Department of Biology

The Department of Biology is at the forefront of the revolution in molecular life sciences that has taken place over the past 50 years. The department is a widely recognized leader in research, scholarship, and education in the fields of molecular cell biology, biochemistry, genetics and genomics, and computational biology.

This past year the National Research Council (NRC) ranked the biology doctoral program as the top PhD program in molecular biology. This is significant because, unlike the *US News and World Report* rankings, the NRC rankings are based on objective criteria, such as papers published per faculty member. The last time the NRC carried out this analysis was 15 years ago.

Research and student training in the department has remained focused on the fundamental understanding of biology. Nevertheless, biology faculty members have made numerous practical advances in translating basic research into clinical medicine, drug development, and industrial microbiology.

Department Demographics

The biology department has 56 primary faculty members, located in five buildings: 23 in Building 68, 16 in the Whitehead Institute, 13 in the David H. Koch Institute for Integrative Cancer Research (Building 76), and two each at the Broad Institute and the Picower Institute. Joint faculty appointments provide important connections to other departments, including: Brain and Cognitive Sciences (5), Chemistry (3), Physics (1), Biological Engineering (5), and Civil and Environmental Engineering (1). Including emeritus faculty, the department has four Nobel laureates, 29 members of the National Academy of Sciences, and 10 Howard Hughes Medical Institute (HHMI) Investigators, and three HHMI Early Career Investigators.

The 2010–2011 academic year was marked by many notable accomplishments: the department awarded 33 PhD degrees in biology and five PhD degrees and three SM degrees in the joint program in biological oceanography with the Woods Hole Oceanographic Institute (WHOI). There were 213 graduate students registered in the biology department and another 28 in the joint WHOI program.

A total of 190 undergraduates registered as biology majors (of whom only four left biology for another major). In the spring of 2011, 41 students declared biology (Course 7 or 7A) as their major—three upperclassmen and 38 freshmen. In addition, 24 students declared the new biology and computer science major (Course 6/7). The BS degree was awarded to 63 students (40 in Course 7 and 23 in Course 7-A).

New Directions

The department hired two senior managers: Michelle Coleman, administrative officer, in September 2010, and Laurie Ledeen, director of development for the departments of Biology and Chemistry in February 2011.

Michelle Coleman's career as an academic administrator spans more than 25 years at three top-tier institutions: Columbia University, New York University School of Medicine, and Harvard School of Public Health. She will serve as a strategic partner to the department head and School of Science and Institute senior management; develop, mentor, and manage a highly functioning team; and direct new initiatives and projects.

Laurie Ledeen spent seven years with the McGovern Institute for Brain Research where she developed strong relationships between faculty and donors and was instrumental in securing significant gifts. She will work closely with the department heads of Biology and Chemistry to develop strategic plans for expanding their donor bases.

The David H. Koch Institute for Integrative Cancer Research opened a spectacular new facility (Building 76) in the spring of 2011. The neighborhood in the vicinity of Main and Vassar streets, which houses the most vibrant community of biomedical researchers in the world, has been transformed from a collection of outdated buildings into a beautiful modern campus. The Koch Institute combines 13 biology faculty, formerly in the Cancer Center, with an equal number of engineering faculty drawn from the departments of Electrical Engineering and Computer Science (EECS), Materials Science and Engineering (MSE), Biological Engineering (BE), Chemical Engineering (CE), and Mechanical Engineering (ME).

The department enjoyed a successful site visit from the MIT Department of Biology Visiting Committee on March 29 and 30. The written committee review has not been completed but the preliminary report delivered at the end of the visit was extremely positive. The department received high marks for hiring outstanding young faculty, developing innovative educational and outreach programs, and coordinating the different parts of the department to work together for maximum synergy.

The department's website is being redesigned to provide better visibility of and access to departmental information from the outside. The new site is expected to launch in the fall of 2011.

Space formerly occupied by the Bio Cafe in Building 68 will be converted to a multipurpose facility to support an infant care facility, a scholar's lounge for senior graduate students and postdoctoral researchers, and a small classroom for undergraduate seminars and other academic activities of the Biology Department. Construction will conclude in the fall of 2011.

Diversity

The department values diversity and inclusion in both our faculty and student population. We attract faculty and students from a wide variety of academic backgrounds and are committed to expanding the recruitment of underrepresented minorities (URM). Thanks to the extraordinary efforts of Dr. Mandana Sassanfar, who coordinates our URM and diversity programs, we have increased the size of the MIT Summer Research Program (MSRP) and our other outreach initiatives are flourishing.

We are very enthusiastic about the Biology and Biotechnology Bridge Program, commonly called B^3 ("B cubed"). This two-year postbaccalaureate program is based on collaboration between the biology department and our local Cambridge-based biotech partners. B^3 had an inaugural class of four students that began in July 2010. The goal of the B^3 program is to provide additional research and academic preparation to talented and driven individuals from minority groups and economically disadvantaged backgrounds to prepare them for the country's most competitive biological and biomedical PhD programs. In the first year, the academic portion of the program took place at MIT, while the research training portion took place at Novartis Institutes for Biomedical Research. The participants were assigned an academic mentor (professor Frank Solomon), a technical instructor (MIT graduate Janelle Whitney) and Novartis research mentors. Two new students joined the program in July 2011, increasing the total number of URM students to six (three African Americans and three Hispanic Americans).

MIT Summer Research Program

In 2010, the biology summer program expanded to include the Department of Brain and Cognitive Sciences. Additional funding to expand the program by six to eight participants was provided by the School of Science. For the 2011 summer program, the number of applicants increased to around 250. Twenty-four summer interns were selected for the program. The twenty-two participants included 12 URMs, as well as others from underrepresented or underserved backgrounds who had received need-based scholarships in college.

HHMI Special Research Seminars

The objective of the HHMI Special Research Seminars series is to enhance our efforts to increase diversity in science by featuring research seminars given by faculty from colleges and non-research-intensive universities. The faculty, who may or may not themselves be from an underrepresented minority group, are selected to speak because they have a strong impact on their undergraduate programs, can influence undergraduate curriculum development, or are undergraduate research program directors or mentors at their institutions. The following people were invited to give seminars:

July 21, 2010	Richard Goldsby, Amherst College (MIT faculty host: Harvey Lodish)
January 24, 2011	Mentewab Ayalew, Spelman College (faculty host: Wendy Gilbert)
March 30 2011	Nikolas Nikolaidis, California State University at Fullerton (faculty host: Susan Lindquist)
April 7, 2011	Maggie Werner-Washburne, University of New Mexico (faculty host: Chris Kaiser)
June 22, 2011	Carlos Gonzalez, University of Puerto Rico (faculty host: Uttam RajBhandary)

Four were from URM groups and one from at a minority-serving institution.

Faculty who participate in the HHMI seminar series encounter a number of MIT faculty, graduate students, and postdoctoral researchers in one-on-one meetings that are conducive to creating opportunities for educational and research collaborations. Dr.

Mentewab Ayalew is collaborating with professor David Bartel through a 10-week mini-sabbatical that started in May 2011. She is learning how to apply the ribosome profiling technique to plants. Dr. Carlos Gonzalez is exploring the possibility of spending next summer at MIT.

Summer Sabbatical Program for URM Faculty Members

In the summer of 2010, the program hosted two visiting faculty: Franklin Carrero-Martínez, a biology professor from the University of Puerto Rico who spent 10 weeks in Troy Littleton's laboratory using confocal and two-photon microscopy to study the very early stages of axon development in fly embryos, and Gustavo Lopez, a professor of chemistry from the University of Puerto Rico who spent 10 weeks in Collins Stultz's laboratory studying combinatorial chemistry and protein folding. Both of them attended the 2010 Quantitative Biology Workshop, during which they were able to explore summer sabbatical opportunities and meet with faculty. Both made significant progress in their own research using techniques learned at MIT.

Quantitative Biology Workshop

A six-day intensive workshop offered during Independent Activities Period in January 2011 drew 45 students and faculty from minority-serving institutions (i.e., University of Puerto Rico at Rio Piedras, University of Puerto Rico at Mayaguez, Barry University, Hunter College, York College, Howard University, Spelman College, and University of Texas at San Antonio). Four of the students who attended the workshop were selected for participation in the 2011 summer program. The workshop included: (1) daily research seminars, each introducing a specific method and topic in biology; (2) daily reading of the primary literature, teaching students how to dissect and critically evaluate research papers; (3) an introduction to quantitative biology; and (4) exposure to cutting-edge technology in a laboratory setting. The faculty who participated were Frank Solomon, Chris Kaiser, David Page, Eric Alm, Amy Keating, Chris Burge, Graham Walker, and Alan Grossman.

URM Graduate Students

Five of our URM graduate students defended in 2011 and are now postdoctoral fellows.

Education

Joint Degree in Computer Science and Molecular Biology

The biology department has entered into a collaboration with the Department of Electrical Engineering and Computer Science to offer a joint degree in Computer Science and Molecular Biology**.** This program is designed to address the increasing interest among our undergraduates in the interface of classical engineering disciplines and the life sciences, particularly in the exciting emerging field of computational biology. We have determined that successful practitioners in computational biology, whether they work in academia, industry, or in a genome center, need to have both the facility in algorithmic problem solving that comes from a background in computer science and the biological intuition that comes from training in molecular biology. The program includes approximately equal numbers of course offerings from Course 7 and Course

6-3, constituting a hybrid major that fits in the 15.5-subject limit for a standard MIT undergraduate degree program. Course 6-7 majors are assigned advisors in each of the departments.

Student Awards

A number of biology majors received awards in 2010–2011.

Class of 2011

Alice A. Chen of San Jose, CA, was awarded the Martha Gray Prize for Excellence in Research.

Michelle Dang from Brockton, MA, won the Randolph G. Wei UROP Award, which is presented each spring to the undergraduate who has made the most outstanding contribution in undergraduate research at the interface of the life sciences and engineering.

Jonathon T. Gunn from St. Charles, MO, was given the Frederick D. Greene Teaching Award for outstanding contributions in the area of teaching.

Nora Hickey from McFarland, WI, a bassoon player, was given an Emerson Music Fellowship.

Emilio T. Jasso from Alice, TX, was awarded second prize for Writing Science Fiction.

Alexander Jordan from Poughkeepsie, NY, won the William Emerson Prize, given to a senior in architecture for academic excellence.

Alexandra Jordan from Sacramento, CA, was given the Award for Excellence as an Undergraduate Teaching Assistant**.** This award recognizes the undergraduate student teaching assistant in the Department of Earth, Atmospheric and Planetary Sciences who is selected by faculty and students as having met the highest standards of performance.

Felicia Lashley from Brockton, MA, was given an Everett Longstreth Jazz Award in recognition of distinguished service and musical contribution to the MIT Festival Jazz Ensemble.

Andrew J. Musacchio from Acton, MA, won the Chemistry Research Award for outstanding contributions in the area of research.

Ann Ouyang from Dayton, MD, was awarded the Roger de Friez Hunneman Prize, which recognizes outstanding scholarship in class and research.

Eric Scarborough from Overland Park, KS, won second prize in the S. Klein Prize for Technical Writing.

Jose L. Villa-Uribe from Richmond, TX, received a Merck Index Award for outstanding scholarship.

Danielle Wang from O'Fallon, MO, and Stephanie Wang from Lilburn, GA, were each given a Wing S. Fong Memorial Prize, which is awarded to a chemical engineering senior of Chinese descent with the highest cumulative GPA. This prize honors the memory of Wing S. Fong for his hard work and dedication to his adopted home, university, and country.

Victoria Wang from Fremont, CA, was given a Service Award for outstanding service to the department.

Sarah Whiteside from Charleston, WV, won first place in the Boit Manuscript Prize for poetry.

Mary Jue Xu from West Chester, PA won second place in the Robert A. Boit Writing Prize for essay.

Jia Zhu from Murfreesboro, TN, won Honorable Mention in the Boit Manuscript Prize for poetry and third place in the Robert A. Boit Writing Prize for essay.

Jabe Ziino from East Wareham, MA, won the Peter S. Donaldson Literature Prize for Excellence in Literary Studies, which is awarded to a literature major who excels academically in literary studies and is an engaging participant in the literature community at MIT.

Class of 2012

Kamena Kostova from Shipka, Bulgaria, won first prize in the S. Klein Prize for Technical Writing.

Class of

2013

Charles Hsu from Taipei, Taiwan, was given an MIT Chamber Music Society Special Award Certificate in recognition of an exceptional performance and commitment to chamber music of the Beethoven String Quartet, op. 18, no. 6.

Shu Zheng from Shanghai, China, was awarded a Ragnar and Margaret Naess Certificate of Distinction in recognition of exceptional talent and commitment to performance at MIT as a pianist. He was also given an Emerson Music Scholarship for piano.

Other Awards

Three biology students were given Chemical Engineering Department Special Service Awards: Timothy Chang '12 from Rego Park, NY; Alexandra Piotrowski '11 from Helsinki, Finland; and Diana Wu '11 from Weston, MA.

Five biology students won Lufthansa Prizes for excellence in German studies: Kamena Kostova '12 from Shipka, Bulgaria, won first prize; Diana Wieser '12 from Lima, OH, won

second prize; Hyunjii (Justina) Cho ’13 from Chicago, IL, Eleanor Kate Phillips ’12 from Fairfax, VA, and Alexandra Piotrowski ’11 of Helsinki, Finland, each won third prize.

The following 11 biology majors, all Class of 2011, were chosen for Phi Beta Kappa: Jenna Caldwell of Indian Springs, AL; Amelia Chang of Singapore; Jonathon Gunn of St. Charles, MO; Yun-Han Huang of Rolla, MO; Alexander Jordan of Poughkeepsie, NY; Matthew Meisner of Madison, WI; Ann Ouyang of Dayton, MD; Jay Rajan of Cerritos, CA; Lauren Rodda of Vienna, VA; Danielle Wang of O’Fallon, MO; and Stephanie Wang of Lilburn, GA.

The Public Service Center gave awards to the following biology majors: Akansh Murthy ’12 from Bangalore, India, was awarded an IAP 2011 Fellowship. Ambar Mehta ’11 from Coral Springs, FL was a Summer 2010 Grantee. Anjali Thakkar ’12 from San Jose, CA, was awarded a Summer 2010 Fellowship and an IAP 2011 Four Weeks for America award.

The biology department presented the following awards and prizes:
Tracy Kambara ’11 from Culver City, CA, and Christine Hazlett ’11 from Whitman, MA received the John L. Asinari award for outstanding research in the life sciences.

Ambar Mehta ’12 from Coral Springs, FL, and Abigail Van Hook ’12 of Framingham, MA, received the Gene Brown Prize for outstanding academic scholarship and demonstrated excellence as a teaching assistant in 7.02.

Ryan Alexander ’12 from Birmingham, AL, received the Susan Hockfield Prize in Life Sciences for a third-year MIT undergraduate student in any area of the life sciences who has demonstrated both exceptional performance and promise for graduate study and research.

Sarah Whiteside ’11 from Charleston, WV, and Naomi Jiang ’11 of Northborough, MA, received the Ned Holt Prize for demonstrated excellence in scholarship as well as service to the MIT community.

Michelle Dang ’11 from Brockton, MA, received the Salvador E. Luria Prize for scholarship and research of publication quality.

Amelia Chang ’11 from Singapore received the Merck Prize for outstanding research and academic performance in biophysical or bioinformatics sciences.

Jenna Caldwell ’11 from Indian Springs, AL, received the Whitehead Prize for outstanding promise for a career in biological research through academic scholarship as well as contributions to research and the MIT community.

Nine students spoke in the Undergraduate Research Symposium in January at the invitation of their research faculty mentors: Michelle Dang ’11; Helen D’Couto ’12; Yun-Han Huang ’11; Tracy Kambara ’11; Kamena Kostova ’12; Oana Ursu ’13; Andrew

VanBenschoten '11, from Minnetonka, MN; Diana Wang '12 from LaGrangeville, NY; and Sarah Whiteside '11.

Faculty

Appointments, Promotions, and Transfers

Mary Gehring joined the biology department in September 2010. She received her PhD in plant biology from the University of California, Berkeley, with Dr. Robert Fischer. Dr. Gehring joined Dr. Steven Heinkoff's laboratory in 2005 as a postdoctoral researcher at the Fred Hutchinson Cancer Research Center, where her work focused on epigenomic reprogramming during plant reproductive development. Her research interests are: (1) the temporal and spatial dynamics of epigenomic programming in relation to development, (2) the relationship between DNA demethylation and chromatin structure, (3) the evolution of imprinting, and (4) the fidelity of epigenetic inheritance from generation to generation. Her research program in epigenetics in *Arabidopsis* nicely complements the work of the current faculty and expands the department's footprint in a model organism that is not well represented at MIT.

Piyush Gupta joined the Department of Biology in July 2010. He earned his PhD in biology in 2005 from MIT, where he studied the molecular basis of cancer progression and metastasis by developing a xenograft model of melanoma in mice. This work was the first to recapitulate many of the features of human disease, particularly its high rate of metastasis. His postdoctoral research was with Eric Lander at the Broad Institute on the role of epithelial stem cells as they occur in normal processes and in cancer. Dr. Gupta is currently exploring these central objectives: (1) understanding the signaling networks that control the biology of normal and cancer epithelial stem cells, (2) understanding the role of stem cells and cell-state perturbations in cancer progression and therapy response, and (3) developing and applying predictive models of stem-cell dynamics.

Michael Hemann was promoted to associate professor without tenure effective July 2011.

Barbara Imperiali's primary appointment was transferred from Chemistry to Biology effective July 2011.

Amy E. Keating was promoted to associate professor with tenure effective July 2011.

Michael T. Laub was promoted to associate professor without tenure effective July 2011.

J. Troy Littleton was promoted to full professor effective July 2011.

Adam Martin joined the biology department in January 2011. He holds a PhD in molecular and cell biology from the University of California, Berkeley, under the mentorship of Drs. David Drubin and Matthew Welch (dissertation entitled "Regulation and Function of Actin Assembly and Myosin Motor Activity at Endocytic Sites"). Dr. Martin did postdoctoral research in the lab of Eric Wieschaus at Princeton, where he began his investigation of the molecular mechanisms underlying the actin cytoskeleton–

driven events in cellularization of the *Drosophila* embryo. His current research interests are to investigate (1) the molecular mechanisms of ratchet-like apical constriction, (2) how apical contractile forces influence global cell shape, and (3) how cell behaviors and forces are coordinated between cells to drive robust tissue movements. His appointment strengthens ongoing work in the department in cell and developmental biology and in *Drosophila* as an experimental system, as well as strengthening links to BE and Physics.

Aviv Regev was promoted to associate professor with tenure effective July 2011.

Thomas Schwartz was promoted to associate professor with tenure effective July 2011.

Awards and Honors

David Bartel was elected to the National Academy of Sciences in the spring of 2011.

Ian Cheeseman received the 2011 R. R. Bensley Award, one of four young investigator awards bestowed by the American Association of Anatomists. The Bensley Award honors a cell biologist who has completed his or her highest degree in the past 10 years, advanced the field of anatomy, and published papers that have made a substantial impact on his or her field.

Penny Chisholm was awarded the Petersen Award by the Leibniz Institute for Marine Sciences (IFM-GEOMAR) in Kiel, Germany.

Gerald Fink was awarded the 2010 Gruber Genetics Prize of the Peter and Patricia Gruber Foundation for his groundbreaking research in yeast genetics.

Mary Gehring was named a 2011 Pew Scholar in the Biomedical Sciences.

Nancy Hopkins, Susan Lindquist, Hazel Sive, and Joann Stubbe were among the faculty that participated in a two day celebration of "Leaders in Science and Engineering: The Women of MIT" that took place March 28 and 29, 2011. The symposium highlighted the work and accomplishments of women at MIT and beyond. In addition, Nancy delivered the University of Chicago's inaugural colloquium on "How to Advance Women in Science and Engineering" on May 12, 2011.

Richard O. Hynes received the 2010 Earl P. Benditt Award from the North American Vascular Biology Organization.

Chris Kaiser was elected a fellow of the American Association for the Advancement of Science.

Amy Keating received an National Institutes of Health Transformative R01 grant. She plans to develop new DNA sequencing technologies to study protein-protein interactions. She expects this will lead to new models that speed annotation of protein functions and dramatically advance protein-engineering capabilities.

Rudolf Jaenisch was named a recipient of the 2011 Warren Triennial Prize of Massachusetts General Hospital (MGH). Created in 1871, the Warren Prize was named for Dr. John Collins Warren, a cofounder of the MGH who played a leading role in establishing what would become *The New England Journal of Medicine*. Usually given every third year, the Warren Prize, which includes a $50,000 award, honors scientists who have made outstanding contributions in fields related to medicine. Rudolf also was also awarded the 2010 Kazemi Prize of the Royan Institute, Iran, the 2010 Order of Merit of the Federal Republic of Germany and the 2011 Wolf Prize for Medicine.

Michael Laub received the Presidential Early Career Award for Scientists and Engineers.

Susan Lindquist received President's National Medal of Science. Lindquist was cited "for her studies of protein folding, demonstrating that alternative protein conformations and aggregations can have profound and unexpected biological influences, facilitating insights in fields as wide-ranging as human disease, evolution, and biomaterials." She also received Mendel Medal from the Genetics Society UK and the Max Delbrück Medal in Berlin.

Harvey Lodish was awarded the 2010 Outstanding Mentor Award in Basic Science from the American Society of Hematology.

Terry Orr-Weaver was elected a fellow of the American Association for the Advancement of Science. She was selected for "distinguished contributions to the field of yeast genetics, specifically protein sorting and secretion."

David Page was named a recipient of the 2011 March of Dimes Prize in Developmental Biology. The prize honors David's groundbreaking body of research on the human Y chromosome. The March of Dimes Prize in Developmental Biology has been awarded annually since 1996 to investigators whose research has profoundly advanced the science that underlies the understanding of birth defects. David was also elected a member of the American Academy of Arts and Sciences.

In January 2011, the American Association of Immunologists named Whitehead member Hidde Ploegh the recipient of its Meritorious Career Award. The award recognizes a midcareer scientist for outstanding research contributions to the field of immunology.

Jeroen Saeij was named a 2010 Pew Scholar in the Biomedical Sciences.

Matthew Vander Heiden was named a 2011 recipient of the Damon Runyon-Rachleff Innovation Award and received a junior faculty award from the Smith Family Award for Excellence in Biomedical Research.

Robert A. Weinberg received an honorary doctorate from Helsinki University and was elected an associate member of the European Molecular Biology Organization. The scientist credited with discovering the first human oncogene, Professor Weinberg also won the 2011 American Society of Clinical Oncology (ASCO) Science of Oncology

Award. According to ASCO, Professor Weinberg won the award for "for furthering the understanding of cancer through his innovative and groundbreaking research."

Research

The Biology Department offers the most brilliant life scientists an opportunity to conduct curiosity-driven basic research, which is something that sets this department apart from many others in the field. The department is fortunate to be embedded in MIT's highly collaborative academic environment, where we are already seeing the rewards of work with colleagues in engineering and physical science departments. The following research highlights exemplify achievements that were made over the past year.

Angelika Amon and her lab made key discoveries concerning mechanisms that cause or prevent aneuploidy—the condition in which cells gain or lose chromosomes. In developing fetuses, aneuploidy causes death or birth defects. However, in cancer cells, aneuploidy appears to confer a survival advantage. Angelika's group is identifying potential drugs that enhance stress and cause too many chromosomes to form. In addition, Angelika's group has identified a new mechanism by which the yeast gene *NDT80* can reverse the effects of cellular aging. If the human cell lifespan is controlled in a similar way, it could offer a new approach to rejuvenating human cells or creating pluripotent stem cells.

David Bartel and his lab found that short pieces of RNA, called microRNAs, control protein production by causing the proteins' RNA templates (known as messenger RNA or mRNA) to be disabled by the cell. Researchers have known that mammalian microRNAs control protein production by causing the mRNAs to degrade, but they have wondered how many additional effects microRNAs impart by jamming the process that translates mRNAs into proteins. These results reveal the outcome of microRNA regulation of many genes and provide a framework for thinking about how microRNAs act.

Jianzhu Chen and his colleagues engineered T cells to attack tumors, thus giving researchers hope of adding a new weapon to their cancer-fighting arsenal. Cancer biologists have long been intrigued by the prospect of harnessing T cells to attack tumors, either to supplement or replace traditional chemotherapy. Using T cells to wipe out tumor cells could avoid the side effects often seen with chemotherapy.

Ian Cheeseman and his group reported that two proteins, once thought to have only supporting roles, are the true "stars" of the kinetochore assembly process in human cells. The kinetochore is vital to proper DNA distribution during cell division. This finding suggests that scientists may be able to stimulate kinetochore assembly in a process that could lead to new genetic research tools, such as efficient creation of artificial human chromosomes.

Michael Hemann and his colleagues, in a study of mice with lymphoma, discovered that a small number of cancer cells escape chemotherapy by hiding out in the thymus, an organ where immune cells mature. Within the thymus, the cancer cells are bathed in growth factors that protect them from the drugs' effects. Professor Hemann conjectures that these cells are likely the source of relapsed tumors. In addition, Michael Hemann

and Graham Walker are senior authors of two papers that elucidate how two key DNA replication enzymes play roles in tumor cells' response to DNA damage. This work has opened the possibility that molecules that would disrupt the action of these enzymes may be used in combination with traditional chemotherapy, to provide a better way to treat cancers that don't respond well to the usual treatments.

Tyler Jacks's lab is working to understand why lung cancer spreads. His work and that of other MIT biologists have pinpointed a genetic change that helps tumors move to other parts of the body. They have also identified a genetic change that makes lung tumors more likely to spread to other parts of the body. These findings offer new insights into how lung cancers metastasize and could help identify drug targets to combat metastatic tumors—which account for 90 percent of cancer deaths.

Rudolf Jaenisch and collaborators identified a protein called Musashi 2 that is predictive of prognosis in acute myeloid leukemia (AML) and chronic myeloid leukemia (CML) patients. High levels of Musashi 2 protein are associated with increased cell proliferation, decreased cell maturation, and multiple cancer-related cellular pathways in human leukemias. The protein and the cellular functions it affects potentially represent therapeutic targets in certain types of leukemia, according to the researchers' article in *Nature Medicine*.

Doug Lauffenburger and his colleagues refined computer models to unravel the complex interconnections of cell signaling networks to enable predictions of the complex behavior of cells in living animals. In their collaboration with researchers from MGH, they created a new computational model that describes how intestinal cells in mice respond to a natural chemical called tumor necrosis factor (TNF).

Susan Lindquist and her colleagues determined that heat shock protein 90 (Hsp90) can create heritable traits in brewer's yeast by affecting a large portion of the yeast genome. The finding led to the conclusion that Hsp90 has played a key role in genome evolution. This work provides a new way of thinking about how organisms could rapidly evolve new traits.

Hidde Ploegh's group created a method that site-specifically modifies proteins to exert control over their properties when administered therapeutically. The technique should be useful to increase potency, slow metabolism, and improve thermal stability of therapeutically useful proteins, such as interferon alpha 2 (IFN-alpha 2), which is used to treat variety of diseases, including leukemia, melanoma, and chronic hepatitis C.

Peter Reddien's lab found that pluripotent adult stem cells power planarian regeneration. Reddien's group identified a single pluripotent cell type that gives rise to the planarian's amazing ability to regenerate body parts.

David Sabatini and collaborating Whitehead Institute researchers found that depriving human melanoma cells of the essential amino acid leucine can be lethal to the cells. This discovery points to a possible strategy for therapeutic intervention. Sabatini's research team also used a new in vivo screening system to identify a protein in the

serine biosynthesis pathway that is essential in estrogen receptor (ER)-negative breast cancer—a notoriously difficult disease to treat that is associated with low five-year survival rates. According to the researchers, when expression of the gene that codes for this protein—phosphoglycerate dehydrogenase, or PHGDH—is suppressed in tumors and cell lines with an overabundance of the protein, the rate of cellular growth declines markedly.

Jeroen Saeij is investigating why certain strains of the *Toxoplasma* parasite (there are at least a dozen) are more dangerous to humans than others. His group has discovered a new *Toxoplasma* protein that may help explain why the type II strain is more virulent than others. The Saeij lab also showed that *Toxoplasma* infection in mice causes intestinal inflammation strongly resembling that seen in Crohn's disease in humans. It is unknown whether any of these cases are actually caused by *Toxoplasma*, but Saeij reports that some studies have shown a higher incidence of *Toxoplasma* in people with Crohn's than in the general population.

Phil Sharp worked on a paper with colleagues about harnessing the power of "convergence" for revolutionary advances in biomedicine and other fields. Convergence is a broad rethinking of how scientific research can be conducted to capitalize on a broad range of knowledge, from microbiology to computer science to engineering design.

Bob Weinberg and his group discovered that a differentiated cell type found in breast tissue could spontaneously convert to a stem-cell-like state—the first time such behavior has been observed in mammalian cells. These results refute scientific dogma that states that differentiation is a one-way path—that once cells specialize they cannot return to the flexible stem-cell state on their own. This surprising finding may have implications for the development of cancer therapeutics, particularly those aimed at eradicating cancer stem cells. As Bob Weinberg has said, "It may be that if one eliminates the cancer stem cells within a tumor through some targeted agent, some of the surviving non-stem tumor cells will generate new cancer stem cells through spontaneous de-differentiation." Cancer stem cells are uniquely capable of reseeding tumors at both primary and distant sites in the body.

Resource Development

Under Michelle Coleman's leadership, the department has taken a significant step toward improving the way it presents itself to, and communicates with, its alumni, friends, donors, and potential donors. A major part of this effort is the redesign of the department's out-of-date website, which gives the department an opportunity to strengthen the case for support and increase annual gifts. Through this work a template will be created for newsletter for the department, which Laurie Ledeen will produce online and in print once each spring and fall. The goal is to launch the website in the fall of 2011. The first edition of the newsletter will announce the new website and feature the work of a faculty member or laboratory, give an update on the B^3 program, and highlight a donor to the department, one whose gift might motivate others. It will be sent to all alumni, friends, and the local biotech community shortly afterward.

We look forward to the dean's colloquium on September 22, which will feature guest speaker Dr. Paul Schimmel. This will be an excellent opportunity to cultivate new potential major donors.

Laurie Ledeen has been working extensively with staff in Foundation Relations to identify new foundations that might support the department. She is preparing a proposal for the Merkin Foundation in Los Angeles focusing on stem cell research, primarily in the laboratory of Laurie Boyer. She has asked Alan Grossman to take the lead on an approach to the Agouron Institute for support on microbiology. In addition, Kate Reynolds and Laurie Ledeen are meeting with select faculty whose work can attract foundation support (Baker, Binge, Kim, Martin, and Krieger). A preliminary proposal has been prepared to the Bingham Trust for Leonard Guarente.

Named Lectures

September 28	Buchanan Lecture: Robert Lefkowitz, Duke University, G Protein Coupled Receptors (faculty host: M. Krieger)
October 12	Glenn Lecture: C. Ronald Kahn, Joslin Diabetes Center, Role of Adipose Tissue in Aging in Mice (faculty host: Leonard Guarente)
December 7	Mayer Lecture: James Nelson, Stanford University, Functional Evolution of the Cadherin-Catenin Complex (faculty host: Frank Gertler)
January 18	Luria Lecture: Irving Weissman, Stanford University, Normal and Neoplastic Stem Cells (faculty host: Richard Young)
March 1	Holt Lecture: Gaudenz Danuser, Harvard Medical School, Integration of mechanical and chemical signals in cell motility (hosted by department)
April 12	Rich Lecture: Alexander Varshavsky, California Institute of Technology, Recent Discoveries About the Ubiquitin System and the N-End Rule Pathway (faculty host: Shuguang Zhang)
April 26	Chipperfield Lecture: Richard Axel, Columbia University, Internal Representations of the Olfactory World Weinberg Lab (hosted by postdoctoral fellow committee)
May 17	Schmitt Lecture: Clifford Woolf, Children's Hospital/Harvard Medical School, Switching on Regeneration (faculty host: Frank Gertler)

Chris A. Kaiser, PhD
Department Head
Professor of Biology