Institute for Medical Engineering and Science

The vision of MIT's Institute for Medical Engineering and Science (IMES) is to pioneer novel research paradigms and curricula that bring together engineering, science, and medicine to advance human science and health and educate students whose work will seamlessly span these historically separate realms.

Founded in 2012 and comprising almost 1,000 faculty members, students, researchers, and staff, IMES focuses on three key areas: studying the fundamental processes that drive disease and wellness, developing new medical devices and products that address clinical challenges, and educating the next generation of biomedical engineers and clinician-scientists through the pioneering Harvard-MIT Program in Health Sciences and Technology (HST). IMES is an integrative force across MIT and the health care community at large, bringing together academia, industry, and medical institutions to work toward these common goals.

HST is one of the world's oldest interdisciplinary educational programs focused on translational medical science and engineering. Founded in 1970, this inter-institutional collaboration among MIT, Harvard, and local teaching hospitals provides students with a deep understanding of the biological sciences and engineering combined with extensive hands-on clinical experience. HST maintains an office at the Harvard Medical School (HMS) Longwood campus in Boston as one of the five medical societies at HMS and reports to the HMS dean for medical education and dean for graduate education.

Centers, Strategic Initiatives, and Other Accomplishments

IMES houses three centers that extend resources to investigators and students.

- The Center for Translational Research, which includes the Living Lab Gateway and Human Subject Center, is a joint effort of IMES and the Office of the Vice President for Research to provide new resources around human subject research, medical device and diagnostic innovation, and data sciences. Part of the human subject component, the Clinical Research Center, led by Professor Elazer Edelman, is a preclinical testing/consulting facility on the MIT campus that works closely with the Beth Israel Deaconess Medical Center (BIDMC), Boston Children's Hospital, Brigham and Women's Hospital, and Massachusetts General Hospital (MGH).
- The Center for Microbiome Informatics and Therapeutics, directed by Professors Eric Alm and Ramnik Xavier, brings together researchers and clinicians to improve human health by diagnosing, treating, and preventing diseases associated with the human microbiome.
- The IMES Industrial Group (IIG), directed by Professor Charles Sodini (IMES, Microsystems Technology Laboratories), convenes local life sciences companies with the goal of deepening relationships with such organizations. IIG met twice in 2019, and attendees included representatives from an array of biotechnology, device, and computational companies in broad areas of health care. The group's next step is to expand the active participation of local industry.

IMES is also home to several initiatives and strategic partnerships that provide research and educational opportunities within and outside MIT.

- The MIT-Sekisui House Program, a collaboration among MIT, eSolutions, and Sekisui House, is designed to advance in-home wellness monitoring and early detection systems (EDSs). The program will innovate to accelerate EDS translation and stimulate market opportunities.
- IMES and the Tufts Clinical and Translational Science Institute are collaborating to uncover clinical insights that can help fine-tune early device testing and development for clinical studies. They are also working to design sequences of promising ideas so that they are more likely to become successful medical applications.
- One Brave Idea, a collaboration among Brigham and Women's Hospital, IMES faculty members, and other researchers, will pursue new biomarkers for atherosclerosis (hardening of the arteries), a condition that kills about 500,000 people in the United States every year.
- IMES is creating opportunities for close work with the Ragon Institute, whose mission is to contribute to the accelerated discovery of an HIV/AIDS vaccine. Several IMES faculty members are associated with Ragon and working to increase research collaborations. IMES PhD students serve as teaching assistants for Ragon director Bruce Walker's HST.S46 Evolution of an Epidemic course in South Africa, sponsored in part by IMES.
- MGH is a key IMES partner in many spheres. Through this partnership, IMES and MGH pursue projects unlikely to receive funding from standard federal grants, including work in noninvasive diagnosis and neurological, infectious, and autoimmune diseases.
- Philips HealthCare, which has an important research facility in Boston, is providing significant funding while working with members of the IMES faculty on areas of mutual interest, primarily medical analytics and new devices.
- MIT linQ is a collaborative initiative focused on increasing the potential of innovative research to benefit society and the economy. The linQ portfolio of international innovation programs includes Catalyst, IMPACT, and IDEA^2 Global.
- IMES has an active collaboration with the Institut Químic de Sarrià (IQS) in Barcelona called the MIT-Spain Program. IMES is expanding and formalizing the collaboration to include bidirectional exchanges of faculty and students, as well as the joint design of an IMES-IQS certificate program and the development of sponsored research agreements with industry partners.
- Miami-Dade County and IMES are collaborating to create a "high-tech concentrator" to facilitate the development of new technologies in the health care industry and launch new innovation-driven enterprises that come out of the work in this community. Miami-Dade County is a regional economic center that connects North and South America, and IMES hopes to leverage this opportunity to extend collaborations into South America.

In December 2019, IMES had its fourth visiting committee meeting. The committee praised IMES for the tremendous progress made since its founding in 2012. Areas highlighted included new initiatives, new faculty searches, impressive junior faculty members, and the HST program.

With the accelerated spread of the COVID-19 pandemic in spring 2020, many IMES faculty members became involved in and contributed to COVID-19 work at MIT.

- Professor Sangeeta Bhatia and her group are developing a nanomedicine-based COVID breathalyzer, a preventive nasal spray, and a lung therapeutic to dampen the hyper-inflammation in advanced disease.
- Professor Arup Chakraborty's lab predicted that immunodominant T cell responses against low-pathogenicity coronaviruses can also target severe acute respiratory syndrome coronavirus clade 2 (SARS-CoV-2), the virus that causes COVID-19.
- Professor James Collins and his group are harnessing synthetic biology technologies to develop multiple COVID-19 diagnostic tests, including a face mask diagnostic, as well as a COVID-19 vaccine candidate.
- Professor Joseph Frassica and his team collaborated with Professor Robert Langer's lab to develop a method to safely share mechanical ventilators in situations of severe shortages.
- Professor Lee Gehrke's lab is engaged in basic science experimentation focused on human host–pathogen interactions with the SARS-CoV-2 virus and the development of low-cost, scalable rapid diagnostics to detect COVID infections.
- Professor Tami Lieberman's lab consulted with Pardis Sabeti from Harvard on COVID epidemiology work.
- Professor Roger G. Mark and the Laboratory for Computational Physiology are collaborating with the Beth Israel Deaconess Medical Center to develop a research resource focused on intensive care unit patients with COVID-19.
- Professor Ellen Roche and her group designed and modeled a low-cost, portable, and readily manufacturable fluidic oscillator that converts a continuous positive airway pressure machine into an emergency ventilator.
- In multiple collaborations, Professor Alex Shalek's lab is examining whether different experimental and approved drugs can be used to make host cells less amenable to viral entry and release, uncovering targetable host factors for controlling infection, and investigating why some individuals with preexisting conditions develop severe disease while others are seemingly resistant to severe infection.

In addition, IMES has been at the center of MIT's outreach to local medical centers, nursing homes, and assisted living facilities. As a result of this effort, involving multiple units at MIT, some 1.2 million forms of personal protective equipment (PPE) have been accumulated from vetted vendors through MIT connections, the MIT community has similarly been provided with needed resources, and local nursing homes, assisted living facilities, and indigenous Native American communities have gained access as well to PPE and viral tests. The Clinical Research Center and IMES leadership worked closely with MIT Medical to establish viral testing facilities and procedures.

Diversity, Equity, and Inclusion

Faculty, students, and staff have had active dialogues around diversity, equity, and inclusion (DEI). IMES/HST participated in the #ShutDownAcademia and #ShutDownSTEM initiatives by taking the day off from regular activities in order to reflect on injustices and systemic racism, to educate ourselves on racial bias, and to brainstorm concrete ways for our community to meaningfully confront history and enact change. Staff created the Diversity & Inclusion at IMES/HST Learning Club, which will engage in educational activities to create an anti-racist, anti-discriminatory work environment. Also, HST Medical Engineering and Medical Physics Program (MEMP) students developed a set of recommendations for building capacity to conduct DEI work in IMES/HST and increase the diversity of faculty, students, and staff. IMES/HST is holding monthly town halls to continue DEI discussions.

Resource Development

Fiscal year 2020 had a promising start with several gift discussions under way to increase fellowship funding. The COVID-19 pandemic and subsequent economic shutdown led to a slowing of many gift discussions across the campus, but the hope is they will continue successfully in FY2021.

Discussions have been initiated with several members of the Resource Development team about giving opportunities for major IMES donors or prospects. Donors have continued to express an interest in learning more about graduate student support. A new endowed fellowship was established earlier in the year with a pledge of $100,000 from Josh and Ann Tolkoff; also, funding of several expendable fellowships continues, and many others are in the pipeline.

Because Elazer Edelman is leading the COVID-19 emergency response effort for MIT, some of IMES's attention was focused on that initiative during the end of FY2020. Daniel Omstead of Tekla Capital Management, who had worked with Professor Edelman for several months, made a first-time gift to MIT of $100,000 to support these emergency efforts. In FY2020, gifts and pledges made to the COVID-19 Emergency Response Fund totaled more than $300,000.

Under the direction of Professor Sodini, the first IIG symposium was held in October 2019. Representatives from several MIT Medical Electronic Device Realization Center (MEDRC) member companies, as well as companies that have sponsored research in IMES in the past two years, were in attendance to hear IMES faculty members discuss their current research. The symposium concluded with a poster session featuring students from each IMES lab, which was popular with industry representatives. The goal of IIG is to educate, inspire, and ignite conversations between MIT faculty and students and industry representatives about mutually important issues and research areas.

IMES leadership giving officer Maura Ridge is working with Heather Kispert Hagerty, assistant dean for development in the School of Engineering, and other School of Engineering giving officers to create and execute a comprehensive, strategic development plan designed to raise awareness, strengthen relationships, and garner financial support for IMES initiatives and academic programs.

Academic Program

HST is among the largest biomedical engineering and physician scientist training programs in the United States, with 302 students enrolled in its graduate degree programs during AY2020:

- 115 Medical Engineering and Medical Physics Program PhD students, including three MEMP/MD students
- 190 MD and MD/PhD students (including the above-mentioned three MEMP/MD students)

HST graduate students work with faculty members from MIT, Harvard, and affiliated teaching hospitals. Whether pursuing careers in medicine, research, industry, or government, HST graduates have made outstanding contributions to advances in human health.

HST's MEMP PhD program, housed in IMES, trains students as engineers or physical scientists who also possess extensive knowledge of medical sciences. The program provides preclinical and clinical training to students. On average, students complete the PhD program in less than six years, and in some cases they also pursue an MD. MEMP students are extremely successful in obtaining outside funding support for their graduate studies, with 37% of these students holding external fellowships in AY2020.

Two specialized programs within MEMP are the Neuroimaging Training Program and the PhD Program in Bioastronautics. The Neuroimaging Training Program is supported by a grant from the National Institute of Biomedical Imaging and Bioengineering. Professors Bruce Rosen and Randy Gollub—both members of the HST faculty based at the Martinos Center at Massachusetts General Hospital—co-direct the program. Trainees are identified from among those already enrolled in MEMP with specific interests in neuroimaging. They take additional classes in a curriculum tailored for the program and participate in networking and enrichment activities with faculty and students who have related research interests.

The PhD Program in Bioastronautics was founded by Professor Laurence Young (Aeronautics and Astronautics, HST, and IMES) and is now directed by Professor Dava Newman (Aeronautics and Astronautics and HST). This program combines the biomedical training of HST's MEMP PhD curriculum with hands-on research exposure at the National Aeronautics and Space Administration's Johnson Space Center. One or two new students enroll in MEMP/Bioastro each year, joining a small, focused cohort of approximately seven students. The program was established in 2006 with the support of an education grant from the National Space Biomedical Research Institute. This financial support ended in 2017, and alternative funding has not yet been secured. IMES/HST will continue to offer the academic program as part of MEMP without dedicated funding.

The HST MD program, housed at Harvard Medical School, is aimed at students interested in a research-based medical career. While eligible to complete the program in four years, many students take an optional fifth year to engage in more extensive research. Approximately 80% of HST MD alumni follow career paths in academia.

Graduate Education in Medical Sciences Certificate Program

The Graduate Education in Medical Sciences (GEMS) certificate program is open to doctoral students in MIT's Schools of Engineering and Science who are interested in working at the intersection where engineering and science meet medicine and real-world health care. GEMS runs concurrently with the normal course of an MIT PhD program and can be completed in two years without prolonging a typical PhD career. In addition to coursework in pathology and pathophysiology, participants attend seminars with HST students and engage in individually tailored clinical experiences. GEMS students learn how advances in basic science and engineering become medically relevant therapies and tools for the improvement of human health while developing a professional network that includes medical researchers, clinicians, and physician-scientists.

GEMS was initially established with support from a Howard Hughes Medical Institute (HHMI) program that encouraged graduate schools to integrate medical knowledge and an understanding of clinical practice into PhD curricula. Thirty-two MIT PhD students enrolled in GEMS between 2007 and 2011. The program, which became dormant after the HHMI funding ended, was revitalized after the founding of IMES. Since 2012, 33 new students have enrolled in GEMS, including one in AY2020.

Summer Institute

The 2020 Summer Institute program in bio-optics was canceled as a result of the COVID-19 pandemic.

Honors and Awards

Faculty Honors and Promotions

Daniel G. Anderson was promoted to full professor (Chemical Engineering and IMES).

Regina Barzilay joined IMES as an affiliate faculty member.

Professor Bhatia became a member of the National Academy of Medicine, was selected as one of WomenInc.'s 2019 Most Influential Corporate Board Directors, and was awarded an honorary degree from the Icahn School of Medicine at Mount Sinai.

Professor Emery Brown received the John and Elizabeth Phillips Award from the Phillips Exeter Academy and became an elected member of the Guggenheim Foundation Board of Trustees and the Simons Foundation Board of Trustees.

Professor Chakraborty was presented the Outstanding Graduate Faculty Award (based on student votes) for his classroom teaching in 2019. Chakraborty continues to serve as a member of the US Defense Science Board.

Professor Kwanghun Chung received the Presidential Early Career Award for Scientists and Engineers.

Professor Edelman received the Excellence in Mentoring Award from the MGH Corrigan Minehan Heart Center and was nominated for the Dr. Joseph Loscalzo Award for the best paper in the journal *Circulation*. Also, he delivered a plenary lecture at Tel Aviv University.

Professor John Gabrieli received the Huttenlocher Award from the Flux Society.

Thomas Heldt was promoted to associate professor with tenure (Electrical Engineering and Computer Science [EECS] and IMES).

Professor Langer received the Dreyfus Prize in the Chemical Sciences, an honorary degree from Columbia University, the National Library of Medicine (Friends) Distinguished Medical Science Award, and the Hope Funds Award of Excellence for Basic Science.

Professor Newman joined IMES as an affiliate faculty member. Also, she won the American Institute of Aeronautics and Astronautics Space Architecture Technical Committee Best Paper Award, was elected to the Aerospace Corporation Board of Trustees, and was named a governing member of the International Space University.

Professor Roche received a National Science Foundation CAREER Award, was presented the Charles H. Hood Foundation Award for Excellence in Child Health Research, and was awarded the W.M Keck Foundation Career Development Professorship.

Professor Shalek received the Harold E. Edgerton Faculty Achievement Award and the Harvard Medical School Young Mentor Award. Also, he was selected as a voice who will guide the next 15 years of methods development by *Nature Methods*.

Many members of the faculty delivered named lectures.

Faculty Mentoring and Teaching Awards

Leo Tsai was honored with HST's Seidman Prize for MD Research Mentorship.

Sabine Hildebrandt won HST's Irving M. London Teaching Award.

Ellen Roche was presented the HST Thomas A. McMahon Mentoring Award.

Mohini Lutchman was honored with HST's Roger G. Mark Outstanding Service Award (Faculty or Staff).

Student Honors and Awards

Dana-Farber Cancer Institute/Boston Children's Hospital Sam E. Lux Fellowship: Minjee Kim (HST MD)

Hertz Coordinated Fellowship: Constantine Tzouanas (MEMP PhD)

Hollis Albright Award (HMS): Selena Li (HST MD, 2020)

Multiculturalism and Diversity Award (HMS): Min Young (Megan) Jang (HST MD, 2020)

Martin Prince Scholarship for Student Innovation (HMS): Jon Hochstein (HST MD)

Leon Resnick Memorial Prize (HMS): Eran Hodis (PhD/HST MD, 2020)

Dr. Sirgay Sanger Award (HMS): Matthew Baum (PhD/HST MD, 2020)

Seidman Prize for Outstanding HST Senior Medical Student Thesis (HMS): Donna Leet (HST MD, 2020)

James Tolbert Shipley Prize (HMS): Clara Starkweather (PhD/HST MD, 2020)

HST Outstanding Teaching Award (Student): Brian Chang (MEMP PhD, 2018/HST MD)

HST Roger G. Mark Outstanding Service Award (Student): Adam Berger (HST MD/MEMP PhD)

Collamore-Rogers Fellowship (MIT): Sandya Subramanian (MEMP PhD)

delta v Summer Award (MIT): Markus Horvath (MEMP PhD)

Lemelson-MIT Student "Cure It" Prize: Shriya Srinivasan (MEMP PhD, 2020)

Wellington and Irene Loh Fund Fellowship (MIT): Ang Cui (MEMP PhD)

MathWorks Engineering Fellowship (MIT): Nicolas Meirhaeghe (MEMP PhD)

Unitec Bio Fund Fellowship (MIT): Ellen DeGennaro (MEMP PhD)

Whitaker Health Sciences Fund Fellowship (MIT): Nicolas Meirhaeghe (MEMP PhD)

Hugh Hampton Young Memorial Fellowship (MIT): Erin Rousseau (MEMP PhD)

Microsoft Research Fellowship: Emily Alsentzer (MEMP PhD)

National Defense Science and Engineering Graduate Fellowship: Aditya Misra (MEMP PhD)

National Institutes of Health (NIH) National Research Service Award: Grissel Cervantes Jaramillo (MEMP PhD)

National Science Foundation Graduate Research Fellowships: Michelle Dion (MEMP PhD), Natalie Ferris (MEMP PhD), Morgan Janes (MEMP PhD), Kim Lamberti (MEMP PhD), Daphne Schlesinger (MEMP PhD), Amy Stoddard (MEMP PhD), and Ami Thakrar (MEMP PhD)

Regeneron Prize for Creative Innovation (finalist): Mindy Bishop (MEMP PhD)

Schmidt Science Fellowship: Shriya Srinivasan (MEMP PhD, 2020)

Paul and Daisy Soros Fellowships for New Americans: Mark Nagy (HST MD/PhD), Jin Park (HST MD/PhD), and Jason Wang (HST MD/PhD)

Research Program

Core Faculty

Magnetic resonance imaging (MRI) in pregnancy involves a variety of opportunities for scientific discovery. However, relative to imaging in pediatric patients and adults, current state-of-the-art hardware and software platforms and methods deliver unreliable and inferior image quality for the mother and fetus, primarily as a result of the unpredictable motion of a noncompliant subject, the fetus. A dominant focus of Professor Elfar Adalsteinsson's current research is improving the image quality and robustness of fetal MRI. With support from the National Institutes of Health, Adalsteinsson's team seeks to develop, validate, and apply novel imaging methods in the fetus and placenta; this work is done in close collaboration with Professors Polina Golland, Jacob White, and Luca Daniel as well as colleagues at the MGH Martinos Center and Boston Children's Hospital. Another active domain of research in the group and with collaborators is the design of algorithms and hardware for optimization of radio frequency transmission and main magnetic fields that stand to offer improved image quality for fast imaging and novel applications such as body imaging and fetal MRI. This effort involves a strong collaboration with Professors Daniel and White along with colleagues at the MGH Martinos Center colleagues.

Daniel G. Anderson has continued his work in nanotherapeutics, biomaterials, and medical devices. This work has resulted in over 400 papers, patents, and patent applications. These advances have led to products that have been commercialized or are in clinical development. For example, a therapeutic mRNA nanoformulation based on his work at MIT was licensed by Translate Bio and recently cleared by the Food and Drug Administration (FDA) to begin human dosing as a therapy for ornithine transcarbamylase genetic disorders. He has also developed "living therapeutics," which are human cell/material constructs capable of resisting rejection. These living therapeutics are being translated for the treatment of multiple diseases including hemophilia and diabetes in a collaboration between Eli Lilly and Sigilon Therapeutics, with multiple clinical trials planned for next year. His lab was also the first to use the CRISPR Cas9 system to treat a disease in an adult animal and continues to make important advances in non-viral systems capable of in vivo CRISPR genome editing. Technology from his laboratory has been licensed by CRISPR Therapeutics, a company that he helped found and that this year began the first company-sponsored CRISPR genome editing clinical trial for a human disease. During the spring, he taught two classes: 10.494B Integrated Chemical Engineering Topics III, a required senior design course for chemical engineering undergraduates that is focused on using chemical engineering principles to develop continuous nanoparticle manufacturing at pharmaceutical scale, and HST.500 Frontiers in Biomedical Engineering and Physics, a required core course that provides a framework for mapping research topics at the intersection of medicine and engineering/physics as well as training in scientific proposal writing, peer review, and communications.

Lung cancer is the leading cause of cancer-related death, and patients most commonly present with incurable advanced-stage disease. US national guidelines recommend screening for high-risk patients with low-dose computed tomography, but this approach has limitations including high false-positive rates. Activity-based nanosensors can detect dysregulated proteases in vivo and release a reporter to provide a urinary readout of disease activity. Sangeeta Bhatia's group demonstrated the translational potential of activity-based nanosensors for lung cancer by coupling nanosensor multiplexing with intrapulmonary delivery and machine learning to detect localized disease in two immunocompetent genetically engineered mouse models. The design of the group's multiplexed panel of sensors was informed by a comparative transcriptomic analysis of human and mouse lung adenocarcinoma data sets and in vitro cleavage assays with recombinant candidate proteases. Intrapulmonary administration of the nanosensors to a Kras- and Trp53-mutant lung adenocarcinoma mouse model confirmed the role of metalloproteases in lung cancer and enabled accurate detection of localized disease with 100% specificity and 81% sensitivity. Professor Bhatia's approach gave rise to similar results in an alternative autochthonous model of lung adenocarcinoma wherein it detected cancer with 100% specificity and 95% sensitivity and was not confounded by lipopolysaccharide-driven lung inflammation. These results encourage the clinical development of activity-based nanosensors for the detection of lung cancer.

Over the past year, Emery Brown and his group developed a machine learning algorithm that can accurately predict the state of unconsciousness maintained by GABAergic anesthetics from electroencephalogram spectral features. Their findings hold promise for the design of decision aids that anesthesiologists can use in real time to track unconsciousness and for the creation of closed loop anesthesia delivery systems. They also established that electrodermal activity can be accurately described through a physiologically based inverse Gaussian model. This research holds promise for developing a real-time device for tracking nociception (pain) in patients under general anesthesia. In other work, the group successfully tested a closed loop control system for delivery of anesthesia in a non-human primate model. This research represents an important step toward receiving FDA approval for the design and testing of a similar system in humans. In addition, the group completed detailed studies of the unconscious state maintained by propofol in a non-human primate model. During propofol-maintained unconsciousness, they recorded from the pre-frontal cortex, the superior temporal gyrus, the posterior parietal cortex, and the central thalamus. They identified two significant features of unconsciousness maintained by propofol: large-scale inhibition of neural spiking across the entire brain and synchronous activity in local field potentials across all four areas. They also demonstrated that arousal could be immediately restored by stimulating the central thalamus.

Arup Chakraborty continued efforts to understand the mechanistic bases of how a systemic immune response to pathogens arises and how its aberrant regulation leads to disease. Research aimed toward understanding how this knowledge can be harnessed for the rational design of vaccines and therapies is an important facet as well. Chakraborty, in collaboration with Professors Phillip Sharp and Richard Young, also continued to work on a project initiated in 2016 on understanding how genes critical in maintaining healthy cell states are regulated. Chakraborty has researched COVID-19 in 2020, and his HIV work has led to an immunogenic vaccine in monkeys. Chakraborty submitted a manuscript for a general audience book (*Viruses, Pandemics, and Immunity*) to The MIT Press. He is also working on a book for physical scientists who want to enter, or have entered, the field of immunology.

Kwanghun Chung continued to lead an interdisciplinary research team that seeks to develop and apply novel technologies for holistic understanding of large-scale complex biological systems. Recent research advances by the Chung lab include the development of technology that transforms human brain tissues into elastic hydrogels to enhance macromolecular accessibility and mechanical stability. He led several large projects, including a $9 million NIH human brain mapping project and a $5 million NIH reusable antibody development project, to apply his technologies for mapping and studying the human brain. In addition, his group has active collaborations with many researchers at

MIT, the Broad Institute, MGH, and Harvard to study various neurological disorders such as autism spectrum disorder and Alzheimer's disease. He has traveled extensively, including visits to the California Institute of Technology, Johns Hopkins University, and the Georgia Institute of Technology, to speak about his group's technologies and their applications. Several Chung group members have received awards, including a Simons Center for the Social Brain Postdoctoral Fellowship and a Picower Fellowship. During the past year, Professor Chung taught 10.302 Transport Processes and HST.562 Pioneering Technologies for Interrogating Complex Biological Systems. He also served on the IMES Committee for Academic Programs and the Department of Chemical Engineering graduate admission committee. In addition, he continued as a chief scientist with start-up LifeCanvas Technologies, which aims to advance the adoption and usage of the technologies developed by the Chung lab.

Professor Richard Cohen continued to support MIT's entrepreneurship efforts and the Sloan Healthcare Certificate program by directing one of the certificate program's core required courses (15.132J/HST.972J Medicine for Managers and Entrepreneurs Proseminar) as well as one of its elective courses (HST.973J/15.124J Evaluating a Biomedical Business Concept). In addition, he served as one of two faculty members on the program's board and advised students regarding their efforts to launch biomedical companies. He is researching materials for a book on hypothesis testing in medicine and biomedical entrepreneurship. Also, he worked with Sirona Medical Technologies Inc. to develop a novel catheter technology for the treatment of life-threatening cardiac arrhythmias. This technology, which combines electrical mapping with focused radio frequency ablation, promises to improve both the efficacy and safety of this important and rapidly growing means of therapy. He also worked as a consultant with start-up company Osteoanalgesia Inc. in the development of a novel anti-inflammatory drug for the treatment of rheumatoid arthritis and other inflammatory diseases.

James Collins (IMES, Biological Engineering), the Termeer Professor of Medical Engineering and Science, continued to develop innovative synthetic biology platforms that can be used to address critical issues in medicine, biotechnology, and the life sciences. Over the past year, Collins has pivoted his research program to address the COVID-19 pandemic. Along these lines, he has shown that his freeze-dried, cell-free synthetic biology platforms can be used to create SARS-CoV-2 diagnostics. Of note, Collins and his team are working to develop a face mask that can also serve as a rapid diagnostic test. Earlier Collins showed that one can take the cellular machinery out of a living cell and freeze dry it onto paper along with engineered RNA sensors to create low-cost diagnostics for Ebola and Zika. The sensors are activated when they are rehydrated via a patient sample that could consist of blood or saliva, for example. It turns out that this technology is not limited to paper but can be applied to other materials, including cloth. For the COVID-19 pandemic, Collins and his team are designing RNA sensors to detect the virus and freeze drying these sensors with the necessary cellular machinery into the fabric of face masks, where the simple act of breathing and the water vapor that comes with it can activate the test. If a patient is infected with SARS-CoV-2, the mask will produce a fluorescence signal that can be detected with a simple, inexpensive hand-held device. Thus, within just an hour or two, a patient could be diagnosed safely, remotely, and accurately. Collins and his team are also using synthetic biology to create a candidate vaccine for COVID-19 by repurposing the BCG vaccine, which has been used against tuberculosis for almost a century. It is a live attenuated vaccine, and Collins and his team are engineering it to express SARS-CoV-2 antigens, which should trigger the production of protective antibodies by the immune system. Importantly, BCG is massively scalable and has one of the best safety profiles of any reported vaccine.

Elazer Edelman's research combines his scientific and medical training, integrating multiple disciplines. His research continues to focus on the applied and basic sciences of cardiovascular diseases. The work of his students and fellows has redefined the nature of critical diseases including aortic stenosis, atrial fibrillation, and coronary artery disease. On a basic level, his students have redefined the nature of endothelial cell heterogeneity and the paracrine regulation of complex diseases such as atherosclerosis and cancer. Edelman's laboratory has also focused on using advanced material science to explain unexpected failures in the most promising emerging medical devices. He and his group have published more than 20 papers over the past year.

John Gabrieli and his group made progress on two major areas of mental health and brain development in children and adolescents. They completed the Human Connectome Project, the premier NIH study of the human brain. This multi-institutional project, which included Massachusetts General Hospital, Boston University, and McLean Hospital, was the largest study ever of the brain basis of adolescent anxiety and depression. They also published papers showing how mindfulness training in a Boston public school serving primarily children from lower-income families of color decreased stress and negative feelings and increased children's ability to sustain focused attention.

Professor Gehrke is a molecular virologist who directs the HST human functional anatomy course at Harvard Medical School. He studies RNA viruses, including SARS-CoV-2, Zika, West Nile, dengue, and others. The Gehrke laboratory is funded by the National Institutes of Health to develop new experimental models to study infectious diseases. This work involves high containment (biosafety level 3) viruses and organoids derived from human cells. Gehrke has also been active in designing and building rapid diagnostic tests to detect viruses such as SARS-CoV-2, dengue, Zika, and chikungunya.

Professor Martha Gray leads the Biomedical Technology Innovation Group. Her research program focuses on formalizing approaches that drive innovation to create impact, particularly in the context of pre-doctoral and postdoctoral research training.

This year the primary effort of Professor Gray and her group has been to refine and grow the recently relaunched MIT Catalyst Program in partnership with the US Department of Veterans Affairs. They have now resumed the cycle of recruiting new cohorts annually for a program residency of 6–36 months. In the relaunched edition, they have had to adapt the program to allow fellows to participate on a part-time basis, so that their involvement is compatible with their regular ongoing research and/or clinical efforts. The program is divided into two phases, project definition and project execution. Thanks to the support of IMES, the 2019 participants have embarked on their execution phase and have now established a robust research effort.

Over the years, Catalyst has been extraordinarily successful in nucleating high-impact projects, many of which have garnered public and private investments, and in providing a unique training experience that accelerates the careers of researchers. This new paradigm for research and training is well aligned with MIT's focus on creating a better world.

Thomas Heldt directs the Integrative Neuromonitoring and Critical Care Informatics Group at IMES. Using physiologically based dynamic models, the group leverages multivariate bedside monitoring data—on the second to hour time scale—to understand the physiology of the injured brain, to improve diagnoses, and to accelerate treatment decisions for the critically ill. The group continues very strong and active collaborations with clinicians at Boston Children's Hospital, the Boston Medical Center, Massachusetts General Hospital, and the Beth Israel Deaconess Medical Center in the areas of neurocritical and neonatal critical care as well as other areas of patient monitoring.

Over the past year, the collaboration among Professor Heldt's group, Robert Tasker (Boston Children's Hospital), and James Holsapple (Boston Medical Center) further validated a calibration-free, noninvasive approach to continuous intracranial pressure (ICP) estimation in an animal model of intracranial hypertension. The preliminary results suggest that the performance metrics previously reported with human subjects in neurocritical care hold up across a much wider range of measured ICP. The estimates remain essentially as accurate and as precise as the invasive measurement, requiring drilling a hole into the patient's skull and advancing a catheter into the brain tissue or cerebrospinal fluid space.

Building on a collaboration with Professor Vivienne Sze (Research Laboratory of Electronics) and Professor Sodini to use cameras on consumer-grade electronic devices (smartphones, tablet computers) as a means of measuring features of eye movements, Professor Heldt's group has teamed up with Air Force-MIT Artificial Intelligence Accelerator and Lincoln Laboratory researchers to use physiological biomarkers to understand and accelerate training of Air Force pilots.

Prior to the COVID-19 outbreak, Professor Heldt's group had initiated data recording efforts at Boston Children's Hospital and the Beth Israel Deaconess Medical Center to collect capnographic information from patients visiting the emergency room with exacerbations of asthma and shortness of breath (for a variety of reasons). These clinical studies are currently on hold, given the COVID-19 pandemic, but the team hopes that research restrictions will soon be lifted. The goals of the data collection effort are to validate a noninvasive approach to gauging the severity of asthma attacks and to differentiate between cardiac and pulmonary causes of shortness of breath.

Tami Lieberman is the Herman L. F. von Helmholtz Career Development Assistant Professor and is a member of the Ragon Institute and the Broad Institute. Her group is developing unique sample sets and evolutionary inference methods to build a mechanistic understanding of microbial community assembly on human skin. This year, her group discovered that bacteria in the skin microbiome of people with eczema acquire adaptive mutations that lead to worse skin disease. This is the first evidence of de novo mutations in commensal species leading to increased disease severity. Professor Lieberman has received funding from Colgate-Palmolive to target these bacterial mutations and will submit a manuscript for publication shortly. This year, she has given seminars at Dartmouth and the Chan-Zuckerberg Institute, among other venues. Professor Lieberman increased enrollments for both of her classes this year, HST.508 Evolutionary and Quantitative Genetics and 1.088 Genomics and Evolution of Infectious Diseases, for which she wrote new assignments based on SARS-CoV-2. A postdoc in her lab, Felix Key, will start as a group leader at the Max Planck Institute for Infection Biology in September.

In July 2019, Roger G. Mark became a post-tenure professor. In the past year, he taught one course: 6.022J/HST.542J Quantitative Systems Physiology, which enrolls undergraduates and early graduate students from multiple engineering departments. His laboratory's objectives are to improve health care through the generation of new clinical knowledge and new monitoring technology and to enhance decision support through the application of data science and machine learning technology to large collections of critical care data. His lab developed the widely used MIMIC (Medical Information Mart for Intensive Care) database, which is freely available to more than 18,000 credentialed investigators worldwide, and developed and supports PhysioNet, an extensive open archive of physiological signals. In terms of administrative and service responsibilities, Professor Mark is chair of the MEMP Board of Advisors, a member of the HST-IMES Committee on Academic Programs and the Qualifying Exam in HST Committee, a MEMP faculty advisor, and an EECS graduate student counselor.

Professor Leonid Mirny is leading a research program aimed at understanding the organization of the human genome in 3D. He is a co-director of the Center for 3D Structure and Physics of the Genome, funded by the NIH 4D Nucleome Program. In the last year, the Mirny lab has published several high-profile papers in *Nature*, *Cell*, *Science*, the *Proceedings of the National Academy of Sciences*, and other journals offering new insights into 3D genome organization. The main achievement of the lab in recent years was the theoretical prediction that the genome is folded by a novel mechanism of loop extrusion. Recent experimental studies have provided strong support for the proposed mechanism, leading to a true paradigm shift in the field of chromosome biology. Professor Mirny continues to explore the physical mechanisms underlying the folding and function of the genome and their role in health and human diseases.

Professor Mirny teaches the HST.508 Evolutionary and Quantitative Genomics and 8.592 Statistical Physics in Biology graduate courses and the HST.A01 Quantitative Biology freshman seminar, in which students learn genomics concepts through interactive games and tabletop experiments.

Ellen Roche started her laboratory at IMES in September 2017. She has a dual appointment (Mechanical Engineering and IMES) and works on the design of innovative therapeutic devices and their enabling technologies. Research in Professor Roche's lab is focused on the design and development of implantable medical devices that augment or assist native organ function, borrowing principles from nature to enhance their architecture and performance. Her work is broadly categorized into mechanical assist and repair devices, biomaterial and therapy delivery devices, and enhanced preclinical and computational test model development with the ultimate goal of translating enhanced therapeutic devices into the clinical arena. Since starting her laboratory, she has published in *Nature Biomedical Engineering*, the *Annals of Biomedical Engineering*, *Advanced Healthcare*

Materials, *Science Robotics*, *Advanced Physics Letters in Bioengineering*, and other journals. She has been granted patents on a cardiac assist device and a light-reflecting catheter technology, and she has licensed a catheter-based technology to a Paris-based start-up.

There is a pressing need to understand the pathogenesis of SARS-CoV-2, which causes the disease COVID-19. ACE2 is the cellular entry receptor for SARS-CoV-2, but the cell subsets that express it (and thus are likely viral targets) in host tissues, and the factors that regulate its expression, had yet to be elucidated. This year Alex Shalek's lab, in collaboration with several researchers around the world, leveraged human, non-human primate, and mouse single-cell RNA-sequencing data sets collected across healthy and diseased conditions to uncover putative cellular targets of SARS-CoV-2, including lung type II pneumocytes, ileal absorptive enterocytes, and nasal goblet secretory cells. Strikingly, they found that the gene encoding ACE2 is an interferon-stimulated gene in human upper airway epithelial cells, but not in mice, suggesting that the virus could exploit species-specific interferon-driven up-regulation of ACE2, a tissue-protective mediator during lung injury, to enhance infection. Overall, their study has key implications for disease modeling and pre-clinical therapeutic development and highlights the power of the global scientific community to rapidly tackle new challenges through open sharing of data and ideas. In parallel, through local, national, and international partnerships, the Shalek lab pursued deep, mechanistic inquiries to elucidate the cellular and molecular features that inform tissue-level function and dysfunction across the spectrum of health and disease as a means of aiding in the design of therapeutic and prophylactic interventions to improve human health.

The vision of the MIT Medical Electronic Device Realization Center, co-directed by Charles Sodini, is to revolutionize medical diagnostics and treatments by bringing health care directly to the individual and to create enabling technology for the future information-driven health care system. Launched in May 2011, MEDRC currently has four member companies (Analog Devices, IBM, Nihon Kohden, Philips Research) at a funding level of approximately $1.5 million per year. MEDRC serves as a focal point for engagement with researchers across MIT, the medical device and microelectronics industries, venture-funded start-ups, and the Boston medical community. The MEDRC companies strongly support the newly formed IMES Industrial Group to broaden industry participation with IMES faculty and students. During the past year, Professors Sodini and Heldt organized the first IIG meeting, with all MEDRC members, Abiomed, and Novartis attending.

Professor David Sontag made several new advances in artificial intelligence (AI) and statistics, specifically with respect to causal inferences from observational data, unsupervised learning, fairness of machine learning, few-shot learning, and approximate inference. Highlights include a commentary published in *Nature Medicine* on using off-policy reinforcement learning in health care and a paper written with the MIT-IBM Watson AI Lab focusing on causal inference. In collaboration with Sanjat Kanjilal from MGH, Sontag showed that one can use antibiotic resistance predictions to nearly eliminate second-line antibiotic usage for uncomplicated urinary tract infections. In addition, Sontag and Steven Horng from BIDMC launched a new project on redesigning electronic medical records with seed funding from the Abdul Latif Jameel Clinic for Machine Learning in Health. Sontag continued serving as the health care theme lead in the MIT-IBM Watson AI Lab and served on a subcommittee of Massachusetts governor Charlie Baker's Mass Digital Health Council.

Research in Professor Collin Stultz's Computational Biophysics Group is focused on three areas: understanding conformational changes in biomolecules that play an important role in common human diseases, using machine learning to develop models that identify patients at high risk of adverse clinical events, and developing new methods to discover optimal treatment strategies for high-risk patients. The group uses an interdisciplinary approach combining computational modeling and machine learning to accomplish these tasks.

In recent years, Stultz and his group have focused on using machine learning for patient risk stratification and clinical decision making. More generally, they have worked with their collaborators at MGH to develop a joint MIT-MGH center for cardiovascular engineering and data science in the area of personalized medicine. The proposed center represents a combined effort between computer/data scientists at MIT and the Division of Cardiology at MGH. This work has been supported by the Abdul Latif Jameel Clinic for Machine Learning in Health and the MIT-IBM Watson AI Lab.

Affiliate Faculty

Regina Barzilay is the Delta Electronics Professor of Electrical Engineering and Computer Science and a member of the Computer Science and Artificial Intelligence Laboratory (CSAIL). Her research interests are in natural language processing and applications of deep learning to chemistry and oncology.

Professor Brett Bouma's research focuses on the development of new instrumentation and methods for imaging and characterizing the microstructural properties of biological tissues. The work ranges from investigating the physics of light-tissue interactions and innovating new optical technology to developing and translating novel instruments into clinical applications in cardiovascular, ophthalmic, and gastrointestinal imaging. His group has previously shown that polarimetry can be used to map the distribution of muscle and collagen in biological samples. In the past year, the group reported on the first in-human use of intravascular polarimetry to locate and characterize arterial disease in the coronary arteries with a miniature (0.8-mm-diameter) catheter. His team has extended their work to uncover the orientation of muscle and collagen fibers and has shown how remodeled coronary plaque can result in layers of disoriented fibers. In order to develop even smaller diameter, flexible catheters on a size scale finer than a human hair, Professor Bouma's group has been investigating novel methods in computational imaging with random encoding patterns obtained by scattering light in complex media. His group has recently demonstrated axial ranging, with a resolution approaching 10 μm and a depth range beyond 1 cm, using the interference of light arising through propagation in multi-mode optical fibers.

This past year, Professor Lydia Bourouiba's lab published key papers revisiting canonical fluid dynamics problems related to droplet formation. This is paving the way toward new detection, tracking, and capture tools for droplets formed from the breakup of contaminated fluids. She continued to establish fundamental collaborations with the Centers for Disease Control and Prevention and local infection control teams.

In collaboration with colleagues at MGH, Polina Golland and her group aim to develop methods that will enable application of computational analysis pipelines to severely undersampled MRI scans typically acquired as part of the clinical practice. Their approach is to generate anatomically plausible high-resolution images that are consistent with clinical scans and can be analyzed by standard software. Professor Golland and her collaborators use machine learning to build a model of anatomical variability from a large collection of clinical images and to fill in the missing values in these images. This work promises to enable computational analysis of the vast image collections accumulated by hospitals as part of their routine imaging. The resulting insights will illuminate disease effects on anatomy and physiology from very large patient cohorts. This research is supported by the NIH Neuroimaging Analysis Center.

In 2019–2020, Robert Langer published 48 papers and delivered 58 lectures and talks across the world. He also filed 11 patents and served on seven Institute boards and 45 industry boards. Professor Langer serves as a consultant to the following government agencies: the US State Department (science envoy), the National Academy of Sciences, the National Academy of Engineering, the National Academy of Inventors, the National Academy of Medicine, and the US Food and Drug Administration.

Dava Newman's research program includes:

- Draper Fellow: Morgan Blevins (Civilian)
- Draper Fellow: Rachel Bellisle (Civilian)
- MIT Portugal Program: Research (Flagships)
- MIT Portugal Program: Seed Grants
- NASA-funded RESOURCE: Resource Exploration and Science of OUR Cosmic Environment
- United States Air Force (USAF)-funded, AI Accelerator, MIT and MITLL, The Earth Intelligence Engine: for Weather and Climate
- NASA-Fellow funding: Novel thermal management and life support technologies for planetary spacesuits

Recent recognition that liquid-liquid phase transitions in cells can concentrate factors into membraneless bodies in cells and that RNA is frequently a component of these assemblies stimulated speculation that super-enhancers (SEs) might be a manifestation of such phenomena. Richard Young introduced the concept of SEs as large regions of DNA bound by transcription factors that dramatically stimulate transcription from proximal promoters. Furthermore, he showed that SE-associated genes are frequently critical for normal development and that new SEs appear near many disease genes. Given that phase transitions can concentrate factors in a highly cooperative fashion to enhance the rate of reactions, Phillip Sharp and his group conjectured that SEs function as a large membraneless assembly of factors that enhance the rate of transcription from adjacent promoters. In collaboration with the Chakraborty and Young labs, Sharp developed a model of phase transitions that illustrated their high dependence on valences and low dependence on affinity and outlined how their properties are consistent with many of the known phenotypes of SEs. Over the past year, the Sharp team has shown that SEs associated with specific genes have dynamic condensate properties formed by liquid-liquid phase transitions. Since these condensates are highly sensitive to drug inhibitors that reduce the valency of interactions between their constituents, this insight potentially offers new opportunities to treat many diseases. This research is ongoing.

Professor Peter Szolovits continued to conduct research on natural language processing of clinical notes and building predictive models that estimate the risks of various morbid events and the likelihood of success of different therapeutic interventions. He served as the overall principal investigator in a medical collaboration between Philips and MIT and continues to collaborate with colleagues at Philips, IBM, MGH, BIDMC, the Tufts Medical Center, Harvard Medical School, the University of Massachusetts Lowell, and George Mason University on a variety of projects. His group's research is increasingly incorporating different modalities of clinical data, including imaging and genetics in addition to medications, diagnoses, procedures, and clinical notes. This encourages work on representation learning, that is, learning what combined representations best capture the linked information across such modalities. The group is larger than ever, reflecting tremendous interest among students in AI applications in health care. Many conference papers and journal articles have been published as a result of the students' work.

Laurence Young and his team published an article in the *Journal of Applied Physiology* ("Computational Model of Cardiovascular Response to Centrifugation and Lower-body Cycling Exercise").

Professors of the Practice

Joseph Frassica leads the Philips Research Americas laboratories. His research interests cover a broad range of topics including the use of high-resolution physiological data and clinical information to create predictors of patient trajectory in critical care, the development of new measurements for ultra-mobile ultrasound, and the application of artificial intelligence to predict the development of infectious diseases (including COVID-19) and detect early signs of toxic exposures in the environment.

Professor Frassica continues to lead the MIT-Philips research alliance. To date, the program has yielded more than 20 high-quality joint studies between Philips Research and MIT faculty spanning a number of institutes including CSAIL, Lincoln Laboratory, IMES, EECS, and the Department of Mechanical Engineering. In addition, the program has resulted in nine successful transfers of technology to Philips businesses, 31 joint MIT-Philips patents for novel technologies, and multiple publications in highly respected peer-reviewed journals. The alliance also sponsors a clinical fellows program, with fellows representing the Langer lab, the McGovern Institute for Brain Research, the Sloan School of Management, IMES, MGH, BIDMC, and other groups.

Frassica's lab continues to work closely with Roger Mark and the Laboratory for Computational Physiology on projects aimed at uncovering new sources of big data for the development of AI for application in health care. Last year, the joint project funded by the MIT-Philips research alliance posted more than 300,000 chest x-rays publicly for researchers around the world to use in AI projects related to diagnosis and treatment of diseases such as acute respiratory distress syndrome.

In addition, his lab continues to work with Professor Heldt on a joint Department of Defense grant in which the goal is to develop a prototype for a device to noninvasively measure intracranial pressure.

Bruce D. Walker is director of the Ragon Institute of MGH, MIT and Harvard and a Howard Hughes Medical Institute investigator. He was appointed a professor of the practice in IMES in 2016.

The overarching goal of the Walker laboratory is to define the interplay of immunologic, virologic, and host genetic factors that determine control of human viral infections as a means of guiding vaccine development and immunotherapeutic interventions. To address this goal, the lab focuses on HIV infection, an ongoing global epidemic with enormous medical, societal, and economic implications. A global solution requires an effective vaccine or a cure, both of which remain elusive. A fully preventive HIV vaccine will likely require induction of broadly neutralizing antibodies and effective T cell immunity, which have thus far defied induction by vaccination. However, optimism for vaccine-mediated control derives from infected individuals who maintain T cell–mediated HIV control without treatment, some for 35 years or more. Vaccines currently entering efficacy trials are unlikely to fully prevent infection but would represent a successful "functional cure" if they maintain viremia below this level. The Walker lab focuses on understanding this remarkable T cell–mediated control of HIV, building on successive discoveries from studying immunology in HIV-infected individuals.

During the past year the Walker lab has leveraged extensive investments in unique patient cohorts, collaborative networks in Africa, and investments in new research facilities to define mechanisms of immune control, immune failure, and immune enhancement in infected individuals. Walker and his Ragon Institute collaborators have recently defined the basis for the ability of a small subset of HIV-infected individuals to maintain undetectable viremia for decades without the need for medication, namely via cytotoxic T cell–mediated elimination of all reservoir cells other than full-length proviruses integrated into deeply latent sites in the host chromosome. With the onset of the COVID-19 pandemic, Walker assumed joint faculty leadership of a new initiative, the Massachusetts Consortium for Pathogen Readiness, consisting of 500 scientists and clinicians from 20 institutions, including all Massachusetts medical schools and teaching hospitals as well as the state department of health. As part of this effort, he mobilized the development of a biorepository of specimens from COVID-19 patients that have been made broadly available.

Walker collaborates with Howard Heller to teach the highly popular HST.S46 Evolution of an Epidemic undergraduate course in South Africa during the January intersession. The class, sponsored in part by IMES, consists of both lectures and field trips to interact with affected communities and visit traditional healers, hospitals, and clinical research sites.

Events

Harvard-MIT Program in Health Sciences and Technology

Faculty Poster Session

Approximately 100 people attended the 2019 HST Faculty Poster Session, held on October 3 at the Courtyard Café at Harvard Medical School. Forty faculty posters, representing 34 labs, were on exhibit. Some posters represented broad research programs, while others presented specific research projects; some included student coauthors. This annual event familiarizes faculty members with their colleagues' research and allows them to recruit students to their laboratories. It also assists students beginning the process of selecting laboratories and mentors for their research.

Student Research Forum

The 34th HST Student Research Forum, originally scheduled for April 6, 2020, was canceled due to the COVID-19 pandemic.

Community Awards

HST has a long-standing tradition of conferring annual awards to recognize faculty, staff, and students for exemplary teaching, mentoring, and service. The selection process is organized by the students, making these awards particularly meaningful to recipients. Normally, the awards are presented in person at the HST spring dinner. This year the dinner was cancelled as a result of the COVID-19 pandemic. We adapted the community awards celebration to a virtual format consisting of a half-hour video featuring statements from all of the nominators and award recipients. The video, accompanied by a well-attended live chat for members of the HST community, premiered on April 30.

Graduation

The 2020 HST graduation celebration took place as a virtual event on May 27. It began with an hourlong graduation video released on HST's YouTube channel, accompanied by a live chat for graduates, their families, and the HST community. The video included remarks by faculty leaders and a student speaker in addition to an individual vignette with a slide show for each graduate who chose to participate. Following the video, all were invited to join graduation reception party rooms via Zoom, hosted by an assortment of faculty and staff.

Community Building

In addition to coordinating formal virtual events such as the community awards and graduation, HST Academic Office staff rallied to provide new formats to build connections and maintain student community. These efforts included hosting Zoom open office hours weekly for our graduate students during the second half of the spring term while concurrently maintaining close contact via frequent emails, establishing an HST community workspace on Slack as an additional communications platform, and participating in the MIT Student Success Coaching Program. Also, we initiated a pilot program to connect HST students across degree programs and class cohorts through weekly informal video calls.

We were fortunate to have launched the new HST website in January 2020, prior to the start of the COVID-19 pandemic. The new site includes student profiles—accessibly only to members of the HST community—that promote networking within the community by making it easier for students to identify and connect with peers based on academic and research interests, personal backgrounds, and extracurricular activities.

Institute for Medical Engineering and Science

Distinguished Speaker Series

IMES modified the Distinguished Speaker Series in AY2020. The new format includes two lectures. One lecture honors IMES founding director Arup Chakraborty, and the other is the Judith Richter Lecture in Education, Science, and Peace.

Professor Chakraborty delivered the inaugural Founding Director's Lecture, "Germs, T Cells, Dewdrops and Genes." The lecture was held on October 30, 2019, and was well received.

The Judith Richter Lecture was postponed due to the COVID-19 pandemic.

Research Progress Talks

IMES hosted a series of events to increase awareness of different research within the Institute. Each month, postdocs and students from two lab groups presented their research to the IMES community, including faculty members, researchers, students, and staff. These events encourage collaboration between labs at IMES and are great opportunities for postdocs to practice their talks before applying for jobs or presenting at conferences.

Elazer Edelman
Director