The David H. Koch Institute for Integrative Cancer Research at MIT

Goals, Objectives, and Priorities

The David H. Koch Institute for Integrative Cancer Research, a National Cancer Institute (NCI)–designated cancer center, provides a state-of-the-art research facility and collaborative environment for cancer research on the MIT campus. The Koch Institute (KI) building allows for the physical co-localization of faculty members from the Department of Biology and a variety of departments in the MIT School of Engineering. This multidisciplinary group of investigators is at the core of the Koch Institute's mission: to combine cancer science and cancer-oriented engineering to develop new insights into cancer as well as new tools and technologies to better diagnose, treat, and prevent the disease.

As a group, our goal is to make the Koch Institute the gold standard in interdisciplinary disease-focused research. The organization is continually expanding a highly effective relationship network that involves other academic and clinical oncology centers, industrial partners, and cancer-focused individuals and foundations. As part of an institution of higher education, we are also deeply committed to training the next generation of cancer researchers. Many of our efforts this past year have been focused on further strengthening internal and external communications and collaborations.

Finances and Funding

Funding for research performed within the KI building comes from several sources, including federal grants, philanthropic gifts, and industrial contracts. The total was more than $75 million in FY2015. This figure is based on intramural faculty expenditures and includes total sponsored research volume, philanthropic funding, funding for five Howard Hughes Medical Institute faculty members, corporate funds, faculty discretionary account spending (typically chair accounts), postdoctoral and graduate fellowship funding through MIT mechanisms, core facility chargeback accounts, and MIT general budget allocations to KI. Also included are funds managed by KI for specific cancer research efforts across MIT.

Critical to cancer research on the MIT campus is the National Cancer Insitute (NCI) cancer center designation, which MIT—first through the Center for Cancer Research and now through the Koch Institute—has held since 1974. The NCI Cancer Center Support Grant is re-competed every five years via a grant application and a site visit from NCI. The grant process was successfully completed in October 2014 with a perfect score of 10 and recommended approval of the budget at requested amounts.

The interdisciplinary nature of the research conducted at the Koch Institute has resulted in faculty members participating in many multi-investigator collaborative projects over the years. Examples include projects funded by grants from NCI, with work performed through, for instance, the Physical Science and Oncology Center, the Center of Cancer Nanotechnology Excellence, the Tumor Cell Network Center (formerly the Integrated

Cancer Biology Program), and the Tumor Microenvironment Network. In addition, the Koch Institute has been successful in identifying and negotiating funding from individuals, foundations, and companies in support of its research mission.

The Ludwig Center for Molecular Oncology at MIT, established in 2006 with a gift from the Virginia and D.K. Ludwig Fund for Cancer Research, is housed at the Koch Institute. The Ludwig Center continues to support the research of several KI faculty while providing fellowships for students and postdocs working in metastasis.

In addition to several smaller-scale sponsored research relationships with various companies, KI has maintained a larger-scale partnership with Janssen Pharmaceuticals, the pharmaceutical division of Johnson & Johnson. TRANSCEND is a five-year collaborative agreement that fosters oncology research and technology development in cancer diagnostics, novel therapeutic targets, drug delivery systems, cancer immunotherapies, and murine disease models to study premalignancies, tumor progression, and target validation. The program is currently in its final funding cycle, and since the inception of TRANSCEND, 21 projects and one pilot project have been funded. Currently 15 projects are active, and 14 MIT faculty members are receiving support. The program offers the opportunity for visiting scientists from Janssen to work in MIT laboratories as well as for regular consultations with company scientists. Faculty members, trainees, company scientists, and members of the Johnson & Johnson Boston Innovation Center are invited to two yearly scientific exchange events, one at KI and one at a Janssen facility. As the Koch Institute's first major collaborative program approaches its close, we are excited for our continuing relationship with Janssen in accelerating the translation of basic cancer science and engineering into the clinic.

The Bridge Project provides additional opportunities for faculty members to develop research toward clinical and commercial applications through collaborations with clinical partners. This collaborative partnership with the Dana-Farber/Harvard Cancer Center (DF/HCC) is designed to foster and support interinstitutional cancer research efforts between faculty at MIT and Harvard. Now in its fifth year of funding, the Bridge Project has supported 15 teams of collaborating investigators from KI and DF/HCC in developing new treatment and diagnostic methods for a variety of cancers. The project is funded solely by philanthropic funds, which have been raised in a collaborative fashion between the development organizations of DF/HCC and KI. Since its inception, outcomes from project teams include 11 joint manuscripts, four patent applications, and one company. We also hold several Bridge Project events each year, including workshops and donor events.

KI's Frontier Research Program supports exciting early-stage, interdisciplinary investigations, as all too often such early-stage ideas do not qualify for funding from traditional government sources. The Frontier program, which is funded solely by philanthropic sources, represents an investment in the future and highlights the far-reaching vision of the KI community. The exciting investigations that have been supported by Frontier include injectable nanoparticles that create urinary biomarkers to reveal the presence of cancer within minutes, an imaging system for early detection and surgical resection that can reveal tumors smaller than a millimeter in diameter, and a genetic marker for metastatic breast cancer that has been licensed for the development of clinical diagnostic tests.

Personnel Information

This year the Koch Institute welcomed a new intramural faculty member identified in a 2014 search, and it prepares to welcome a second identified in a 2015 search. Ömer Yilmaz, assistant professor in the Department of Biology, began in September 2014, and Michael Birnbaum will begin his appointment as an assistant professor in the Department of Biological Engineering in January 2016. In addition, a search process is under way for a KI clinical investigator.

Scott Floyd, KI clinical investigator, will leave to begin an appointment as an assistant professor in the Department of Radiation Oncology at the Duke University School of Medicine. Dr. Floyd is the second KI clinical investigator since the inception of the program for early-career physician-scientists—and the second to move on to a faculty appointment at an academic medical center.

Paul Chang, assistant professor of biology, is transitioning out of KI for other opportunities.

By January 2016, we anticipate that the Koch Institute building will house 28 faculty members—13 from the Department of Biology, 14 from the School of Engineering, and the president emerita—as well as two clinical investigators.

KI also houses 25 MIT faculty who are extramural members, including the directors of the Whitehead Institute (David Page) and the Broad Institute (Eric Lander). Through their involvement in research on cancer or cancer-related subjects, these individuals participate in a variety of ways in the research activities of the Koch Institute.

The Swanson Biotechnology Center, which includes the core facilities of KI, is available not only to the KI faculty but also to the whole of MIT. The center employs approximately 50 full-time staff scientists working within 13 distinct core facilities.

At the end of FY2015, 162 graduate students and 177 postdoctoral fellows or associates had active appointments in KI building faculty laboratories. KI's total personnel count exceeds 780, up from 750 in the year prior.

Faculty Honors and Awards

While external recognitions are certainly not uncommon for KI faculty members, this was a year of several major awards—especially for our Sangeeta Bhatia. In September, Bhatia received the 2014 Lemelson-MIT Prize in recognition of her design and commercialization of miniaturized technologies with applications to improve human health. This is the second consecutive year, and third overall, in which a Koch Institute faculty member has been awarded the prize and only the fourth time an MIT faculty member has received the prize in its 20-year history. In April, Bhatia received the Heinz Award for Technology, the Economy, and Employment for her work in developing simple, affordable cancer screening tools and applying the principles of microchip fabrication to develop artificial human "microlivers." Finally, Bhatia was elected to both the National Academy of Engineering and the American Academy of Arts and Sciences in 2015.

Robert Langer, the David H. Koch Institute Professor, was named the winner of the 2015 Queen Elizabeth Prize for Engineering in February. Langer is being awarded the prize for his revolutionary advances, for his leadership in engineering at the interface with chemistry and medicine, and for being the first person to engineer polymers to enable the controlled release of large-molecular-weight drugs in the treatment of cancer and other diseases. He will receive the prize from Queen Elizabeth II at Buckingham Palace later this year.

At the meeting of the MIT faculty, KI director Tyler Jacks was announced as the 2015–2016 recipient of the James R. Killian Jr. Faculty Achievement Award in recognition of his leadership of MIT's cancer research community and his influence on the field of cancer research. The Killian Award is the highest honor MIT grants to members of its faculty. Jacks will deliver his Killian Award lecture in February 2016.

Publications, Patents, and Companies

Over the past seven years, 20 companies have been started by KI faculty as a mechanism for discoveries in new technologies to be brought to the marketplace. For example, BIND Therapeutics, a nanomedicine technology endeavor launched in 2007, is now treating phase II clinical trial patients.

KI researchers, intramural and extramural, produced more than 450 publications in FY2015, 62 of which have multiple KI faculty members as authors. Further reflective of cross-disciplinary collaborations is the increase in the number of publications resulting from biology-engineering collaborations. Due in large part to the co-location of these disciplines in the Koch Institute building, our intramural faculty members' interdisciplinary investigations represented 36% of joint publications in FY2015, up from figures in previous years. It is anticipated that this number will continue to increase.

Additional Accomplishments

In 2015, KI ran a series of workshops and other activities aimed at community building, with the goal of strengthening integration and furthering interactions between scientists and engineers as well as exposing researchers to the clinical, patient-based side of cancer work.

Ken Burns presents CANCER: THE EMPEROR OF ALL MALADIES: This three-part documentary, which aired on PBS from March 30 to April 1, presented a historical narrative of cancer research and treatment grounded in the personal stories of patients, clinicians, and researchers. The film featured several KI members and collaborators, including faculty members Robert Weinberg and Eric Lander, as well as alumna and former KI clinical investigator Alice Shaw. To celebrate the film, KI faculty member Phillip Sharp, Institute Professor and chair of Stand Up To Cancer's Scientific Advisory Committee, hosted an advance screening for the KI community that featured a panel discussion including first-episode director and producer Jack Youngelson.

Oncology Seminar Series: Now in its third year, this cancer-specific seminar series at MIT invites top-level cancer researchers and clinicians to present their work and meet with faculty and researchers at the Koch Institute. The seminars have been well attended and have received very favorable reviews.

Yearly Fall Retreat: The purpose of this retreat is to provide an off-campus opportunity for sharing lab research and highlighting new research areas through formal presentations, poster sessions, and casual events.

Friday Focus: This internal weekly seminar series has broken down language barriers and become a very successful cross-disciplinary educational/training platform for presenting recent data from each of the KI labs.

Crossfire: This in-house lecture series is designed to bring our two major constituencies closer together. Biology lectures cover the basics of key areas of cancer biology, while engineers present lectures on trends in materials, tissue engineering, and nanoparticles. Graduate students and postdoctoral fellows present broad-scope lectures explicitly designed to reach across disciplines.

The Doctor Is IN: Presented by MDs, this event exposes researchers in the building to real clinical issues, including patient case studies and new treatments being tested in the clinic.

Committee for Community Life: KI volunteers (trainees, staff, researchers, and administrators) organize community-building events and the seminars/lectures listed above. They also discuss other issues of importance to postdocs and graduate students.

Cancer Community Newsletter: This electronic newsletter, published since 2009, sends news and highlights of KI members' achievements, awards, and publications to current and past members.

KI also focused on outreach beyond our research community. The following are some examples.

KI Cancer Solutions Newsletter: This electronic newsletter sends highlights of newsworthy achievements, awards, and publications of KI members to over 2,800 readers with an interest in the Koch Institute.

Koch Institute Public Galleries: The galleries were established to connect the community in Kendall Square and beyond with work being done at the cutting edge of cancer research and, more generally, with life sciences work at MIT. Within the galleries, visitors can explore current cancer research projects, examine striking biomedical images, hear personal reflections on cancer and cancer research, and investigate the historical, geographical, and scientific contexts from which the Koch Institute emerged. The galleries are free and open to the public on weekdays from 8 am to 6 pm (4 pm on Fridays). New exhibits are unveiled regularly, including the annual exhibition of winning life sciences and biomedical images from the Koch Institute Image Awards.

with/in/sight Lecture Series: Initiated in September 2011, this public lecture series features the insights that emerge when science meets engineering, clinical practice meets urgent patient needs, entrepreneurial drive meets venture capital, and imaging technology meets artistic vision. Four with/in/sight events were held over the past year with a total attendance of about 650: a program featuring three women at the forefront of the fight against cancer, an exploration of how a basic science discovery in cancer metabolism was translated into a clinical solution in less than six years, a celebration of those who push the boundaries of what's possible for cancer patients and those who care for them, and the annual Image Awards exhibition opening.

Annual Symposium: The 14th annual Summer Symposium, "CANCER COMPLEXITY: Heterogeneity in Tumor Progression and Drug Response," was held on June 12, 2015. This sold-out event, with more than 1,100 attendees, explored the genetic and epigenetic heterogeneity within tumors that yield diverse cancer phenotypes, such as drug resistance. Speakers highlighted the latest breakthroughs in overcoming clinical challenges in cancer diagnostics and therapy.

Bridging the Gap in Ovarian Cancer: In September, the Koch Institute hosted a special symposium for ovarian cancer patients, survivors, family members, advocates, researchers, and other interested members of the public. This free public event, hosted by KI faculty member Paula Hammond, featured KI investigators and collaborators who discussed advances in science and technology to fight ovarian cancer. The event highlighted the power of bringing bioengineering, advanced cancer science, and clinical oncology together to solve today's most challenging problems in ovarian cancer through collaborative, interdisciplinary research.

TEDxCambridge: Koch Institute director Tyler Jacks was selected as a speaker for TEDxCambridge's September event, where he shared insights from his 34 years in the "maze" of cancer research. KI hosted a TEDxCambridge simulcast and the event's Innovation Lab, which showcased local innovators and entrepreneurs, including KI researchers. The TEDx event brought hundreds of people through KI's doors and into the Public Galleries.

Herman Eisen Symposium: This year the KI community mourned the loss of Professor Emeritus Herman Eisen, a founding member of the MIT Center for Cancer Research and pioneering immunologist. To honor his memory and the body of knowledge he contributed to the field of immunology, KI and the Department of Biology hosted the Herman N. Eisen Symposium: Understanding Adaptive Immunity in May. Throughout the daylong event, which also included a dedication of a conference room near his second-floor office, Herman's colleagues, former trainees, and family joined in celebrating his scientific legacy.

School Group Programs: The Koch Institute is committed to fostering an interest in science and engineering among young people. As part of this mission, we invite groups of middle and high school students (grades 7–12) to visit our facilities, meet researchers who work every day to solve cancer problems, and learn interactively about the science and technology of cancer research. Over the past year, we hosted more than 1,300 students in about 25 school groups, presenting hands-on demonstrations of work in the building and making full use of the teaching resources in the Koch Institute Public Galleries. These events are offered free of charge and can optionally be paired with other activities at MIT, including life sciences and engineering workshops at the MIT Museum. The Koch Institute education outreach program regularly participates in other MIT programs for students and teachers, including those run by the Office of Engineering Outreach Programs, the Scheller Teacher Education Program, and the Department of Biology.

Cambridge Science Festival: During this year's Cambridge Science Festival, more than 100 KI volunteers from 22 laboratories and core facilities welcomed approximately 300 visitors for a three-hour open-house event, "Behind the Beaker, Beyond the Machines." The volunteers provided a research showcase

and a hands-on "mini-lab," engaging visitors and captivating minds by sharing KI's work in cancer biology and cancer-oriented engineering.

Administrative Initiatives

The Koch Institute's administrative goal is to support and facilitate the work of Koch Institute researchers, and input from external reviewers is crucial in reaching this goal.

The Scientific Advisory Board provides key scientific input to KI as an NCI-designated cancer center. The board, composed of outstanding cancer center scientists and administrators, meets annually at the Koch Institute and also provides interim feedback to the director throughout the year. In October 2014, KI defended the competitive application for renewal of its designation for years 45 to 49 during a National Institutes of Health site visit. The board's input was integral in the "exceptional" score awarded to KI.

The Koch Institute Leadership Council is a group of friends and benefactors—primarily individuals from the biotechnology, pharmaceutical, entrepreneurship, and philanthropy communities—who generously contribute their time, energy, and personal resources to advancing the work of the Koch Institute. Many of the members have strong connections to MIT, and nearly all have been touched by cancer. Combining professional expertise and personal commitment, members provide valuable advice and support to KI leaders as they seek to strategically expand the scope of research, education, public outreach, communications, and fundraising programs.

Summary

With an intense focus on developing new solutions to the complex challenges of cancer, MIT's Koch Institute assembles world-class interdisciplinary researchers in a state-of-the-art cancer research and technology facility. By leveraging KI's collaborative research model and its strengths in cancer biology and cancer-oriented engineering, we are accelerating the rate of progress and bringing new innovation to the lives of patients.

Tyler Jacks
Director
David H. Koch Professor of Biology