HARVARD-MIT HEALTH SCIENCES AND TECHNOLOGY PROGRAM

Founded in 1970, the Harvard-MIT Program in Health Sciences and Technology (HST) is one of the world's oldest interdisciplinary educational programs focused on translational medical science and engineering.

The program is an inter-institutional collaboration between MIT, Harvard, and local teaching hospitals, dedicated to fostering academic excellence, scientific rigor, and clinical expertise.

Our MD, PhD, and MD-PhD students study side-by-side, gaining a deep understanding of the biomedical sciences, a strong quantitative foundation, and extensive hands-on clinical experience in Boston-area hospitals. HST students engage in translational research projects, collaborating with MIT and Harvard faculty drawn from across departments and disciplines to develop preventative, diagnostic, and therapeutic innovations.

Alumni of the program are responsible for countless groundbreaking innovations, including the drug regimen that transformed HIV/AIDS into a treatable disease and the first non-invasive technology for observing the brain in action.

HST has a home on each side of the Charles River. At MIT, the program is part of the Institute for Medical and Engineering Science (IMES) (*http://imes.mit.edu*) and represents the vanguard of IMES' educational initiatives. At Harvard, the program is part of Harvard Medical School's Program in Medical Education, housed within the Irving M. London Society.

HST offers degrees in two multidisciplinary areas of graduate study:

- Medical Sciences MD Program
- Medical Engineering and Medical Physics Doctoral Program

Graduate Study

Medical Sciences (HST MD Program)

Who is the program for?
HST's MD program is designed for bold, curious students who aspire to careers as physician-scientists. We're committed to welcoming qualified applicants from a wide range of communities, backgrounds, and experiences.

Half of the students in our MD program have majored in biological sciences and half in physical sciences. They're comfortable with mathematics and computational methods, biochemistry, and molecular biology.

How is the HST MD program different from other MD programs?
HST adds a new dimension to medical school. The HST MD curriculum highlights the frontiers of what is known and what remains to be discovered. As an HST student, you'll gain a deep understanding of the fundamental principles underlying disease and acquire the clinical skills of traditional medical training. In addition, you'll undertake a meaningful research project in one of several hundred laboratories at Harvard, MIT, and local hospitals. It's the perfect beginning to a multidisciplinary career as a physician-scientist.

What degree will I earn?
You'll earn an MD degree from Harvard Medical School.

What can I do with this degree?
As a graduate of the program, you can become a pioneering physician-scientist, ready to care for patients and lead translational research to develop preventative, diagnostic, and therapeutic innovations.

What can I expect?
In your first two years, you'll build a deep understanding of the medical sciences and lay the groundwork for further exploration. You'll explore the complex mechanics of human biology, study the technical underpinnings of healthcare, and gain a fundamental knowledge of molecular biology, biotechnology, engineering, and the physical sciences. You'll also explore the human side of medical science, meeting with a variety of patients in clinical settings.

You will also conduct research in a lab at MIT, Harvard, or one of the area teaching hospitals, building your expertise and learning from a thriving community of researchers, educators, and fellow students.

Beginning in April of your second year, you'll join your classmates from the other curricular track at Harvard Medical School in clinical clerkships and electives, gaining valuable real-world experience in a clinical setting.

How long will it take me to earn an MD degree from HST?
The HST MD program is designed to be completed in four years, with an option to extend the program to five years by including a year of full-time research. This additional research year typically occurs after the second year of the MD curriculum.

Can the HST MD be combined with other degree programs?
Many HST MD students join the Harvard/MIT MD-PhD program, earning a PhD in addition to their medical training. As an HST MD student, you may also pursue dual degrees in business (MBA), public health (MPH), public policy (MPP), or law (JD).

To learn more about the HST MD curriculum, visit the HST program overview (*https://meded.hms.harvard.edu/health-sciences-technology*) on Harvard Medical School's website.

Medical Engineering and Medical Physics

Who is the program for?
HST's Medical Engineering and Medical Physics (MEMP) PhD program offers a unique curriculum for engineers and scientists who want to impact patient care by developing innovations to prevent, diagnose, and treat disease. We're committed to welcoming qualified applicants from a wide range of communities, backgrounds, and experiences.

How is HST's MEMP PhD program different from other PhD programs?
As a MEMP student, you'll choose one of 11 technical concentrations and design an individualized curriculum to ground yourself in the foundations of that discipline. You'll study medical sciences alongside MD students and become fluent in the language and culture of medicine through structured clinical experiences. You'll select a research project from among laboratories at MIT, Harvard, and local hospitals, then tackle important questions through the multiple lenses of your technical discipline and your medical training. As a result, you will learn how to ask better questions, identify promising research areas, and translate research findings into real-world medical practice.

What degree will I earn?
You'll earn a PhD awarded by MIT or by the Harvard Faculty of Arts and Sciences.

What can I do with this degree?
Lead pioneering efforts that translate technical work into innovations that improve human health and shape the future of medicine.

How long will it take me to earn a PhD in HST's MEMP program?
The average time-to-degree for MEMP PhD students is six years.

What can I expect?
You'll begin by choosing a concentration in a classical discipline of engineering or physical science. During your first two years in HST, you'll complete a series of courses to learn the fundamentals of your chosen area.

In parallel, you'll become conversant in the biomedical sciences through preclinical coursework in pathology and pathophysiology, learning side-by-side with HST MD students.

With that foundation, you'll engage in truly immersive clinical experiences, gaining a hands-on understanding of clinical care, medical decision making, and the role of technology in medical practice. These experiences will help you become fluent in the language and culture of medicine and gain a first-hand understanding of the opportunities for—and constraints on—applying scientific and technological innovations in health care.

You'll also take part in two seminar classes that help you to integrate science and engineering with medicine while developing your professional skills.

A two-stage qualifying examination tests your proficiency in your concentration area, your skill at integrating information from diverse sources into a coherent research proposal, and your ability to defend that research proposal in an oral presentation.

Finally, as the culmination of your training, you'll investigate an important problem at the intersection of science, technology, and medicine through an individualized thesis research project, with opportunities to be mentored by faculty in laboratories at MIT, Harvard, and affiliated teaching hospitals.

The program's academic curriculum includes multiple components that prepare students to be medical innovators who will advance human health. First, HST provides MEMP students with a thorough graduate education in a classical discipline of engineering or physical science. Each student selects a concentration area, such as biological engineering, mechanical engineering, chemistry and chemical engineering, materials science, electrical engineering, computer science, physics, aeronautics and astronautics, brain and cognitive science, or nuclear science and engineering, and completes substantial coursework in this discipline.

Students then become conversant in the biological sciences through preclinical coursework followed by a series of clinical experiences. Courses such as pathology and pathophysiology are taken together with HST MD students. Then students engage in immersive clinical experiences where they acquire a hands-on understanding of clinical care, medical decision-making, and the role of technology in medical practice. Through these experiences, students become fluent in the language and culture of medicine and gain a firsthand understanding of the opportunities for, and constraints on, applying scientific and technological innovations in health care.

Two seminar classes help students integrate science and engineering with medicine and develop professional skills. A two-stage qualifying examination ensures that each student is proficient in his or her chosen concentration area, can integrate information from diverse sources into a coherent research proposal, and is able to defend that research proposal in an oral presentation.

Finally, MEMP students investigate important problems at the interfaces of science, technology, and clinical medicine through individualized research projects that prepare them to undertake independent research. MEMP students have the opportunity to perform thesis research in laboratories at MIT, Harvard, and the Harvard affiliated teaching hospitals.

Neuroimaging and bioastronautics are areas of specialization within MEMP for which HST offers specially designed training programs. MEMP candidates may choose to apply through MIT, Harvard, or both. Those applying to MEMP through MIT should submit a single application. Those applying to MEMP through Harvard must also

apply to the School of Engineering and Applied Sciences or the Biophysics Program. Additional information about applying to MEMP is available on the MEMP website (*http://hst.mit.edu/academics/memp/admissions*).

Inquiries

Visit the website (*https://hst.mit.edu*) or email HST (*hst@mit.edu*) for additional information on degree programs, admissions, and financial aid.

Faculty and Teaching Staff

Emery N. Brown, MD, PhD
Edward Hood Taplin Professor of Medical Engineering
Warren M. Zapol Professor of Anaesthesia, HMS
Professor of Computational Neuroscience
Member, Institute for Data, Systems, and Society
Associate Director, Institute for Medical Engineering and Science
Co-Director, Health Sciences and Technology Program

Wolfram Goessling, MD, PhD
Robert H. Ebert Professor of Medicine, HMS
Chief, Division of Gastroenterology, MGH
Co-Director, Health Sciences and Technology Program

Professors

Elfar Adalsteinsson, PhD
Eaton-Peabody Professor
Professor of Electrical Engineering
Core Faculty, Institute for Medical Engineering and Science

Daniel Griffith Anderson, PhD
Professor of Chemical Engineering
Core Faculty, Institute for Medical Engineering and Science

Bonnie Berger, PhD
Simons Professor of Mathematics
Member, Health Sciences and Technology Faculty

Sangeeta N. Bhatia, MD, PhD
John J. and Dorothy Wilson Professor of Health Sciences and Technology
Professor of Electrical Engineering and Computer Science
Core Faculty, Institute for Medical Engineering and Science

Arup K. Chakraborty, PhD
Institute Professor
Robert T. Haslam (1911) Professor in Chemical Engineering
Professor of Chemistry
Professor of Physics
Core Faculty, Institute for Medical Engineering and Science

Richard J. Cohen, MD, PhD
Whitaker Professor in Biomedical Engineering
Core Faculty, Institute for Medical Engineering and Science
(On leave, fall)

James J. Collins, PhD
Termeer Professor of Medical Engineering and Science
Professor of Biological Engineering
Core Faculty, Institute for Medical Engineering and Science

Elazer R. Edelman, MD, PhD
Edward J. Poitras Professor in Medical Engineering and Science
Professor of Medicine, HMS
Director, Institute for Medical Engineering and Science

Dennis M. Freeman, PhD
Henry Ellis Warren (1894) Professor
Professor of Electrical Engineering
Member, Health Sciences and Technology Faculty

John D. E. Gabrieli, PhD
Grover Hermann Professor of Health Sciences and Technology
Professor of Cognitive Neuroscience
Core Faculty, Institute for Medical Engineering and Science

Lee Gehrke, PhD
Hermann L. F. von Helmholtz Professor of Health Sciences and Technology
Professor of Microbiology and Immunobiology, HMS
Core Faculty, Institute for Medical Engineering and Science

Martha L. Gray, PhD
J. W. Kieckhefer Professor of Health Sciences and Technology
Professor of Electrical Engineering and Computer Science
Core Faculty, Institute for Medical Engineering and Science

Robert Langer, ScD
David H. Koch (1962) Institute Professor
Professor of Chemical Engineering
Professor of Mechanical Engineering
Professor of Biological Engineering
Affiliate Faculty, Institute for Medical Engineering and Science

Roger Greenwood Mark, MD, PhD
Distinguished Professor Post-Tenure in Health Sciences and Technology
Core Faculty, Institute for Medical Engineering and Science

Leonid A. Mirny, PhD
Distinguished Professor in Medical Engineering and Science
Professor of Physics
Core Faculty, Institute for Medical Engineering and Science
(On leave, fall)

Dava Newman, PhD
Apollo Professor of Astronautics and Engineering Systems
Member, Institute for Data, Systems, and Society
Affiliate Faculty, Institute for Medical Engineering and Science
Member, Health Sciences and Technology Faculty

David C. Page, MD
Professor of Biology
Member, Health Sciences and Technology Faculty

Phillip A. Sharp, PhD
Institute Professor
Professor of Biology
Affiliate Faculty, Institute for Medical Engineering and Science

Collin M. Stultz, MD, PhD
Nina T. and Robert H. Rubin Professor
Professor in Biomedical Engineering
Professor of Electrical Engineering and Computer Science
Core Faculty, Institute for Medical Engineering and Science

Peter Szolovits, PhD
Professor of Computer Science and Engineering
Affiliate Faculty, Institute for Medical Engineering and Science
(On leave)

Ioannis V. Yannas, PhD
Professor of Polymer Science and Engineering
Member, Health Sciences and Technology Faculty

Associate Professors
Lydia Bourouiba, PhD
Associate Professor of Civil and Environmental Engineering
Affiliate Faculty, Institute for Medical Engineering and Science

Kwanghun Chung, PhD
Associate Professor of Chemical Engineering
Associate Professor of Brain and Cognitive Sciences
Core Faculty, Institute for Medical Engineering and Science

Thomas Heldt, PhD
Associate Professor of Electrical Engineering and Computer Science
Core Faculty, Institute for Medical Engineering and Science

Ellen Roche, PhD
W.M. Keck Career Development Professor
Associate Professor of Mechanical Engineering
Core Faculty, Institute for Medical Engineering and Science

Alex K. Shalek, PhD
Associate Professor of Chemistry
Core Faculty, Institute for Medical Engineering and Science

David Sontag, PhD
Von Helmholtz Professor of Medical Engineering
Associate Professor of Electrical Engineering and Computer Science
Core Faculty, Institute for Medical Engineering and Science

Assistant Professors
Marzyeh Ghassemi, PhD
Herman L. F. von Helmholtz Career Development Professor
Assistant Professor of Electrical Engineering and Computer Science
Core Faculty, Institute for Medical Engineering and Science

Tami Lieberman, PhD
Assistant Professor of Civil and Environmental Engineering
Core Faculty, Institute for Medical Engineering and Science

Senior Lecturers
Julie E. Greenberg, PhD
Senior Lecturer, Institute for Medical Engineering and Science

Lecturers
Sonal Jhaveri, PhD
Lecturer, Institute for Medical Engineering and Science

William M. Kettyle, MD
Lecturer, Institute for Medical Engineering and Science

Anna K. Young, PhD
Lecturer, Institute for Medical Engineering and Science

HST Affiliated Faculty
Ana Paula Abreu, MD, PhD
Instructor in Medicine, BWH

R. Rox Anderson, MD
Professor of Dermatology, MGH

Robert L. Barry, PhD
Assistant Professor of Radiology, MGH

Daniel Bauer, MD, PhD
Associate Professor of Pediatrics, HMS

Sudha B. Biddinger, MD, PhD
Associate Professor of Pediatrics, CHB

Berkin Bilgic, PhD
Assistant Professor of Radiology, MGH

Joseph V. Bonventre, MD, PhD
Samuel A. Levine Professor
Professor of Medicine, BWH

Brett Bouma, PhD
Professor of Dermatology, MGH
Affiliate Faculty, Institute for Medical Engineering and Science

Mary L. Bouxsein, PhD
Professor of Orthopedic Surgery, BIDMC

Thomas N. Byrne, MD
Professor of Neurology and Health Sciences and Technology, MGH

Elliot L. Chaikof, MD, PhD
Johnson and Johnson Professor
Professor of Surgery, BIDMC

Yee-Ming Chan, MD, PhD
Assistant Professor of Pediatrics, BCH

George M. Church, PhD
Robert Winthrop Professor
Professor of Genetics, HMS

George Daley, MD, PhD
Dean of the Faculty of Medicine, HMS
Professor of Biological Chemistry and Molecular Pharmacology, CHB
Professor of Pediatrics, CHB
Caroline Shields Walker Professor of Medicine, CHB

Georges el Fakhri, PhD
Professor of Radiology, MGH

Stan N. Finkelstein, MD
Associate Professor of Medicine, BIDMC

Stuart A. Forman, MD, PhD
Professor of Anaesthesia, MGH

Matthew P. Frosch, MD, PhD
Lawrence J. Henderson Associate Professor
Associate Professor of Pathology and Health Sciences and Technology, HMS

Salil Garg, MD, PhD
Research Fellow of Pathology, MGH

Georg K. Gerber, MD, PhD
Associate Professor of Pathology, BWH

Randy L. Gollub, MD, PhD
Professor of Psychiatry, MGH

Matti S. Hamalainen, PhD
Professor of Radiology, MGH

Sebastien J. Haneuse, PhD
Professor of Biostatistics, HSPH, HMS

C. Corey Hardin, MD, PhD
Assistant Professor of Medicine, MGH

Tayyaba Hasan, PhD
Professor of Dermatology, MGH

Howard M. Heller, MPH, MD
Assistant Professor of Medicine, MGH

Miguel Hernan, MD, DrPH
Kolkotrones Professor of Biostatistics and Epidemiology, HSPH

Paul L. Huang, MD, PhD
Professor of Medicine, MGH

David Izquierdo-Garcia, PhD
Assistant Professor of Radiology, MGH

Rakesh K. Jain, PhD
A. Werk Cook Professor
Professor of Radiation Oncology (Tumor Biology), MGH

Ursula B. Kaiser, MD
Professor of Medicine, BWH

Jeffrey M. Karp, PhD
Professor of Medicine, BWH

Isaac S. Kohane, MD, PhD
Marion V. Nelson Professor
Professor of Biomedical Informatics, HMS
Professor of Pediatrics, CHB
Associate Professor of Medicine, BWH

Scott B. Lovitch, MD, PhD
Assistant Professor of Pathology, BWH

Mohini Lutchman, PhD
Lecturer on Neurobiology, HMS

Richard N. Mitchell, MD, PhD
Professor of Pathology and Health Sciences and Technology, HMS

Sahar Nissim, MD, PhD
Assistant Professor of Medicine, BWH

Timothy P. Padera, PhD
Associate Professor of Radiation Oncology, MGH

Shiv S. Pillai, MD, PhD
Professor of Medicine, MGH

Jonathan R. Polimeni, PhD
Assistant Professor of Radiology, MGH

Nathaniel O. Price, MB, ChB
Instructor in Medicine, BIDMC and MAH

Bruce R. Rosen, MD, PhD
Laurence Lamson Robbins Professor
Professor of Radiology, MGH

Douglas A. Rubinson, MD, PhD
Assistant Professor of Medicine, DFCI

Sol Schulman, MD, PhD
Instructor in Medicine, BIDMC

Brian Seed, PhD
Professor of Genetics, MGH

Shiladitya Sengupta, PhD
Assistant Professor of Medicine, BWH

Harvey B. Simon, MD
Associate Professor of Medicine, MGH

David Sosnovik, MD
Associate Professor of Medicine, MGH

Myron Spector, PhD
Professor of Orthopedic Surgery (Biomaterials), BWH/VAMC-Boston

Judith M. Strymish, MD
Assistant Professor of Medicine, VAMC-Boston

Steven M. Stufflebeam, MD
Associate Professor of Radiology, MGH

Guillermo J. Tearney, MD, PhD
Professor of Pathology, MGH

Mehmet Toner, PhD
Helen Andrus Benedict Professor
Professor of Surgery, MGH

Benjamin Vakoc, PhD
Associate Professor of Dermatology, MGH

Lawrence L. Wald, PhD
Professor of Radiology, MGH

William Wells, PhD
Professor of Radiology, BWH

M. Brandon Westover, MD, PhD
Associate Professor of Neurology, MGH

Seok-Hyun Yun, PhD
Professor of Dermatology, MGH

Warren M. Zapol, MD
Reginald Jenney Professor
Professor of Anaesthesia, MGH

Professors Emeriti

George B. Benedek, PhD
Alfred H. Caspary Professor Emeritus of Physics
Professor Emeritus of Biological Physics

Louis D. Braida, PhD
Henry Ellis Warren (1894) Professor Emeritus
Professor Emeritus of Electrical Engineering
Professor Emeritus of Health Sciences and Technology

Nelson Yuan-Sheng Kiang, PhD
Eaton Peabody Professor Emeritus
Professor Emeritus of Health Sciences and Technology
Professor Emeritus of Brain and Cognitive Sciences
Professor Emeritus of Physiology, HMS, MEEI

Thomas F. Weiss, PhD
Professor Emeritus of Electrical and Bioengineering
Professor Emeritus of Health Sciences and Technology

IMPORTANT NOTES regarding preclinical subjects (HST.011-HST.200):*
*Students not enrolled in an HST program are limited to two HST preclinical courses and must provide justification for enrolling in these courses. This action must be approved by the course director and the student's advisor. These subjects are scheduled according to the Harvard Medical School academic calendar, which differs from the MIT calendar. Students whose graduation depends upon completing one or more of these subjects should take particular care regarding the schedule. * HST.141, HST.163 HST.198 are NOT included in the two-course limit.*

HST.011 Human Functional Anatomy
Subject meets with HST.010
Prereq: Permission of instructor
G (Fall)
3-11-10 units

Lectures, detailed laboratory dissections, and prosections provide a thorough exploration of the gross structure and function of the human body. Fundamental principles of bioengineering are employed to promote analytical approaches to understanding the body's design. The embryology of major organ systems is presented, together with certain references to phylogenetic development, as a basis for comprehending anatomical complexity. Correlation clinics stress both normal and abnormal functions of the body and present evolving knowledge of genes responsible for normal and abnormal anatomy. Lecturers focus on current problems in organ system research. Only HST students may register under HST.010, graded P/D/F. Lab fee. Enrollment restricted to graduate students.
L. Gehrke

HST.015 MATLAB for Medicine
Prereq: None
G (Summer)
2-0-4 units

Practical introduction to use of quantitative methods in medicine and health research. Each session covers a different topic in quantitative techniques, provides an application to medicine, and includes a modeling activity using MATLAB. Students also complete problem sets. Restricted to first year HST MD students.
M. Frosch

HST.021 Musculoskeletal Pathophysiology
Subject meets with HST.020
Prereq: HST.030 and HST.160
G (Spring)
3-0-3 units

Growth and development of normal bone and joints, the biophysics of bone and response to stress and fracture, calcium and phosphate homeostasis and regulation by parathyroid hormone and vitamin D, and the pathogenesis of metabolic bone diseases and disease of connective tissue, joints, and muscles, with consideration of possible mechanisms and underlying metabolic derangements. Only HST students may register under HST.020, graded P/D/F. Enrollment limited; restricted to medical and graduate students.
M. Bouxsein, L. Tarter

HST.031 Human Pathology
Subject meets with HST.030
Prereq: Biology (GIR), Physics I (GIR), and permission of instructor
G (Fall)
4-3-8 units
Credit cannot also be received for HST.034, HST.035

Introduction to the functional structure of normal cells and tissues, pathologic principles of cellular adaptation and injury, inflammation, circulatory disorders, immunologic injury, infection, genetic disorders, and neoplasia in humans. Lectures, conferences emphasizing clinical correlations and contemporary experimental biology. Laboratories with examination of microscopic and gross specimens, and autopsy case studies emphasizing modern pathology practice. Only HST students may register under HST.030, graded P/D/F. Lab fee. Enrollment limited.
R. N. Mitchell, R. Padera

HST.035 Pathology of Human Disease
Subject meets with HST.034
Prereq: 7.05 or permission of instructor
G (Spring)
4-2-10 units
Credit cannot also be received for HST.030, HST.031

Provides a comprehensive overview of human pathology with emphasis on mechanisms of disease and modern diagnostic technologies. Topics include general mechanisms of disease (inflammation, infection, immune injury, transplantation, genetic disorders and neoplasia); pathology of lipids, enzymes, and molecular transporters; pathology of major organ systems; and review of diagnostic tools from surgical pathology to non-invasive techniques such as spectroscopy, imaging, and molecular markers of disease. The objectives of this subject are achieved by a set of integrated lectures and laboratories, as well as a student-driven term project leading to a formal presentation on a medical, socioeconomic, or technological issue in human pathology. Only HST students enrolled in specific degree programs may register under HST.034, graded P/D/F. Credit cannot also be received for HST.030 or HST.031.
S. Lovitch

HST.041 Mechanisms of Microbial Pathogenesis
Subject meets with HST.040
Prereq: Biology (GIR), 7.05, and permission of instructor
G (Fall)
4-2-6 units

Deals with the mechanisms of pathogenesis of bacteria, viruses, and other microorganisms. Approach spans mechanisms from molecular to clinical aspects of disease. Topics selected for intrinsic interest and cover the demonstrated spectrum of pathophysiologic mechanisms. Only HST students may register under HST.040, graded P/D/F. Lab fee. Enrollment limited.
S. Kanjilal, K. Hysell

HST.061 Endocrinology
Subject meets with HST.060
Prereq: Biology (GIR), 7.05, and permission of instructor
G (Spring)
3-0-6 units

Physiology and pathophysiology of the human endocrine system. Three hours of lecture and section each week concern individual parts of the endocrine system. Topics include assay techniques, physiological integration, etc. At frequent clinic sessions, patients are presented who demonstrate clinical problems considered in the didactic lectures. Only HST students may register under HST.060, graded P/D/F. Enrollment limited.
W. Kettyle, Y-M. Chan, A. Abreu

HST.071 Human Reproductive Biology
Subject meets with HST.070
Prereq: 7.05 and permission of instructor
G (Fall; first half of term)
4-0-2 units

Lectures and clinical case discussions designed to provide the student with a clear understanding of the physiology, endocrinology, and pathology of human reproduction. Emphasis is on the role of technology in reproductive science. Suggestions for future research contributions in the field are probed. Students become involved in the wider aspects of reproduction, such as prenatal diagnosis, in vitro fertilization, abortion, menopause, contraception and ethics relation to reproductive science. Only HST students may register under HST.070, graded P/D/F.
A. Koniaris, D. Page, T. Lau

HST.081 Hematology
Subject meets with HST.080
Prereq: 7.05 and permission of instructor
G (Spring; partial term)
2-1-3 units

Intensive survey of the biology, physiology and pathophysiology of blood with systematic consideration of hematopoiesis, white blood cells, red blood cells, platelets, coagulation, plasma proteins, and hematologic malignancies. Emphasis given equally to didactic discussion and analysis of clinical problems. Enrollment limited.
D. Bauer, S. Schulman

HST.091 Cardiovascular Pathophysiology
Subject meets with HST.090
Prereq: (HST.030 or HST.031) and permission of instructor
G (Spring)
4-3-8 units

Normal and pathologic physiology of the heart and vascular system. Emphasis includes hemodynamics, electrophysiology, gross pathology, and clinical correlates of cardiovascular function in normal and in a variety of disease states. Special attention given to congenital, rheumatic, valvular heart disease and cardiomyopathy. Only HST students may register under HST.090, graded P/D/F. Enrollment limited.
E. Edelman

HST.101 Respiratory Pathophysiology
Subject meets with HST.100
Prereq: Physics I (GIR), 7.05, and permission of instructor
G (Spring)
4-0-8 units

Lectures, seminars, and laboratories cover the histology, cell biology, and physiological function of the lung with multiple examples related to common diseases of the lung. A quantitative approach to the physics of gases, respiratory mechanics, and gas exchange is provided to explain pathological mechanisms. Use of medical ventilators is discussed in lecture and in laboratory experiences. For MD candidates and other students with background in science. Only HST students may register under HST.100, graded P/D/F. Enrollment limited.
C. Hardin, E. Roche, K. Hibbert

HST.111 Renal Pathophysiology
Subject meets with HST.110
Prereq: 7.05 and permission of instructor
G (Spring)
4-0-8 units

Considers the normal physiology of the kidney and the pathophysiology of renal disease. Renal regulation of sodium, potassium, acid, and water balance are emphasized as are the mechanism and consequences of renal failure. Included also are the pathology and pathophysiology of clinical renal disorders such as acute and chronic glomerulonephritis, pyelonephritis, and vascular disease. New molecular insights into transporter mutations and renal disease are discussed. Only HST students may register under HST.110, graded P/D/F. Enrollment limited.
G. McMahon, M. Yeung

HST.121 Gastroenterology
Subject meets with HST.120
Prereq: Biology (GIR), Physics I (GIR), 7.05, and permission of instructor
G (Fall; second half of term)
3-1-2 units

Presents the anatomy, physiology, biochemistry, biophysics, and bioengineering of the gastrointestinal tract and associated pancreatic, liver, and biliary systems. Emphasis on the molecular and pathophysiological basis of disease where known. Covers gross and microscopic pathology and clinical aspects. Formal lectures given by core faculty, with some guest lectures by local experts. Selected seminars conducted by students with supervision of faculty. Only HST students may register under HST.120, graded P/D/F. Enrollment limited.
A. Rutherford, S. Flier

HST.131 Neuroscience
Subject meets with HST.130
Prereq: Permission of instructor
G (Fall)
6-3-6 units

Comprehensive study of neuroscience where students explore the brain on levels ranging from molecules and cells through neural systems, perception, memory, and behavior. Includes some aspects of clinical neuroscience, within neuropharmacology, pathophysiology, and neurology. Lectures supplemented by conferences and labs. Labs review neuroanatomy at the gross and microscopic levels. Only HST students may register under HST.130, graded P/D/F. Limited to 50.
J. Assad, M. Frosch

HST.141 Molecular Medicine
Subject meets with HST.140
Prereq: 7.05
G (Fall)
2-0-4 units

Conducted as a seminar to study a variety of human diseases and the underlying molecular, genetic, and biochemical basis for the pathogenesis and pathophysiology of the disorders. Lectures by faculty and seminars conducted by students, with tutorials and supervision by faculty. Patients presented when feasible. Appropriate for students who have had a course in biochemistry and/or molecular biology.
S. Agarwal

HST.147 Biochemistry and Metabolism
Prereq: Permission of instructor
G (Fall)
4-0-5 units

First-year graduate level intensive subject in human biochemistry and physiological chemistry that focuses on intermediary metabolism, structures of key intermediates and enzymes important in human disease. Subject is divided into four areas: carbohydrates, lipids, amino acids and nucleic acids. The importance of these areas is underscored with examples from diseases and clinical correlations. Preparatory sessions meet in August. Only HST students may register under HST.146, graded P/D/F. Enrollment limited.
R. Sharma

HST.151 Principles of Pharmacology
Subject meets with HST.150
Prereq: Biology (GIR), Physics I (GIR), and 7.05
G (IAP, Spring; partial term)
6-0-6 units

An introduction to pharmacology. Topics include mechanisms of drug action, dose-response relations, pharmacokinetics, drug delivery systems, drug metabolism, toxicity of pharmacological agents, drug interactions, and substance abuse. Selected agents and classes of agents examined in detail. Course follows HMS calendar. Restricted to HST MD HST PhD students.
S. Forman

HST.161 Genetics in Modern Medicine
Subject meets with HST.160
Prereq: 7.05
G (Fall; second half of term)
2-0-4 units

Provides a foundation for understanding the relationship between molecular biology, genetics, and medicine. Starts with an introduction to molecular genetics, and quickly transitions to the genetic basis of diseases, including chromosomal, mitochondrial and epigenetic disease. Translation of clinical understanding into analysis at the level of the gene, chromosome, and molecule; the concepts and techniques of molecular biology and genomics; and the strategies and methods of genetic analysis. Includes diagnostics (prenatal and adult), cancer genetics, and the development of genetic therapies (RNA, viral, and genome editing). The clinical relevance of these areas is underscored with patient presentations. Only HST students may register under HST.160, graded P/D/F.
S. Garg, S. Nissim

HST.163 Molecular Diagnostics and Bioinformatics
Subject meets with HST.162
Prereq: HST.160
G (Fall; first half of term)
2-0-4 units

Introduction of molecular diagnostic methods in medicine and relevant bioinformatics methods. Discussion of principles of molecular testing for diagnosis of somatic and germline diseases using FISH, classical genotyping, array CGH, next generation sequencing, and other technologies. Case conferences emphasize clinical correlation and integration of information from multiple diagnostic tests. Bioinformatics lectures, problem sets, and laboratory sessions will introduce key concepts in biological sequence analysis and provide experience with bioinformatics tools. HST.015 and HST.191 recommended. Only HST students may register under HST.162, P/D/F. Enrollment limited, preference to HST students.
G. Gerber, L. Li

HST.165 Principles of Biomedical Imaging
Subject meets with HST.164
Prereq: Permission of instructor
G (IAP)
2-0-4 units

Reviews fundamental principles and techniques underlying modern biomedical imaging, as well as their application in modern medicine. Particular emphasis on magnetic resonance; also covers ultrasound, computed tomography, positron emission tomography and optical techniques. Didactic lectures accompanied by problem sets and experiments with portable magnetic resonance systems and ultrasound systems. Focuses on the quantitative aspects of biomedical imaging and requires a knowledge of differential equations, MATLAB, and intermediate-level physics. Only HST students may register under HST.164, P/D/F. Restricted to HST students.
S. Huang, D. Sosnovik

HST.176 Cellular and Molecular Immunology
Subject meets with HST.175
Prereq: 7.05
G (Fall)
6-0-6 units

Covers cells and tissues of the immune system, lymphocyte development, the structure and function of antigen receptors, the cell biology of antigen processing and presentation including molecular structure and assembly of MHC molecules, lymphocyte activation, the biology of cytokines, leukocyte-endothelial interactions, and the pathogenesis of immunologically mediated diseases. Consists of lectures and tutorials in which clinical cases are discussed with faculty tutors. Details of each case covering a number of immunological issues in the context of disease are posted on a student website. Only HST students may register under HST.175, graded P/D/F. Limited to 45.
S. Pillai, B. Cherayil

HST.191 Introduction to Biostatistics
Subject meets with HST.190
Prereq: Calculus II (GIR)
G (Summer)
3-0-3 units

Provides training on how to comprehend, critique and communicate findings from biomedical literature. Considers how to assess the importance of chance in the interpretation of experimental data. Topics include probability theory, chi-squared and t-tests, ANOVA, linear and logistic regression, survival analysis, and statistical analysis using MATLAB. Includes critical reading of studies published in medical literature. Only HST students may register under HST.190, graded P/D/F. Enrollment limited; restricted to medical and graduate students.
S. Haneuse

HST.192 Medical Decision Analysis and Probabilistic Medical Inference
Prereq: Permission of instructor
G (IAP)
2-0-2 units

Teaches the essentials of quantitative diagnostic reasoning and medical decision analysis. Guides participants through the process of choosing an appropriate contemporary medical problem in which risk-benefit tradeoffs play a prominent role, conducting a decision analysis, and ultimately publishing the results in a medical journal. Topics include decision trees, influence diagrams, Markov decision models and Monte Carlo simulation, methods for quantifying patient values, Bayesian inference, decision thresholds, and the cognitive science of medical decision making. HST.191 recommended. Limited to 8; preference to HST students.
M. B. Westover

HST.195 Clinical Epidemiology
Subject meets with HST.194
Prereq: HST.190
G (IAP, Spring; first half of term)
1-0-1 units

Introduces methods for the generation, analysis, and interpretation of data for clinical research. Major topics include the design of surveys, predictive models, randomized trials, clinical cohorts, and analyses of electronic health records. Prepares students to formulate well-defined research questions, design data collection, evaluate algorithms for clinical prediction, design studies for causal inference, and identify and prevent biases in clinical research. Emphasizes critical thinking and practical applications, including daily assignments based on articles published in major clinical journals and the discussion of a case study each week. Trains students to comprehend, critique, and communicate findings from the biomedical literature. Familiarity with regression modeling and basic statistical theory is a prerequisite. Only HST students may register under HST.194, graded P/D/F. Enrollment limited; restricted to medical and graduate students.
M. Hernan

HST.196 Teaching Health Sciences and Technology
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

For teaching assistants or instructors in HST where the teaching assignment is approved for academic credit by the department.
HST Faculty

HST.198 Independent Study in Health Sciences and Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Opportunity for independent study of health sciences and technology under regular supervision by an HST faculty member. Projects require prior approval from the HST Academic Office, as well as a substantive paper.
HST Faculty

HST.199 Research in Health Sciences and Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
0-10-0 units
Can be repeated for credit.

For HST MD students with research assistantships where the assigned research is approved for academic credit by the department.
HST Faculty

HST.200 Introduction to Clinical Medicine
Prereq: Permission of instructor
G (IAP, Spring; partial term)
9-19-12 units

Intensive preparation for clinical clerkships that introduces the basic skills involved in examination of the patient in addition to history taking and the patient interview. Provides exposure to clinical problems in medicine, surgery, and pediatrics. Students report their findings through history taking and oral presentations. Restricted to MD program students.
W. Goessling, D. Rubinson, D. Solomon

HST.201 Introduction to Clinical Medicine and Medical Engineering I
Prereq: Permission of instructor
G (Fall, Summer)
0-20-0 units

Develop skills in patient interviewing and physical examination; become proficient at organizing and communicating clinical information in both written and oral forms; begin integrating history, physical, and laboratory data with pathophysiologic principles; and become familiar with the clinical decision-making process and broad economic, ethical, and sociological issues involved in patient care. There are two sections: one at Mount Auburn Hospital and one at West Roxbury VA Hospital, subsequent registration into HST.202 must be continued at the same hospital as HST.201. Restricted to MEMP students.
C. Stultz, N. Price, J. Strymish

HST.202 Introduction to Clinical Medicine and Medical Engineering II
Prereq: HST.201
G (Fall, IAP, Spring, Summer)
0-20-0 units

Strengthens the skills developed in HST.201 through a six-week clerkship in medicine at a Harvard-affiliated teaching hospital. Students serve as full-time members of a ward team and participate in longitudinal patient care. In addition, students participate in regularly scheduled teaching conferences focused on principles of patient management. Restricted to MEMP students.
C. Stultz, N. Price, J. Strymish

HST.211 Biomedical Inventions: Clinical Introduction
Prereq: Permission of instructor
G (IAP)
Not offered regularly; consult department
3-0-3 units

Provides students with an understanding of modern biomedicine. Explores the clinical areas where medical practice and biomedical enterprise intersect. Hear and interact with academic physicians engaged in care and treatment of patients, in the wards, ICUs, ORs and outpatient areas, and develop the knowledge base needed to obtain elective clinical experiences. Learn to interact with patients and clinicians. Focus is on the various needs of medical specialties, both device, IT and pharma to better treat common medical diseases.
W. Zapol, R. Anderson

HST.212 Biomedical Inventions: Clinical Experience and Selected Success Analysis
Prereq: HST.211
G (Spring)
Not offered regularly; consult department
3-0-3 units

Provides students with a survey of key biomedical research needs by lecture-discussions and facilitating interaction with academic-clinicians and scientists active in medical care/research. Both drug and technology development in the various medical and surgical specialties are examined. Students develop the knowledge base needed to obtain elective clinical experiences. Unsolved clinical problems are sought by each student in a biomedical area of their interest and presented to the class. Interactions with academic physicians who have successfully developed technologies and drugs that are approved by the FDA and in widespread clinical use. How, where, when and why biomedical enterprise and medical practice can successfully intersect is explored. Students can interact with academic physicians engaged in the development of novel technology and drugs, analyze successes and autopsy failed biomedical enterprises.
W. Zapol, R. Anderson

HST.220 Introduction to the Care of Patients
Prereq: Permission of instructor
G (Spring)
1-0-2 units

Elective subject for HST/MD candidates only. Provides an introduction to the care of patients through opportunities to observe and participate in doctor-patient interaction in an outpatient, office-based environment, and through patient-oriented seminars. Students are exposed to some of the practical realities of providing patient care. Topics include basic interviewing, issues of ethics and confidentiality, and other aspects of the doctor-patient relationship. Requirements include regular attendance, and a short paper on patient care. Limited to 15.
H. Heller, MIT Medical Department Staff

HST.240 Translational Medicine Preceptorship
Prereq: HST.035
G (Fall, Spring, Summer)
0-12-0 units

Individually designed preceptorship joins together scientific research and clinical medicine. Students devote approximately half of their time to clinical experiences, and the remaining part to scholarly work in basic or clinical science. The two might run concomitantly or in series. Follow a clinical preceptor's daily activity, including aspects of patient care, attending rounds, conferences, and seminars. Research involves formal investigation of a focused and directed issue related to selected clinical area. Final paper required. Limited to students in the GEMS Program.
E. Edelman

HST.420[J] Principles and Practice of Assistive Technology
Same subject as 2.78[J], 6.811[J]
Prereq: Permission of instructor
Acad Year 2021-2022: Not offered
Acad Year 2022-2023: U (Fall)
2-4-6 units

See description under subject 6.811[J]. Enrollment may be limited.
R. C. Miller, J. E. Greenberg, J. J. Leonard

HST.431[J] Infections and Inequalities: Interdisciplinary Perspectives on Global Health
Same subject as 11.134[J]
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-S

See description under subject 11.134[J]. Limited to 25.
E. James, A. Chakraborty

HST.434 Evolution of an Epidemic (Study Abroad)
Prereq: None
U (IAP)
3-0-1 units

Examines the medical, scientific, public health and policy responses to a new disease, by focusing on the evolution of the AIDS epidemic. Begins with a review of how this new disease was first detected in the US and Africa, followed by the scientific basis as to how HIV causes profound dysfunction of the body's immune defense mechanisms, the rational development of drugs, the challenge of an HIV vaccine, and how public health and policy decisions have influenced the course of the global epidemic. Class conducted in Johannesburg Durban, South Africa. Open to all majors. Limited to 20. Application required; see class website for eligibility details.
H. Heller, B. Walker

HST.S43 Special Subject: Evolution of an Epidemic
Prereq: None
U (IAP)
Units arranged [P/D/F]

Examines the medical, scientific, public health and policy responses to a new disease, by focusing on the evolution of the AIDS epidemic. Begins with a review of how this new disease was first detected in the US and Africa, followed by the scientific basis as to how HIV causes profound dysfunction of the body's immune defense mechanisms, the rational development of drugs, the challenge of an HIV vaccine, and how public health and policy decisions have influenced the course of the global epidemic. Compares and contrasts the HIV and the COVID-19 pandemics. Class typically conducted in Johannesburg and Durban, South Africa; IAP 2021 lectures conducted via Zoom, with Zoom interactions with collaborators in KwaZulu-Natal SA. Licensed for academic year 2020-2021 by the Committee on Curricula. Enrollment limited.
‹em›H. Heller, B. Walker‹/em›

HST.438[J] Viruses, Pandemics, and Immunity
Same subject as 5.002[J], 10.380[J]
Subject meets with 5.003[J], 8.245[J], 10.382[J], HST.439[J]
Prereq: None
U (Spring)
2-0-1 units

Covers the history of infectious diseases, basics of virology, immunology, and epidemiology, and ways in which diagnostic tests, vaccines, and antiviral therapies are currently designed and manufactured. Examines the origins of inequities in infection rates in society, and issues pertinent to vaccine safety. Final project explores how to create a more pandemic-resilient world. Subject can count toward the 6-unit discovery-focused credit limit for first-year students. Preference to first-year students; all others should take HST.439[J].
A. Chakraborty

HST.439[J] Viruses, Pandemics, and Immunity
Same subject as 5.003[J], 8.245[J], 10.382[J]
Subject meets with 5.002[J], 10.380[J], HST.438[J]
Prereq: None
U (Spring)
2-0-1 units

Covers the history of infectious diseases, basics of virology, immunology, and epidemiology, and ways in which diagnostic tests, vaccines, and antiviral therapies are currently designed and manufactured. Examines the origins of inequities in infection rates in society, and issues pertinent to vaccine safety. Final project explores how to create a more pandemic-resilient world. HST.438[J] intended for first-year students; all others should take HST.439[J].
A. Chakraborty

HST.450[J] Biological Physics
Same subject as 8.593[J]
Prereq: 8.044 recommended but not necessary
G (Spring)
Not offered regularly; consult department
4-0-8 units

See description under subject 8.593[J].
G. Benedek

HST.452[J] Statistical Physics in Biology
Same subject as 8.592[J]
Prereq: 8.333 or permission of instructor
Acad Year 2021-2022: G (Spring)
Acad Year 2022-2023: Not offered
3-0-9 units

A survey of problems at the interface of statistical physics and modern biology: bioinformatic methods for extracting information content of DNA; gene finding, sequence comparison, phylogenetic trees. Physical interactions responsible for structure of biopolymers; DNA double helix, secondary structure of RNA, elements of protein folding. Considerations of force, motion, and packaging; protein motors, membranes. Collective behavior of biological elements; cellular networks, neural networks, and evolution.
M. Kardar, L. Mirny

HST.460[J] Statistics for Neuroscience Research
Same subject as 9.073[J]
Prereq: Permission of instructor
Acad Year 2021-2022: Not offered
Acad Year 2022-2023: G (Spring)
3-0-9 units

See description under subject 9.073[J].
E. N. Brown

HST.482[J] Biomedical Signal and Image Processing (New)
Same subject as 6.026[J]
Subject meets with 6.555[J], 16.456[J], HST.582[J]
Prereq: (6.041 or permission of instructor) and (2.004, 6.003, 16.002, or 18.085)
U (Spring)
3-1-8 units

See description under subject 6.026[J].
J. Greenberg, E. Adalsteinsson, W. Wells

HST.500 Frontiers in (Bio)Medical Engineering and Physics
Prereq: None
G (Spring)
3-0-9 units

Provides a framework for mapping research topics at the intersection of medicine and engineering/physics in the Harvard-MIT community and covers the different research areas in MEMP (for example, regenerative biomedical technologies, biomedical imaging and biooptics). Lectures provide fundamental concepts and consider what's hot, and why, in each area. Training in scientific proposal writing (thesis proposals, fellowship applications, or research grant applications) through writing workshops. Topics include how to structure a novel research project, how to position research within the scientific community, how to present preliminary data effectively, and how to give and respond to peer reviews.
S. Bhatia, D. Anderson, S. Jhaveri

HST.504[J] Topics in Computational Molecular Biology
Same subject as 18.418[J]
Prereq: 6.047, 18.417, or permission of instructor
G (Fall, Spring)
3-0-9 units
Can be repeated for credit.

See description under subject 18.418[J].
B. Berger

HST.506[J] Computational Systems Biology: Deep Learning in the Life Sciences
Same subject as 6.874[J]
Subject meets with 6.802[J], 20.390[J], 20.490
Prereq: Biology (GIR) and (18.600 or 6.041)
G (Spring)
3-0-9 units

See description under subject 6.874[J].
D. K. Gifford

HST.507[J] Advanced Computational Biology: Genomes, Networks, Evolution
Same subject as 6.878[J]
Subject meets with 6.047
Prereq: (Biology (GIR), 6.006, and 6.041) or permission of instructor
G (Fall)
4-0-8 units

See description under subject 6.878[J].
M. Kellis

HST.508 Evolutionary and Quantitative Genomics
Prereq: Permission of instructor
Acad Year 2021-2022: Not offered
Acad Year 2022-2023: G (Fall)
3-0-9 units

Develops deep quantitative understanding of basic forces of evolution, molecular evolution, genetic variations and their dynamics in populations, genetics of complex phenotypes, and genome-wide association studies. Applies these foundational concepts to cutting-edge studies in epigenetics, gene regulation and chromatin; cancer genomics and microbiomes. Modules consist of lectures, journal club discussions of high-impact publications, and guest lectures that provide clinical correlates. Homework assignments and final projects develop practical experience and understanding of genomic data from evolutionary principles.
L. Mirny, T. Lieberman

HST.514[J] Sensory-Neural Systems: Spatial Orientation from End Organs to Behavior and Adaptation
Same subject as 16.430[J]
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units

Introduces sensory systems,and multi-sensory fusion using the vestibular and spatial orientation systems as a model. Topics range from end organ dynamics to neural responses, to sensory integration, to behavior, and adaptation, with particular application to balance, posture and locomotion under normal gravity and space conditions. Depending upon the background and interests of the students, advanced term project topics might include motion sickness, astronaut adaptation, artificial gravity, lunar surface locomotion, vestibulo-cardiovascular responses, vestibular neural prostheses, or other topics of interest. Background in neuroscience or systems engineering preferred.
K. Faisal, L. Young

HST.515[J] Aerospace Biomedical and Life Support Engineering
Same subject as 16.423[J], IDS.337[J]
Prereq: 16.06, 16.400, or permission of instructor
Acad Year 2021-2022: G (Fall)
Acad Year 2022-2023: Not offered
3-0-9 units

See description under subject 16.423[J].
D. J. Newman

HST.516 Sleep and Circadian Clocks: from Biology to Public Health
Prereq: Permission of instructor
G (Spring)
3-0-9 units

Explores the neurobiology of the brain's circadian clock that regulates the timing and structure of sleep, its interaction with the periodic environment, and the consequences of circadian disruption (in our 24/7 society) on health, performance, and safety. Students must possess an understanding of biological sciences. Follows Harvard FAS calendar.
C. A. Czeisler, F. Scheer

HST.518[J] Human Systems Engineering
Same subject as 16.453[J]
Subject meets with 16.400
Prereq: 16.09, 6.041, or permission of instructor
G (Fall)
3-0-9 units

See description under subject 16.453[J].
L. A. Stirling

HST.522[J] Biomaterials: Tissue Interactions
Same subject as 2.79[J]
Prereq: (Biology (GIR), Chemistry (GIR), and Physics I (GIR)) or permission of instructor
G (Fall)
3-0-9 units

Principles of materials science and cell biology underlying the development and implementation of biomaterials for the fabrication of medical devices/implants, including artificial organs and matrices for tissue engineering and regenerative medicine. Employs a conceptual model, the "unit cell process for analysis of the mechanisms underlying wound healing and tissue remodeling following implantation of biomaterials/devices in various organs, including matrix synthesis, degradation, and contraction. Methodology of tissue and organ regeneration. Discusses methods for biomaterials surface characterization and analysis of protein adsorption on biomaterials. Design of implants and prostheses based on control of biomaterials-tissue interactions. Comparative analysis of intact, biodegradable, and bioreplaceable implants by reference to case studies. Criteria for restoration of physiological function for tissues and organs.
I. V. Yannas, M. Spector

HST.523[J] Cell-Matrix Mechanics
Same subject as 2.785[J]
Prereq: (Biology (GIR), Chemistry (GIR), and 2.001) or permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-9 units

See description under subject 2.785[J].
I. V. Yannas, M. Spector

HST.524[J] Design of Medical Devices and Implants
Same subject as 2.782[J]
Prereq: (Biology (GIR), Chemistry (GIR), and Physics I (GIR)) or permission of instructor
G (Spring)
3-0-9 units

See description under subject 2.782[J].
I. V. Yannas, M. Spector

HST.525[J] Tumor Microenvironment and Immuno-Oncology: A Systems Biology Approach
Same subject as 10.548[J]
Prereq: None
Acad Year 2021-2022: Not offered
Acad Year 2022-2023: G (Fall)
2-0-4 units

Provides theoretical background to analyze and synthesize the most up-to-date findings from both laboratory and clinical investigations into solid tumor pathophysiology. Covers different topics centered on the critical role that the tumor microenvironment plays in the growth, invasion, metastasis and treatment of solid tumors. Develops a systems-level, quantitative understanding of angiogenesis, extracellular matrix, metastatic process, delivery of drugs and immune cells, and response to conventional and novel therapies, including immunotherapies. Discussions provide critical comments on the challenges and the future opportunities in research on cancer and in establishment of novel therapeutic approaches and biomarkers to guide treatment.
R. K. Jain

HST.526[J] Future Medicine: Drug Delivery, Therapeutics, and Diagnostics
Same subject as 10.643[J]
Subject meets with 10.443
Prereq: 5.12 or permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-6 units

See description under subject 10.643[J]. Limited to 40.
D. G. Anderson

HST.527 Blood Vessels and Endothelial Phenotypes in Health and Disease
Prereq: Permission of instructor
G (Spring)
3-0-3 units

Overview of the endothelium as a model system for understanding biological complexity in health and disease. Emphasis placed on: mechanisms of endothelial cell heterogeneity, including genetic and microenvironmental determinants; the role of endothelial cell trafficking, hemostasis, barrier function, antigen presentation and vasomotor tone; and the role of endothelial cell dysfunction in disease, including tumors, sickle cell disease, pulmonary hypertension, veno-occlusive disease of the liver, thrombotic microangiopathies and xenotransplanation. Additional topics covered include novel proteomic and genomic strategies for mapping endothelial cell phenotypes, evolutionary (Darwinian) principles, and complexity theory. Knowledge of introductory biology or physiology, and biochemistry or molecular biology required.
W. Aird, G. Garcia-Cardena

HST.531 Medical Physics of Proton Radiation Therapy
Prereq: None
Acad Year 2021-2022: G (Spring)
Acad Year 2022-2023: Not offered
2-0-4 units

Acceleration of protons for radiation therapy; introduction into advanced techniques such as laser acceleration and dielectric wall acceleration. Topics include the interactions of protons with the patient, Monte Carlo simulation, and dose calculation methods; biological aspects of proton therapy, relative biological effectiveness (RBE), and the role of contaminating neutrons; treatment planning and treatment optimization methods, and intensity-modulated proton therapy (IMPT); the effect of organ motion and its compensation by use of image-guided treatment techniques; general dosimetry and advanced *in-vivo* dosimetry methods, including PET/CT and prompt gamma measurements. Outlook into therapy with heavier ions. Includes practical demonstrations at the Proton Therapy Center of the Massachusetts General Hospital.
B. Winey, J. Schuemann

HST.533 Medical Imaging in Radiation Therapy
Prereq: 18.06
Acad Year 2021-2022: Not offered
Acad Year 2022-2023: G (Spring)
2-0-4 units

Introduces imaging concepts and applications used throughout radiation therapy workflows, including magnetic resonance imaging (MRI), positron emission tomography (PET), and computed tomography (CT). Advanced topics include proton imaging modalities, such as prompt gamma imaging and proton radiography/CT. Includes lectures regarding image reconstruction and image registration. Introduces students to open-source medical image computing software (3D Slicer, RTK, and Plastimatch). Includes imaging demonstrations at Massachusetts General Hospital.
B. Winey, J. Schuemann

HST.535[J] Tissue Engineering and Organ Regeneration
Same subject as 2.787[J]
Prereq: (Biology (GIR), Chemistry (GIR), and Physics I (GIR)) or permission of instructor
G (Fall)
3-0-9 units

Principles and practice of tissue engineering (TE) and organ regeneration (OR). Topics include factors that prevent the spontaneous regeneration of tissues/organs in the adult (following traumatic injury, surgical excision, disease, and aging), and molecular and cell-biological mechanisms that can be harnessed for induced regeneration. Presents the basic science of organ regeneration. Principles underlying engineering strategies for employing select biomaterial scaffolds, exogenous cells, soluble regulators, and physical stimuli, for the formation of tissue in vitro (TE) and regeneration of tissues/organs in vivo (OR). Describes the technologies for producing biomaterial scaffolds and for incorporating cells and regulatory molecules into workable devices. Examples of clinical successes and failures of regenerative devices are analyzed as case studies.
M. Spector, I. V. Yannas

HST.537[J] Fluids and Diseases
Same subject as 1.631[J], 2.250[J]
Subject meets with 1.063
Prereq: None
G (Spring)
3-3-6 units

See description under subject 1.631[J].
L. Bourouiba

HST.538[J] Genomics and Evolution of Infectious Disease
Same subject as 1.881[J]
Subject meets with 1.088
Prereq: Biology (GIR) and (1.000 or 6.0002)
G (Spring)
3-0-9 units

See description under subject 1.881[J].
T. Lieberman

HST.539[J] Frontiers of Interdisciplinary Science in Human Health and Disease
Same subject as 5.64[J]
Prereq: 5.13, 5.60, and (5.07[J] or 7.05)
G (Spring)
3-0-9 units

See description under subject 5.64[J].
A. Shalek, X. Wang

HST.540[J] Human Physiology
Same subject as 7.20[J]
Prereq: 7.05
U (Fall)
5-0-7 units

See description under subject 7.20[J].
M. Krieger, D. Sabatini

HST.541[J] Cellular Neurophysiology and Computing
Same subject as 2.794[J], 6.521[J], 9.021[J], 20.470[J]
Subject meets with 2.791[J], 6.021[J], 9.21[J], 20.370[J]
Prereq: (Physics II (GIR), 18.03, and (2.005, 6.002, 6.003, 10.301, or 20.110[J])) or permission of instructor
G (Spring)
5-2-5 units

Integrated overview of the biophysics of cells from prokaryotes to neurons, with a focus on mass transport and electrical signal generation across cell membrane. First third of course focuses on mass transport through membranes: diffusion, osmosis, chemically mediated, and active transport. Second third focuses on electrical properties of cells: ion transport to action potential generation and propagation in electrically excitable cells. Synaptic transmission. Electrical properties interpreted via kinetic and molecular properties of single voltage-gated ion channels. Final third focuses on biophysics of synaptic transmission and introduction to neural computing. Laboratory and computer exercises illustrate the concepts. Students taking graduate version complete different assignments.
J. Han, T. Heldt

HST.542[J] Quantitative and Clinical Physiology
Same subject as 2.792[J], 6.022[J]
Subject meets with 2.796[J], 6.522[J]
Prereq: Physics II (GIR), 18.03, or permission of instructor
U (Spring)
4-2-6 units

See description under subject 6.022[J].
T. Heldt, R. G. Mark

HST.552[J] Medical Device Design
Same subject as 2.75[J], 6.525[J]
Subject meets with 2.750[J], 6.025[J]
Prereq: 2.008, 6.101, 6.111, 6.115, 22.071, or permission of instructor
G (Spring)
3-3-6 units

See description under subject 2.75[J]. Enrollment limited.
A. H. Slocum, G. Hom, E. Roche, N. C. Hanumara

HST.560[J] Radiation Biophysics
Same subject as 22.55[J]
Subject meets with 22.055
Prereq: Permission of instructor
Acad Year 2021-2022: G (Spring)
Acad Year 2022-2023: Not offered
3-0-9 units

See description under subject 22.55[J].
Staff

HST.562[J] Pioneering Technologies for Interrogating Complex Biological Systems
Same subject as 9.271[J], 10.562[J]
Prereq: None
G (Spring)
3-0-9 units

Introduces pioneering technologies in biology and medicine and discusses their underlying biological/molecular/engineering principles. Topics include emerging sample processing technologies, advanced optical imaging modalities, and next-gen molecular phenotyping techniques. Provides practical experience with optical microscopy and 3D phenotyping techniques. Limited to 15.
K. Chung

HST.563 Imaging Biophysics and Clinical Applications
Prereq: (8.03 and 18.03) or permission of instructor
Acad Year 2021-2022: G (Spring)
Acad Year 2022-2023: Not offered
2-1-9 units

Introduction to the connections and distinctions among various imaging modalities (x-ray, optical, ultrasound, MRI, PET, SPECT, EEG), common goals of biomedical imaging, broadly defined target of biomedical imaging, and the current practical and economic landscape of biomedical imaging research. Emphasis on applications of imaging research. Final project consists of student groups writing mock grant applications for biomedical imaging research project, modeled after an exploratory National Institutes of Health (NIH) grant application.
C. Catana

HST.565 Medical Imaging Sciences and Applications
Prereq: None
G (Fall)
3-0-9 units

Covers biophysical, biomedical, mathematical and instrumentation basics of positron emission tomography (PET), x-ray and computed tomography (CT), magnetic resonance imaging (MRI), single photon emission tomography (SPECT), optical Imaging and ultrasound. Topics include particles and photon interactions, nuclear counting statistics, gamma cameras, and computed tomography as it pertains to SPECT and PET (PET-CT, PET-MR, time-of-flight PET), MR physics and various sequences, optical and ultrasound physics foundations for imaging. Discusses clinical applications of PET and MR in molecular imaging of the brain, the heart, cancer and the role of AI in medical imaging. Includes medical demonstration lectures of SPECT, PET-CT and PET-MR imaging at Massachusetts General Hospital. Considers the ways imaging techniques are rooted in physics, engineering, and mathematics, and their respective role in anatomic and physiologic/molecular imaging.
G. El Fakhri

HST.576[J] Topics in Neural Signal Processing
Same subject as 9.272[J]
Prereq: Permission of instructor
Acad Year 2021-2022: G (Spring)
Acad Year 2022-2023: Not offered
3-0-9 units

See description under subject 9.272[J].
E. N. Brown

HST.580[J] Data Acquisition and Image Reconstruction in MRI
Same subject as 6.556[J]
Prereq: 6.011
Acad Year 2021-2022: Not offered
Acad Year 2022-2023: G (Fall)
3-0-9 units

See description under subject 6.556[J].
E. Adalsteinsson

HST.582[J] Biomedical Signal and Image Processing (New)
Same subject as 6.555[J], 16.456[J]
Subject meets with 6.026[J], HST.482[J]
Prereq: (6.041 and (2.004, 6.003, 16.002, or 18.085)) or permission of instructor
G (Spring)
3-1-8 units

See description under subject 6.555[J].
J. Greenberg, E. Adalsteinsson, W. Wells

HST.583[J] Functional Magnetic Resonance Imaging: Data Acquisition and Analysis
Same subject as 9.583[J]
Prereq: 18.05 and (18.06 or permission of instructor)
Acad Year 2021-2022: Not offered
Acad Year 2022-2023: G (Fall)
2-3-7 units

Provides background necessary for designing, conducting, and interpreting fMRI studies in the human brain. Covers in depth the physics of image encoding, mechanisms of anatomical and functional contrasts, the physiological basis of fMRI signals, cerebral hemodynamics, and neurovascular coupling. Also covers design methods for stimulus-, task-driven and resting-state experiments, as well as workflows for model-based and data-driven analysis methods for data. Instruction in brain structure analysis and surface- and region-based analyses. Laboratory sessions include data acquisition sessions at the 3 Tesla MRI scanner at MIT and the Connectom and 7 Tesla scanners at the MGH/HST Martinos Center, as well as hands-on data analysis workshops. Introductory or college-level neurobiology, physics, and signal processing are helpful.
J. Polimeni, A. Yendiki

HST.584[J] Magnetic Resonance Analytic, Biochemical, and Imaging Techniques
Same subject as 22.561[J]
Prereq: Permission of instructor
Acad Year 2021-2022: Not offered
Acad Year 2022-2023: G (Spring)
3-0-12 units

Introduction to basic NMR theory. Examples of biochemical data obtained using NMR summarized along with other related experiments. Detailed study of NMR imaging techniques includes discussions of basic cross-sectional image reconstruction, image contrast, flow and real-time imaging, and hardware design considerations. Exposure to laboratory NMR spectroscopic and imaging equipment included.
L. Wald, B. Bilgic

HST.590 Biomedical Engineering Seminar Series
Prereq: None
G (Fall, Spring)
1-0-0 units
Can be repeated for credit.

Seminars focused on the development of professional skills. Each term focuses on a different topic, resulting in a repeating cycle that covers medical ethics, responsible conduct of research, written and oral technical communication, and translational issues. Includes guest lectures, case studies, interactive small group discussions, and role-playing simulations.
J. Behrens, E. Lindemer

HST.599 Research in Health Sciences and Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

For students conducting pre-thesis research or lab rotations in HST, in cases where the assigned research is approved for academic credit by the department. Hours arranged with research supervisor. Restricted to HST students.
Consult Faculty

HST.712[J] Laboratory on the Physiology, Acoustics, and Perception of Speech
Same subject as 6.542[J], 24.966[J]
Prereq: Permission of instructor
G (Spring)
2-2-8 units

See description under subject 6.542[J].
S. Shattuck-Hufnagel, J.-Y. Choi

HST.714[J] Introduction to Sound, Speech, and Hearing
Same subject as 9.016[J]
Prereq: (6.003 and 8.03) or permission of instructor
G (Fall)
4-0-8 units

Introduces students to the acoustics, anatomy, physiology, and mechanics related to speech and hearing. Focuses on how humans generate and perceive speech. Topics related to speech, explored through applications and challenges involving acoustics, speech recognition, and speech disorders, include acoustic theory of speech production, basic digital speech processing, control mechanisms of speech production and basic elements of speech and voice perception. Topics related to hearing include acoustics and mechanics of the outer ear, middle ear, and cochlea, how pathologies affect their function, and methods for clinical diagnosis. Surgical treatments and medical devices such as hearing aids, bone conduction devices, and implants are also covered.
S. S. Ghosh, H. H. Nakajima, S. Puria

HST.716[J] Signal Processing by the Auditory System: Perception
Same subject as 6.552[J]
Prereq: (6.003 and (6.041B or 6.431)) or permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-9 units

See description under subject 6.552[J].
L. D. Braida

HST.718 Anatomy of Speech and Hearing
Prereq: Biology (GIR) and permission of instructor
G (IAP)
2-0-2 units

Studies the anatomy of the human head and neck, with cadaver dissection, stressing structures important in speech and hearing. Lecture topics include basic neuroanatomy, imaging, surgery, and cancer of head and neck. IAP 2021 subject will not include anatomy lab cadaver dissection and lectures will be delivered remotely. Limited to 12; undergraduates admitted based on seniority. Classes held through Harvard Medical School course platform.
B. C. Fullerton

HST.721 Biology of the Inner Ear
Prereq: Permission of instructor
G (Fall)
3-1-8 units

Reviews the normal biology, biophysics, physiology and morphology of the inner ear and auditory nerve, as well as the mechanisms underlying sensorineural hearing loss.
M. C. Liberman, S. F. Maison

HST.723[J] Audition: Neural Mechanisms, Perception and Cognition
Same subject as 9.285[J]
Prereq: Permission of instructor
G (Spring)
6-0-6 units

Neural structures and mechanisms mediating the detection, localization and recognition of sounds. General principles are conveyed by theme discussions of auditory masking, sound localization, musical pitch, cochlear implants, cortical plasticity and auditory scene analysis. Follows Harvard FAS calendar.
J. McDermott, D. Polley, B. Delgutte, M. C. Brown

HST.725 Music Perception and Cognition
Prereq: HST.723[J] or permission of instructor
G (Spring)
Not offered regularly; consult department
4-0-8 units

Survey of perceptual and cognitive aspects of the psychology of music, with special emphasis on underlying neurocomputational representations and mechanisms. Systematically explores basic dimensions of hearing (pitch, timbre, consonance, loudness) and the time sense (duration, temporal pattern) that form our perception of tonal quality, melody, harmony, meter, and rhythm in music. Examines mechanisms responsible for separation of multiple voices/instruments (polyphony), and for melodic and rhythmic grouping of events (musical phrase structure). Special topics include comparative, evolutionary, and developmental psychology of music; biological vs. cultural influences; Gestaltist, associationist, and schema-based theories; music vs. speech perception; music vs. language cognition; music and cortical function, music therapy, and neural basis of music performance.
P. Cariani

HST.728[J] Spoken Language Processing
Same subject as 6.345[J]
Prereq: 6.011 and 6.036
Acad Year 2021-2022: G (Spring)
Acad Year 2022-2023: Not offered
3-1-8 units

See description under subject 6.345[J].
J. R. Glass

HST.914[J] Frontiers in Therapeutics and Drug Delivery
Same subject as 10.644[J]
Prereq: 7.05 or permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-6 units

See description under subject 10.644[J]. Limited to 40.
D. G. Anderson

HST.916[J] Case Studies and Strategies in Drug Discovery and Development
Same subject as 7.549[J], 15.137[J], 20.486[J]
Prereq: None
Acad Year 2021-2022: G (Spring)
Acad Year 2022-2023: Not offered
2-0-4 units

See description under subject 20.486[J].
A. W. Wood

HST.918[J] Economics of Health Care Industries
Same subject as 15.141[J]
Prereq: None
G (Spring; first half of term)
3-0-3 units

See description under subject 15.141[J].
J. Doyle

HST.920[J] Principles and Practice of Drug Development
Same subject as 10.547[J], 15.136[J], IDS.620[J]
Prereq: Permission of instructor
G (Fall)
3-0-6 units

See description under subject 15.136[J].
S. Finkelstein, A. J. Sinskey, R. Rubin

HST.928[J] Engineering Health: Understanding and Designing Affordable Health Diagnostics
Same subject as MAS.534[J]
Prereq: None
G (Fall)
Not offered regularly; consult department
3-1-8 units

See description under subject MAS.534[J].
R. Raskar

HST.929[J] Engineering Health: Designing and Deploying Affordable Health Diagnostics and Therapeutics
Same subject as MAS.535[J]
Prereq: None
G (Spring)
Not offered regularly; consult department
6-0-0 units

See description under subject MAS.535[J].
R. Raskar

HST.936 Global Health Informatics to Improve Quality of Care
Subject meets with HST.937, HST.938
Prereq: None
Acad Year 2021-2022: Not offered
Acad Year 2022-2023: G (Spring)
2-0-1 units

Addresses issues related to how health information systems can improve the quality of care in resource poor settings. Discusses key challenges and real problems; design paradigms and approaches; and system evaluation and the challenges of measuring impact. Weekly lectures led by internationally recognized experts in the field. Students taking HST.936, HST.937 and HST.938 attend common lectures; assignments and laboratory time differ. HST.936 has no laboratory.
L. G. Celi, H. S. Fraser, V. Nikore, K. Paik, M. Somai

HST.937 Global Health Informatics to Improve Quality of Care
Subject meets with HST.936, HST.938
Prereq: None
Acad Year 2021-2022: Not offered
Acad Year 2022-2023: G (Spring)
2-2-2 units

Addresses issues related to how health information systems can improve the quality of care in resource poor settings. Discusses key challenges and real problems; design paradigms and approaches; and system evaluation and the challenges of measuring impact. Weekly lectures led by internationally recognized experts in the field. Students taking HST.936, HST.937 and HST.938 attend common lectures; assignments and laboratory time differ. HST.936 has no laboratory.
L. G. Celi, H. S. Fraser, V. Nikore, K. Paik. M. Somai

HST.938 Global Health Informatics to Improve Quality of Care
Subject meets with HST.936, HST.937
Prereq: None
Acad Year 2021-2022: Not offered
Acad Year 2022-2023: G (Spring)
2-2-8 units

Addresses issues related to how health information systems can improve the quality of care in resource poor settings. Discusses key challenges and real problems; design paradigms and approaches; and system evaluation and the challenges of measuring impact. Weekly lectures led by internationally recognized experts in the field. Students taking HST.936, HST.937 and HST.938 attend common lectures; assignments and laboratory time differ. HST.936 has no laboratory.
L. G. Celi, H. S. Fraser, V. Nikore, K. Paik, M. Somai

HST.940[J] Bioinformatics: Principles, Methods and Applications
Same subject as 10.555[J]
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units

See description under subject 10.555[J].
Gr. Stephanopoulos, I. Rigoutsos

HST.953 Collaborative Data Science in Medicine
Prereq: Permission of instructor
G (Fall)
3-0-9 units

A guide for students who are interested in performing retrospective research using data from electronic health records (Medical Information Mart for Intensive Care or MIMIC database and the eICU Collaborative Research Database). Covers steps in parsing a clinical question into a study design and methodology for data analysis and interpretation, but the emphasis is on the data curation that is required before any analysis can be performed. Activities include review of case studies using the MIMIC and the eICU CRD, and a team project. Student teams choose a question and clinician to work with for their project. Teams meet weekly with clinicians at the hospitals at pre-arranged time.
L. A. Celi, J. Raffa, T. Pollard, A. Johnson

HST.956[J] Machine Learning for Healthcare (New)
Same subject as 6.871[J]
Prereq: 6.034, 6.036, 6.438, 6.806, 6.867, or 9.520[J]
G (Spring)
4-0-8 units

Introduces students to machine learning in healthcare, including the nature of clinical data and the use of machine learning for risk stratification, disease progression modeling, precision medicine, diagnosis, subtype discovery, and improving clinical workflows. Topics include causality, interpretability, algorithmic fairness, time-series analysis, graphical models, deep learning and transfer learning. Guest lectures by clinicians from the Boston area, and projects with real clinical data, emphasize subtleties of working with clinical data and translating machine learning into clinical practice. Limited to 55.
D. Sontag, P. Szolovits

HST.962 Medical Product Development and Translational Biomedical Research
Prereq: Permission of instructor
G (Spring; second half of term)
1-0-3 units

Explores the translation of basic biomedical science into therapies. Topics span pharmaceutical, medical device, and diagnostics development. Exposes students to strategic assessment of clinical areas, product comparison, regulatory risk assessment by indication, and rational safety program design. Develops quantitative understanding of statistics and trial design.
M. Cima

HST.971[J] Strategic Decision Making in the Life Sciences
Same subject as 15.363[J]
Prereq: None
G (Spring)
3-0-6 units

See description under subject 15.363[J].
J. Fleming, A. Zarur

HST.972[J] Medicine for Managers and Entrepreneurs Proseminar
Same subject as 15.132[J]
Prereq: None
G (Spring)
3-0-6 units

See description under subject 15.132[J].
R. J. Cohen

HST.973[J] Evaluating a Biomedical Business Concept
Same subject as 15.124[J]
Prereq: None
Acad Year 2021-2022: Not offered
Acad Year 2022-2023: G (Fall)
3-0-6 units

Involves critical analysis of new biomedical business ideas. Inventors or principals of early stage companies present their ideas and provide background material including scientific papers and patents. Student teams interact with the companies, potential customers, other stakeholders and experts to develop a series of analyses concerning the critical issues. Company and student presentations supplemented by topic-specific lectures and presentations by biomedical entrepreneurs. Enrollment limited.
R. J. Cohen

HST.978[J] Healthcare Ventures
Same subject as 15.367[J]
Prereq: None
G (Spring)
3-0-9 units

Addresses healthcare entrepreneurship with an emphasis on startups bridging care re-design, digital health, medical devices, and high-tech. Includes prominent speakers and experts from key domains across medicine, pharma, med devices, regulatory, insurance, software, design thinking, entrepreneurship, and investing. Provides practical experiences in venture validation/ creation through team-based work around themes. Illustrates best practices in identifying and validating health venture opportunities amid challenges of navigating healthcare complexity, team dynamics, and venture capital raising process. Intended for students from engineering, medicine, public health, and MBA programs. Video conference facilities provided to facilitate remote participation by Executive MBA and traveling students.
M. Gray, Z. Chu

HST.980 Emerging Problems in Infectious Diseases
Prereq: None
G (IAP)
1-0-2 units

Introduces contemporary challenges in preventing, detecting, diagnosing and treating emerging and newly emerging pathogens. Provides students with team-based opportunities to brainstorm, propose and present innovative solutions to such challenges. Expert lecturers discuss emerging problems in infectious diseases. Includes brainstorming sessions in which student teams identify problems in infectious diseases and propose innovative solutions. The teams then prepare and deliver short presentations, outlining identified problems and solutions.
J. J. Collins

HST.999 Practical Experience in Health Sciences and Technology
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

For HST students who seek practical off-campus research experiences or internships related to health sciences and technology. Before enrolling, students must have a written offer from the outside organization, approval from their HST thesis supervisor (not required for summer registration), and approval of HST's Academic Office. Upon completion of the activity, the student must submit a letter from the employer describing the work accomplished, along with a substantive final report written by the student. Consult HST's Academic Office for details on procedures and restrictions.
J. Greenberg

HST.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research leading to the writing of a PhD or ScD thesis or an HST SM thesis; to be arranged by the student and an appropriate faculty advisor.
Faculty

HST.UR Undergraduate Research in Health Sciences and Technology
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Extended participation in the work of a faculty member or research group. Research is arranged by mutual agreement between the student and a member of the faculty of the Harvard-MIT Program Health Sciences and Technology, and may continue over several terms. Registration requires submission of a written proposal to the MIT UROP, signed by the faculty supervisor and approved by the department. A summary report must be submitted at the end of each term.
J. Greenberg

HST.URG Undergraduate Research in Health Sciences and Technology
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Extended participation in the work of a faculty member or research group. Research is arranged by mutual agreement between the student and a member of the faculty of the Harvard-MIT Program in Health Sciences and Technology, and may continue over several terms. Registration requires submission of a written proposal to the MIT UROP Office; signed by the faculty supervisor and approved by the department. A summary report must be submitted at the end of each term.
J. Greenberg

HST.S16 Special Graduate Subject: Health Sciences and Technology
Prereq: None
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Opportunity for group study of advanced subjects related to Health Sciences and Technology not otherwise included in the curriculum. Offerings are initiated by IMES/HST faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.
IMES/HST Faculty

HST.S17 Special Graduate Subject: Health Sciences and Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Opportunity for group study of advanced subjects related to Health Sciences and Technology not otherwise included in the curriculum. Offerings are initiated by IMES/HST faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.
IMES/HST Faculty

HST.S18 Special Graduate Subject: Health Sciences and Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Opportunity for group study of advanced subjects related to Health Sciences and Technology not otherwise included in the curriculum. Offerings are initiated by IMES/HST faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.
IMES/HST Faculty

HST.S19 Special Graduate Subject: Health Sciences and Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Opportunity for group study of advanced subjects related to Health Sciences and Technology not otherwise included in the curriculum. Offerings are initiated by IMES/HST faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.
IMES/HST Faculty

HST.S46 Special Undergraduate Subject: Health Sciences and Technology
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Group study of subjects related to health sciences and technology not otherwise included in the curriculum. Prerequisites may vary by topic; consult faculty at time of offering.
IMES/HST Faculty

HST.S47 Special Undergraduate Subject: Health Sciences and Technology
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Group study of subjects related to health sciences and technology not otherwise included in the curriculum. Prerequisites may vary by topic; consult faculty at time of offering.
IMES/HST Faculty

HST.S48 Special Undergraduate Subject: Health Sciences and Technology
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Group study of subjects related to health sciences and technology not otherwise included in the curriculum. Prerequisites may vary by topic; consult faculty at time of offering.
IMES/HST Faculty

HST.S49 Special Undergraduate Subject: Health Sciences and Technology
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Group study of subjects related to health sciences and technology not otherwise included in the curriculum. Prerequisites may vary by topic; consult faculty at time of offering.
IMES/HST Faculty

HST.S56 Special Graduate Subject: Medical Engineering and Medical Physics
Prereq: Permission of instructor
G (Fall)
Units arranged [P/D/F]
Can be repeated for credit.

Opportunity for group study of advanced subjects related to the Medical Engineering and Medical Physics Program not otherwise included in the curriculum. Offerings are initiated by IMES/HST faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.
IMES/HST Faculty

HST.S57 Special Graduate Subject: Medical Engineering and Medical Physics
Prereq: Permission of instructor
G (Fall)
Units arranged [P/D/F]
Can be repeated for credit.

Opportunity for group study of advanced subjects related to the Medical Engineering and Medical Physics Program not otherwise included in the curriculum. Offerings are initiated by IMES/HST faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.
IMES/HST Faculty

HST.S58 Special Subject: Medical Engineering and Medical Physics
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Opportunity for group study of advanced subjects related to the Medical Engineering and Medical Physics Program not otherwise included in the curriculum. Offerings are initiated by HST faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.
HST Faculty

HST.S59 Special Graduate Subject: Medical Engineering and Medical Physics
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Opportunity for group study of advanced subjects related to the Medical Engineering and Medical Physics Program not otherwise included in the curriculum. Offerings are initiated by IMES/HST faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.
IMES/HST Faculty

HST.S78 Special Subject: Speech and Hearing Sciences
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Opportunity for group study of advanced subjects related to the Speech and Hearing Sciences not otherwise included in the curriculum. Offerings initiated by members of the SHS faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.
P. Cariani

HST.S96 Special Graduate Subject: Biomedical Entrepreneurship
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Opportunity for group study of advanced subjects relating to biomedical entrepreneurship not otherwise included in the curriculum. Offerings are initiated by HST/IMES faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic. Consult faculty at time of offering.
HST/IMES Faculty

HST.S97 Special Graduate Subject: Biomedical Entrepreneurship
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Opportunity for group study of advanced subjects relating to biomedical entrepreneurship not otherwise included in the curriculum. Offerings are initiated by HST faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic. Consult faculty at time of offering.
HST Faculty

HST.S98 Special Graduate Subject: Biomedical Entrepreneurship
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit.

Opportunity for group study of advanced subjects relating to biomedical entrepreneurship not otherwise included in the curriculum. Offerings are initiated by HST faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic. Consult faculty at time of offering.
M. Gray, F. Murray

HST.S99 Special Graduate Subject: Biomedical Entrepreneurship
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Opportunity for group study of advanced subjects relating to biomedical entrepreneurship not otherwise included in the curriculum. Offerings are initiated by HST faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic. Consult faculty at time of offering.
HST/IMES Faculty