

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

Goals, Objectives, and Priorities

The [David H. Koch Institute for Integrative Cancer Research](#) (KI), a National Cancer Institute (NCI)–designated cancer center, is the hub of cancer research on the MIT campus. The Koch Institute’s state-of-the-art facility provides for the physical co-localization of faculty members from MIT’s 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 science and 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 \$92 million in FY2017. This figure is based on intramural faculty expenditures and includes total sponsored research volume, philanthropic funding, funding for five Howard Hughes Medical Institute (HHMI) 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 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. We will begin the process for our next renewal in fiscal year 2018.

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. Two of these center projects were funded in 2017: the Physical Science and Oncology Center, led by Forest White, and the Cancer Systems Biology Consortium, led by Scott Manalis. In addition, KI has been successful in identifying and negotiating funding from individuals, foundations, and companies in support of its research mission.

Two cancer-focused centers have been established at the Koch Institute: the Ludwig Center for Molecular Oncology and the Marble Center for Cancer Nanomedicine. The Ludwig Center for Molecular Oncology, established in 2006 with a gift from the Virginia and D.K. Ludwig Fund for Cancer Research, supports the research of 12 KI faculty members while also providing fellowships for students and postdocs working in metastasis. The Marble Center for Cancer Nanomedicine was launched in spring 2016 through the generosity of Curt Marble '63 and his late wife, Kathy. The center's inaugural director is Professor Sangeeta Bhatia. The center brings together six of KI's leading faculty members to focus on grand challenges in cancer diagnosis and treatment that could benefit from emerging nanoscale biology and physics: detecting cancer earlier than existing methods allow, harnessing the immune system to fight cancer even as it evolves, exploiting therapeutic insights from cancer genomics in order to design therapies for targets that have not previously responded to drugs, combining existing drugs for synergistic action, and creating tools for better surgical intervention. The center will also facilitate important fellowship support and training opportunities for the next generation of nanoscientists and nanoengineers. By galvanizing the MIT cancer research communities, and ideally the larger Boston clinical oncology community, the center will help to revolutionize cancer diagnosis, treatment, and monitoring.

The Koch Institute engages in multiple outward-facing initiatives to increase the likelihood that the institute's innovative research is translated from bench to bedside to benefit cancer patients. The Koch Institute Frontier Research Program supports exciting early-stage, interdisciplinary investigations, because all too often such early-stage ideas do not qualify for funding from traditional government sources. The Frontier Research Program, which is funded solely from philanthropic sources, represents an investment in the future and highlights the far-reaching vision of the KI community. The groundbreaking projects 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. Several Frontier-funded projects have resulted in intellectual property and the founding of new companies (see below).

The Bridge Project provides additional opportunities for faculty members to develop research toward clinical and commercial applications through collaborations with clinical partners. This partnership with the Dana-Farber/Harvard Cancer Center (DF/HCC) is designed to foster and support inter-institutional cancer research efforts between faculty members at MIT and Harvard. Now in its seventh year of funding, the Bridge Project has so far supported 37 research teams in developing new treatment and diagnostic methods for a variety of the most challenging cancers. The project is funded

exclusively with philanthropic funds raised collaboratively by the KI and DF/HCC development teams. Thanks to a \$20 million challenge gift from the Commonwealth Foundation for Cancer Research, we have been able to expand the number of funded teams significantly. Outcomes from Bridge Project teams include joint manuscripts, patent applications, several clinical trials, and one company.

KI also has philanthropic and sponsored research relationships with several companies (currently 15), including a new gift from Takeda Oncology, a long-standing partnership with Janssen Pharmaceuticals (the pharmaceutical division of Johnson & Johnson), and a collaboration with the J&J Innovation Center.

Personnel Information

This year the Koch Institute welcomed a new intramural faculty member identified in a 2016 search. Dr. Stefani Spranger, recruited to the Department of Biology and KI, began her appointment in July 2017.

KI also concluded a successful search for a clinical investigator. Dr. Salil Garg will begin his appointment in January 2018. Dr. Garg will be the fourth KI clinical investigator since the inception of the program for early-career physician-scientists; two of the previous clinical investigators have moved on to faculty appointments at academic medical centers.

Currently, the Koch Institute building houses 29 faculty members—14 from the Department of Biology (including one emerita faculty member), 14 from the School of Engineering, and the president emerita—as well as one clinical investigator.

KI also houses 26 MIT faculty who are extramural members, among them 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 the institute, 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 FY2017, 137 graduate students and 153 postdoctoral fellows or associates had active appointments in KI building faculty laboratories. KI's total personnel count exceeds 700.

Faculty Honors and Awards

Several KI members were recognized this year for their contributions to science, technology, and the fight against cancer. Regarding formal awards, multiple KI faculty members were elected to national academies: Sangeeta Bhatia and Stephen Bell to the National Academy of Sciences and Paula Hammond to both the National Academy of Engineering and the National Academy of Medicine. Additionally, Michael Cima was named a fellow of the National Academy of Inventors and Angelika Amon was elected to the American Academy of Arts and Sciences.

Phillip Sharp received the Raymond and Beverly Sackler Award for Sustained National Leadership from Research!America and was chosen to deliver the 127th annual Shattuck Lecture at the Massachusetts Medical Society's annual meeting.

Stephen Lippard was recognized as a 2016 Welch Award in Chemistry recipient and was a 2017 honoree of the Massachusetts General Hospital Cancer Center's "the one hundred." David Sabatini received the Lurie Prize in Biomedical Sciences.

Michael Birnbaum received an American Association for Cancer Research (AACR) Career Development Award, KI trainee Liangliang Hao was presented an AACR Women in Cancer Research Scholar Award, and KI trainee Helen Evans received an AACR Scholar-in-Training Award.

Newly tenured professor Matthew Vander Heiden was named to HHMI's inaugural class of faculty scholars. In addition, he won the Stand Up To Cancer Phillip A. Sharp Innovation in Collaboration Award along with research collaborator Melissa Skala from the University of Wisconsin-Madison's Morgridge Institute for Research.

A team of MIT professors led by KI's Christopher Love has joined forces with professors from the University of Kansas and University College London to develop new ways to produce low-cost vaccines for global distribution through their innovative ULTRA manufacturing platform. With the support of a Grand Challenge grant from the Bill and Melinda Gates Foundation, the team aims to establish the ULTRA platform to produce certain vaccines for less than 15 cents a dose.

Other distinctions, while less formal, are equally notable. For example, in the fall NCI accepted 10 research recommendations proposed by a blue ribbon panel of top cancer experts to shape the research blueprint for the Cancer Moonshot initiative. The panel, co-chaired by KI director Tyler Jacks, was tasked by the Obama/Biden administration with guiding the direction of the initiative's goal: to make a decade's worth of advancements in cancer prevention, diagnosis, treatment, and care in only five years.

Susan Hockfield was inducted into the *U.S. News and World Report* STEM Leadership Hall of Fame, and KI trainees Adam Behrens, Jiang He, and Tim Wang were named among *Forbes* magazine's "30 Under 30" in health care for 2017.

In spring 2017, Angela Belcher and Sangeeta Bhatia were the first engineers to deliver presentations during plenary sessions at the AACR annual meeting. These talks have traditionally been presented by life scientists.

Publications and Companies

Koch Institute researchers, intramural and extramural, produced more than 440 publications in FY2017; approximately 16% had multiple KI faculty members as authors.

Over the past nine years, more than 50 companies have been started by KI faculty (both with and without MIT intellectual property) as a mechanism for discoveries and new technologies to be brought to the marketplace.

Additional Accomplishments

Over the past year, KI organized a series of activities with the goal of strengthening integration and furthering interactions among scientists, engineers, and clinicians.

- *Oncology Seminar Series*: Now in its fifth year, this cancer-specific seminar series at MIT invites leading 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.
- *Summer Lunch & Learn Seminar Series*: With the goal of fostering the next generation of cancer researchers, this seminar series gives MIT's high school and undergraduate summer students a rare opportunity to hear firsthand from our faculty members about their research and career paths.
- *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.
- *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, *Changing the Course of Cancer*, published since 2009, sends news and highlights of KI members' achievements, awards, and publications to current and past KI members.

The Koch Institute also continues to focus on outreach beyond our research community. The following are some examples.

- *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. This year also

marked the seventh annual exchange with Wellcome Images in London; each year one winning image from each site's competition is selected for inclusion in the other's exhibition.

- *with/in/sight Lecture Series*: Initiated in 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 750. This year's programs completed the celebration of the fifth anniversary of the KI building's dedication with two master-class presentations by KI faculty members and opened a new season with the seventh annual Image Awards exhibition lightning talks, followed by the first in a series of programs celebrating the impact of KI's signature funding programs. At this latest event, three outstanding trainees (introduced by their KI faculty mentors) shared innovative projects from the Frontier Research Program, which (as noted earlier) supports high-risk, high-reward research.
- *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 1,100 students in 47 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. With help from trainee and staff volunteers, the visits also included tours, short courses, and career panels about life sciences and biomedical engineering research at MIT's cancer research center.
- *Cambridge Science Festival*: During this year's Cambridge Science Festival, KI trainees and staff members came together to create a custom-designed pop-up mini-golf course to teach people about the work of the Koch Institute. With individual holes aligned to KI's five core research focus areas, approximately 200 visitors enjoyed a sampling of cancer biology, engineering challenges, and biomedical obstacles over the course of this five-hour event.
- *Off-Site Outreach Programs*: In addition to the on-site outreach programs run in and around the Koch Institute building, KI volunteers participated in four off-site outreach programs, sharing MIT and cancer research work with youth and family audiences. From small-scale events such as the Girl Scouts of Eastern Massachusetts' annual STEM Expo and the NetPals mentorship program with the Cambridge Public Schools to large events such as the MIT Museum's Girls Day and the American Association for the Advancement of Science's Family Science Days, more than 2,300 visitors had an opportunity to learn about MIT cancer research through hands-on activities and conversations with researchers.
- *Annual Symposium*: The 16th annual Summer Symposium, "Convergence of Science and Engineering in Cancer," was held on June 16, 2017. Convergence—the merging of historically distinct disciplines such as engineering, physics, computer science, chemistry, mathematics, and the life sciences—has created

extraordinary opportunities in cancer research and care. Leaders in this emerging field discussed innovative new approaches and technologies to better detect, monitor, treat, and prevent cancer. This one-day symposium included a panel discussion on the impact of convergence on the future of medical care. The day's presentations were posted on KI's website.

- *Judith Ann Lippard Memorial Lecture*: Established in 2014 in honor of Judy Lippard, the wife of KI member Stephen Lippard, the annual Judith Ann Lippard Memorial Lecture brings together the most innovative minds in cancer research from a variety of disciplines—biology, chemistry, engineering, and clinical medicine—and features an individual whose research has the potential to change the course of cancer. In addition to giving a formal lecture at MIT and delivering grand rounds at Massachusetts General Hospital, the lecturer spends time with trainees, researchers, and physician-scientists at both institutions, inspiring the best and brightest young minds to advance cancer therapies. The second annual Lippard Lecture was held on November 4, 2016, and featured Dr. Alan Ashworth, president of the Helen Diller Family Comprehensive Cancer Center at the University of California, San Francisco.
- *KI Cancer Solutions Newsletter*: This monthly electronic newsletter conveys highlights of newsworthy achievements, awards, and publications of KI members to more than 3,000 readers who are interested in the Koch Institute.

Administrative Initiatives

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

The Scientific Advisory Board provides key scientific input to the Koch Institute 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.

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 the Koch Institute's collaborative research model and its strengths in cancer biology and cancer-oriented engineering, we are accelerating the rate of progress and bringing innovation to the lives of patients.

Tyler Jacks

Director

David H. Koch Professor of Biology