after ablation the immune response in humans is weak and not sufficient to eradicate tumors elsewhere in the body or to prevent disease progression. However, what we've discovered in our research in mice

is that when we give a drug called ipilimumab (Yervoy™) after tumor ablation we can boost the immune system and see a response at other sites in the animal's body. We're now investigating this approach with a variety of cancers and with several different drugs; and, in collaboration with colleagues on the Breast Cancer Medicine Service, we've begun a small clinical study in women with localized breast cancer. We are looking at applying this technique to other cancers as well.

Another area of investigation in our group involves a new ablation tool called irreversible electroporation (IRE), which does not use heat or cold to kill cancer cells. This technique uses an electrical current to punch holes in cell walls, irreversibly destroying the cells. Some organs, such as blood vessels, are not made up of just cells-there's also a protein structure. Because IRE targets only cells, we may be able to target a tumor abutting a major blood vessel, killing the cancer cells while the vessel wall—because it's made up of these structural proteins—remains intact.

MSKCC interventional radiologists also can treat certain liver tumors by blocking branches of the hepatic artery in a procedure called embolization. With their blood supply cut off, the tumors die. We have expanded our use of the technique to include treatments for liver cancer using beads that deliver chemotherapy or radiation directly to tumors. The beads combine the therapeutic effects of radiation or chemotherapy with those of embolization.

In light of recent advances in individualized therapy for many types of cancer, molecular profiling of tumors is vital for guiding treatment decisions. To perform the

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(Below, from left) Drs. Sofocleous and Solomon collaborate on an IR procedure; (at right) Dr. Solomon meets with a patient before beginning an IR procedure.



necessary studies, larger amounts of tissue are required than in the past. One of the things we do as interventional radiologists is to obtain tumor samples by doing needle biopsies. We currently have a major initiative to develop innovative ways to determine—during a needle biopsy-when we have collected enough tissue. One technology we're in the preliminary stages of exploring is spectral analysis, which involves shining a special light on a specimen as soon as it's removed from a patient to allow us to see whether we have enough cells in the sample.

With so much progress in the field of interventional radiology we've also established an Oncologic Interventional Radiology Fellowship in which fellows are exposed to the full range of interventions and which also includes time to pursue research.

These are just a few examples of the ways in which our IR group is working to enhance and improve the care we provide to patients. ••



Our immune system has evolved highly

sophisticated ways of fighting infection that hinge on its ability to distinguish between healthy cells and cells harboring intruders such as viruses.

This system provides powerful protection against pathogens, but it comes at a price: Unless the different cell types of the immune system are controlled precisely, they may inflict severe damage on the body's own cells and tissues.

My laboratory studies T lymphocytes, white blood cells that are vital in the immune system's response to infection.

One of the areas we focus on is a subset of T lymphocytes called regulatory T cells. We've found that regulatory T cells are critical for keeping other white blood cells in check, thereby playing an important role in controlling immune system reactions. In the absence of regulatory T cells, instead of

pathways underlie their ability to regulate the immune system—has many potential clinical applications. For example, numerous studies have shown that most tumors are infiltrated by regulatory T cells, which are believed to suppress immune responses to cancer. Drugs that act by inhibiting regulatory T cell function might offer new and effective ways to control the disease.

Other potential therapies that act by boosting or targeting these cells are being explored to treat conditions characterized by an overactive immune system—including autoimmune disorders such as rheumatoid arthritis, psoriasis, and diabetes.

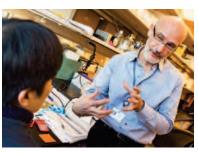
Previously, we and others found that a gene called *Foxp3* plays a

the *Foxp3* gene is essential for the process by which extrathymic regulatory T cells—those regulatory T cells that are generated outside of the thymus — mature and acquire specialized traits and functions.

In one of our studies, published in the journal *Cell* in July 2012, we discovered that one unique function of these cells is to control the immune system during pregnancy. Our findings suggest that extrathymic development of regulatory T cells emerged during evolution to prevent a mother's immune system from attacking the fetus. In mice that lack the aforementioned Foxp3 DNA element, extrathymic regulatory T cells do not develop normally, causing pregnant females to lose their embryos more frequently and develop complications reminiscent of those seen in human pregnancies.

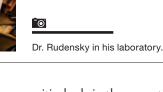
In another study, published in Nature in February 2012, we found that extrathymic regulatory T cells control allergic and asthmalike inflammation in the gut and lungs. My colleagues and I are now exploring whether subsets of regulatory T cells generated in and outside of the thymus play a role in different types of cancer.

We biologists tend to study an organism by breaking it down into parts-essentially attempting to reduce it to a mechanism. And it used to be that immunologists focused largely on specific parts of the immune system, overlooking its entirety and the interactions that take place between the immune, endocrine, and nervous systems. Working with MSKCC clinicians, we are now starting to apply our knowledge about the ways regulatory T cells control multiple body functions to practical use. Clinicians are trained to treat the entire organism. Their perspective is vital in bringing the scattered parts together. ••

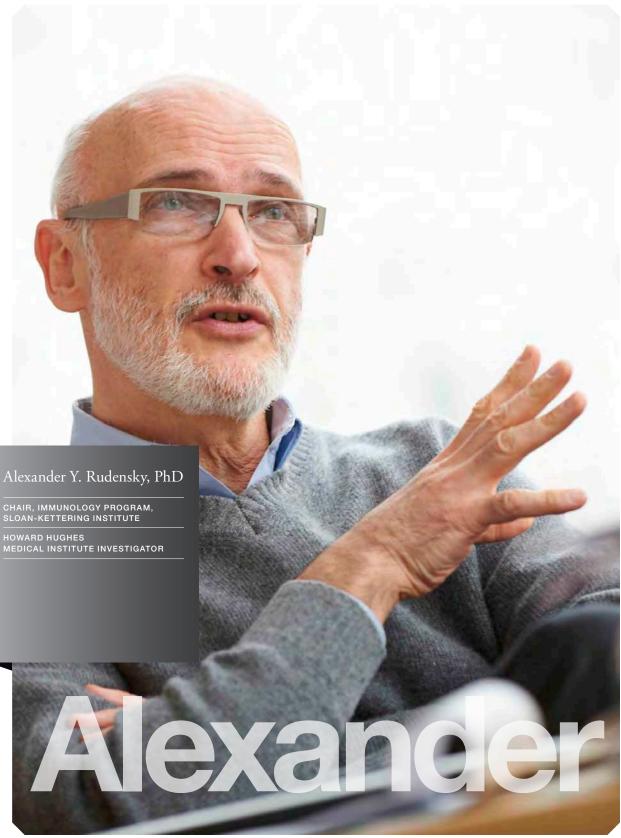


attacking foreign cells, the immune system attacks normal cells and tissues, which may lead to sometimes fatal inflammatory responses.

Understanding how these cells function—what genes and biological



critical role in the generation of regulatory T cells both in and outside of the thymus, a small organ located underneath the breastbone. In a series of recent studies, we reported that a distinct DNA element within





I was initially drawn to surgery because it couples intellect with manual elegance. When I was training in the 1990s, it was obvious that opportunities to improve brain surgery were on the horizon—technologies were becoming available that would allow us to operate more safely and effectively.

I knew this would be a field that would explode in my lifetime, and that has already turned out to be true in so many ways.

To a great extent, brain tumor surgery has become a form of personalized medicine, as we are now better able to devise strategies for removing a particular tumor both before and during the procedure.

At Memorial Sloan-Kettering, we have the ability to perform complex surgery with the patient awake and responsive, using advanced navigation systems. We choose an awake approach when the tumor is located in a deep area of the brain or near a region involved in speech expression or speech comprehension

Before going into the operating room, we first perform a traditional MRI, which I liken to a lowresolution Google map. It tells us what the brain looks like and where the tumor is located. Then, we perform a functional MRI, which shows where the brain activates when the patient speaks or moves.

The highest-resolution, three-dimensional map is obtained in the operating room. We stimulate particular areas of the brain while talking to the patient until we determine—to the exact millimeter-where nerve cells that control speech and motion reside. We are also fortunate to have access to an MRI scanner in the operating room for both brain and pituitary tumor surgeries, which allows us to see, as the surgery proceeds, how much of the tumor has been removed and how much remains.

With all of these tools managed by our team of surgeons, anesthesiologists, neurophysiologists, and neurologists—we are able to design a brain operation in real time that takes into account the preservation of a patient's quality of life. We are also able to remove tumors that would have been previously considered inoperable.

Outside of the operating room, I have been translating my research involving stem cells to brain tumors.

One of the most striking aspects of stem cells is their flexibility and versatility. They can adapt and respond to both intrinsic signaling and their immediate environment to become a specific type of cell.

Glioblastoma multiforme—one of the most common and aggressive types of brain tumor—is recognized for its heterogeneity in appearance and genetics. Scientists have suspected that a small portion of this type of tumor may consist of cancer stem-like cells, which could repopulate the tumor after treatment.

This is what drove us to apply some of my previous stem cell research to glioblastoma multiforme and discover that a subset of these tumors can generate their own blood vessels from tumor stem-like cells. Instead of simply recruiting blood vessels, which many other tumors do, glioblastoma multiforme tumors can actually contribute to making their own blood vessels.

As a physician-scientist, when I'm operating on a patient and taking out a tumor, I am also thinking about the tumor's cellular components. I think physician-scientists have a unique role in that they are so close to the subject of study that they are positioned to ask the right questions in the laboratory. 🐢



Dr. Tabar consults with Clinical Nurse Leader Lystra M. Swift in the operating room before a patient surgery.

Proteins are amazing machines. Inside the cells, they act like members of an orchestra, carrying out specific functions at specific times and in regulated ways. And what we do in my laboratory is try to understand how proteins work—primarily by determining what they look like in three dimensions. If you can see something, you can get an idea of how it functions.



Dr. Long collaborates with Alexandria M. Miller, a graduate student in the Gerstner Sloan-Kettering Graduate School of Biomedical Sciences. Ms. Miller is the first author of the potassium ion channel paper Dr. Long discusses in his narrative. (Miller and Long, Science, January 2012.)

My colleagues and I focus primarily on ion channels, proteins that reside within the plasma membrane surrounding cells. The plasma membrane can be likened to a balloon that separates the inside of the cell from the outside, and these channels span the thickness of the balloon.

The plasma membrane is a very thin layer, but it's incredibly important because it's what contains the cell, and cells also communicate through it. Membrane proteins — proteins such as ion channels that reside within the membrane—are gatekeepers and relay stations that allow each individual cell to communicate with its neighbors and interact with its environment. In comparison to proteins found within cells, membrane proteins are typically more difficult to study and consequently relatively little is known about their inner workings.

Ion channels act like molecular sieves, only letting their particular ion go in or out of a cell. So a calcium channel is selective for calcium, allowing calcium to pass in and out of a cell but not, for example, sodium or potassium.

Recently, my lab revealed for the first time the threedimensional structure of two proteins found in humans, one of which—K2P1—regulates the flow of potassium ions in and out of cells, and the other-called Orai-which regulates the flow of calcium. In both cases we used a technique called x-ray crystallography, which is a method of determining the shape or structure of



a protein at an atomic level of detail. In order to do this, we first

produced large amounts of the proteins, then purified and coaxed them to form crystals—solid structures in which all the proteins are symmetrically lined up. A typical crystal would contain approximately a trillion protein molecules. Next, we illuminated the crystals with an intense beam of x-ray light generated by a massive instrument called a synchrotron located at Brookhaven National Laboratories on Long Island. As the x-rays interact with each individual protein molecule within the crystal, the rays are diffracted at different angles. Captured on a screen, the diffracted rays form a unique pattern.

From these patterns we were able to derive detailed information about the unique shapes of K2P1 and Orai. Finally, using a computer, we built an atomic model—an architectural mockup that shows every atom of both proteins. From this work, we obtained the first visualizations of any human potassium channel and of any calcium channel.

By drawing the detailed three-dimensional model of K2P1 and studying this model atom by atom, we and other scientists will be able to come up with ideas about how this channel works and test our ideas in the lab. It's too early to say with certainty, but I think there are good reasons to be hopeful that our study will guide the development of certain types of drugs in the future.

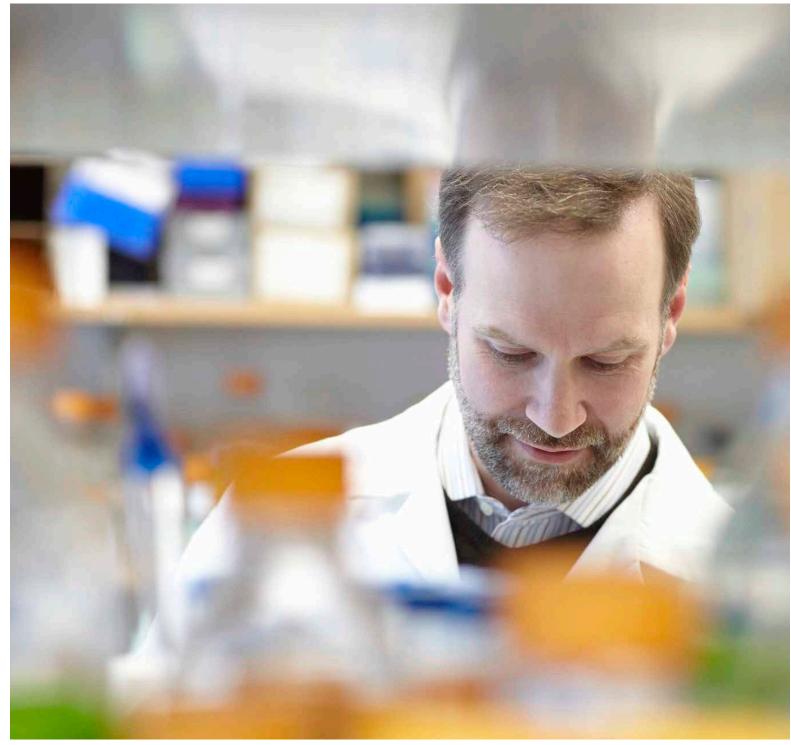
Orai has been detected in almost every tissue of the body, which underscores the importance of calcium signaling in all sorts of biological processes. We still have much to learn about calcium signaling, but one setting in which we understand it relatively well is in T cells [a type of immune cell]. Calcium is an important signaling molecule in these cells, and Orai is essential for the activation of the immune response. As with K2P1, this is very early work, but I hope that what we've revealed of the structure of Orai may set the stage for the development of drugs that target this channel and can be used to control the activation of the immune system in the context of autoimmune diseases, allergy, cancer, and other disorders.

In a small way, what we do is like going to the moon for the first time. We were the first people to see what K2P1 and Orai look like, and now we're telling others. There are very few places besides MSKCC where I could have done what I've done with these projects. The institutional support of basic science has been crucial, the mindset that says, "We want you to try difficult things. We want you to take risks." Researchers here can commit to trying to answer basic science questions, limited only by their own imaginations. As we have seen time and again, research that seeks to address fundamental biological questions relating to the inner workings of cells can lead, in the long run, to novel therapies for human diseases that wouldn't have been possible without the commitment to basic science research like that ongoing at the Sloan-Kettering Institute. 🕶



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(Top) The architectural mockup of the calcium channel known as Orai, which regulates the flow of calcium ions into cells and thereby controls crucial cellular functions including immune responses. The channel is viewed as it would appear from outside the cell. The protein is depicted as a ribbon-a simplification of its thousands of atoms. Glutamate amino acid residues (pictured as yellow and red sticks) discriminate among ions, allowing only calcium ions to pass through. A single calcium ion (magenta sphere) is poised at the entrance to the channel, waiting for the channel to open and allow its entry into the cell.





One of the reasons I joined Memorial Sloan-Kettering was because of the great opportunities here to do translational and multidisciplinary cancer research. An outstanding example of this is our Imaging and Radiation Sciences program [IMRAS].



Dr. Powell's research interests include the role of DNA repair deficiencies in human breast cancer; breast cancer genetics and the function of BRCA1 and BRCA2 proteins; and the optimization of radiation therapy planning and delivery for both early-stage and advanced breast cancer

The program focuses on looking at how the effects of radiation - in cells, in mouse models, and in people—can be observed by imaging and other biological measures. Knowing as much as possible about how a tumor responds to radiation enables us to more accurately guide treatment decisions and develop new treatment strategies. IMRAS reflects collaborative investigations across the Department of Radiation Oncology, the Department of Medical Physics, the Molecular Imaging and Therapy Service, and the Department of Radiology.

Imaging has made it possible to evaluate how effective radiation therapy is, both during and after treatment. Sophisticated technologies that already exist give us a lot of information about how a tumor is responding, but IMRAS members are working to develop even more advanced tools to image the effects

in patients. members are investigating the

> improve patient outcomes. Another field of great interest to us is radiation genomics. Broadly speaking, radiation genomics recognizes that when you irradiate people they don't all respond the same way. Just as there are genetic factors that control the way people

of radiation on cells-tools that we hope to eventually translate into use

For example, the presence of hypoxia [a low concentration of oxygen] in tumors is common, and tumor hypoxia is known to compromise the effectiveness of radiation and chemotherapy. IMRAS biological underpinnings of tumor hypoxia imaging and are working on novel imaging methods to measure hypoxia status before, during, and after treatment. The more precisely we can identify and quantify tumor hypoxia, the more we'll be able to

respond to drugs, there are genetic factors that influence the way they respond to radiation. So both genetic and tumor-specific factors may contribute to the way a tumor responds to a fixed dose of radiation. Ultimately, we want to understand in real patients, exposed to real doses of radiation, why some respond well and others poorly.

A project in my laboratory is aimed at learning more about this variation in radiation sensitivity. We've taken lymphoid cell lines from individuals whose entire genomes have been sequenced and we've irradiated them. Then we've looked at the way the cells handle the radiation. What we see is a spectrum of response that exactly mirrors what we observe in people. Then, because these genomes are fully known, we can do association analyses. These are genome-wide association studies to attempt to relate what it is about the radiation-sensitive or resistant people that makes them sensitive or resistant. We're doing these studies in collaboration with colleagues in Memorial Hospital's Clinical Genetics Service and the Sloan-Kettering Institute's Computational Biology Program and are looking to discover whether there are common parts of the genome that associate with radiation sensitivity or resistance. Understanding these variations will help radiation oncologists make the best treatment decisions for each patient. For example, if we know a tumor has built-in radiation resistance mechanisms we might choose any one of a number of options—we might not use radiation at all, perhaps use a higher dose, or use a drug to make the tumor more radiosensitive.

We're entering a new and exciting era in radiation oncology, and these are just several of the many initiatives and research efforts under way at MSKCC. ••

Ethel Law, RN, ANP-BC, OCN

NURSE PRACTITIONER, GASTRIC AND MIXED TUMOR SERVICE

2012 SAMUEL AND MAY RUDIN AWARD FOR EXCELLENCE IN NURSING RESEARCH

NEW YORK TIMES TRIBUTE TO NURSE FINALIST. RESEARCH



I joined MSKCC in 1991 directly from nursing school, and began my career caring for neuro-oncology and neurosurgery inpatients. The care of these patients attracted me because it provided me with the experience to build a strong foundation of nursing skills. But more importantly, I felt I could offer a great deal to patients with neurologic problems.

4any such patients have motor or ensory deficits, and helping them vercome these challenges allowed he to begin fulfilling the aspiration hat drew me to nursing— to help atients have the best quality of life uring and after treatment.

In 1999, I moved to ambulato care [treatment delivered to outpatients], working first on the Endocrinology Service and later with the Department of Radiation Oncology, where I again worked with neuro-oncology patients who received radiation as part of their treatment. For the next ten years I cared for gastrointestinal cancer patients receiving radiation therap Today, I work in the Gastric and Mixed Tumor Service, a surgical oncology service.

Early in my career I knew I wanted to pursue nursing research. I became an active member of MSKCC's Ambulatory Nursing Research Council and was also the ambulatory care representative on the institution's first Evidence-Base Practice Nursing Council.

Ms. Law meets with a patient



In 2004, I collaborated on an evidence-based practice project that resulted in the development of a patient-education book for families of MSKCC patients called *A Guide for Caregivers*. In 2009, I collaborated on another evidencebased practice project within the Department of Radiation Oncology in which we produced guidelines to manage skin reactions in patients receiving radiation.

It was through my work with women who received pelvic radiation for rectal and anal cancer that I decided to undertake a research study focused on improving patient quality of life. I pursued the research under the auspices of the Nursing Fellowship Program.

Radiation to the pelvic area for the treatment of colorectal or gynecologic cancers can create a number of side effects in female patients, most notably vaginal stenosis, a narrowing and shortening of the vagina. As a result, women may experience pain with intercourse and have difficulty tolerating a pelvic exam, limiting the effectiveness of this critical examination.

To minimize the effects of stenosis, women are often advised to use a vaginal dilator. Historically, adherence to this therapy is low and there has been little follow-up to determine its effectiveness.

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My study was focused on evaluating adherence to and the effectiveness of using vaginal dilators to minimize stenosis. We accrued 115 women who had been treated for gynecologic and colorectal cancers at either MSKCC's main campus or the regional network sites. This broad sample gave our study a statistically relevant representation of the population. And another wonderful aspect of the study was that it was conducted with a multidisciplinary team approach that included both radiation oncologists and nurses. It was professionally gratifying to bring together this mix of specialists to support the protocol. It made the study even more meaningful, relevant, and thorough.

The study opened in 2009 and we are now performing data analyses I'm hopeful that the study's work wil shed light on the long-term benefits of vaginal dilator use and will lead to the improvement of patients' quality of life

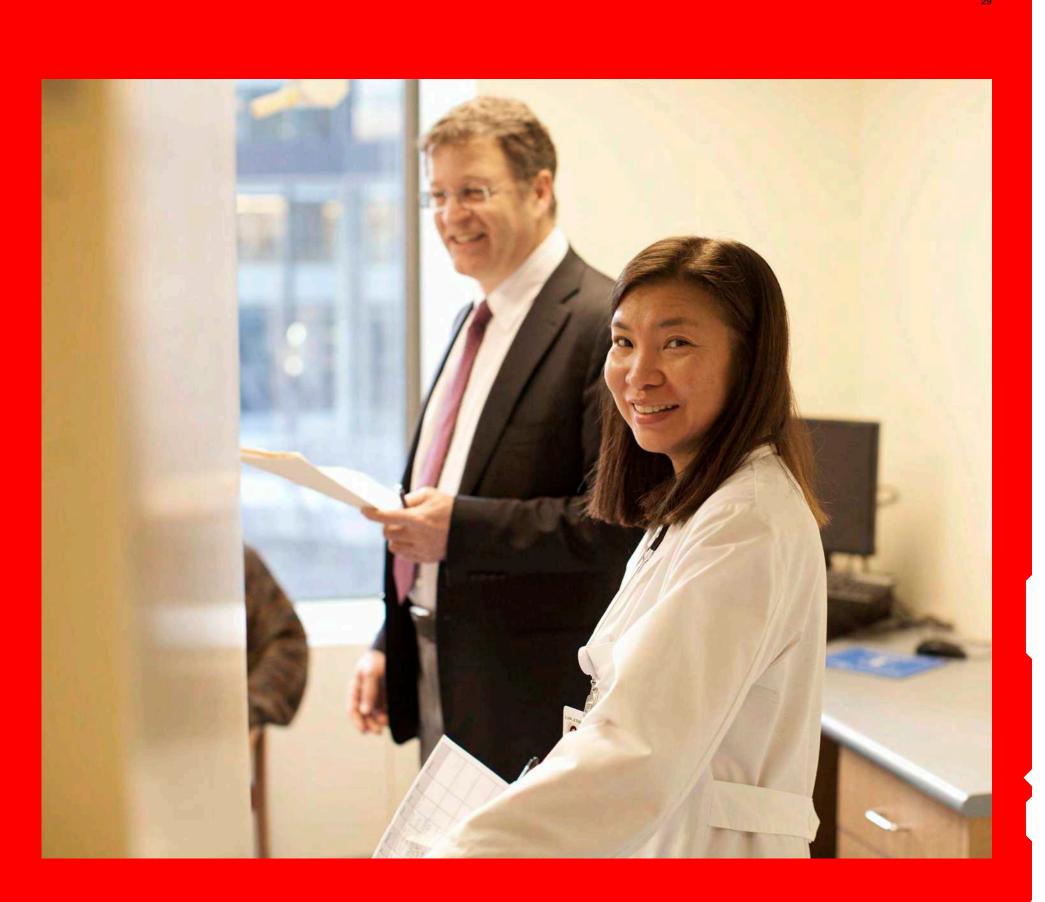
I am committed to continuing to conduct research as I carry on my clinical work. I love caring for and interacting with patients, which has remained my goal since my first day of nursing. And it's only from this hands-on experience that I can learn about and understand the clinical needs of patients, which will serve as an inspiration for my next research project.

(Clockwise from right) Ms. Law works closely with Samuel Singer, Chief of the Gastric and Mixed Tumor Service; Ms. Law in her office; Ms. Law consult with ourse liene Goldman





Ms. Law wishes to thank many people for their support and contributions to her study, including Clinical Nurse Specialist Joanne Frankel Kelvin, radiation oncologist Karen Goodman, Senior Research Specialist Bridget Thom, Senior Research Biostatistician Elyn Riedel, Research Study Assistant Ashlyn Tom, Department of Nursing leadership, the Nursing Fellowship Program, and the Geri and ME Fund fo nursing at MSKCC.



PEDIATRIC ONCOLOGIST

VICE CHAIR, BASIC AND TRANSLATIONAL RESEARCH, DEPARTMENT OF PEDIATRICS

MEMBER, HUMAN ONCOLOGY AND PATHOGENESIS PROGRAM

GRAYER FAMILY CHAIR

Many would argue that the next big development in cancer research will be in the field of epigenetics — the study of changes in gene expression that are controlled by factors other than changes in an individual's DNA sequence. These proteins and mechanisms contribute to cancer development in ways that we didn't really understand ten years ago.



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Dr. Armstrong specializes in the treatment of children and young adults with leukemia. He is especially interested in developing new therapies that are less toxic and more effective.

For example, we have discovered that a mutation that affects cells' epigenetic programs—in this case by changing the structure of chromosomes—occurs in a number of different types of leukemia. Changing that chromosomal structure causes a gene expression program to get turned on when it shouldn't. And for these types of leukemia, we now know exactly what the protein is that allows that to happen. The protein is called a histone methyltransferase (HMT), and we're working to develop small-molecule inhibitors of the protein that are now in clinical trials at MSKCC in several adult leukemias. The research is particularly exciting because this is the first small-molecule inhibitor of an HMT to be evaluated in humans.

It's becoming increasingly clear that many types of cancer have abnormalities in histone methyltransferases and that these abnormalities are likely part of the tumor development process in many cancers. So what we are learning with these new approaches in leukemia is likely to have a much broader impact as we understand more about how abnormalities in HMTs are working to drive cancer development.

The idea behind MSKCC's new Leukemia Center [of which Dr. Armstrong is director] is to continue to develop ways to connect what's going on in the laboratory to what's going on in the clinic. It will provide the infrastructure—the people, research, and technologies—to help move exciting new discoveries from the lab into clinical trials as quickly as possible. We will use next-generation genomic sequencing technology to characterize leukemia samples from patients in order to understand, in as much depth as possible, which mutations are present in leukemias and how they work together; develop mouse model systems of those leukemias; and then test newly developed therapies to support the rationale for ultimately doing clinical

trials in patients. Our goal is to streamline the process and encourage multiple MSKCC labs to work together using a common approach. The synergy that will develop will make it easier for the institution to support these efforts and for pharmaceutical companies and others to work with us.

We've gotten to the point where basic research discoveries are making a difference for patients. One of the things that makes me most proud as a pediatric oncologist who specializes in treating children with leukemia is when I talk to the parents of a child who has leukemia and I'm able to tell them that we're making discoveries that are likely to influence the course of the disease for the better. It's incredibly motivating to think of the comfort it gives parents to know that there are people focused on studying leukemia as deeply and intensely as we are, and if our efforts don't make a difference for their child, we expect they will for patients in the future.

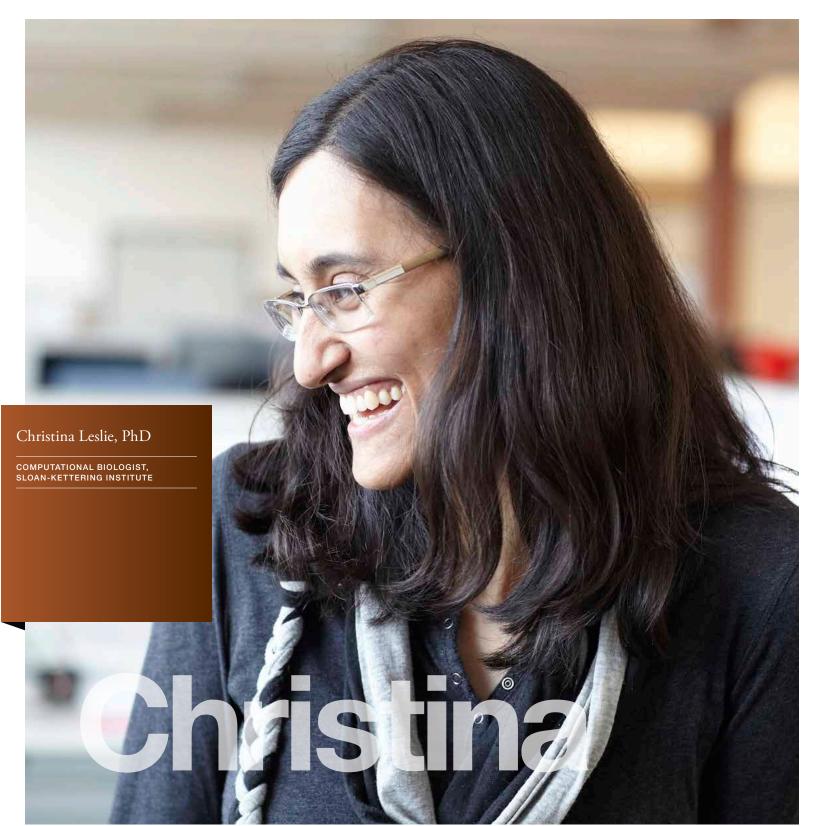
I don't know of a better goal than being able to look back in ten or 15 years and say that I had a tangible influence on the way that people are treated for cancer. That is definitely what drives me and the people I work with here. ••



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(Above) Dr. Armstrong meets with colleagues in his office. (Right) Dr. Armstrong with (from left) research fellows Michael Kuehn, Haihua Chu, and Monica Cusan, and instructor Andrei Kritsov, who are all members of his laboratory.







Computational biology is a broad field, but a short explanation for what most computational biologists do is that we use computational methods to help make sense of very large amounts of biological data. I trained as a mathematician, and mathematicians are often attached to finding elegant solutions to problems.



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Postdoctoral fellow Raphael Pellosof (left) and graduate student Julie Yang (center) pursue research in Dr. Leslie's laboratory. In biology, our focus instead is on deriving meaningful insights into biological processes. So while we still like to design clever algorithms to solve problems, the most important thing is asking the right question in the first place.

For most of the history of modern biology, scientists have studied one gene at a time. In the late 1990s, it became possible to simultaneously measure the expression of thousands of genes using microarrays [also known as DNA chips], giving a kind of genome-wide "snapshot" of gene activity in each sample of cells.

More recently, there has been another technological revolution, called next-generation sequencing, and now biologists are rapidly amassing even more comprehensive data. For example, for each tumor sample that we study, RNA sequencing produces millions of short sequences ["reads"] that we match to the genome and analyze statistically. [Like DNA, RNA is a large biological molecule consisting of strings of nucleotides; RNAs are transcribed from the genome using regions of DNA as a template.] This statistical analysis allows us to measure changes in expression for thousands of protein-coding genes as well as RNAs that don't code for proteins, to detect alterations in the way these genes were processed and to map their mutations.

My lab develops computational and statistical methods to exploit this data in order to study how genes are expressed in regular cells and to learn what goes wrong when gene expression gets dysregulated in cancer cells.

The methods we use often come from machine learning. These are algorithms that "learn" from data to build a model that can be used to make accurate predictions. Many

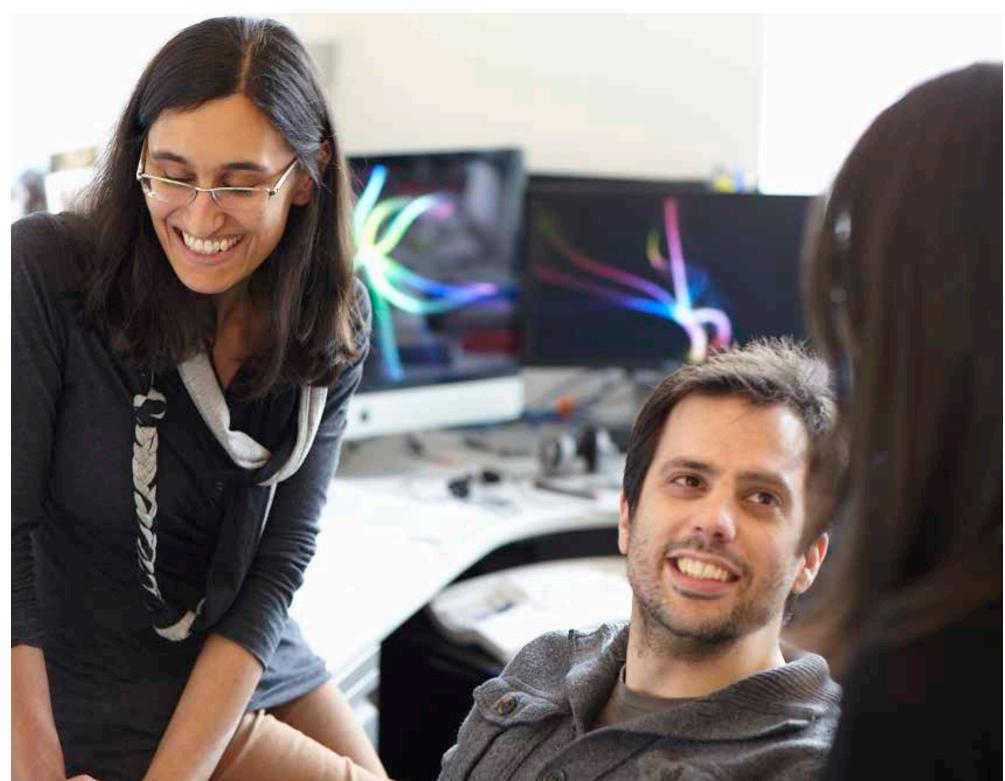
PhD student Steve Lianoglou did his PhD degree research in Dr. Leslie's laboratory.

people have interacted with machine learning applications, perhaps without realizing it. For example, when you use a digital camera to take a picture, face detection software locates the faces in the field of view to allow the camera to focus better. The face detector was "trained" on a big data set of photos where the locations of faces were known, so that it could learn to discriminate between face and non-face patches of photos. It can then be applied to new data—in this case, new faces in the photo you want to take—and accurately predict are trying to decode the information the faces.



In our work, rather than faces, the data sets are made up of large quantities of data derived from different kinds of sequencing or microarray technologies. Often our models are designed to predict how genes are regulated. In one project, we are trying to train a model that will teach us more about the mechanism of gene silencing—a process that is dysregulated in many diseases, including cancer—using small pieces of RNA called microRNAs. In another project, we in regulatory regions of the genome that govern differentiation of stem cells into fully specialized cell types. As a computational scientist, I

came to Memorial Sloan-Kettering because I wanted to be immersed in an exciting biomedical science environment and work on important problems in cancer biology. This is an amazing place because scientists are encouraged to be ambitious and tackle big questions—which sometimes involves generating huge and complex data sets. Through close collaboration with experimental labs here, we have started to leverage the power of computational and machine learning methods to advance cancer research.





Breast cancer is not a single disease, but a collection of different diseases that originate in the breast. Pathologists have described many types of breast cancer based on careful analysis of tumor samples under the microscope.

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Postdoctoral research fellows Luciano Martelotto and Catherine Cowell with Dr. Reis-Filho.



There are at least 20 types of breast cancer with distinctive features in their morphology [structure and form] that allow them to be identified by microscopy. These tumors collectively are known as special types of breast cancer. Each of them is relatively rare, but together they account for about 25 percent of all breast cancers.

The most common type of breast cancer, called invasive ductal carcinoma of no special type, makes up the other 75 percent of breast cancers. As the name implies, the category comprises all breast cancers that cannot be classified as of one of the special types. This group of tumors is diverse, with varying morphologic characteristics, clinical behaviors, molecular features, and responses to therapies. Although special types of breast cancer have been known for a long time, patients with the rare types are currently treated in the same way as patients with ductal cancers.

Recent large-scale studies investigating the genetic basis of breast cancer have focused on the common type of the disease, and have confirmed that these tumors are diverse in their repertoire of gene mutations. Little is known, however, about the genetic characteristics of rare types of breast cancer.

The main goal of my lab is to develop a classification system for all breast cancers that is reflective not only of features seen under the microscope, but also of their molecular characteristics and response to therapies. To achieve this goal, we are studying the special types of breast cancer that are not categorized as ductal carcinoma.



In recent years, we and others have found that tumors from each of these rare types are less diverse than ductal carcinomas at the molecular level, and that some of these special types of breast cancer are underpinned by very specific genetic changes.

By using the molecular tools that we have access to here at MSKCC, we can now determine, at an unprecedented level, the genetic alterations that drive the malignant behavior of the cells of each special type of breast cancer. Once we know which mutations cause these cells to be malignant or are required for cancer cell survival, we can start figuring out how to develop therapies tailored for patients with these rare types of breast cancer. Furthermore, when we find the molecular drivers for these cancers, we will be able to go back and look for the same drivers in ductal carcinoma and then further classify subsets of these common tumors into groups that have molecular features and behave like the rare types.

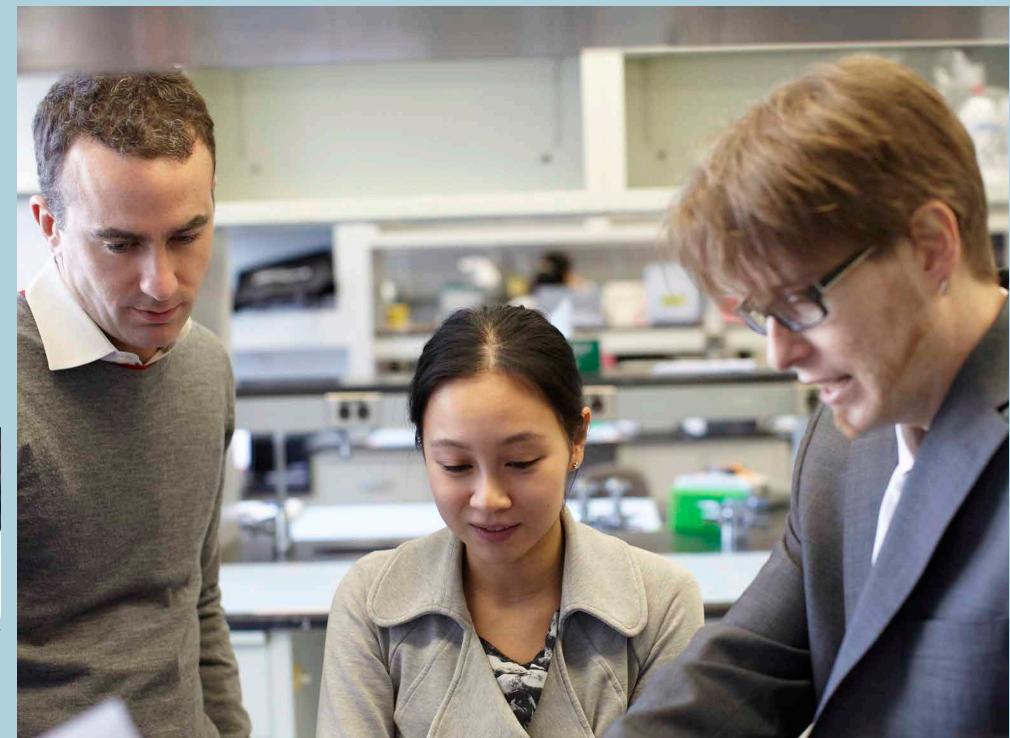
Our laboratory is also developing approaches to assess the molecular alterations in breast cancer cells by analyzing blood samples from breast cancer patients. We know that cells and genetic material from breast cancers can be found in the blood. We are currently applying cutting-edge genetic tools to compare cancerous materials obtained from blood samples with those from the tumors themselves. Our aim is to determine how the information obtained from these "liquid biopsies" can be employed to guide treatment decision making for breast cancer patients.

I have only been at MSKCC a short time, but I already appreciate what a fantastic institution this is. The critical mass of basic, translational, and clinical scientists is unparalleled, and the clinicians are world-class. There is no other place that brings together people of this caliber who are working on issues that affect cancer patients. I have already had the chance to set up collaborations with other scientists and clinicians at MSKCC, and am looking forward to developing my research program with the aim of matching breast cancer patients with the therapy that will be most beneficial for them. ••

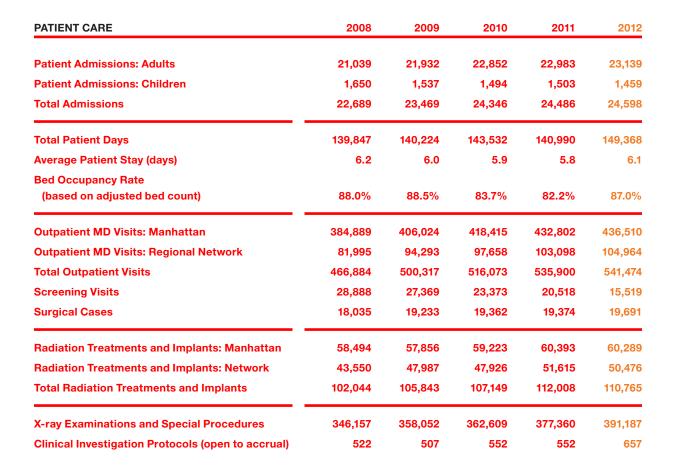


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(Opposite page) Visiting clinical fellow Francois-Clement Bidard (left) and bioinformatics postdoctoral research fellow Charlotte Ng with Dr. Reis-Filho in his laboratory.



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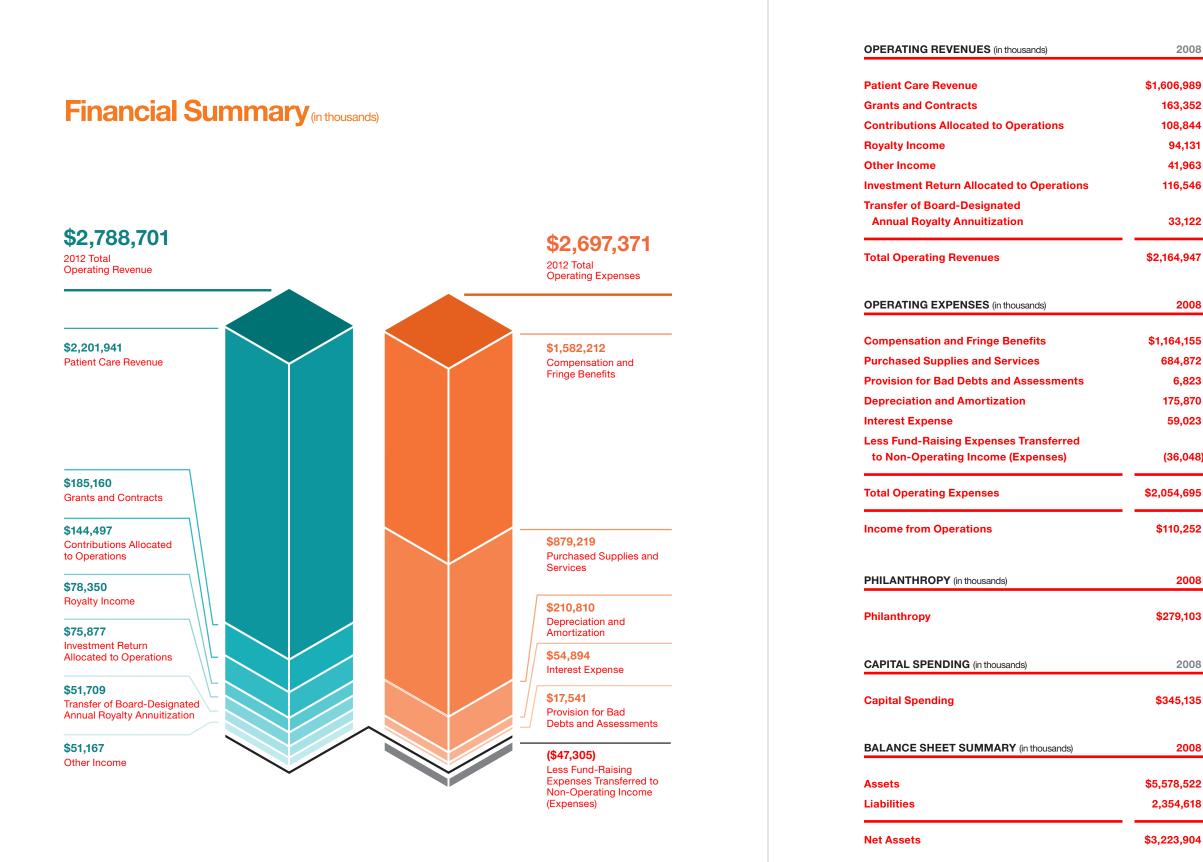


STAFF	2008	2009	2010	2011	2012
Sloan-Kettering Institute Members	133	140	142	143	149
Hospital Attending Staff	727	768	804	834	876
Registered Nurses	1,734	1,845	1,945	2,018	2,133
Support Staff	7,945	8,321	8,613	8,989	9,244
Total Staff*	10,505	11,039	11,469	11,950	12,402
Volunteers	871	917	942	1,058	1,018

*In 2012, 34 staff members held appointments in both the Institute and the Hospital.

EDUCATION	2008	2009	2010	2011	2012
Residents and Clinical Fellows – Positions	418	436	447	440	445
Residents and Clinical Fellows — Annual Total	1,609	1,651	1,625	1,676	1,682
Research Fellows	254	303	295	321	320
Research Scholars	140	121	132	131	124
Research Associates	87	90	94	82	89
Graduate Research Assistants	_	_	23	29	39
PhD Candidates	232	227	231	225	222
MD/PhD Candidates	29	28	26	21	21
Registrants in CME Programs	2,115	2,395	2,554	2,533	3,968
Medical Observers	561	572	541	526	566
Medical Students	358	399	391	429	431
Nursing Students	72	109	105	142	178
Social Work Students	6	6	6	6	6
Radiation Oncology Technology Students	15	15	14	14	13
Cytotechnology Students	3	3	2	3	4
Physical Therapy Students	3	3	3	4	7
Occupational Therapy Students	5	4	3	3	4

Statistical Profile



8	2009	2010	2011	2012
9	1,723,313	1,854,776	2,141,421	2,201,941
2	167,495	186,327	190,948	185,160
4	126,250	117,323	130,791	144,497
1	62,232	68,663	77,510	78,350
3	43,144	44,874	48,351	51,167
6	103,998	100,389	104,699	75,877
	,	,	,	,
2	37,158	41,578	46,417	51,709
7	2,263,590	2,413,930	2,740,137	2,788,701
8	2009	2010	2011	2012
5	1,286,536	1,361,032	1,466,667	1,582,212
2	757,863	772,968	835,621	879,219
3	10,881	11,046	18,285	17,541
0	171,806	175,494	195,461	210,810
3	64,997	47,931	57,098	54,894
8)	(40,320)	(43,926)	(44,665)	(47,305)
B) 5	(40,320) 2,251,763	(43,926) 2,324,545	(44,665) 2,528,467	(47,305) 2,697,371
5	2,251,763	2,324,545	2,528,467	2,697,371
5	2,251,763 11,827	2,324,545 89,385	2,528,467 211,670	2,697,371 91,330
5 2 8	2,251,763 11,827 2009	2,324,545 89,385 2010	2,528,467 211,670 2011	2,697,371 91,330 2012
5 2 8 3	2,251,763 11,827 2009 166,247	2,324,545 89,385 2010 237,666	2,528,467 211,670 2011 301,374	2,697,371 91,330 2012 231,159
5 2 8 3	2,251,763 11,827 2009 166,247 2009	2,324,545 89,385 2010 237,666 2010	2,528,467 211,670 2011 301,374 2011	2,697,371 91,330 2012 231,159 2012
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5 2 8 3 8 5 8	2,251,763 11,827 2009 166,247 2009 2226,049 2009	2,324,545 89,385 2010 237,666 2010 262,371 2010	2,528,467 211,670 2011 301,374 2011 2223,251 2011	2,697,371 91,330 2012 231,159 2012 258,613 2012

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WEILL CORNELL GRADUATE	Kenneth J. Marians, PhD Director, Graduate Studies	ES Alan Hall, PhD Cell and Developmental Biology Unit	as of December 31, 2012 Alexander Y. Rudensky, PhD Immunology and Microbial Pathogenesis Unit

The Campaign for **Memorial Sloan-Kettering**

The Campaign for Memorial Sloan-Kettering maintained strong momentum in 2012, with gifts and pledges as of December 31 totaling more than \$2.752 billion. Generous supporters from around the world contributed cash gifts totaling \$235.6 million over the course of the year, including a record-setting \$61.3 million in **December.** This marks the largest December total in Center history, and the 130,000 gifts processed during the month helped bring 2012 to an especially strong close.

As the Campaign continues ahead of pace toward its \$3.5 billion goal under the leadership of co-chairs Douglas A. Warner III and Louis V. Gerstner, Jr., and President Craig B. Thompson, its ongoing achievement is sustained by the generosity of donors at every level. Benefactors of Memorial Sloan-Kettering generated a 30 percent increase in new pledges in 2012 from the previous year, and the commitment and support for the Center's lifesaving mission demonstrated by its donors is exemplified by the following:

- the deadliest forms of cancer.







(From top) Douglas A. Warner III, Louis V. Gerstner. Jr., Craig B. Thompson.

• David M. Rubenstein committed \$10 million to establish the David M. Rubenstein Center for Pancreatic Cancer **Research**, which enables the launch of an intensive, fully integrated effort designed to achieve meaningful progress against one of

• The Tow Foundation pledged \$8 million to underwrite the work of the Michael G. Harris Cell Therapy & Cell Engineering Facility (formerly the Center for Cell Engineering), which develops advanced cell-based cancer therapies through cutting-edge molecular and cellular techniques. This brings the Tow Foundation's total giving to the Campaign to more than \$38 million.

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(Clockwise, from top) The Washington, DC, Cycle for Survival event at Equinox Bethesda on February 10; Fred's Team members (from left) Emily Fried, Nicole Gill, Brynna Lipson, and Jennifer Cunningham at the finish of the Brooklyn Half Marathon: Mark Rubin, the 2012 BBC Decathlon's top athlete, flanked by event co-founders Dave Maloney (left) and Marc Hodulich.

• The Estate of Samuel Mitchell, a long-standing donor to Memorial Sloan-Kettering, made a bequest of \$3.6 million in unrestricted funds to the Center, part of the more than \$37 million in bequests received by the Center in 2012.

• The Thompson Family Foundation made a \$3.8 million grant in support of prostate cancer research at Memorial Sloan-Kettering as part of a groundbreaking international collaboration with Israel's Weizmann Institute of Science.

The driving commitment to making a difference is also displayed by the thousands of volunteers and participants in athletic fundraisers who support Memorial Sloan-Kettering's work with their efforts each year. The newest of these fundraisers, The RBC Decathlon, challenges professionals in financial services to compete against one another in ten separate athletic events. In 2012, participants in The RBC Decathlon raised nearly \$1.3 million for pediatric cancer research at the Center, more than double the amount raised in the previous year.

The Center's Cycle for Survival indoor team cycling event is one of the fastest-growing athletic fundraisers in the country. The most recent event saw 12,000 participants across ten cities nationwide join the battle, raising more than \$14 million for research into rare cancers. In its seven-year history, Cycle for Survival has raised a total of \$31.5 million, funding 53 clinical trials and studies in its first six years alone.





And despite the cancellation of the 2012 ING New York City Marathon in the aftermath of Hurricane Sandy, members of Fred's Team registered to participate on behalf of Memorial Sloan-Kettering showed extraordinary commitment, raising a total for the year of more than \$4.6 million to support high-priority research at the Center.

Memorial Sloan-Kettering benefits enormously from the generosity of its committed benefactors, whose support at every level helps the Center's physicians and scientists pursue the most-promising avenues of research and advance the standard of care for the benefit of patients around the world.

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ASSOCIATE ATTENDINGS

ASSISTANT ATTENDINGS

Shari Goldfarb, MD Alexia E. Iasonos, PhD Allison N. Lipitz-Snyderman, PhD Susan Oliveria, ScD, MPH Irina Ostrovnaya, PhD Sujata Patil, PhD Li-Xuan Qin, PhD Talya Salz, PhD Ronglai Shen, PhD Camelia S. Sima, MD Zhigang Zhang, PhD

INSTRUCTOR

Jennifer Brooks, PhD

as of March 15, 2013

Maria E. Arcila, MD Ngolela Esther Babady, PhD Christine Gi-Yun Moung, MD Kazunori Murata, PhD Christopher Y. Park, MD, PhD David C. Park, MD Larry J. Smith, PhD

INSTRUCTOR Samuel I. McCash, MD

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George J. Bosl, MD

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ATTENDINGS Howard I. Amols, PhD Chandra M. Burman, PhD John L. Humm, PhD Peter Kijewski, PhD Jason A. Koutcher, MD, PhD Gloria C. Li, PhD Thomas J. LoSasso, PhD Gikas S. Mageras, PhD Jean M. St. Germain, MS Ellen D. Yorke, PhD Marco Zaider, PhD Pat B. Zanzonico, PhD

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Douglas J. Ballon, PhD Maria F. Chan, PhD Amita Dave, PhD Yusuf E. Erdi, DSc

DIVISION HEADS AND

Ephraim S. Casper, MD

Division of Network

Division of General Medicine:

Medicine Services

Eric G. Pamer, MD

ATTENDINGS

Doracy P. Fontenla, PhD Y. C. David Huang, PhD Margie A. Hunt, MS Andrew Jackson, PhD Assen S. Kirov, PhD Dale M. Lovelock, PhD Yousef Mazaheri, PhD James G. Mechalakos, PhD Sadek Nehmeh, PhD Ceferino H. Obcemea, PhD Joseph A. O'Donoghue, PhD Kristen L. Zakian, PhD

ASSISTANT ATTENDINGS

Ellen Ackerstaff, PhD Ase M. Ballangrud-Popovic, PhD Lawrence T. Dauer, PhD Cesar Della Biancia, PhD Paul Frisch, PhD

Hongbiao Carl Le, PhD Guang (George) Li, PhD Jingdong Li, PhD Ruimei Ma, PhD Jung Hun Oh, PhD Kyung K. Peck, PhD Charles R. Schmidtlein, PhD Jazmin Schwartz, PhD Govindarajan Srimathveeravalli, PhD Yulin Song, PhD Sunitha B. Thakur, PhD Neelam Tyagi, PhD Harini Veeraraghavan, PhD Weijun Xiong, PhD Guozhen (Jenny) Yang, PhD Pengpeng Zhang, PhD Qinghui Zhang, PhD

David H. Gultekin, PhD

as of March 15, 2013

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as of March 15, 2013

Department of Medicine

Paul A. Glare, MBBS

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Oncology

William J. Schneider, MD

Craig H. Moskowitz, MD

ASSOCIATE ATTENDINGS Ghassan K. Abou-Alfa, MD

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Enid A. Haupt Chair

- in Clinical Investigation David R. Spriggs, MD Division of Solid Tumor Oncology: Winthrop Rockefeller Chair in Medical Oncology
 - Marcel R. M. van den Brink. MD. PhD Division of Hematologic Oncology; Alan N. Houghton Chair

SENIOR ATTENDING Bayard Clarkson, MD Enid A. Haupt Chair of

Therapeutic Research

ATTENDINGS

Carol Aghajanian, MD Scott A. Armstrong, MD, PhD Graver Family Chair Peter Bach, MD Dean F. Bajorin, MD José Baselga, MD, PhD Michael S. Baum, MD Ellin Berman, MD William S. Breitbart, MD Murray F. Brennan, MD Benno C. Schmidt Chair in Clinical Oncology Arthur E. Brown, MD

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Sergio A. Giralt, MD

as of March 15, 2013

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ASSISTANT ATTENDINGS

Omar I. Abdel-Wahab, MD Juliet B. Aizer, MD Arlyn Apollo, MD Abraham Aragones, MD, MS Dalit Ashany, MD Shrujal Baxi, MD Katherine M. Bell-McGuinn. MD, PhD Stefan Berger, MD Jessica R. Berman, MD Victoria S. Blinder, MD Laura Boucai, MD Michelle S. Boyar, MD Vivian P. Bykerk, MD Richard D. Carvajal, MD Andrea Cercek Hanjis, MD Iamie E. Chaft, MD

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as of March 15, 2013

Department of Medicine

Neil H. Segal, MD, PhD Pari M. Shah, MD Eric J. Sherman, MD Marisa Siebel, MD Stephanie Smith-Marrone, MD Philip S. Spencer, MD Stacy M. Stabler, MD, PhD Zsofia K. Stadler, MD Sung Wu Sun, MD William D. Tap, MD Ying Taur, MD Sohail F. Tavazoie, MD, PhD William P. Tew, MD Muthukumar Thangamani, MBBS Dharmarao Thapi, PhD

Department of Neurology



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ATTENDINGS

Ronald G. Blasberg, MD

Kathleen M. Foley, MD

Paul A. Glare, MBBS

in Oncology

of Neurology

Jerome B. Posner, MD

Neal Rosen, MD, PhD

Medical Oncology

Eric Holland, MD, PhD

Emily Tow Jackson Chair

Gavril W. Pasternak, MD, PhD

Anne Burnett Tandy Chair

Chair of Neuro-Oncology

Enid A. Haupt Chair in

Jonathan D. Victor, MD, PhD

American Cancer Society Clinical

Robert B. Darnell, MD, PhD

The Society of Memorial Sloan-

Kettering Cancer Center Chair

Samarth Beri, MD Maria I. Carlo, MD Judy Dong, DO

Alan C. Carver, MD Xi Chen, MD, PhD Denise D. Correa, PhD Yasmin Khakoo, MD Ingo K. Mellinghoff, MD Craig P. Nolan, MD Ying-Xian Pan, PhD Michael D. Stubblefield, MD

ASSISTANT ATTENDINGS

Edward K. Avila, DO Christian M. Custodio, MD Marc J. Dinkin, MD Research Professor; George C. Cotzias Igor T. Gavrilovic, MD Yvona Griffo, MD Katarzyna Ibanez, MD Thomas Kaley, MD Susruta Majumdar, PhD Natalie Moryl, MD

as of March 15, 2013

Kenneth Ho-Ming Yu, MD Marjorie G. Zauderer, MD

INSTRUCTORS

Vivek K. Arora, MD, PhD Kathleen R. Atlas, MD Juan Pablo Galvez, MD Nicole C. Hadi, MD Stephan Heo, MD Gopakumar V. Iyer, MD Nivedita N. Kumar, MBBS Stephen J. Kuperberg, MD Oscar Boutros Lahoud, MD James C. Lee, MD Alison Marie Mainardi, MD Anjali A. Nigalaye, MD Ranish Gautam Patel, MD Pallavi Patri, MD Tracy Ann Proverbs-Singh, MD Yael Miriam Raymon, MD Wael C. Saleh, MB, ChB Nicole Marie Tyer, MD

as of March 15, 2013

ASSOCIATE ATTENDINGS

Babak Navi, MD Antonio M. P. Omuro, MD Elena Pentsova, MD Lisa M. Ruppert, MD Sonia K. Sandhu, DO Jonas M. Sokolof, DO Roma Tickoo, MD, MPH Efstathia Tzatha, MD Kaleb H. Yohay, MD

INSTRUCTORS

Milan Chheda, MD Kevin C. De Braganca, MD Christian Grommes, MD

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Department of Neurosurgery



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ATTENDINGS Mark H. Bilsky, MD Eric C. Holland, MD, PhD Emily Tow Jackson Chair in Oncology Samuel H. Selesnick, MD Philip E. Stieg, MD, PhD Lorenz P. Studer, MD

ASSOCIATE ATTENDINGS Cameron W. Brennan, MD Michael Kaplitt, MD, PhD

Mark M. Souweidane, MD

Viviane S. Tabar, MD

as of March 15, 2013

as of March 15, 2013

ASSISTANT ATTENDINGS Jeffrey P. Greenfield, MD, PhD Ilya Laufer, MD

Department of Pediatrics



CHAIR AND ATTENDING Richard J. O'Reilly, MD Claire L. Tow Chair in Pediatric Oncology Research

ATTENDINGS

David H. Abramson, MD Scott A. Armstrong, MD, PhD Grayer Family Chair Nai-Kong V. Cheung, MD, PhD Enid A. Haupt Chair in Pediatric Oncology Laurel J. Steinherz, MD Peter G. Steinherz, MD Leonard H. Wexler, MD

ASSOCIATE ATTENDINGS

James B. Bussel, MD Irene Y. Cheung, ScD Ira J. Dunkel, MD Patrick A. Flynn, MD Bruce M. Greenwald, MD Jeffrey Kern, MD

Department of Pathology



CHAIR AND ATTENDING David S. Klimstra, MD James Ewing Chair of Pathology

ATTENDINGS Cristina Antonescu, MD

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ASSOCIATE ATTENDINGS Emily Cheng, MD, PhD April Chiu, MD Marija Drobnjak, MD Dilip D. Giri, MBBS Cyrus V. Hedvat, MD, PhD André L. Moreira, MD, PhD Lee K. Tan, MD Laura H. Tang, MD, PhD Liying Zhang, MD, PhD

ASSISTANT ATTENDINGS

Narasimhan Agaram, MBBS Hikmat A. Al-Ahmadie, MD Maria E. Arcila, MD Olca Basturk, MD Michael F. Berger, PhD Laetitia A. Borsu-Valente, PhD Yingbei Chen, MD, PhD Donavan Cheng, PhD Sarah Chiang, MD Adriana Dionigi Corben, MD

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as of March 15, 2013

Yasmin Khakoo, MD Kim Kramer, MD Richard C. Meagher, PhD Shakeel Modak, MD Joshua P. Needleman, MD Andromachi Scaradavou, MD Mark Souweidane, MD Tanya M. Trippett, MD Maria G. Vogiatzi, MD Stefan Worgall, MD, PhD

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Seena S. Abraham, MBBS Zoltan Antal, MD Abraham Bartell, MD Naomi B. Bishop, MD Sheila J. Carroll, MD Alexander Ja-Ho Chou, MD Nana E. Coleman, MD Jeffrey Dayton, MD Ekaterina Doubrovina, MD, PhD Jennifer S. Ford, PhD Stephen W. Gilheeney, MD Jeffrey P. Greenfield, MD, PhD Aisha N. Hasan, MBBS Joy D. Howell, MD Devin Doreen Hsing, MD

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ATTENDINGS

Department of Psychiatry and Behavioral Sciences



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ASSOCIATE ATTENDINGS

Carma L. Bylund, PhD Jeanne Carter, PhD

Denise D. Correa, PhD Jennifer L. Hay, PhD Tomer T. Levin, MBBS Yuelin Li, PhD

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Abraham Aragones, MD Yesne Alici-Evcimen, MD Thomas M. Atkinson, PhD Smita Banerjee, PhD Abraham S. Bartell, MD Jack E. Burkhalter, PhD Lisa C. Diamond, MD, MPH Jennifer S. Ford, PhD Julia A. Kearney, MD

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as of March 15, 2013



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Robert D. Zimmerman, MD

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Department of Radiation Oncology



CHAIR AND ATTENDING Simon N. Powell, MD, PhD Enid A. Haupt Chair in Radiation Oncology

ATTENDINGS David H. Abramson, MD Kaled M. Alektiar, MD Adriana Haimovitz-Friedman, PhD Gloria C. Li, PhD Beryl McCormick, MD Karen D. Schupak, MD Suzanne L. Wolden, MD Joachim Yahalom, MD

Michael J. Zelefsky, MD

ASSOCIATE ATTENDINGS Timothy Chan, MD, PhD Daphna Y. Gelblum, MD Karyn A. Goodman, MD Nancy Lee, MD Borys R. Mychalczak, MD Yoshiya Yamada, MD

as of March 15, 2013

Christopher A. Barker, MD Kathryn F. Beal, MD Karen Borofsky, MD Pinaki R. Dutta, MD, PhD Richard M. Gewanter, MD Alice Yoosun Ho, MD Marisa A. Kollmeier, MD James E. Lee, MD Boris Mueller, MD Preeti K. Parhar, MD William R. Polkinghorn, MD Shyam S. D. Rao, MD, PhD Andreas Rimner, MD Helen L. Sidebotham, MD Abraham Jing-Ching Wu, MD Melissa R. Remis Zinovov, MD

ASSISTANT ATTEDINGS

ASSISTANT ATTENDINGS Allison S. Aguado, MD Miriam Benezra, PhD

as of March 15, 2013

Linda R. Aboody, MD William Alago, Jr., MD Douglas J. Ballon, PhD Michelle S. Bradbury, MD, PhD Lynn A. Brody, MD Betty A. Caravella, MD Anne M. Covey, MD Otilia-Liana Dumitrescu, MD Jeremy C. Durack, MD Kimberly N. Feigin, MD Arthur A. Fruauff, MD Scott R. Gerst, MD Linda A. Heier, MD Tunç A. Iyriboz, MD Stefanie S. Jacobs, MD Maxine S. Jochelson, MD Jennifer B. Kaplan, MD Sasan Karimi, MD Karen B. Karlson, MD Delia M. Keating, MD Robert A. Lefkowitz, MD Yousef Mazaheri, PhD Michael R. McDevitt, PhD Sadek Nehmeh, PhD Neeta Pandit-Taskar, MBBS Harpreet K. Pannu, MD Naga Vara Kishore Pillarsetty, PhD Jurgen Rademaker, MD Debra M. Sarasohn, MD Marc Z. Simmons, MD Constantinos T. Sofocleous, Raymond H. Thornton, MD Barbara Wajsbrot-Kandel, MD Jonathan W. Weinsaft, MD Corinne B. Winston, MD Kristen L. Zakian, PhD

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INSTRUCTOR

Barbara Raphael, MD

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Department of Surgery



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DIVISION HEAD AND ATTENDING

Ronald P. DeMatteo, MD Division of General Surgical Oncology; Alexandra S. Heerdt, MD Leslie H. Blumgart Chair in Surgery

ATTENDINGS

David H. Abramson, MD Nadeem R. Abu-Rustum, MD Manjit S. Bains, MD Neil H. Bander, MD Richard R. Barakat, MD Ronald O. Perelman Chair in Gynecologic Surgery Leslie H. Blumgart, MD Bernard H. Bochner, MD Patrick I. Boland, MD Murray F. Brennan, MD Benno C. Schmidt Chair in Clinical Oncology Mercedes Castiel, MD Dennis S. Chi, MD Hiram S. Cody III, MD Daniel G. Coit, MD Peter G. Cordeiro, MD Guido Dalbagni, MD Joseph J. Disa, MD S. Machele Donat, MD Robert J. Downey, MD James A. Eastham, MD Florence and Theodore Baumritter/ Enid Ancell Chair of Urologic Oncology Mahmoud El-Tamer, MD Yuman Fong, MD Murray F. Brennan Chair in Surgery Harold P. Freeman, MD Julio Garcia-Aguilar, MD, PhD Stuart H. Q. Quan Chair in Colorectal Surgery

José G. Guillem, MD John H. Healey, MD Stephen McDermott Chair in Surgery Harry W. Herr, MD William J. Hoskins, MD Joseph M. Huryn, DDS William R. Jarnagin, MD Enid A. Haupt Chair in Surgery Maureen Killackey, MD Michael P. LaQuaglia, MD Joseph H. Burchenal Chair in Pediatrics Hans G. Lilja, MD Monica Morrow, MD Anne Burnett Windfohr Chair of Clinical Oncology John P. Mulhall, MB, BCh, BAO Raul O. Parra, MD Philip B. Paty, MD Valerie W. Rusch, MD Miner Family Chair in Intrathoracic Cancers Paul Russo, MD Virgilio Sacchini, MD Lisa M. Sclafani, MD Jatin P. Shah, MD Elliot W. Strong Chair in Head and Neck Oncology Ashok R. Shaha, MD Jatin P. Shah Chair in Head and Neck Surgery and Oncology Joel Sheinfeld, MD William G. Cahan Chair in Surgery Samuel Singer, MD Bhuvanesh Singh, MD, PhD Pramod C. Sogani, MD Diane E. Stover, MD Kimberly J. Van Zee, MD

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as of March 15, 2013

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as of March 15, 2013

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as of March 15, 2013

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as of March 15, 2013

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as of March 15, 2013

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Assistant Laboratory Members

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AT CORNELL UNIVERSITY

Assistant Member (Affiliate) Hening Lin, PhD

AT THE BOCKEFELLER UNIVERSITY Assistant Member (Affilaite)

Sean Brady, PhD

JOINT APPOINTMENTS

Michelle S. Bradbury, MD, PhD Renier J. Brentjens, MD, PhD Jason A. Koutcher, MD, PhD Jason S. Lewis, PhD Vladimir Ponomarev, MD, PhD Woflgang A. Weber, MD

as of March 15, 2013

PROFESSIONAL SUPPORT STAFF Associate Laboratory Member Yehuda Goldgur, PhD

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