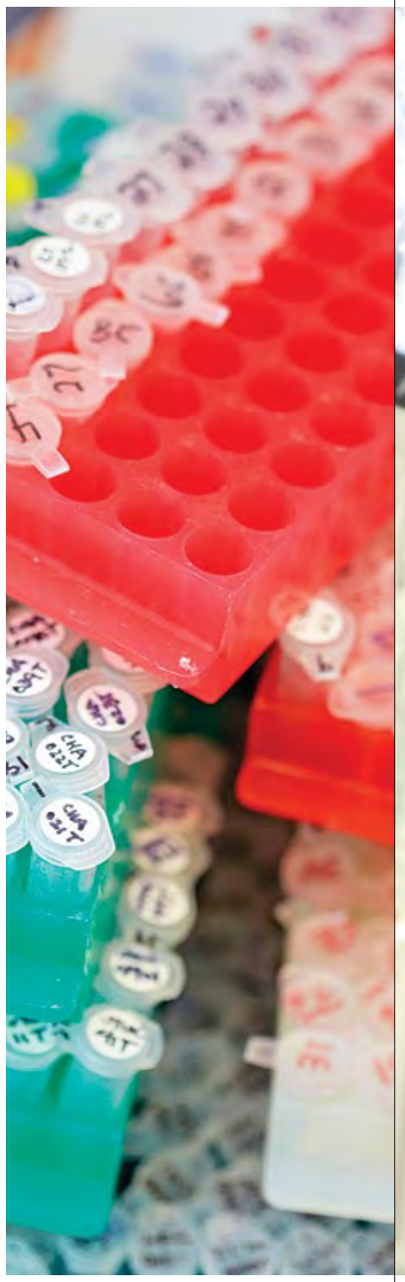
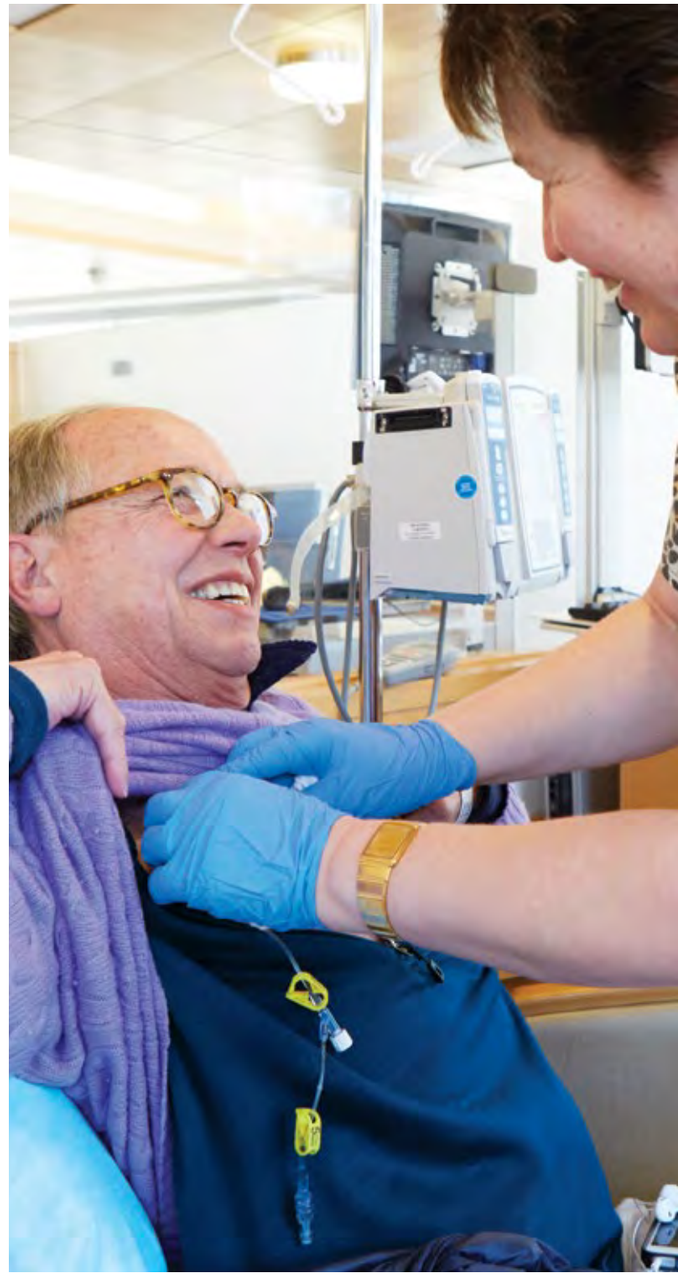
Memorial Sloan Kettering Cancer Center

Transformations





Our vision is nothing less than to revolutionize the treatment of cancer.

Our goal over the next decade is to integrate molecular and clinical information to develop therapies that home in on the abnormalities driving each patient's disease.

At Memorial Sloan Kettering, this new era in precision cancer medicine is already becoming a reality for many of our patients.

Capitalizing on our exceptionally powerful combination of clinical and scientific resources, we are delivering on the promise of personalized cancer therapy and are setting the stage for transformational change, both in the immediate future and for years to come.

Join us now on a journey that will span our institution. It begins with the outstanding biomedical research that informs novel early-stage drug discovery and development, takes us through paradigm-breaking precision medicine and robust clinical research, and concludes with innovative new approaches that will transform individualized cancer care and extend it to more patients than ever before.

Cover: (*Center, in green scrubs*) Surgical oncologist and breast cancer researcher George Plitas; (*right*) clinical dietitian Tatanisha Peets

Inside cover: (*Far left*) Patient care technician Jasmattie Persaud at a patient's bedside; (*second from right*) plastic and reconstructive surgery fellow Adrian Sjarif during an operation; (*far right*) Valda Gaubiene, Clinical Nurse II, administers chemotherapy to patient Charles Fetter at MSK's Basking Ridge, New Jersey, outpatient care facility.

Back cover: Radiation therapist Michael Guida (*left*) and patient Renaldo Hill at Memorial Sloan Kettering's Basking Ridge, New Jersey, outpatient care facility

DOUGLAS WARNER III
Chairman, Boards of Overseers and Managers

CRAIG THOMPSON
President and Chief Executive Officer

In 2013 we implemented strategic programs and long-term approaches that can harness the power of big and innovative ideas — ideas that are revolutionizing how we understand and treat cancer.

Before going further, we would like to acknowledge that these achievements are made possible by the hard work, generosity of spirit, and creativity of our staff. They are unswerving in their dedication to advancing our knowledge of cancer, discovering more-precise ways to diagnose and treat it, and making the lives of our patients and their families as comfortable as possible. Our staff is the heart, soul, and engine of MSK.

The year began with the homecoming of José Baselga, our new Physician-in-Chief and Chief Medical Officer, who did a fellowship here in the 1990s and remained on the faculty for several years before returning to his native Spain. An internationally renowned physician-scientist and breast cancer expert, he joined 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 began his tenure with two key appointments. First, medical oncologist Paul Sabbatini was named Deputy Physician-in-Chief for Clinical Research and has led an extraordinary team in streamlining and accelerating MSK's clinical trials process. We now have two Institutional Review Boards, doubling our capacity to do clinical trial reviews. We've seen remarkable decreases in the time between the review and approval of trials and are seeing a significant increase in trials, with more patients participating.

Later in the year, Dr. Baselga named gynecologic surgeon and Chief of the Gynecology Service Richard R. Barakat Deputy Physician-in-Chief for the Regional Care Network and MSK Cancer Alliance.

The Memorial Sloan Kettering Cancer Alliance, a unique initiative established to improve the quality of cancer care and the lives of cancer patients, was announced in 2013. Simultaneously, we introduced the Alliance's first member, Hartford HealthCare, a five-hospital system in Connecticut. The MSK Cancer Alliance will allow more patients access to our clinical trials. It will also offer them the benefit of precision medicine as we translate molecular insights into innovations ranging from the latest diagnostic tests to targeted therapies. Clinical and administrative teams led by Dr. Barakat are now focusing on preparations to fully implement the program later this year.

Dr. Baselga brought energy and innovation to other important areas, including molecular oncology, and participated in MSK's partnership with IBM in developing a powerful cancer resource. Built on the IBM Watson cognitive computing platform, it will provide medical professionals with improved access to current, comprehensive cancer data and practices. In collaboration with Executive Vice President and Chief Hospital Operating Officer Kathryn Martin, he also guided us through the Joint Commission accreditation review of both our hospital and clinical laboratories, for which we received outstanding marks.

The year concluded with the appointment of Joan Massagué as the Director of the Sloan Kettering Institute. An exemplary scientist whose research has produced results central to the understanding of cancer, Dr. Massagué has led SKI's Cancer Biology and Genetics Program since 2003 and has been part of the SKI community since 1989, when he joined us as the Alfred P. Sloan Chair of SKI's Cell Biology Program. His scientific acumen and invaluable expertise coupled with his ability to unite people will keep MSK at the forefront of cancer research.

During the national and international search for a new SKI director, we received strong interim leadership from Molecular Biology Program Chair Kenneth J. Marians and Molecular Pharmacology and Chemistry Program Chair David A. Scheinberg. Dr. Marians helped shepherd us through the National Cancer Institute's review of our cancer research, also known as the Core Grant. It is a tribute to our entire community that we received a rating of "exceptional" and were awarded a full five-year renewal. Many people contributed to the success of our programs — and the grant submission itself. We thank them all.

Dr. Scheinberg led the effort to establish the Tri-Institutional Therapeutics Discovery Institute (Tri-I TDI), a unique partnership between MSK, Weill Cornell Medical College, and The Rockefeller University. The Tri-I TDI has entered into an initial partnership with Takeda Pharmaceuticals International, Japan's largest pharmaceutical company, to assist investigators at the three institutions in developing small-molecule therapeutic agents and molecular probes for the treatment and diagnosis of cancer and other human diseases. (To read more about the Tri-I TDI, see *Transforming Drug Discovery & Development* beginning on page 20 of this report.)

In recent years, scientists have shown that the mutations that give rise to cancer vary among people, even those with the same type of cancer. The identification of genetic and molecular targets in individual cancers can be used to help select effective therapies and create new ones. In 2013, MSK established several new centers to capture a tumor's genetic information and exploit it to its full potential.

A transformative $100 million gift from the Marie-Josée and Henry R. Kravis Foundation allowed us to create the Marie-Josée and Henry R. Kravis Center for Molecular Oncology (CMO). This new center will make it possible to realize the promise of precision oncology and support the development of new, individualized cancer therapies and diagnostic tools. Among the aims of the CMO will be to analyze more than 10,000 patient tumors in the first year alone, with an eye toward offering molecular analysis for every type of cancer and for all MSK patients. Mrs. Kravis has been a member of MSK's Boards of Overseers and Managers since 2000 and is Chair of the Board of the Sloan Kettering Institute. (To learn more about the CMO, see *Transforming Precision Medicine* beginning on page 30.)

With an initial commitment of $10 million, MSK Board member David M. Rubenstein paved the way for another ambitious initiative. Called the David M. Rubenstein Center for Pancreatic Cancer Research (CPCR), it brings together MSK's outstanding physicians and an expanding group of scientists in an intensive program designed to speed progress in understanding and treating one of the deadliest types of cancer — and one that has been relatively understudied. (To learn more about the CPCR, see page 38.)

Also among MSK's many accomplishments in 2013 were the development of important new treatments for prostate cancer and improved ways to diagnose leukemia, endometrial cancer, and salivary gland cancer, and the determination of the structure of a complex protein (mTOR) that plays a role in many forms of cancer.

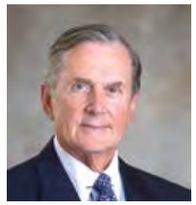
While it is impossible to list all of MSK's scientific achievements, one in particular deserves special mention. This year, *Science* magazine identified the development of immunotherapy for the treatment of cancer as the most important scientific advance of 2013 — in *all* fields. The magazine cited the efforts of two groups of MSK investigators as exceptional.

Singled out by *Science* was the collaborative preclinical and clinical work of Jedd D. Wolchok, Chief of our Melanoma and Immunotherapeutics Service, and immunologist James P. Allison (formerly at MSK, now at MD Anderson Cancer Center in Houston) in their development of a drug called ipilimumab (Yervoy™), approved by the FDA in 2011 for the treatment of metastatic melanoma. The other work came from Michel Sadelain, Director of the Center for Cell Engineering, and his colleagues Renier J. Brentjens, Director of Cellular Therapeutics, and Isabelle Rivière, Director of the Cell Therapy and Cell Engineering Facility. These investigators played a seminal role in the development of a major area of research highlighted by the magazine: a cell-based targeted immunotherapy called chimeric antigen receptor (CAR) therapy. Chimeric antigen receptors are a new class of drugs in oncology with the potential to be applied to many types of cancer. (To learn more about CAR therapy and these researchers, see *Cell-Based Therapies* on page 26.)

JOHN R. GUNN
Chief Operating Officer

JOSÉ BASELGA
Physician-in-Chief and Chief Medical Officer, Memorial Hospital

JOAN MASSAGUÉ
Director, Sloan Kettering Institute



JAMES D. ROBINSON III
Honorary Chairman, Boards of Overseers and Managers

In addition to the new approaches to therapy taken by our scientists, MSK infectious disease specialist Kent Sepkowitz has been appointed Deputy Physician-in-Chief for Quality and Safety. This newly created position highlights MSK's commitment to continuing to lead in the development and implementation of a comprehensive quality of care program as well as increased dedication to a center-wide promotion of a culture of safety. Dr. Sepkowitz, who joined MSK in 1988 as a fellow in the Infectious Disease Service, has led the Hospital Infection Control program for the past 15 years and earned the trust and respect of staff members in every part of the institution. He will bring to this new role an ability to unite people in pursuit of an environment continually focused on quality.

Members of the Boards of Overseers and Managers have recently accepted new roles as well. Scott M. Stuart has been elected Chair of the Board of Managers of Memorial Hospital, and Louis V. Gerstner, Jr., formerly Vice Chair of the Boards of Overseers and Managers, has become Honorary Chair of the Sloan Kettering Institute and remains Chair of the Board of Gerstner Sloan Kettering Graduate School of Biomedical Sciences. We are deeply grateful for the extraordinary and steadfast guidance Mr. Gerstner has provided to MSK in his many leadership roles since joining the board in 1977.

Richard I. Beattie, formerly Vice Chair of the Boards and Chair of the Board of Managers of Memorial Hospital, has become Honorary Chair of the Memorial Hospital Board. Mr. Beattie has our profound thanks for offering his acute intelligence and leadership as we carried out our mission at a time of significant change in the healthcare landscape.

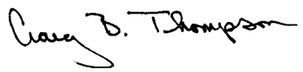
MSK's network of regional sites continues to develop, beginning with our new ambulatory care facility in Harrison, New York, slated to open this fall. Construction on the Josie Robertson Surgery Center on York Avenue is ongoing, and work will soon begin at the East 74th Street complex we are jointly developing with Hunter College of the City University of New York.

We are pleased with our 2013 financial results. Our investment and philanthropic revenues were strong, allowing us to invest in MSK's future.

The title of this report — *Transformations* — perfectly characterizes and captures the past year. Indeed, "transformational" is the word we heard, time and again, on the lips of our clinicians, scientists, and other staff as they described their feelings about the progress we've made and what they know is to come.

We stand on the brink of opportunities in cancer research that are leading to discoveries inconceivable a mere decade ago. And today, the gifted men and women of Memorial Sloan Kettering are translating these discoveries into treatment realities. On the pages that follow, we invite you to join us on an inspiring journey into the future.

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



Craig B. Thompson
President and Chief Executive Officer

Transforming Biomedical Research

A detail from the laboratory of chemical biologist Gabriela Chiosis, whose drug development research is featured in *A Long and Winding Road: PU-H71* on page 28

Q&A

"What was inconceivable in cancer science even a decade ago is within reach today. And at the end of the next ten years, oncology will not be as we now know it," says cancer biologist Joan Massagué, the new Director of the Sloan Kettering Institute.

"My ambition for the Institute is to look back a decade from now and say, 'We have been at the center of the most transformative period in the quest to put our arms around cancer and to change our perception of, and power over, the disease.'"

Dr. Massagué, an international leader in the study of cancer metastasis and the growth factors that regulate cell behavior, joined Memorial Sloan Kettering in 1989 as Chair of the Sloan Kettering Institute's Cell Biology Program. In 2003, he was named inaugural Chair of SKI's Cancer Biology and Genetics Program. Dr. Massagué was a Howard Hughes Medical Investigator for 24 years and is the incumbent of the Alfred P. Sloan Chair at Memorial Sloan Kettering. He succeeds Thomas J. Kelly, who served as SKI director for more than ten years.

Here, Dr. Massagué talks about his new role, his expectations for the SKI research enterprise, and what excites him most in cancer research today.

Q: What does this new appointment mean to you personally?

A: Well, it's a fantastic thing, and an opportunity to serve. It comes at a moment when I feel prepared. Having produced a significant body of scientific work, which remains robust, I am now increasingly motivated to look beyond my own science. I'm eager to work to enhance our extremely vibrant programs in ways that will be most productive for the many people who make up our research community.

And of course, Memorial Sloan Kettering is a wonderful institution. It's never crossed my mind to go anywhere else!

Q: Why have you spent 25 years at MSK? What's so special about this place?

A: For me, there has never been a question of where I should be. For example, I would not have started on my metastasis project had I not been at the Sloan Kettering Institute. Were there other places like it? Not really. Some that came close? Yes, but not many. You could count them on the fingers of one maimed hand! Not many places at all.

If I put a word on it, it would be "togetherness." It's being surrounded by scientists and physicians who know both the fundamental mechanisms of biology and the processes of cancer intimately, and who know the right questions to ask. And this is applicable to any aspect of cancer: genetic origins, tumor spread and metastasis, drug resistance, cancer stem cells — you name it. We have both the intellectual firepower and the technology necessary to unravel the mysteries of the disease and find its weak flanks. MSK is unrivaled as a place to do research at the highest levels.

Q: Can you give an example?

A: Certainly. Take immunity and cancer. The immune system has both tumor-inhibiting and tumor-promoting functions. MSK is positioned with cutting-edge strength both in elucidating the intricacies of the immune system and in developing new ways to exploit it for the benefit of patients.

There are three big examples in this field, and I'm proud to say we're leading in all three of them. The first chapter of the story is based on the presence of great basic immunology research and laboratories that are studying the biology of immune cells in the tumor microenvironment. Current work is pointing at novel ways to leverage special kinds of immune cells, called tumor-associated macrophages, in order to turn them against the tumor. [See *Reeducating Macrophages to "Eat" Cancer* on page 19.]

The other two chapters are linked. Each year, *Science* magazine announces one pivotal scientific achievement as the "Breakthrough of the Year." The magazine identified the development of immunotherapy for the treatment of cancer as the most important scientific advance of 2013 and singled out two modalities of immunotherapy in the hands of MSK researchers that have played leading roles in pioneering this work.

One of the key milestones cited by *Science* is the work of immunologists to explain how a protein receptor on the surface of T cells, called CTLA-4, puts the brakes on the T cells and prevents them from carrying out immune attacks. Immunologist James Allison [now at MD Anderson Cancer Center in Houston] identified an antibody that blocks CTLA-4 and showed that turning off those brakes allows T cells to destroy cancer. Anti-CTLA-4 eventually became ipilimumab

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Srinivas Malladi is a research scholar in the laboratory of Joan Massagué.

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Lan He works as a senior research technician in Dr. Massagué's lab.

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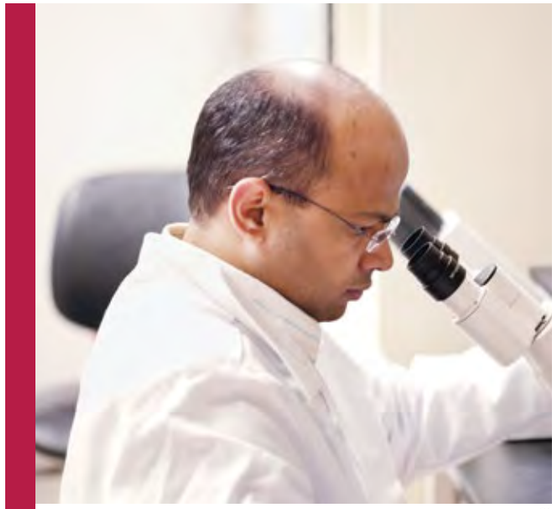
Research scholar Jie Su is a member of Dr. Massagué's laboratory team.



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[Yervoy™], a drug that was approved in 2011 for the treatment of metastatic melanoma. While he was at MSK, Dr. Allison, along with [MSK physician-scientist] Jedd D. Wolchok, helped guide the development of ipilimumab from the first laboratory studies through the late-stage clinical trials that led to its approval.

The final example, also cited in the *Science* article, is the development of chimeric antigen receptor [CAR] therapy. This is based on the idea that a patient's own T cells can be collected from the blood, engineered to recognize cancer cells and acquire stronger antitumor properties, and then reinfused to circulate through the bloodstream and attack those cancerous cells. MSK has been a leading center in developing this technology. One of the first great successes in the field has come in the treatment of leukemia. [To learn more about this work, see *Cell-Based Therapies* on page 26.]

Q: Could you elaborate on the opportunities in cancer research today, and also some of the challenges?

A: Let's start with the challenges: funding resources. They're always limited. And paradoxically, they are more limited than ever right now, when we are in a golden era of opportunity in cancer research.

On the positive side, the opportunities, and our capabilities, are tremendous. Philanthropy is a wonderful resource that is having a huge impact on our ability to move basic and translational research forward. And so, with limited resources and great scientific and medical opportunities, the big challenge is the challenge of choice: Individually as investigators and collectively as an institution, we must choose well what to investigate.

Q: How does one make choices?

A: You think carefully about why to study a particular problem — a fundamental cellular process, a particular form of cancer, whatever. Then you decide how and when to apply your effort in this vast landscape of cancer-related and basic biology questions.

The skill at a premium now more than ever is understanding how and why to choose your research problem. This is what I try to teach my students and postdocs: Choose a problem that's important, that's feasible, that has value in as many areas as possible. And that goes for every investigator and every program here. With the wealth of choice comes the responsibility of choosing well.

Q: Tell us more about this "golden era."

A: A major goal of cancer research in the years ahead will be to join molecular and clinical information to develop treatments individualized to each patient's cancer. And on this score, we have entered a new revolution. Today, genomic-scale molecular oncology applied to the clinic is possible, and soon it will be routine.

For instance, we are now able to interrogate the genetic profiles of tumors from patients who have had an unusually good response to a drug that most other patients did not respond to and ask why those patients responded. Tumors are giving us answers, as revealed in their genetic analysis. We can then go on to use what we learn to make the drug in question effective in a broader population of patients, while shedding new light on the fundamental mechanisms that drive normal cells as well as cancer.

> "We have entered a new revolution. Today, genomic-scale molecular oncology applied to the clinic is possible, and soon it will be routine."

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A detail from the laboratory of Joan Massagué

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Research technician Ruzeen Patwa in Dr. Massagué's lab

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A detail from the laboratory of Joan Massagué

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Pipetting a reagent in Dr. Massagué's lab

To this end, we've recently created the Marie-Josée and Henry R. Kravis Center for Molecular Oncology [CMO]. No other medical center has yet put together such a program, and it's a transformative initiative. The CMO will cut across our community, from the clinic to the investigators who focus on the more basic aspects of our research endeavors. [To learn more about the CMO, see *Transforming Precision Medicine* on page 30.]

We are truly at an inflection point, a moment in history when mankind is turning cancer from what we've known it to be — the way we've related to it in the 20th century as an impossible, obscure disease — into a "normalized" disease. Our relationship with it will be much more like the one we have with infectious diseases, for which we have antibiotics and other treatments to cure or control them.

Q: What is your vision for the Sloan Kettering Institute over the next several years?

A: There will be changes, of course, and I intend to engage my colleagues from SKI and Memorial Hospital to help craft and implement them.

I'll work closely with [Memorial Hospital Physician-in-Chief and Chief Medical Officer] José Baselga to further integrate the research in SKI with that done in the hospital. We would like to see a fluidity in how we appoint and connect our investigators within departments, programs, and centers. Some of our investigators may be based within SKI, and some may be centered in the hospital, but that distinction won't matter all that much. As laboratory and clinical sciences are becoming one, we're erasing the conceptual barriers between basic, translational, and applied cancer research. I would actually say that a growing portion of the most impactful research being done here, both in terms of quality and relevance, is work that involves both clinical and experimental scientists. And of course, this is surrounded by brilliant basic science as well as superb clinical research.

We are also looking at a refreshment of our workplaces. I recently appointed a task force to propose improvements that will ensure our classic Rockefeller Research Laboratory building remains as vibrant and cutting-edge for the next 20 years as the newer Zuckerman Research Center building.

It's also important to me to keep developing our training activities. With our educational leaders, we will cultivate our teaching and professional developmental tools for graduate students and research fellows across all programs and departments. Expanding our training in biostatistics and bioinformatics is a must, too. There is more and more research that is generating large amounts of extremely complex data, so all of us depend heavily on these disciplines to navigate this information and understand its biological or clinical relevance.

And, naturally, I want to lead by continuing robust research, both basic and translational, in my own laboratory and inspiring others to join in our efforts. The level of confidence we have in what is achievable in cancer is higher now than it ever has been.

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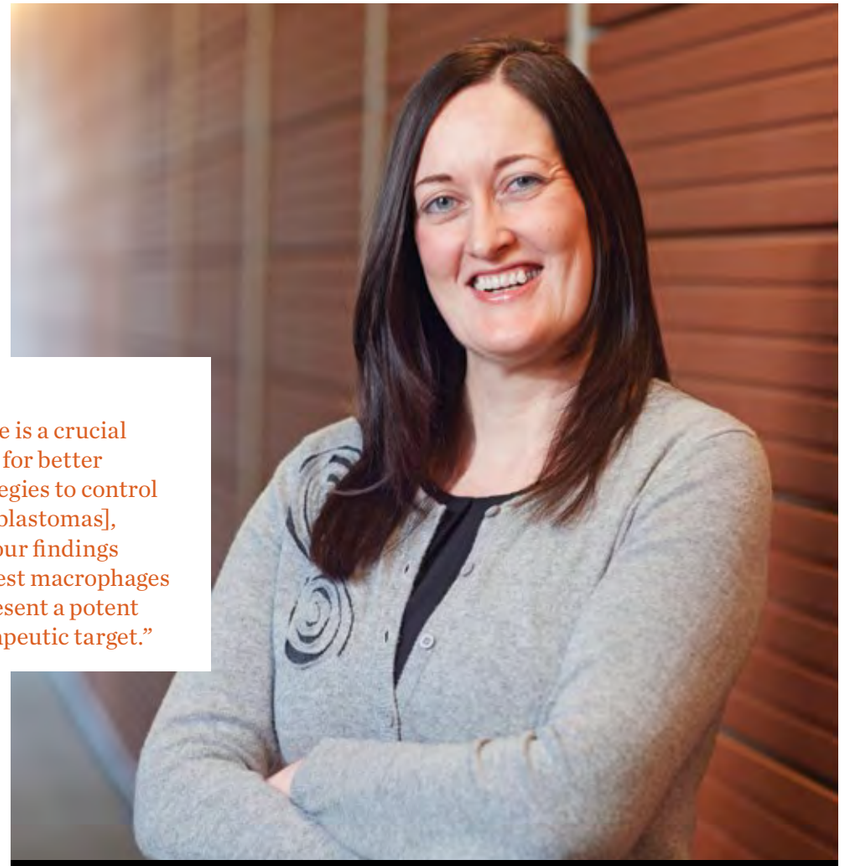

"There is a crucial need for better strategies to control [glioblastomas], and our findings suggest macrophages represent a potent therapeutic target."

JOHANNA JOYCE
Cancer Biologist

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Johanna Joyce talks with graduate students (*from left*) Ryan Smith and Robert Bowman.

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Dr. Joyce and research fellow Daniela Quail

Reeducating Macrophages to "Eat" Cancer

Researchers have tried for decades to fight cancers by killing cancer cells. But cancer biologist Johanna Joyce, a member of the Sloan Kettering Institute's Cancer Biology and Genetics Program, proposes a promising new approach: targeting the noncancerous white blood cells known as macrophages that surround and infiltrate tumors.

Macrophages patrol virtually every tissue of the body, gobbling up bacteria, dead cells, and other waste. Indeed, some biologists have referred to them as "garbage trucks." However, Dr. Joyce and other scientists had an idea that these cells may not be so innocent. And they were correct.

About 20 percent of the cells in brain tumors are macrophages. A 2013 study led by Dr. Joyce and published in the journal *Nature Medicine* revealed that macrophages can support the growth and progression of glioblastoma brain tumors — the commonest and most deadly form of primary brain tumor — and that it might be possible to control the disease by manipulating these cells with a drug.

Less than 5 percent of people with glioblastoma survive longer than five years after they are diagnosed, even if they undergo treatment with surgery, chemotherapy, radiation, or a combination of these. "There is a crucial need for better strategies to control these tumors," Dr. Joyce says, "and our findings suggest macrophages represent a potent therapeutic target."

Dr. Joyce and her colleagues set out to test a drug that inhibits a protein called CSF-1R, known to be essential for macrophage survival. They used mouse models of a subtype of brain cancer called proneural glioblastoma.

The results were both striking and surprising. First, the drug stopped newly formed tumors from progressing, caused more-established tumors to shrink, and allowed the mice to live significantly longer.

The next result was no less surprising, although initially confounding. "We thought CSF-1R would wipe out the macrophages in the tumors," Dr. Joyce explains. "But when we looked at the tumors of mice we had treated, we found that the macrophages in the tumors were still there, even though the drug had killed macrophages in the surrounding normal brain tissue."

What the investigators ultimately discovered was that the drug had actually changed the behavior of the macrophages — in effect reeducating them, blunting their tumor-promoting functions while making them more apt to elicit an antitumor response. For example, macrophages exposed to the reeducating effects of CSF-1R were induced to attack tumors by "eating" glioblastoma cells, a process known as phagocytosis.

CSF-1R inhibitors are currently being tested in early-stage clinical trials in glioblastoma patients and could be applicable to other diseases as well. "Studies have shown that in several cancer types, including breast, ovarian, thyroid, and pancreatic neuroendocrine tumors, increased numbers of tumor-associated macrophages correlate with poor prognoses, so it would be logical to test the drug in these diseases as well," Dr. Joyce notes.

Transforming Drug Discovery & Development

Research technician Smit Shah works in the laboratory of chemical biologist Gabriela Chiosis.

Taking an idea out of the laboratory and into the clinic: Easier said than done. Sometimes called the “valley of death,” this no-man’s-land is where great ideas developed at academic institutions may languish for years for lack of funding or support from drug companies. Bringing together academic and pharmaceutical scientists to speed the development of new drugs and diagnostics underlies the 2013 establishment of the Tri-Institutional Therapeutics Discovery Institute (Tri-I TDI).

MICHAEL FOLEY
Director, Tri-Institutional Therapeutics Discovery Institute

DAVID SCHEINBERG
Chair, Experimental Therapeutics Center

Why do so many good ideas born in academia die in their infancy? The answer, according to chemist and entrepreneur Michael A. Foley, inaugural Director of the Tri-I TDI, is simple: a lack of the right kind of research funding. Many high-value projects have advanced too far to qualify for funding from the National Institutes of Health but are still too early to interest partners or venture capitalists.

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"The investment required to move research through the traditional pathway of drug development is so great that the economics become prohibitive," says Dr. Foley. "The courage of the leaders of the three Tri-I TDI institutions in publicly declaring that they are going to try to advance beyond where academia can typically take research is what attracted me to join them."

Launched in October 2013, the Tri-I TDI is a pioneering partnership between Memorial Sloan Kettering, The Rockefeller University, and Weill Cornell Medical College. The aim — to accelerate biomedical research findings into innovative treatments for people with various diseases, including cancer — will leverage the talent and resources on the three campuses, including MSK's Experimental Therapeutics Center and Technology Development Fund, the Abby and Howard P. Milstein Program in Medicinal Chemistry at Weill Cornell Medical College, and the High-Throughput Screening Resource Center at The Rockefeller University. The Tri-I TDI has also formed an initial partnership with Takeda Pharmaceuticals International, Japan's largest pharmaceutical company, to develop small-molecule drugs.

This first-of-its-kind institute was founded with a $15 million gift from Lewis and Ali Sanders (Mr. Sanders is a member of the MSK, Rockefeller, and Weill Cornell boards).

"The Tri-I TDI is unique because for the first time it joins three academic institutions with different expertise and resources — all of which complement each other — to advance a myriad of therapeutic and diagnostic ideas toward the clinic," explains physician-scientist David A. Scheinberg. As Chair of the Experimental Therapeutics Center and the Molecular Pharmacology and Chemistry Program at the Sloan Kettering Institute, Dr. Scheinberg led the effort to establish the Tri-I TDI at MSK. "This is not licensing our ideas to a pharmaceutical company that will then take them and develop them elsewhere. This is actually bringing academia and industrial groups together on our campuses to work as a team."

"The partnership is spectacular," says Dr. Foley, who brings 25 years of industry and academic experience to the Tri-I TDI and who has placed 12 drugs into clinical development. "Takeda appreciates how special the setting here is. They chose to do this with us for a reason — because it's an extraordinary environment for biomedical research."

Takeda's medicinal chemists will bring their expertise to bear on the projects of Tri-I TDI scientists, but "our researchers will get all the benefit of Takeda's expertise without losing control," says Dr. Foley. "When you license your project or drug target to a pharmaceutical company, it's gone. They might call you once in a while to ask your advice, but it's not your project anymore. In the Tri-I TDI, we will be working shoulder-to-shoulder with Takeda."

The initial goal for the Tri-I TDI will be to develop small-molecule therapeutics for the treatment of cancer, as well as infectious diseases, diabetes, cardiovascular disease, and neurodegenerative disorders. Longer-term, says Dr. Scheinberg, "We will expand our work to include biological agents such as monoclonal antibodies, which are increasingly being used to treat cancer, as well as other diseases. In addition, we expect to begin to try to make a new generation of molecular imaging agents to improve diagnosis."

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The new program will also allow scientists to develop drugs for neglected diseases, sometimes referred to as "orphans." "Many diseases don't involve that many patients," says Dr. Scheinberg. "As a consequence, pharmaceutical companies and sometimes even funding agencies are not interested. But the resources of this new partnership will let us focus on some of these very important and lethal diseases and get early pharmaceutical company involvement to develop drugs to treat them."

"I want to empower investigators at all three institutions," says Dr. Foley. "They're brilliant. Let them dream big dreams. And let the Tri-I TDI facilitate certain aspects of the drug development process while they concentrate on advancing our understanding of important biological processes."

"Given our scientists' deep understanding of the biology of human disease — which is essential to making a drug — it almost borders on tragedy that economics do not allow them to push their ideas forward," he adds. "It is incumbent upon the academic community to find ways to rework the traditional process for answering the key question, 'Will this impact human health and be useful?' I believe it can be done. My colleagues — the leaders of MSK, Weill Cornell, Rockefeller, Takeda, along with Lew Sanders and Howard Milstein — believe it can be done. And we all believe absolutely that it can be done right here."

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A detail from the laboratory of chemical biologist Gabriela Chiosis

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Research fellow Liza Shrestha is a member of Dr. Chiosis' lab team.

Cell-Based Therapies:

A Radical Departure Paves the Way for the Future

Every year, *Science* magazine spotlights a pivotal scientific achievement as the "Breakthrough of the Year." The 2013 winner was cancer immunotherapy, an approach that aims to instruct the immune system to recognize and attack tumor cells in much the same way that it targets infectious agents. And MSK investigators played a seminal role in a major area of research highlighted by the magazine: the development of a cell-based targeted immunotherapy called chimeric antigen receptor (CAR) therapy.

"CAR therapy is at the same time cell therapy, gene therapy, and immunotherapy," explains Michel Sadelain, Director of MSK's Center for Cell Engineering. "It represents a radical departure from all forms of medicine in existence until now."

In 2013, Dr. Sadelain, along with Renier J. Brentjens, Director of Cellular Therapeutics, reported that genetically modified immune cells (T cells) showed great promise in killing cancer cells in patients with relapsed B cell acute lymphoblastic leukemia (ALL). The study, reported in *Science Translational Medicine,* included five patients. A more recent study reported in the same journal in February 2014 included an additional 11 patients. The researchers found that 14 of 16 total treated patients, all presenting with chemotherapy-resistant disease, showed a complete response after receiving the T cells.

Over the past decade, Drs. Sadelain and Brentjens; Isabelle Rivière, Director of the Cell Therapy and Cell Engineering Facility; and other MSK researchers have investigated this approach, which involves removing T cells from patients and introducing a synthetic gene into the cells using an engineered viral vector. Viral vectors are disabled viruses that cannot replicate but are capable of delivering their genetic cargo into a host cell. The genetically altered T cells are then infused back into the patient, where they multiply, seeking out and destroying cancer cells.

"Chimeric antigen receptors are a new class of drugs in oncology," says Dr. Sadelain. "What makes CAR technology so attractive is the potential to apply it to many cancers. The engineered cells must persist in the patient long enough to induce substantial tumor regression and eventually a complete remission, acting like a 'living drug' and patrolling the body in search of tumor cells to eliminate."

The majority of the 14 treated patients who responded to CAR therapy either already had or will eventually undergo stem cell transplants. However, some patients are not able to undergo transplants because they are not well enough, and others choose not to have additional treatment.

"As more patients get CAR therapy, and not all of them are able to go on to get a transplant, we're getting an increasing number of patients we can follow over time who we hope will remain in remission for the long term without a transplant," says Dr. Brentjens. He adds that cell-based immune therapy could eventually become the new standard of care, allowing patients to avoid transplants altogether.

"An important feature that distinguishes MSK from most other academic centers is our ability to translate conceptual innovations and preclinical modeling and bring them to the first-in-human clinical trials, as was the case with the ALL study," says Dr. Rivière.

"In a broad context, the significance of CAR therapy is the fact that it utilizes cells, not molecules, as drugs," concludes Dr. Sadelain. "We see it as a potential sea change in medicine, paving the way for the immunotherapies, stem cell therapies, and regenerative medicine of the future. We created the Center for Cell Engineering to spearhead this research, then established the Cell Therapy and Cell Engineering Facility to support the clinical research and, more recently, the Cell Therapy Center to deliver this new form of medicine to more patients."

MSK currently has trials under way evaluating cell-based immune therapies in the adult and pediatric forms of ALL as well as chronic lymphocytic leukemia, B cell non-Hodgkin lymphoma, and prostate cancer.

In late 2013, Drs. Sadelain, Brentjens, and Rivière were among the founders of a biotechnology company called Juno Therapeutics. (All three researchers will continue in their roles at MSK.) Juno is pioneering efforts to speed the development of novel immunotherapies for cancer and is based on groundbreaking discoveries by scientists at MSK, Fred Hutchinson Cancer Center, and the Seattle Children's Research Institute.

RENIER BRENTJENS
Director,
Cellular Therapeutics

ISABELLE RIVIÈRE
Director,
Cell Therapy and Cell Engineering Facility

MICHEL SADELAIN
Director,
Center for Cell Engineering

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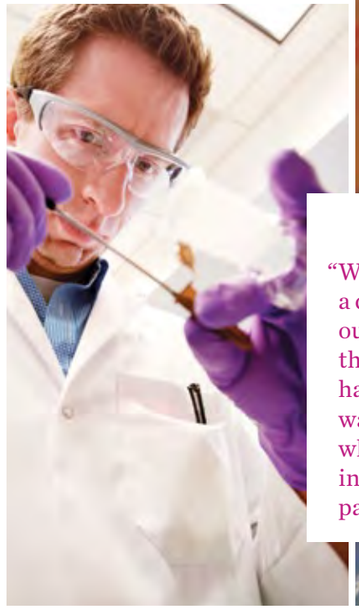
GABRIELA CHIOSIS
Chemical Biologist



"We're not just giving a drug and crossing our fingers hoping that something will happen. We have a way of monitoring what we are doing in every tumor. It is patient specific."

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Liza Shrestha is a research fellow in Gabriela Chiosis' lab.

02
Research fellow Alexander Bolaender is a member of Dr. Chiosis' laboratory.

A Long and Winding Road: PU-H71

Drug discovery is "a long, complex effort," says chemical biologist Gabriela Chiosis, a member of the Sloan Kettering Institute's Molecular Pharmacology and Chemistry Program. She should know. The journey to the discovery in her laboratory of how a small molecule can be used to block the activity of a cancer-promoting protein began more than a decade ago.

Dr. Chiosis' laboratory brings together experts in biology, chemistry, and medicine to investigate proteins called chaperones, which help maintain a cell's function by assisting other proteins to fold properly. In some diseases, however, the protective function of chaperones has the paradoxical effect of stabilizing a variety of proteins required for tumor growth and progression. One such chaperone protein is called heat shock protein 90 (Hsp90). As its name suggests, heat shock proteins protect cells when they are stressed by high temperatures, but Hsp90 is also known to play a role in cancer, as well as in some neurodegenerative diseases.

"Hsp90 is a very promising target for cancer therapy," Dr. Chiosis says. In 2005, she and her colleagues discovered a small molecule called PU-H71 that blocks the activity of Hsp90. "It was recognized at the time as an important finding," she recalls. Next, she and her collaborators began exploring the biology of PU-H71 and how best to develop the compound into an agent that could be used clinically.

What they knew was that certain cancers are "addicted" to the activity of Hsp90, and that it would be these tumors that would be most sensitive to therapy with PU-H71. The investigators needed a way to select patients who had cancers with increased reliance on Hsp90. It became clear that attaching a radioactive label to PU-H71 could allow them to identify Hsp90-avid tumors. Working with MSK's Departments of Radiochemistry and Radiology, Dr. Chiosis' laboratory developed a radioactively labeled version of PU-H71.

"Now we can see the real-time distribution of PU-H71 everywhere in the body," she says. "When you give a patient a drug, you don't really know where it goes. But with radiolabeled PU-H71, a patient is like an open book."

In early investigational clinical studies now ongoing at MSK, patients are given PU-H71 labeled with a very small amount of radioactive iodine, enabling doctors to perform PET scans to visualize how the drug is taken up in cancer cells.

"Tumors with active Hsp90 light up — and the more sensitive a tumor, the more it lights up," explains Dr. Chiosis. "We can see not only where the agent is but also how long it stays there. And we can also see how much of the agent is actually in a tumor itself, so we know the concentration of the drug at any given time. This is a feat I don't think has yet been achieved in any targeted therapy in oncology."

Having not only the therapeutic agent but also the companion diagnostic provides investigators and clinicians with a rational way to deliver PU-H71. "We're not just giving a drug and crossing our fingers hoping that something will happen," she says. "We have a way of monitoring what we are doing in every tumor. It is patient specific."

In their early studies, Dr. Chiosis and her colleagues are focusing on the use of PU-H71 in several cancers, determined by the presence of Hsp90 activity.

Integrated Genomics Operation and Center for Molecular Oncology group leader Daoqi You and Center for Molecular Oncology Associate Director Agnès Viale work with an Ion Proton Sequencer.

Transforming Precision Medicine

Let's now look for genetic needles in cancer's haystack. It is not a simple quest. But against the backdrop of an explosion in the discovery of biologically and therapeutically significant aberrations in human tumor genomes, that's exactly what scientists and clinicians at Memorial Sloan Kettering are doing — with remarkable success.

MICHAEL BERGER
Associate Director,
Marie-Josée and Henry R. Kravis
Center for Molecular Oncology

AGNÈS VIALE
Associate Director,
Marie-Josée and Henry R. Kravis
Center for Molecular Oncology

DAVID SOLIT
Director,
Marie-Josée and Henry R. Kravis
Center for Molecular Oncology

Until about 1980, most research on cancer therapy was directed at tumor cells that were rapidly dividing, not "targeted" in the sense that the word is used today. The aim was to discover universal cancer drugs that would stop tumor cells from growing in all patients with a certain cancer type.

More recently, scientists have shown that cancers are highly genetically variable. Identification of genetic and molecular targets in individual tumors can be used to help select effective therapies and create new ones. And with the development of newer technologies, identification of these genetic and molecular targets has accelerated exponentially over the past few years. MSK established several new centers in 2013 to allow our researchers to harness a tumor's genetic information and exploit it to its full clinical potential.

The new Marie-Josée and Henry R. Kravis Center for Molecular Oncology (CMO), made possible by a transformative $100 million gift from the Marie-Josée and Henry R. Kravis Foundation, is undertaking a wide-ranging effort to correlate tumor molecular profiles with clinical outcomes and responses to therapy. CMO investigators will aim to identify the functional significance of genetic alterations in tumors and the opportunities they offer for treating cancer patients in a more individualized manner.

"In an era of personalized cancer therapy, the CMO brings together the diverse expertise and advanced technology required to perform molecular profiling of tumors," says MSK physician-scientist David B. Solit, inaugural Director of the CMO. "This multidisciplinary team includes clinicians, pathologists, cancer biologists, and bioinformaticians. By using next-generation sequencing [one of the methods by which scientists extract genetic information from tumors], we are able to rapidly decode tumor genomes. Our goal is to perform genomic profiling for all patients at Memorial Sloan Kettering. The CMO provides the infrastructure and expertise to accomplish this goal. It also brings physicians together with scientists who are working to discover new molecular changes that promote tumor formation, which may represent new drug targets." (To learn more about next-generation sequencing, see the sidebar at right.)

Over the past decade, MSK has compiled a remarkable record of achievement focused on understanding cancer at its most fundamental levels and using that knowledge to guide treatment decisions. For example, MSK was the first academic center to perform large-scale tumor profiling when Marc Ladanyi, the William J. Ruane Chair in Molecular Oncology and Chief of the Molecular Diagnostics Service, developed methods to genotype lung cancer patients for genetic mutations in their tumors that predict for response to targeted drugs.

Another approach, developed by CMO Associate Director Michael F. Berger — who also holds an appointment in the Department of Pathology — Dr. Ladanyi, and colleagues in the Department of Pathology including Maria Arcila and Donavan Cheng, is a cancer genomic assay called MSK-IMPACT, which uses next-generation sequencing to capture and analyze 341 select genes.

During this time, Memorial Sloan Kettering researchers drew upon a range of resources. Of special importance to studies of the molecular underpinnings of cancer is the institution's extensive collection of tumor samples, taken from virtually all patients whose tumors have been removed at Memorial Hospital in the past ten to 15 years. No institution in the world has a comparable resource.

"We have collected tens of thousands of tumors that can be used by MSK scientists to determine the spectrum of molecular changes that underpin the development of specific cancer types," explains Dr. Solit. "Among many other initiatives, Marie-Josée and Henry Kravis's gift will allow for a more comprehensive collection of tumor samples and the associated clinical histories of the patients treated by MSK physicians. For example, it will allow for the creation of a comprehensive centralized database linking the tumor archive with the relevant information associated with each sample, including molecular and pathological characterization of the tumor and the clinical course of the disease of the patient from whom the tumor was removed."

One of the challenges investigators face is making as many of these tissue samples available for DNA sequencing as possible. Dr. Berger will work to accomplish this. "We are optimizing our protocols and computational methods to be able to analyze the vast majority of clinical samples, many of which may contain very small amounts of cancer cells or may have been stored using preservatives that can reduce the quality of the DNA," he says.

MSK-IMPACT sequences genes that previously have been implicated in the development or behavior of tumors, and many can be targeted with existing drugs or with newer therapies now being tested in clinical trials at MSK.

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(*From left*) CMBT Co-Chair Neal Rosen, CMO Director David Solit, and Memorial Hospital Physician-in-Chief and CMBT Co-Chair José Baselga attend a weekly meeting of the CMBT.

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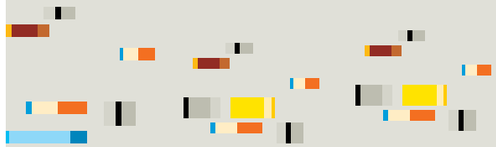
Next-Generation Sequencing



Next-generation sequencing is a term that describes a number of modern sequencing technologies that have revolutionized the study of genomics and molecular biology.

Compared to traditional DNA sequencing methods — the process by which the precise order of nucleotides is determined within a DNA molecule — next-generation sequencing scales up the process considerably, producing millions or billions of sequences at the same time. Scientists can analyze more samples simultaneously, look at more genes at once, and identify different classes of mutations — as well as look deeper into a tumor sample. If a mutation is present in only a tiny percentage of cells in a sample, next-generation sequencing allows researchers to detect that mutation more easily.

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IGO and CMO group leader Juan Li works with a HiSeq Sequencer.

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IGO and CMO research assistant Tony Deblasio talks with Agnès Viale in her laboratory.

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An RNA chip for the 2100 Bioanalyzer in Dr. Viale's lab, used to measure the quality and quantity of RNA

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"Targeted sequencing makes genomic research on needle biopsy samples or low-quality tissue more feasible," Dr. Berger explains. "And in some cases we have a better chance of making clinically relevant discoveries if we focus on deep sequencing these previously characterized genes in many specimens, rather than broadly analyzing the genome."

He and his colleagues are also working to develop new assays to detect mutations that the MSK-IMPACT assay may miss.

Another challenge MSK researchers face is the rapid development of new technologies. To help make certain that the institution remains ahead of the curve, Agnès Viale was recruited as Associate Director of the CMO and head of the MSK Integrated Genomics Operation (IGO). Dr. Viale, who created and has directed the MSK Genomics Core Laboratory for the past ten years, says, "My role is to ensure that our investigators have access to the technologies they need to conduct cutting-edge research. Our goals are not just to foster this crucial research but also to enable clinicians to use these genomics technologies as new, precise diagnostic tools that can guide cancer treatment decision-making. We want to develop new tests that will help our patients get the best treatments for their individual cancer."

"This is a very exciting time," she continues. "Sequencing is changing the way we study cancer in the laboratory and provide cancer care to patients. During the next ten years, I expect that we will move beyond the classification and treatment of cancers based upon the 'geographic' location of the tumor — for example, breast, lung, or brain cancers — but instead will tailor therapy to the genetic landscape of the tumor. That's where we're headed: We're going to sequence each individual's cancer to identify the therapy mostly likely to beat it."

Researchers at the CMO will also work closely with MSK's Center for Mechanism-Based Therapies (CMBT) to bring new findings into the clinic. "There are two aspects to what we're doing," says Dr. Solit. "First, find the mutations that are important and figure out which ones predict for a response to treatment, treatment resistance, early onset of cancer, or prognosis. Second, after we have identified the relevant mutations, we need to develop therapies that directly target the mutant proteins or the pathways activated as a result. The CMBT will be the 'effector' arm of the CMO and will help translate our findings into clinical trials."

When mutations are discovered that may be targets for drug treatment — whether with currently available targeted drugs or new therapies — novel trials are needed to test these hypotheses. One such trial is called a "basket" study. Traditional clinical trials focus on a particular cancer type. Basket studies, however, are not tumor type specific but gene or mutation specific. "We enroll patients in basket trials based on a specific mutation found in their tumor and not on the basis of where their cancer originated," explains Dr. Solit. "We have patients in these studies with different cancer types, such as ovarian, colorectal, and lung cancers, all being treated with the same drug because their tumors carry a similar molecular signature. What we're trying to figure out is whether patients with a specific mutation all respond to a particular targeted drug." (To learn more about basket studies, see *Transforming Clinical Research* beginning on page 40.)

"We predict that the work performed within the Center for Molecular Oncology will eventually impact the care of all patients at Memorial Sloan Kettering," he says. "Our vision is nothing less than to revolutionize the treatment of cancer, and I do not believe that there is another institution in the world as well-equipped to perform this work on such a large scale."

The CMBT, the next chapter in this story, involves the patient as a partner in both research and care. Co-chaired by physician-scientist Neal Rosen and Memorial Hospital Physician-in-Chief and Chief Medical Officer José Baselga, the CMBT's patient focus represents a paradigm shift in cancer medicine that illuminates, on a molecular level and over time, a tumor's adaptation to therapy.

It remains an unfortunate fact of treatment that even with the use of the latest targeted drugs, eventually most cancers will develop resistance. Yet the mechanics by which this happens are still largely unexplored. CMBT investigators aim to discover the mechanisms of tumor adaptation and the predominant molecular targets for halting this process.

"Our investigations will lay a foundation for developing new combination therapies that strike a primary tumor target as well as key secondary targets that underlie tumor adaptation," says Dr. Rosen. "The goal is to eradicate the tumor while preempting its ability to adapt and develop drug resistance."

Research at the CMBT will begin with targeted therapies involving close collaborations with the CMO and MSK's

Human Oncology and Pathogenesis Program, among other divisions. The genetics-based research of these groups focuses on primary cancer-driving pathways and novel drugs that specifically inhibit them. "The CMBT takes the next step, emphasizing an integrated approach and looking at the physiology of the cell as a unified system," Dr. Rosen explains. "We'll study how a drug hits its target, how it shrinks a tumor and causes toxicity as a result of how often it's given, and how the cell adapts when the drug inhibits a targeted pathway. We'll then investigate ways to prevent this adaptation."

Finally, CMBT researchers will translate findings into clinical trials. As part of this work, they will closely monitor patients to determine the molecular course of their disease as well as the most effective mechanism-based therapy and schedule of therapy to increase their chances for a cure. In such studies, they will use many of the novel technologies developed by scientists in the CMO.

As part of a robust new effort to address some of the most "difficult" cancers — those that have proved especially treatment-resistant — MSK has established the David M. Rubenstein Center for Pancreatic Cancer Research (CPCR), directed by surgeon, developmental biologist, and pancreas cancer expert Steven D. Leach. Dr. Leach is a recent recruit from Johns Hopkins, where he was the Paul K. Neumann Professor in Pancreatic Cancer. The CPCR will be co-directed by medical oncologist Eileen M. O'Reilly, surgical oncologist Peter J. Allen, and pathologist Christine Iacobuzio-Donahue.

"The resources provided by Mr. Rubenstein [a member of MSK's Boards of Overseers and Managers] are transformative," says Dr. Leach. "They allow us to assemble a truly multidisciplinary team of physicians and scientists. There has never been a gift like this, focused completely on pancreatic cancer. This cancer has historically been under-studied and funding is woefully deficient, even as the vast majority of patients still die of their disease. There is an urgent need for much more study and better results, which this gift will accelerate."

Partnering with MSK clinicians and scientists, researchers at the CPCR will attack pancreatic cancer in a number of ways, including uncovering alterations in the genome responsible for the onset, growth, and spread of the disease. Dr. Iacobuzio-Donahue, another recent recruit from Johns Hopkins, has done seminal work in showing how pancreatic cancer cells with a series of mutations evolve into ever-more-complex lineage trees, and has started to look at the disease from an evolutionary biology perspective.

One of the initiatives she pioneered — which will be deployed by the CPCR — is a rapid medical donation program. In the program, patients with end-stage disease consent to have a rapid autopsy, in which living tumor cells can be taken from both the primary tumor and metastatic disease in other organs. "By engaging these patients, Dr. Iacobuzio-Donahue has been able to understand — in ways that nobody else has before — how different mutations are linked to the spread of the disease and how different subpopulations of cancer cells undergo evolutionary selection and growth," says Dr. Leach.

Working with biologist Scott W. Lowe, Chair of the Geoffrey Beene Cancer Research Center at MSK, CPCR scientists will also support the distribution of innovative mouse research technologies that Dr. Lowe has created. These methods can rapidly and inexpensively create mice with pancreatic cancers that biologically are very similar to those in their human counterparts. "These mouse models will be made available to the MSK community so that they can be readily used in preclinical studies, allowing us to rapidly screen new therapeutic strategies for pancreatic cancer," Dr. Leach says.

Beyond mice, Dr. Leach adds that "we will create an infrastructure that fosters increased investigation related to pancreatic cancer throughout MSK. We want to make sure that clinicians and scientists interested in the study of pancreatic cancer tissue have ready access to tumor material, tumor microarrays, and tumor DNA and RNA."

An expanded program of clinical trials will also be launched under the umbrella of the CPCR. And, says Dr. Leach, "there are aspects of the biology of this cancer that make it an often-fatal disease, even when diagnosed early, so we'll also be exploring ways for ever-earlier diagnosis."

"The CPCR's mission statement is 'To improve the lives of patients with pancreatic malignancies through bold, innovative, multidisciplinary research,' and we want to devote all our energies to making this the best center in the world for pancreatic cancer research," he concludes. "We want to do the highest-impact research and rapidly apply our findings to benefit patients."

STEVEN LEACH
Director, the David M. Rubenstein Center for Pancreatic Cancer Research

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"We want to devote all our energies to making this the best center in the world for pancreatic cancer research."

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(Clockwise from left)
Peter Allen, Steven Leach, Christine Iacobuzio-Donahue, and Eileen O'Reilly

02
Pathologist Christine Iacobuzio-Donahue, Co-Director of the CPCR

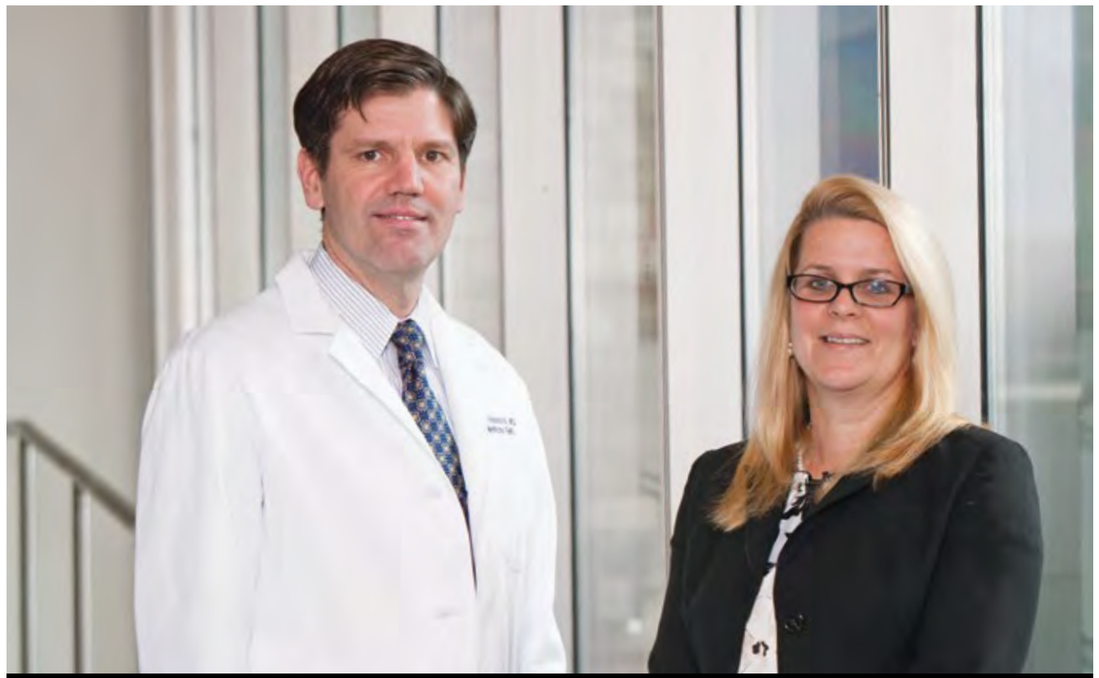
03
Surgeon Peter Allen, Co-Director of the CPCR

04
Medical oncologist Eileen O'Reilly, Co-Director of the CPCR

Transforming Clinical Research

Clinical Research Nurse IV
Jennifer Winkelmann

Smarter, smaller, faster: From cars to computers, it's the future. It's also the new paradigm of clinical research at Memorial Sloan Kettering, where we've taken transformative steps to bring novel therapies to more patients more quickly.



PAUL SABBATINI
Deputy Physician-in-Chief for Clinical Research

COLLETTE HOUSTON
Executive Director, Office of Clinical Research

Paul Sabbatini, Deputy Physician-in-Chief for Clinical Research, has been leading the endeavor. A physician-scientist who cares for women with ovarian cancer, Dr. Sabbatini was appointed in 2013 to support a coordinated effort to expand and streamline MSK's clinical research program.

"Most of the approaches that doctors use to treat cancer today are the direct result of successful clinical trials in the past," he says. But the times — and our understanding of the biology of cancer — are changing radically. With that, clinical research is also evolving.

"The historical way to develop cancer treatments was built on an inflexible sequence of clinical trials," Dr. Sabbatini says. "This methodical progression from phase I to phase III trials advanced the field, but progress has been slower than we would have liked, and in many instances there have been only incremental improvements." And while clinical trials remain the best way to improve treatments, the rigid trial paradigm has become outmoded in many contexts. "What we need to rethink is the large clinical trial with long follow-up looking for small improvements," he explains.

In a new era of precision medicine, increasing numbers of patients can be enrolled in trials of therapeutic agents targeting specific mutations or pathways present in their individual tumors, independent of the type of cancer with which they were diagnosed. This means that new cancer drugs can be tested in smaller trials with fewer patients.

"The key to these trials is that we have become much more nimble in confirming responses early on. In a phase I trial we're able not only to evaluate safety and get the correct dose but also to get a real hint of efficacy," says Dr. Sabbatini. "You get answers and you get them quickly."

To bring these novel therapies to patients more efficiently, Dr. Sabbatini and his colleagues doubled the capacity of the Research Council, which is responsible for the scientific review of trials, and created a second Institutional Review Board (IRB). The IRBs are responsible for approving, monitoring, and reviewing all biomedical research involving human subjects.

"We've also created a system in which we can track where protocols are in the approval pipeline," says Dr. Sabbatini. "We have someone dedicated to reviewing that and intervening when protocols fall off track. And in selected protocols, we've seen the time-to-activation numbers [which measure how long it takes to get a drug or therapy into a clinical trial] fall. We still have work to do, but that's our focus as we go forward."

> "[MSK clinical trials] are a real partnership among patients, physicians, and our entire clinical research team."
>
> – Richard Carvajal
> Director, Developmental Therapeutics Program

The Center for Mechanism-Based Therapies (CMBT) provides a venue in which investigators and doctors can begin to align patients that have particular targets with specific drugs. (To read more about the CMBT, see *Transforming Precision Medicine* beginning on page 30.)

"In the CMBT we are now able to bring developmental therapeutics [led by physician-scientist Richard D. Carvajal], immunotherapeutics [led by physician-scientist Jedd D. Wolchok], and cellular therapeutics [led by physician-scientist Renier J. Brentjens] under one roof," Dr. Sabbatini explains.

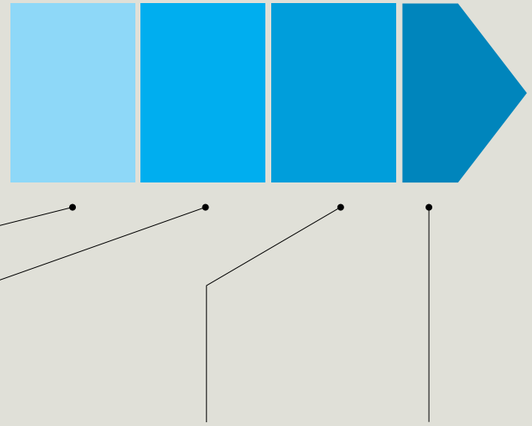
"Quite literally, the CMBT gathers a large group of people in one room — we meet every Thursday — and provides a venue for discussion for investigators who have phase I trial ideas or concepts, or for pharmaceutical companies that want to partner with us in developing concepts or trials," he says. "It's been very successful both in improving efficiencies of trial conduct and in getting our scientists and clinicians involved in early drug development, which is where we think we can have the most impact." (To learn about more of MSK's efforts in this regard, see *Transforming Drug Discovery & Development* on page 20.)

The hub of operations of MSK's clinical research program is the Office of Clinical Research, led by Executive Director Collette Houston. Her staff is responsible for managing all aspects of clinical trial protocols. "This means the development of protocols from initiation through completion, quality assurance, and everything in between," Ms. Houston says. The "in between" includes informatics, education, training of the staff that conduct the research, and committee reviews.

Traditional Clinical Trials versus Basket Trials

The standard approach for developing many cancer treatments has been built upon a series of clinical trials to establish the effectiveness of drugs in specific cancers — for example, in breast or colon cancer. (See the infographic below.) A novel approach to clinical trial design called a "basket" trial starts with one trial, the basket, and one or more "targets" and allows patients with different diseases to enroll in a group or cohort. (See the infographic on the opposite page.) This allows for exploration of a treatment's effectiveness across many diseases early, quickly, and in one trial. The goals of such trials are to accelerate the translation of scientific discoveries into new therapies and to increase the number of patients who can benefit from innovative mechanistic approaches with molecularly targeted therapies.

Traditional Clinical Trial Design



Phase I

A treatment is tested to establish a dose (often the maximum tolerated dose) and to establish safety and learn about side effects. Traditional phase I trials are generally small.

Phase II

A treatment is evaluated typically in about 35 patients with the same type of cancer and with the dose established in the phase I study. The goal is to observe tumor shrinkage over a period of time.

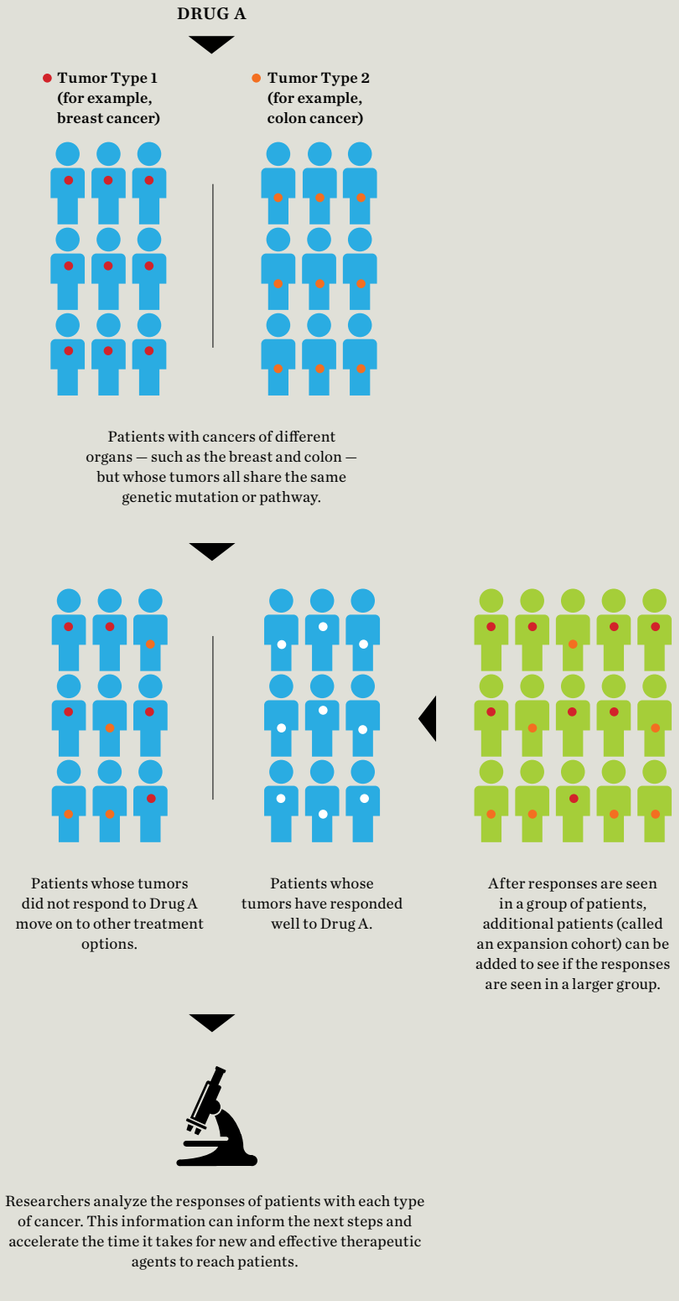
Phase III

The same treatment is tested in a randomized trial with a large number of patients organized into groups to assess the effectiveness of the new agent often compared to a standard of care treatment.

Phase IV

If the new drug is approved by the FDA, phase IV trials may be continued to learn more about how best to use it, as well as its long-term benefits and side effects.

Basket Clinical Trial Design



In addition, her office is responsible for contracting, research billing, multicenter trial management, and research support services to help clinical departments manage their activities.

Dr. Carvajal, Director of the Developmental Therapeutics Program, explains that the program is primarily the small-molecule arm of MSK's drug development efforts, looking at what have come to be called targeted therapies. Dr. Wolchok's program studies novel agents that modulate the immune system's response to cancer. And Dr. Brentjens' program works on a form of gene therapy in which patients' own immune cells are genetically manipulated to directly attack tumors. (To learn more about Dr. Brentjens' research, see *Cell-Based Therapies* on page 26.)

Dr. Carvajal, a member of the Melanoma and Immunotherapeutics Service in the Department of Medicine, is charged with developing and increasing early-phase clinical trials at MSK. He says that historically, patients would be referred to phase I trials only when their oncologists had run out of standard options. But not anymore.

"Because of molecular profiling and having more-precise understandings about the unique biology of individual tumors, we are now able to identify patients with tumors harboring alterations in gene X, to understand the effects of these alterations on tumor growth, and then to match patients directly to trials studying agents that address each specific molecular event," he says.

As researchers are better able to assemble these genetic profiles — correlating the biology of tumors to treatments — they are seeing dramatic responses in patients who previously have experienced disease growth after a number of prior therapies and who have opted to join an early-stage trial. "So even if there are standard options available," says Dr. Carvajal, "sometimes we'll recommend to patients that perhaps we should consider this particular clinical trial."

Twelve physicians with disease-specific and specialized drug development expertise — along with specially trained phase I clinical and treatment research nurses, technicians, and research and administrative staff — make up the Developmental Therapeutics Program. Each physician has a particular drug development focus, such as cancer metabolics, epigenetics, stem cell targeting, cell cycle targeting, cell signaling pathways, novel chemotherapeutics, resistance mechanisms, or DNA damage repair.

Another significant area in the evolving clinical research landscape at MSK is basket trials. These trials study a drug with a specific mechanism of action that may potentially work regardless of the type of cancer a patient has. So instead of starting with multiple clinical trials in different diseases, investigators begin with one trial — the basket — and one or more targets, and allow patients with different cancers to enroll. If one group shows a good response, physicians can expand the group to immediately assess whether other patients would also benefit.

On the flip side, if a group is not showing evidence of effectiveness, the trial can be closed and patients can move on to consider other therapies. This can happen quickly, so patients do not lose valuable time receiving a treatment that isn't working. "We can make decisions much, much sooner than if we used the traditional trial model," explains Dr. Sabbatini.

"More and more, we're going to see that drugs will go from phase I directly to phase III clinical trials in terms of the developmental path," Dr. Carvajal says. "Because we're now not only looking at toxicity and dosage in these contemporary phase I studies, but also assessing efficacy. We are going to see a decrease in the number of phase II trials conducted. It's no longer enough just to show we can give a drug at a certain dose safely; we have to show that it does something to help our patients."

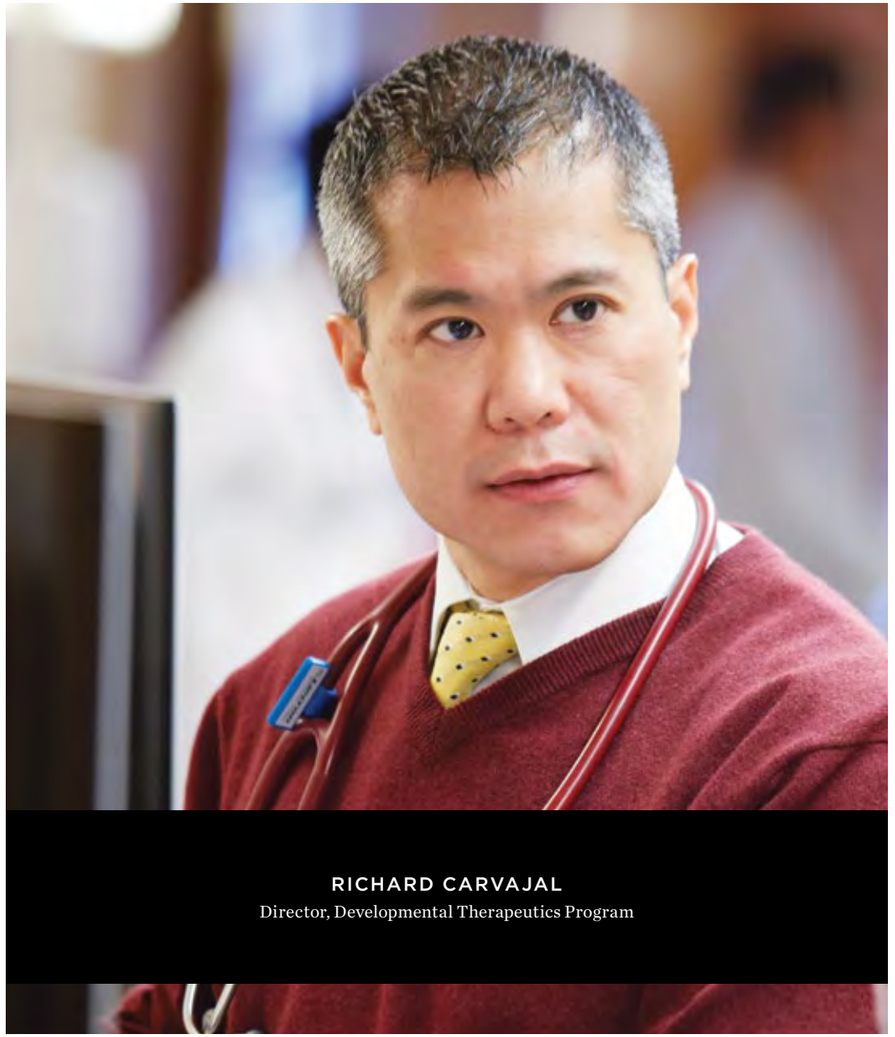
Both men speak movingly of the patients who participate. "It's truly humbling for us to look at our patients, who are dealing with a serious illness, with many choices to make with regard to therapy, and see how many are willing to enroll in these trials," says Dr. Sabbatini.

"This is a real partnership among patients, physicians, and our entire clinical research team," says Dr. Carvajal. "Patients are very selfless. We do this, of course, in the hope that we're going to help them — and often we do. And patients do it in the hope that they will be helped. But they also do it because they know they'll help people in the future."

(To learn more about how MSK's clinical research program is expanding at our network sites and as part of the new MSK Cancer Alliance, see *Transforming Cancer Care & Delivery* beginning on page 48.)

01
Jennifer Winkelmann, Clinical Research Nurse IV, and Richard Carvajal, Director of the Developmental Therapeutics Program, talk with a patient.

02
Ms. Winkelmann and Dr. Carvajal



RICHARD CARVAJAL
Director, Developmental Therapeutics Program

Transforming Cancer Care & Delivery

Patient Renaldo Hill (*left*) and radiation therapist Michael Guida at Memorial Sloan Kettering's Basking Ridge, New Jersey, outpatient care facility

Q&A

An internationally recognized physician-scientist, José Baselga joined Memorial Sloan Kettering in 2013 from Massachusetts General Hospital (MGH), where he was Chief of the Division of Hematology/Oncology and Associate Director of the MGH Cancer Center.

It was a homecoming of sorts: He did his medical oncology fellowship at Memorial Hospital and was a faculty member on the Breast/Gynecology Service from 1994 through 1996, after which he returned to his native Spain.

His laboratory research includes the development of novel molecularly targeted cancer therapies, with a special focus on breast cancer and therapeutic approaches to targeting a pathway called PI3K. His work in the preclinical and early clinical development of therapies has helped introduce a number of new targeted agents.

Dr. Baselga talked to us about several of the highlights of 2013 and the future of Memorial Sloan Kettering's clinical enterprise.

Q: You've just marked your first year as Physician-in-Chief. What was it like?

A: This was a year of getting acquainted — or reacquainted — with MSK. Over the course of the past 12 months, I met a tremendous number of people from every part of the institution and learned about the workings of its clinical operations. I spent a lot of time with our department chairs and visited virtually all our treatment facilities, both in Manhattan and in our regional network. It was a wonderful experience, and my most indelible impression is that you have to live in this place to see how great it is.

Q: You mentioned our patient-care facilities, so let's begin there.

A: A good place to start!

This was the year in which we laid out the vision and strategic planning for our sites. My colleagues and I spent a great deal of time thinking about how to achieve even better clinical integration across all our locations, and I include in this not only our network campuses on Long Island and in New Jersey and Westchester County, but also our Manhattan facilities.

Central to realizing these plans has been the appointment of [Chief of the Gynecology Service] Richard R. Barakat to the newly created position of Deputy Physician-in-Chief for the Regional Care Network and MSK Cancer Alliance. Dr. Barakat will lead the network, expanding its presence throughout the New York metropolitan area and building relationships with medical institutions outside the region. He'll also lead the effort to fully implement and expand the recently announced Memorial Sloan Kettering Cancer Alliance.

Q: The MSK Cancer Alliance, whose first partnership is with Hartford HealthCare (HHC), is an unprecedented undertaking and represents a sea change in MSK's clinical enterprise.

A: Yes, it does. Let me put it into an important and all-encompassing context, which is clinical research: During 2013, we embarked on a major restructuring of our clinical research operations, and Hartford HealthCare — and, eventually, other Alliance members — will play a key role in this. In order to continue our clinical research mission and make it even more robust, we need larger patient populations. Almost every important advance in cancer treatment has come about as a result of clinical trials — and to conduct effective trials, you need many patients to participate.

Early in my tenure, I appointed [medical oncologist] Paul Sabbatini as Deputy Physician-in-Chief for Clinical Research, and he's been doing a tremendous job of streamlining and accelerating our clinical trial process. We now have two Institutional Review Boards, doubling our capacity to do clinical trial reviews. As a result, we've seen remarkable decreases in the time between the review and the approval of clinical trial protocols — down from 200 to 90 days. And we are also seeing an increase in clinical trials with more patients participating.

I'm deeply grateful to Dr. Sabbatini and to everyone who has contributed so much to these efforts, including Collette Houston [Executive Director, Office of Clinical Research] and her colleagues. [To learn more about the clinical research enterprise at MSK, see *Transforming Clinical Research* on page 40.]

Q: During your first year at MSK a number of new centers were established to foster collaborations among clinical investigators and scientists, with the aim of bringing more novel therapies to patients. Can you talk about this?

A: My "big" answer is that I believe MSK is becoming a real engine of execution of new ideas that will transform patients' lives.

More specifically, the new centers are part of a larger vision to develop and bring treatments to patients that were not available before — indeed, that didn't exist before.

First, with the participation of our gifted pathologists, we have massively expanded our tumor sequencing program. In the past year, we have sequenced more than 10,000 patient tumors. That's

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01
Jessica Uporsky, Clinical Nurse II, chats with patient Eric R. Nahm at MSK's Basking Ridge facility.

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02
Patient Charles Fetter is prepared for his chemotherapy treatment by Valda Gaubiene, Clinical Nurse II, also at MSK Basking Ridge.

02

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02

03

01
(*From left*) Gynecologic oncologist and head of the Gynecology Research Laboratory Douglas Levine, hematologist and Chief of the Leukemia Service Martin Tallman, and medical oncologist David Hyman attend a weekly meeting of the Center for Mechanism-Based Therapies (CMBT).

02
Computational biologist Nikolaus Schultz speaks at a meeting of the CMBT.

03
(*From left*) CMBT Co-Chair Neal Rosen, CMO Director David Solit, and Physician-in-Chief and CMBT Co-Chair José Baselga listen to a presentation at a CMBT weekly meeting.

an incredible tour de force. In order to design tumor-specific treatments, we must know what is happening within individual cancers, and tumor profiling is fundamental to this.

A landmark $100 million gift from the Marie-Josée and Henry R. Kravis Foundation has allowed us to create the Marie-Josée and Henry R. Kravis Center for Molecular Oncology [CMO]. Its inaugural leader will be [physician-scientist] David B. Solit; we have also appointed [physician-scientist] Richard D. Carvajal as Director of the Developmental Therapeutics Program. The major goal of cancer research in the years ahead will be to integrate molecular and clinical information in order to develop precision treatments, and the CMO will be the first program in the country to span the full range of activities required to translate molecular insights into clinical innovations.

The Center for Mechanism-Based Therapies [CMBT], co-led by me and [physician-scientist] Neal Rosen, is another important virtual center. In 2013 we reinvigorated the CMBT, and it has become the forum in which ideas from the lab are being brought into the clinic. We've launched a weekly CMBT conference, for example, where clinical investigators are coming together with scientists and biotechnology companies to discuss how to develop and advance new therapies.

And with generous support from [MSK Board member] David Rubenstein, we've established the Center for Pancreatic Cancer Research, headed by [surgeon and cell biologist] Steven D. Leach, an expert in pancreas cancer and a recent recruit from Johns Hopkins. This is part of a transformative effort at MSK to rigorously address the more "difficult" cancers — the cancers that have proved most treatment-resistant. [To learn more about these new centers, see *Transforming Precision Medicine* on page 30.]

Q: Improving patient access to MSK has also been one of your priorities.

A: It has. And we've made great progress over the past year. As everyone knows, these are challenging times for the medical community generally. But at MSK, despite these challenges — which include space constraints — we've been able to improve patient access. Several initiatives spanning the entire institution have resulted in shortening the time between a call from a patient or caregiver seeking an appointment and when that patient can see one of our physicians.

Q: Looking ahead to your second year, what will be on your mind?

A: Interestingly, I think this next year will partly be one of turning my attention back to some of MSK's core values. Of course, I will continue to focus on clinical excellence — we are who we are because we have the best people anywhere: the best physicians, nurses, and support staff. They are all superb professionals.

But we should never get so focused on our research mission that we forget that in the end, patients are our main mission, the reason we are here. And during 2014 I want to work with my colleagues to make certain we deliver the best, most compassionate patient-care experience possible.

Q: Broader picture, how do you see the state of cancer research and treatment now and as we move into the future?

A: I can tell you that I've been doing this for many years and I've never seen the acceleration of progress that I see today. While it's difficult to make predictions — and cancer is anything but simple — I will point to just a few major advances that have deepened our understanding of cancer biology and are changing the way we think about treating these diseases.

For the first time, we have the capacity to sequence tumors in real time and identify actionable mutations [which can be targeted with drugs or help doctors diagnose or make predictions about a person's disease]. For the first time, we have the ability to investigate the complex patterns of feedback in cellular signaling pathways that drive the growth of cancer, and this has opened the gates for us to explore new combination therapies. For the first time, we have proof that harnessing a person's immune system to fight cancer actually works.

On top of that, there are extraordinary and continuing developments in surgery, in radiation oncology, in molecular imaging and nanotechnology. And this is only the tip of the iceberg.

Let me put it another way: If someone went away to a desert island at the start of 2013 and came back now, they would be amazed. And it would take them more than a year to catch up.

As I begin my second year here, I personally couldn't be more enthusiastic about the future. MSK is an energizing and inspiring institution, and I feel both excited and privileged to play a part in our communal efforts to conquer cancer.

RICHARD BARAKAT
Deputy Physician-in-Chief for the Regional Care Network and MSK Cancer Alliance

"If you want to extend the best patient care in the world — the best protocols, the best surgical procedures, and so on — you can't do it from an ivory tower in Manhattan," asserts Memorial Hospital Physician-in-Chief and Chief Medical Officer José Baselga. So let's leave the tower and go into the streets. ...

"Our mission is to improve the lives of people with cancer, and to do that we need to be a force in the community, to have a presence, an influence, and to make certain our innovations get to patients," Dr. Baselga continues.

For Richard R. Barakat, Deputy Physician-in-Chief for the Regional Care Network and MSK Cancer Alliance, his recent appointment brings him back to a familiar place: He was the first MSK surgeon to work at one of Memorial Sloan Kettering's regional campuses — at Mercy Hospital in Rockville Centre on Long Island. Today, MSK campuses also include freestanding ambulatory care facilities in Basking Ridge, New Jersey, and in Commack, Long Island; a skin cancer center in Hauppauge, also on Long Island; and a facility in Sleepy Hollow, New York. A new 114,000-square-foot freestanding outpatient site will open in Harrison, New York, in the fall of 2014. (To learn more about MSK Harrison, see *Facilities Update* on page 67.)

"I've always thought our network campuses were a great idea," says Dr. Barakat, who has been Chief of MSK's Gynecology Service for 13 years. "I've also had a real personal fondness and attachment to them because of my earlier association."

Dr. Barakat makes a special point of mentioning that he uses the word "campuses" very deliberately when he talks about the facilities in MSK's network. "We are all colleagues," he says. "I like to think of Memorial Sloan Kettering as one institution where we all have one shared mission, and our network campuses are where we are able to achieve the goals of that mission. One of the most important aspects of my job will be to fully integrate the campuses and make sure that the physicians, nurses, and support staff who practice at them feel empowered and part of this great institution."

For many new patients, MSK's regional facilities offer an easier point of access to MSK's care. "We provide care for patients that is both convenient and outstanding — whether that's surgical consultations, chemotherapy, radiation therapy, or psychosocial or other support services," Dr. Barakat says.

In an effort to make that care even better, there are several new strategies that Drs. Barakat and Baselga and their colleagues will be implementing over the coming months and years. The Harrison facility offers a template for these changes, including a reevaluation of how the campuses are staffed.

"When we began thinking about clinicians who might want to work in Harrison, rather than thinking only about hiring new people who may not be familiar with the MSK culture,

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(*From left*) Richard Barakat talks with radiation oncologist Preeti Parhar, radiation oncologist Karen Borofsky, and network administrator Miriam Balsamo.

we came up with a model that can be extended to all our campuses," says Dr. Barakat. "We're speaking to our surgeons who have been at MSK — in some cases for many years — and even chiefs of services, all of whom live in the community, and asking them to work at Harrison one day a week. [Surgical consultations, often the first point of patient contact with MSK, will be offered at Harrison.] This will allow us to infuse the MSK multidisciplinary culture across all our campuses with a blend of senior clinicians and new clinicians so everyone can learn from one another. And we want to look at this for all models of care, including nursing."

And so people who spend a portion of their time at MSK's Manhattan campus but live near the regional facilities will also be serving their own communities. "That's a very powerful message," Dr. Barakat says. "MSK doctors and nurses and social workers will be seeing patients — as well as clinicians who have practices in the community — not only professionally, but as part of their daily lives. They'll be running into these

same people in their churches, their synagogues, at the grocery, at social events. It's a great way to become part of the community. And I think we have to do more of that. We don't want to be viewed as interlopers but as people who are there to help their community."

"I also want to integrate the clinicians who work full-time at our network campuses more fully with our Manhattan campus," Dr. Barakat emphasizes. "I want them to spend some time in the city, participate in videoconferencing, and in every way have opportunities to interact and collaborate with clinicians in Manhattan."

Memorial Sloan Kettering is also seeking to transform cancer care delivery beyond its own network of campuses. A transformative new initiative announced in 2013 called the Memorial Sloan Kettering Cancer Alliance will expand the institution's ability to offer a range of services as well as the clinical trials that reflect MSK's mission to develop new therapies and deliver them to patients as rapidly as possible. (To learn more about MSK's clinical research programs, see *Transforming Clinical Research* on page 40.)

"About 80 percent of cancer care in the United States is delivered in community settings, and cancer advances can take years to reach patients," explains Dr. Baselga. "Many of these patients also lack access to sophisticated genetic tests and clinical trials. The MSK Cancer Alliance — of which Hartford HealthCare [HHC] is the first member — is creating a new model to address the challenges of providing high-quality cancer care to many more patients, including cutting-edge, state-of-the-art trials. HHC will include our first clinical trials site established through the MSK Cancer Alliance, and it will be an extraordinary resource for these patients."

01

HHC, a multihospital healthcare system in Connecticut, is responsible for the care of approximately 18 percent of all cancer patients in the state. "The MSK Cancer Alliance is an opportunity to further our mission by working with top-quality institutions in the community," says Dr. Barakat. "HHC was identified as our first partner because it shares our commitment to excellence in patient care and has one of the highest-quality cancer programs in the region."

Dr. Barakat makes it clear that the Alliance is a two-way street. "We truly look at this as a bidirectional flow of information and learning," he says. "HHC has outstanding clinicians, and we'll be learning from them because they are pros at delivering community-centered cancer care. At the same time, they will learn from us." However, he says, "We are not asking them to do everything exactly as we do it. We're not saying, 'Do this, then that.' It's not an algorithm. It's really just allowing clinicians at HHC to look at what they're doing that's different from us and consider incorporating our practices into theirs."

As the collaboration evolves, certain HHC cancer clinicians will participate in observerships and will be integrated into MSK's disease management teams. The two institutions will also jointly recruit a physician-in-chief for the Hartford HealthCare Cancer Institute who will be on staff at both HHC and MSK. In addition, a dedicated research manager will be employed by MSK but based in Hartford to assist with the clinical trials mechanisms.

"We are really linking care across the institutions," says Dr. Baselga, "but it's important to note that HHC patients will remain patients of HHC Cancer Institute and will continue to receive their treatment locally."

Dr. Barakat concludes by explaining that while HHC is the first member of the MSK Cancer Alliance, it won't be the last. "At MSK, we are all committed to advancing our goal of bringing leading-edge cancer care into the community," he says. "Our immediate focus is on ensuring that the alliance with Hartford works, and works well. But ultimately we want to create a network of providers so that we can reach more patients in even more communities."

01
Patient Janet A. Klikier *(left)* and radiation therapist Marisa Losco

2013 Year in Review

Statistical Profile

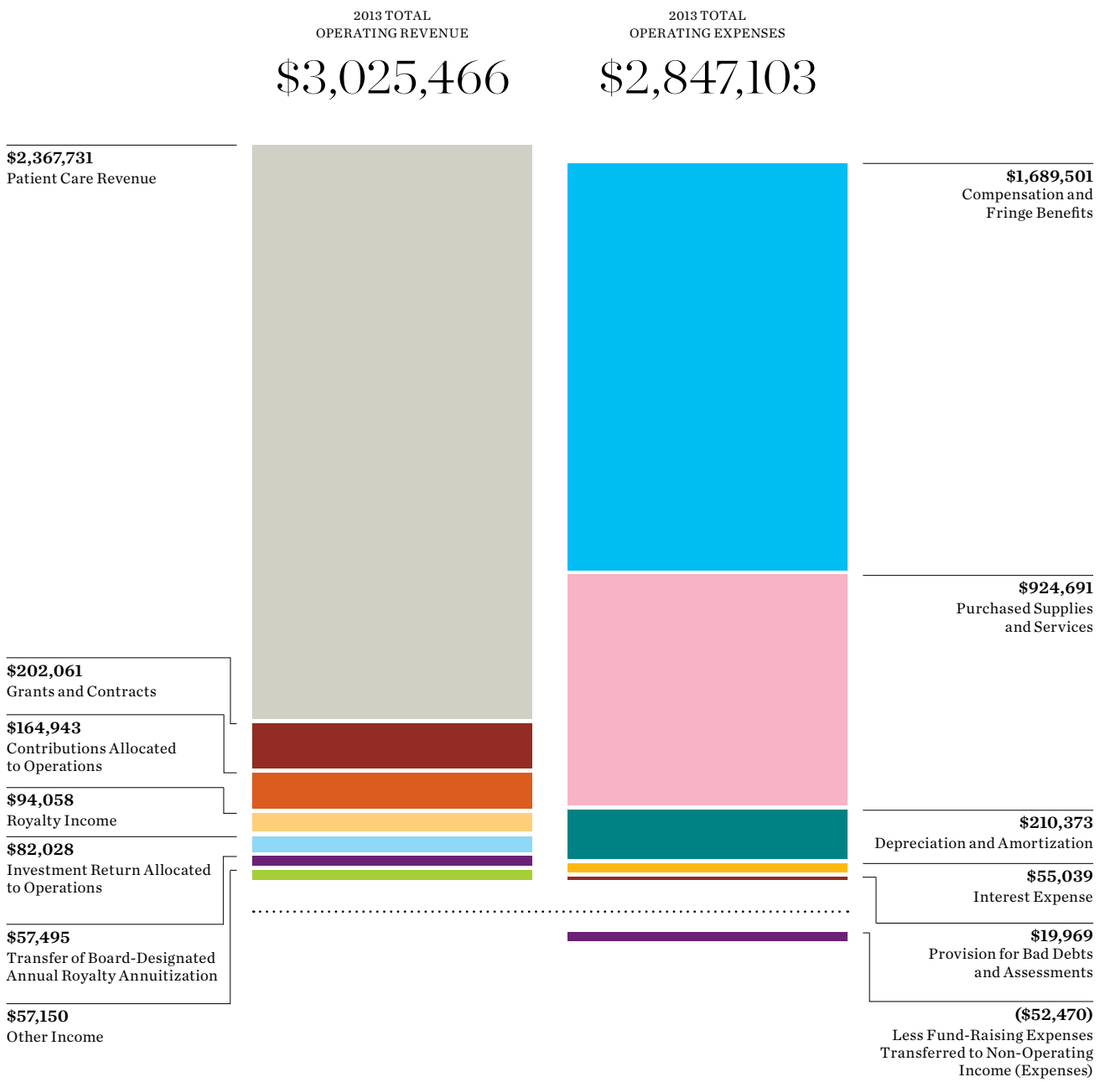
	09	10	11	12	13
PATIENT CARE					
Patient Admissions: Adults	21,932	22,852	22,983	23,139	20,773
Patient Admissions: Children	1,537	1,494	1,503	1,459	1,553
Total Admissions	23,469	24,346	24,486	24,598	22,326
Total Patient Days	140,224	143,532	140,990	149,368	144,345
Average Patient Stay (days)	6.0	5.9	5.8	6.1	6.5
Bed Occupancy Rate (based on adjusted bed count)	88.5%	83.7%	82.2%	87.0%	83.0%
Outpatient MD Visits: Manhattan	406,024	418,415	432,802	436,510	463,724
Outpatient MD Visits: Regional Network	94,293	97,658	103,098	104,964	108,198
Total Outpatient Visits	500,317	516,073	535,900	541,474	571,922
Screening Visits	27,369	23,373	20,518	15,519	12,826
Surgical Cases	19,233	19,362	19,374	19,691	20,465
Radiation Treatments and Implants: Manhattan	57,856	59,223	60,393	60,289	61,335
Radiation Treatments and Implants: Network	47,987	47,926	51,615	50,476	53,660
Total Radiation Treatments and Implants	105,843	107,149	112,008	110,765	114,995
Diagnostic and Interventional Radiology Procedures	358,052	362,609	377,360	391,187	416,360
Clinical Investigation Protocols (open to accrual)	507	552	552	657	735

	09	10	11	12	13
STAFF					
Sloan Kettering Institute Members	140	142	143	149	143
Hospital Attending Staff	768	804	834	876	935
Registered Nurses	1,845	1,945	2,018	2,133	2,221
Support Staff	8,321	8,613	8,989	9,244	9,707
Total Staff*	11,039	11,469	11,950	12,402	12,975
Volunteers	917	942	1,058	1,018	1,004
EDUCATION					
Residents and Clinical Fellows — Positions	436	447	440	445	464
Residents and Clinical Fellows — Annual Total	1,651	1,625	1,676	1,682	1,691
Research Fellows	303	295	321	320	323
Research Scholars	121	132	131	124	133
Research Associates	90	94	82	89	91
Graduate Research Assistants	—	23	29	39	41
PhD Candidates	227	231	225	222	227
MD/PhD Candidates	28	26	21	21	19
Registrants in CME Programs	2,395	2,554	2,533	3,968	3,681
Medical Observers	572	541	526	566	630
Medical Students	399	391	429	431	392
Nursing Students	109	105	142	178	179
Social Work Students	6	6	6	6	7
Radiation Oncology Technology Students	15	14	14	13	15
Physical Therapy Students	3	3	4	7	2
Occupational Therapy Students	4	3	3	4	2

*In 2013, 31 staff members held appointments in both the Institute and the Hospital.

Financial Summary

(in thousands)



	09	10	11	12	13
OPERATING REVENUES (in thousands)					
Patient Care Revenue	$ 1,723,313	1,854,776	2,141,421	2,201,941	2,367,731
Grants and Contracts	167,495	186,327	190,948	185,160	202,061
Contributions Allocated to Operations	126,250	117,323	130,791	144,497	164,943
Royalty Income	62,232	68,663	77,510	78,350	94,058
Other Income	43,144	44,874	48,351	51,167	57,150
Investment Return Allocated to Operations	103,998	100,389	104,699	75,877	82,028
Transfer of Board-Designated Annual Royalty Annuitization	37,158	41,578	46,417	51,709	57,495
Total Operating Revenues	$ 2,263,590	2,413,930	2,740,137	2,788,701	3,025,466
OPERATING EXPENSES (in thousands)					
Compensation and Fringe Benefits	$ 1,286,536	1,361,032	1,466,667	1,582,212	1,689,501
Purchased Supplies and Services	757,863	772,968	835,621	879,219	924,691
Provision for Bad Debts and Assessments	10,881	11,046	18,285	17,541	19,969
Depreciation and Amortization	171,806	175,494	195,461	210,810	210,373
Interest Expense	64,997	47,931	57,098	54,894	55,039
Less Fund-Raising Expenses Transferred to Non-Operating Income (Expenses)	(40,320)	(43,926)	(44,665)	(47,305)	(52,470)
Total Operating Expenses	$ 2,251,763	2,324,545	2,528,467	2,697,371	2,847,103
Income from Operations	$ 11,827	89,385	211,670	91,330	178,363
PHILANTHROPY (in thousands)					
Philanthropy	$ 166,247	237,666	301,374	231,159	380,500
CAPITAL SPENDING (in thousands)					
Capital Spending	$ 226,049	262,371	223,251	258,613	315,282
BALANCE SHEET SUMMARY (in thousands)					
Assets	$ 6,068,707	6,448,415	6,790,005	7,795,606	8,481,418
Liabilities	2,467,135	2,550,889	2,848,843	3,562,546	3,337,444
Net Assets	$ 3,601,572	3,897,526	3,941,162	4,233,060	5,143,974

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as of March 26, 2014

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Memorial Sloan Kettering Cancer Center

as of March 26, 2014

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John R. Gunn
Chief Operating Officer

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Chief Medical Officer, Memorial Hospital

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Director, Sloan Kettering Institute

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Deputy Physician-in-Chief
for Clinical Research

Richard R. Barakat, MD
Deputy Physician-in-Chief,
Regional Care Network and MSK Cancer Alliance

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For a listing of the members of the professional staff of Memorial Hospital and the Sloan Kettering Institute, please visit www.mskcc.org/annualreport.

Louis V. Gerstner, Jr. Graduate School of Biomedical Sciences
Memorial Sloan Kettering Cancer Center

as of March 26, 2014

Sloan Kettering Division
Weill Cornell Graduate School of Medical Sciences

as of March 26, 2014

Facilities Update

01
(*Left)* An exterior view of MSK Harrison; (*right, top and bottom*) Many interior spaces at MSK Harrison are flooded with natural light.

2014

Memorial Sloan Kettering continues to expand to meet the growing needs of its clinical and research enterprises. Building new facilities and extending MSK's reach ensures that we are able to bring our expert, multidisciplinary cancer care to as many communities and patients as possible while simultaneously advancing our pioneering research programs.

01

Memorial Sloan Kettering's new **60th Street Outpatient Center** at 16 East 60th Street, scheduled to open in September 2014, will offer care from MSK experts in dermatology (including Mohs surgery), general internal medicine, geriatrics, head and neck surgery, interventional and general radiology, ophthalmic oncology, orthopaedics, plastic and reconstructive surgery, male sexual health and reproduction, and presurgical testing. The location will also provide space for two innovative new clinics: a Melanoma High-Risk Surveillance Clinic for patients with a personal or family history of melanoma, and a multidisciplinary Advanced Skin Cancer Program for patients with nonmelanoma skin cancers who may require specialized follow-up care.

In October 2014, **Memorial Sloan Kettering Harrison** will join MSK's growing network of regional ambulatory care facilities, providing the multidisciplinary cancer care of MSK clinicians to residents of Westchester and Fairfield Counties and the Hudson Valley. Patients will have access to personalized medicine and leading-edge clinical trials all under one roof. Among the services offered will be medical oncology, radiation oncology, neuro-oncology, chemotherapy, diagnostic and interventional radiology, surgical consultations, dermatology, social work, and survivorship and other support services. We will also offer a range of sophisticated imaging technologies, including MRI, CT, PET scans, PET/CT, ultrasound, and mammography, as well as a robust radiation treatment planning system.

01
(*Left*) The Josie Robertson Surgical Center; (*right, top and bottom*) the interior spaces of the surgical center will be serene and inviting for patients and caregivers.

02
Memorial Sloan Kettering's 74th Street complex will overlook the East River and offer state-of-the-art cancer care.

2015

01

2018

02

The Memorial Sloan Kettering Josie Robertson Surgery Center, made possible by a generous commitment from the Robertson Foundation, is slated to be completed in 2015. This 16-story, 179,000-square-foot building on York Avenue between East 61st and 62nd Streets will feature 12 operating rooms equipped to provide technologically sophisticated surgical care on an outpatient basis. The Robertson Foundation was established by investor Julian Robertson and his wife, the late Josephine "Josie" Robertson, along with their family. Mrs. Robertson, who was elected to MSK's Boards of Overseers and Managers in 2004, worked with her husband to support a range of causes in education, medical research, and other areas.

More than six percent of MSK's patients live in the Jersey Shore area — a region that will be served by our **Memorial Sloan Kettering Monmouth** facility, expected to be ready to receive patients in Fall 2016. Located in Middletown, the clinical portion of the site will occupy approximately half the building and will offer comprehensive ambulatory oncology services delivered by MSK clinicians. A portion of the remaining space will house a new MSK data center, providing a second active production site in New Jersey to enhance data security.

Laboratory testing is particularly important in cancer treatment, and as MSK has grown, so has our need for laboratory services. Last year more than 6.5 million lab tests were performed by our Department of Laboratory Medicine — more than double the annual volume of just a decade ago. A new **Laboratory Medicine Building** being constructed on East 64th Street will consolidate all our laboratory medicine programs and allow us to meet our growing clinical demands. It is slated to be completed in the second quarter of 2017.

Playing a critically important role in MSK's overall cancer care delivery system will be our new **Memorial Sloan Kettering Ambulatory Care Center at 74th Street**, expected to be completed in 2018. Located between East 73rd and 74th Streets along the FDR Drive, the property was purchased by MSK from the New York Economic Development Corporation in collaboration with Hunter College of The City University of New York, and the two institutions are jointly developing it. The complex will house an MSK outpatient facility along with Hunter College's new Science and Health Professions building. Current plans for the MSK portion of the site are to provide care for patients with lung, head and neck, and hematologic cancers. The facility will also include a state-of-the-art outpatient bone marrow transplantation program as well as sophisticated radiation oncology, diagnostic imaging, and interventional radiolology.

The Campaign for Memorial Sloan Kettering

Memorial Sloan Kettering benefited enormously from the generosity of thousands of donors who made contributions large and small to the Campaign for Memorial Sloan Kettering.

Douglas A. Warner III

Louis V. Gerstner, Jr.

Craig B. Thompson

Campaign Co-Chairs Douglas A. Warner III, Chairman of MSK's Boards of Overseers and Managers, and Louis V. Gerstner, Jr., Honorary Chair of the Boards, continued to lead the historic Campaign, working with their fellow Board members and President Craig B. Thompson to share news about the Campaign's vital priorities to a wide group of potential donors.

As of December 31, 2013, the Campaign had recorded a total of $3.128 billion in gifts and pledges; it is now closing in on its $3.5 billion goal. Under the leadership of Anne M. McSweeney and Richard K. Naum, the MSK Office of Development had an especially successful year, generating $382.1 million in gifts and pledges — an all-time high for the institution by a wide margin.

The spirit of giving exhibited by MSK's benefactors at all levels was also evident in the increasing number of donors who made their gifts online. According to the *Chronicle of Philanthropy*'s annual report on online giving, Memorial Sloan Kettering ranked first in online fund-raising among all hospitals, medical centers, and universities.

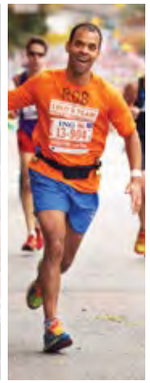
Thousands of volunteers participated on behalf of MSK in a range of athletic fund-raising initiatives, spotlighting our lifesaving mission while raising vital funds for research and patient care.

Cycle for Survival, MSK's indoor team cycling fund-raiser to benefit research into rare cancers, drew nearly 17,000 participants and generated a record $20 million for the cause.

01

02

03



04

Together with Equinox, the event's founding partner, Cycle for Survival is now the fastest-growing athletic fund-raising event in the country. It kicked off the season in September 2013 with outdoor events in Times Square and went on to hold a total of 41 rides in 13 cities nationwide in February and March 2014.

The RBC Decathlon, which brings together members of the financial community to compete in traditional track-and-field events, is now in its third year. In combination with another new event, the Wall Street Mile race, the Decathlon raised approximately $1.4 million to benefit research leading to new therapies for pediatric cancers.

Fred's Team brought together its largest group ever — 877 members — to raise funds for MSK in the ING New York City Marathon. Fred's Team members also participated in the NYC Half-Marathon, Boston Marathon, and various other events of their choice, raising $4.4 million in contributions through their efforts.

As the Campaign for Memorial Sloan Kettering advances toward its $3.5 billion goal, it will continue to rely on the generosity of donors whose dedication and support make a crucial impact on every aspect of MSK's mission in the fight against cancer in all its forms.

01
A Cycle for Survival event in Bethesda, Maryland

02
Evelyn Konrad and Mark Rubin, best all-around athletes at the 2013 RBC Decathlon

03
Members of Fred's Team in Times Square before the 2013 New York City Marathon

04
Rob Simmelkjaer, a Fred's Team member, running the New York City Marathon

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The Society of Memorial Sloan Kettering Cancer Center

Founded in 1946, The Society of MSK is a volunteer organization that works to ensure the well-being and comfort of patients; raise funds for cancer research and treatment; and provide public education on the prevention, early detection, and treatment of cancer.

Four hundred guests dined and danced at The Society's sixth annual **Spring Ball**, held in April at the Metropolitan Museum of Art's Temple of Dendur. The evening, sponsored by Harry Winston, raised $1.5 million for The Society's mission, and included a special funding initiative to support MSK's Targeted Therapy Translational Research Program for Kidney Cancer. Led by medical oncologist Robert J. Motzer, urologic surgeon Paul Russo, and physician-scientist James J. Hsieh, the program works to develop novel and more-effective treatment strategies to extend the lives of many patients and eventually eradicate the disease.

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01
(*From top*) Singer Diana Krall performs at the 2013 Spring Ball; MSK President Craig Thompson, former Society President Annette U. Rickel, and Robert Motzer at the Spring Ball; Chairman of the MSK Boards of Overseers and Managers Douglas A. Warner III and his wife, Patsy Warner, enjoy the Spring Ball.

02
(*From left*) Associates Committee Fall Party Co-Chairmen Emilia Fanjul Pfeifler and Cynthia Cook Smith, Honorary Chairman Patricia Herrera Lansing, Associates Committee Chairman Shoshanna Gruss, and Fall Party Co-Chairmen Hayley Bloomingdale and Joanna Baker de Neufville

03
(*From left*) Spring Ball Co-Chairmen Karen LeFrak, Julia Koch, and Shelley Carr

04
(*From left*) Courtney Arnot, Society President Martha Vietor Glass, and Muffie Potter Aston during the "Miracle on Madison" event

Since 1948, The Society of MSK's **Annual Appeal** has raised money to support cancer research conducted by Memorial Sloan Kettering clinicians and scientists. The Society partnered with MSK's Chief of Endocrinology, James A. Fagin, for its 2013 campaign in support of thyroid cancer research, raising more than $800,000. An estimated 56,000 new cases of thyroid cancer are diagnosed in the United States each year — and that number is rising. The Appeal is a hands-on initiative of The Society in which members write personal letters to friends, family, and colleagues urging them to support MSK research. Administrative Board members also make personal contributions to the campaign.

One of the most beloved New York City philanthropic holiday traditions is "**Miracle on Madison**," organized by the Madison Avenue Business Improvement District. During the 2013 holiday season, The Society of MSK was the beneficiary and partner of the shopping event for the second year, with funds benefiting its pediatric initiatives. On December 7, more than 85 of the world's most prestigious brands and retailers along Madison Avenue, from 57th Street to 86th Street, welcomed shoppers who wanted to join them in giving back. Twenty percent of the day's sales — a total of more than $200,000 — was donated to The Society by the participating retailers and businesses.

New York City's Four Seasons hotel was the setting in November for the annual **Fall Party** of the Associates Committee. Three hundred and sixty guests attended the festivities, which featured a presentation from MSK pediatric medical oncologist and sarcoma expert Paul A. Meyers, and raised funds to accelerate and support the first clinical trial of a treatment with a monoclonal antibody called 3F8 against osteosarcoma, a tumor of the bone. Sponsored by Carolina Herrera, the event kicked off the Associates Committee's newest initiative, Harnessing the Immune System to Target Sarcoma. The event raised $532,000.

Since The Society's beginnings, its mission has included the funding of early-stage research. **The Society's Research Grants** support important clinical and translational research projects of MSK's junior faculty members, many of which have gone on to become permanent programs and features of MSK. In 2013, seven research proposals were funded. The projects included investigations into lung cancer, breast cancer, multiple myeloma, hematologic cancers, testicular cancer, ovarian clear cell carcinoma, and pancreatic neuroendocrine tumors.

02

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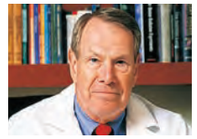

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as of February 1, 2014

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