

## HEALTH SCIENCES AND TECHNOLOGY (HST)

*IMPORTANT NOTES regarding preclinical subjects (HST.011-HST.176 and HST.191):*

*Students not enrolled in an HST graduate degree 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 students 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.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: Permission of Instructor

G (IAP)

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*

### HST.031 Human Pathology

Subject meets with HST.030

Prereq: Biology (GIR), Physics I (GIR), 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, 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.

*C. Crumpacker II, H. Simon*

### **HST.061 Endocrinology**

Subject meets with HST.060

Prereq: Biology (GIR), 7.05, 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. Kettle, D. Breault*

### **HST.071 Human Reproductive Biology**

Subject meets with HST.070

Prereq: 7.05, 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, O. Pourquie*

### **HST.081 Hematology**

Subject meets with HST.080

Prereq: 7.05, 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.

*N. Berliner*

### **HST.091 Cardiovascular Pathophysiology**

Subject meets with HST.090

Prereq: HST.030 or HST.031; 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, 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.

*J. Drazen, S. Loring*

**HST.111 Renal Pathophysiology**

Subject meets with HST.110

Prereq: 7.05, 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.

*J. Seifter, A. Lam*

**HST.121 Gastroenterology**

Subject meets with HST.120

Prereq: Biology (GIR), 7.05, Physics I (GIR), 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.

*I. M. London, V. Sankaran, S. Agarwal*

**HST.147 Human Biochemistry and Metabolic Diseases**

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.

*M. Larvie, S. Biddinger*

### **HST.151 Principles of Pharmacology**

Subject meets with HST.150

Prereq: Biology (GIR), 7.05, Physics I (GIR)

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.

*C. Rosow, S. Forman*

### **HST.161 Genetics in Modern Medicine**

Subject meets with HST.160

Prereq: 7.05

G (Fall; first 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.

*HST Faculty*

### **HST.163 Molecular Diagnostics and Bioinformatics**

Subject meets with HST.162

Prereq: HST.160

G (Fall; second 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, M. Bianchi*

**HST.194 Clinical Epidemiology (New)**

Subject meets with HST.195

Prereq: HST.190

G (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.195 Clinical Epidemiology (New)**

Subject meets with HST.194

Prereq: HST.190

G (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 in HST where the teaching assignment is approved for academic credit by the department.

*Staff*

**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, as well as a substantive paper.

Minimum 12 units required.

*Consult HST Faculty*

**HST.199 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 research assistants in HST where the assigned research is approved for academic credit by the department. Hours are arranged with research supervisor.

*S. S. Pillai, R. L. Maas, S. P. Balk, M. L. Bulyk, A. Rosenzweig*

**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*

**HST.201 Introduction to Clinical Medicine and Medical Engineering I**

Prereq: Permission of instructor  
G (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.

*R. G. Mark, 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.

*R. G. Mark, A. Chabrerie, 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 (IAP, 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)

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.299 Research in Health Sciences and Technology**

Prereq: Permission of instructor

G (Fall, Spring, Summer)

Units arranged [P/D/F]

For research assistants in HST where the assigned research is approved for academic credit by the department. Hours are arranged with research supervisor. Restricted to HST MD students in clinical phase of program.

*HST Staff***HST.420[J] Principles and Practice of Assistive Technology**

Same subject as 2.78[J], 6.811[J]

Prereq: Permission of instructor

U (Fall)

2-4-6 units

See description under subject 6.811[J].

*R. C. Miller, J. E. Greenberg, J. J. Leonard***HST.426 Maker Lab: Creating Technologies to Re-invent Health Care**

Prereq: None

U (Spring)

1-3-8 units

Students work in teams to design do-it-yourself medical technologies, creative biosensors, and health construction kits to create accessible, patient-centered solutions. Covers affordable prototyping and design strategies for application in the American healthcare system and in low-resource settings. Explores the diverse possibilities that result from patient-designed solutions. Labs address paper diagnostics, microcontroller applications, wearable sensors, mobile health application design, and health kit architectures. Preference to undergraduates; open to graduate students with permission of instructor.

*L. Gehrke, J. Gomez-Marquez, A. Young*

**HST.431[] Infections and Inequalities: Interdisciplinary Perspectives on Global Health**

Same subject as 7.331[], 21A.331[]

Prereq: None

Acad Year 2017-2018: Not offered

Acad Year 2018-2019: U (Spring)

3-0-9 units. HASS-S

See description under subject 21A.331[] Limited to 25.

*E. James, D. Kim, A. Chakraborty*

**HST.450[] Biological Physics**

Same subject as 8.593[]

Prereq: 8.044 recommended but not necessary

Acad Year 2017-2018: G (Spring)

Acad Year 2018-2019: Not offered

4-0-8 units

See description under subject 8.593[].

*G. Benedek*

**HST.452[] Statistical Physics in Biology**

Same subject as 8.592[]

Prereq: 8.333 or permission of instructor

Acad Year 2017-2018: G (Spring)

Acad Year 2018-2019: 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[] Statistics for Neuroscience Research**

Same subject as 9.073[]

Prereq: Permission of instructor

Acad Year 2017-2018: Not offered

Acad Year 2018-2019: G (Spring)

3-0-9 units

See description under subject 9.073[].

*E. N. Brown*

**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, S. Jhaveri*

**HST.506[] Computational Systems Biology**

Same subject as 6.874[]

Subject meets with 6.802[], 20.390[], 20.490

Prereq: Biology (GIR); 18.600 or 6.041B

G (Spring)

3-0-9 units

See description under subject 6.874[].

*D. K. Gifford*

**HST.507[] Advanced Computational Biology: Genomes, Networks, Evolution**

Same subject as 6.878[]

Subject meets with 6.047

Prereq: 6.006, 6.041B, Biology (GIR); or permission of instructor

G (Fall)

4-0-8 units

See description under subject 6.878[].

*M. Kellis*

**HST.508 Quantitative Genomics**

Prereq: Permission of instructor

G (Fall)

3-0-9 units

Provides in-depth quantitative understanding of evolutionary and population genetics, comparative and clinical genomics. Each module consists of a series of lectures, a journal club discussion of high impact publications, and lectures that provide clinical correlates. Homework assignments and final projects aim to develop understanding of genomic data from evolutionary principles.

*S. Sunyaev, L. Mirny*

**HST.514[] Sensory-Neural Systems: Spatial Orientation from End Organs to Behavior and Adaptation**

Same subject as 16.430[]

Prereq: Permission of instructor

G (Spring)

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[] Aerospace Biomedical and Life Support Engineering**

Same subject as 16.423[], IDS.337[]

Prereq: 16.400, 16.06, or permission of instructor

G (Spring)

3-1-8 units

See description under subject 16.423[].

*D. J. Newman***HST.516 Circadian Biology: From Cellular Oscillators to Sleep Regulation**

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***HST.518[] Human Systems Engineering**

Same subject as 16.453[]

Subject meets with 16.400

Prereq: 6.041B, 16.09, or permission of instructor

G (Fall)

3-0-9 units

See description under subject 16.453[].

*L. A. Stirling***HST.522[] Biomaterials: Tissue Interactions**

Same subject as 2.79[]

Prereq: Chemistry (GIR), Biology (GIR), 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[] Cell-Matrix Mechanics**

Same subject as 2.785[]

Prereq: 2.001, or 2.01 and 2.02A; Chemistry (GIR), Biology (GIR); or permission of instructor

Acad Year 2017-2018: Not offered

Acad Year 2018-2019: G (Fall)

3-0-9 units

See description under subject 2.785[].

*I. V. Yannas, M. Spector***HST.524[] Design of Medical Devices and Implants**

Same subject as 2.782[]

Prereq: Chemistry (GIR), Biology (GIR), Physics I (GIR); or permission of instructor

G (Spring)

3-0-9 units

See description under subject 2.782[].

*I. V. Yannas, M. Spector*

**HST.525[] Tumor Microenvironment and Transport Phenomena: A Systems Biology Approach**

Same subject as 10.548[]  
Prereq: 18.03; 10.301  
Acad Year 2017-2018: G (Fall)  
Acad Year 2018-2019: Not offered  
2-0-4 units

Studies the critical role tumor microenvironment plays in the growth, invasion, metastasis and treatment of solid tumors. Applies principles of transport phenomena to develop a systems-level, quantitative understanding of angiogenesis, blood flow, extracellular matrix, stromal cells, local and transiting immune cells, transport and binding of small and large molecules, movement of cancer and immune cells, metastatic process, and response to conventional and emerging therapies, including immunotherapy.  
*R. K. Jain*

**HST.526[] Future Medicine: Drug Delivery, Therapeutics, and Diagnostics**

Same subject as 10.643[]  
Subject meets with 10.443  
Prereq: 5.12 or permission of instructor  
G (Spring)  
3-0-6 units

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

**HST.527 Blood Vessels and Endothelial Phenotypes in Health and Disease**

Prereq: Permission of instructor  
G (Spring)  
2-0-4 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 xenotransplantation. 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 2017-2018: G (Spring)  
Acad Year 2018-2019: 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 Optimization Problems in Radiation Therapy and Medical Imaging**

Prereq: 18.06  
G (Spring)  
Not offered regularly; consult department  
2-0-4 units

Discusses mathematical problems that arise in radiation therapy planning, from imaging to treatment. Provides an introduction to treatment plan optimization, image reconstruction, and selected topics in image processing. Goes on to lead students towards cutting edge research topics in the field.

*B. Winey, J. Schuemann*

**HST.535 Principles and Practice of Tissue Engineering/  
Regenerative Medicine (TERM)**

Prereq: Chemistry (GIR), Biology (GIR), Physics I (GIR); or permission of instructor

G (Spring)

3-0-9 units

Engineering and clinical leaders present the principles and practice of tissue engineering (TE) and regenerative medicine (RM). 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 principles underlying 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* (RM). Describes the methodologies 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[] Fluid Dynamics and Disease**

Same subject as 1.631[], 2.250[]

Prereq: None

G (Spring)

3-0-9 units

See description under subject 1.631[].

*L. Bourouiba*

**HST.539[] Frontiers of Interdisciplinary Science in Human  
Health and Disease**

Same subject as 5.64[]

Prereq: 5.13, 5.60; 5.07[] or 7.05

G (Spring)

3-0-9 units

See description under subject 5.64[].

*A. Shalek*

**HST.540[] Human Physiology**

Same subject as 7.20[]

Prereq: 7.05

U (Fall)

5-0-7 units

See description under subject 7.20[].

*M. Krieger, D. Sabatini*

**HST.541[] Cellular Neurophysiology and Computing**

Same subject as 2.794[], 6.521[], 9.021[], 20.470[]

Subject meets with 2.791[], 6.021[], 9.21[], 20.370[]

Prereq: Physics II (GIR); 18.03; 2.005, 6.002, 6.003, 6.071, 10.301, 20.110[], or permission of instructor

G (Fall)

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[] Quantitative Systems Physiology**

Same subject as 2.792[], 6.022[]

Subject meets with 2.796[], 6.522[]

Prereq: Physics II (GIR), 18.03, or permission of instructor

U (Spring)

4-2-6 units

See description under subject 6.022[].

*T. Heldt, R. G. Mark*

**HST.545 Physiological Systems Analysis**

Prereq: 18.03, 18.06

U (Fall)

3-3-6 units

A survey of systems theory with applications from bioengineering and physiology. Analysis: differential equations, linear and nonlinear systems, stability, the complementary nature of time and frequency domain methods, feedback, and biological oscillations. Applications: nerve function, muscle dynamics, cardiovascular regulation. Laboratory: neural models, feedback control systems, properties of muscle, cardiovascular function. Follows Harvard FAS calendar.

*Staff*

### **HST.552[] Medical Device Design**

Same subject as 2.75[], 6.525[]

Subject meets with 2.750[], 6.025[]

Prereq: 2.008, 6.101, 6.111, 6.115, 22.071, or permission of instructor  
G (Fall)

3-0-9 units

See description under subject 2.75[]. Enrollment limited.

*A. H. Slocum, G. Hom, E. Roche, N. C. Hanumara*

### **HST.560[] Radiation Biophysics**

Same subject as 22.55[]

Subject meets with 22.055

Prereq: Permission of instructor

Acad Year 2017-2018: G (Spring)

Acad Year 2018-2019: Not offered

3-0-9 units

See description under subject 22.55[].

*Staff*

### **HST.562[] Pioneering Technologies for Interrogating Complex Biological Systems**

Same subject as 10.562[]

Prereq: None

G (Spring)

3-1-8 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: 18.03, 8.03; or permission of instructor

Acad Year 2017-2018: Not offered

Acad Year 2018-2019: G (Spring)

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 the biophysical, 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 (including PET-CT, PET-MR, and time-of-flight PET). Discusses the clinical applications of PET and MR in molecular imaging of the brain, the heart, and cancer. Includes a practical demonstration of SPECT and PET-CT imaging at the Massachusetts General Hospital. Considers the ways in which these imaging techniques are rooted in physics, engineering, and mathematics as well as their respective role in anatomic and physiologic/molecular imaging.

*G. El Fakhri*

### **HST.576[] Topics in Neural Signal Processing**

Same subject as 9.272[]

Prereq: Permission of instructor

Acad Year 2017-2018: G (Spring)

Acad Year 2018-2019: Not offered

3-0-9 units

See description under subject 9.272[].

*E. N. Brown*

### **HST.580[] Data Acquisition and Image Reconstruction in MRI**

Same subject as 6.556[]

Prereq: 6.011

G (Fall)

3-0-9 units

See description under subject 6.556[].

*E. Adalsteinsson*

**HST.582[] Biomedical Signal and Image Processing**

Same subject as 6.555[], 16.456[]

Prereq: 6.003, 2.004, 16.002, or 18.085

G (Spring)

3-3-6 units

Fundamentals of digital signal processing with emphasis on problems in biomedical research and clinical medicine. Basic principles and algorithms for processing both deterministic and random signals. Topics include data acquisition, imaging, filtering, coding, feature extraction, and modeling. Lab projects, performed in MATLAB, provide practical experience in processing physiological data, with examples from cardiology, speech processing, and medical imaging. Lectures cover signal processing topics relevant to the lab exercises, as well as background on the biological signals processed in the labs.

*J. Greenberg, E. Adalsteinsson, W. Wells***HST.583[] Functional Magnetic Resonance Imaging: Data Acquisition and Analysis**

Same subject as 9.583[]

Prereq: 18.05; 18.06 or permission of instructor

Acad Year 2017-2018: G (Fall)

Acad Year 2018-2019: Not offered

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.

*S. Whitfield-Gabrieli, J. Polimeni, A. Yendiki***HST.584[] Magnetic Resonance Analytic, Biochemical, and Imaging Techniques**

Same subject as 22.561[]

Prereq: Permission of instructor

Acad Year 2017-2018: G (Spring)

Acad Year 2018-2019: Not offered

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, K. Setsompop***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.

*HST Faculty***HST.598 Research in Health Sciences and Technology**

Prereq: None

U (Fall, IAP, Spring, Summer)

Units arranged

Can be repeated for credit.

For undergraduates desiring to carry on substantial projects of their own choosing in biomedical sciences or engineering. Work may be of experimental, theoretical, or design nature. A project proposal is required at time of registration.

*Consult HST Faculty***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 research in HST, in cases where the assigned research is approved for academic credit by the department. Hours arranged with research supervisor.

*Consult HST 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].

*L. D. Braida, S. Shattuck-Hufnagel, J.-Y. Choi*

**HST.714[J] Acoustics, Production and Perception of Speech**

Same subject as 9.016[J]

Prereq: 8.03, 6.003; or permission of instructor

G (Fall)

4-0-8 units

Reviews the physical processes involved in the production and propagation of sound, and acoustics related to hearing. Particular attention to how the acoustics and mechanics of the speech and auditory system define what sounds we are capable of producing and how we sense sound. Introduces acoustic theory of speech production, digital speech processing, and neural mechanisms of speech production and perception. Exposes students to applications around acoustics, recognition, and speech disorders. Also introduces analysis of various types of sounds. Includes take-home laboratory assignments and discussions of classic papers.

*S. S. Ghosh, H. H. Nakajima*

**HST.716[J] Signal Processing by the Auditory System: Perception**

Same subject as 6.552[J]

Prereq: 6.003; 6.041B or 6.431B; or permission of instructor

Acad Year 2017-2018: Not offered

Acad Year 2018-2019: G (Fall)

3-0-9 units

See description under subject 6.552[J].

*L. D. Braida*

**HST.718 Anatomy of Speech and Hearing**

Prereq: Biology (GIR), permission of instructor

G (IAP)

2-2-2 units

Studies the anatomy of the human head and neck, focusing on structures involved in speech and hearing. Covers general organization of the nervous system and control of the peripheral structures. Involves dissection of a human cadaver, examination of brain specimens, and analysis of cross-sectional radiographic images. Limited to 12; undergraduates admitted based on seniority.

*B. C. Fullerton*

**HST.721 The 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] Neural Coding and Perception of Sound**

Same subject as 9.285[J]

Prereq: Permission of instructor

G (Spring)

3-1-8 units

Neural structures and mechanisms mediating the detection, localization, and recognition of sounds. Discussion of how acoustic signals are coded by auditory neurons, the impact of these codes on behavioral performance, and the circuitry and cellular mechanisms underlying signal transformations. Topics include temporal coding, neural maps and feature detectors, learning and plasticity, and feedback control. General principles are conveyed by theme discussions of auditory masking, sound localization, musical pitch, cochlear implants, and auditory scene analysis. Follows Harvard FAS calendar.

*B. Delgutte, M. C. Brown, J. McDermott, D. Polley*

**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[] Automatic Speech Recognition**

Same subject as 6.345[]

Prereq: 6.011, 6.036

Acad Year 2017-2018: Not offered

Acad Year 2018-2019: G (Spring)

3-1-8 units

See description under subject 6.345[].

*J. R. Glass, V. W. Zue*

**HST.914[] Frontiers in Therapeutics and Drug Delivery**

Same subject as 10.644[]

Prereq: 7.05 or permission of instructor

G (Fall)

Not offered regularly; consult department

3-0-6 units

See description under subject 10.644[]]. Limited to 40.

*D. G. Anderson*

**HST.916[] Case Studies and Strategies in Drug Discovery and Development**

Same subject as 7.549[], 15.137[], 20.486[]

Prereq: None

G (Spring)

2-0-4 units

See description under subject 20.486[]].

*S. R. Tannenbaum, A. J. Sinskey, A. W. Wood*

**HST.918[] Economics of Health Care Industries**

Same subject as 15.141[]

Prereq: Permission of instructor

G (Spring; first half of term)

3-0-3 units

See description under subject 15.141[]].

*J. Doyle*

**HST.920[] Principles and Practice of Drug Development**

Same subject as 7.547[], 10.547[], 15.136[], IDS.620[]

Prereq: Permission of instructor

G (Fall)

3-0-6 units

See description under subject 15.136[]].

*T. J. Allen, C. L. Cooney, S. N. Finkelstein, A. J. Sinskey, G. K. Raju*

**HST.928[] Engineering Health: Understanding and Designing Affordable Health Diagnostics**

Same subject as MAS.534[]

Prereq: None

Acad Year 2017-2018: Not offered

Acad Year 2018-2019: G (Fall)

3-1-8 units

See description under subject MAS.534[]].

*R. Raskar*

**HST.929[] Engineering Health: Designing and Deploying Affordable Health Diagnostics and Therapeutics**

Same subject as MAS.535[]

Prereq: None

G (Spring)

6-0-0 units

See description under subject MAS.535[]].

*R. Raskar*

**HST.936 Global Health Informatics to Improve Quality of Care**

Subject meets with HST.937, HST.938

Prereq: None

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

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

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[] Bioinformatics: Principles, Methods and Applications**

Same subject as 10.555[]

Prereq: Permission of instructor

G (Spring)

3-0-9 units

See description under subject 10.555[].

*Gr. Stephanopoulos, I. Rigoutsos*

**HST.950[] Biomedical Computing**

Same subject as 6.872[]

Prereq: 6.034, 6.036, or permission of instructor

G (Fall)

3-0-9 units

See description under subject 6.872[].

*G. Alterovitz, P. Szolovits*

**HST.953 Collaborative Data Science in Medicine**

Prereq: Permission of instructor

G (Fall)

3-0-9 units

A guide for data scientists, engineers, and clinicians who are interested in performing retrospective research using data from electronic health records. Instruction provided in clinical decision-making and secondary use of clinical data, using the Medical Information Mart for Intensive Care (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. Activities include review of case studies using the MIMIC and the eICU Collaborative Research Database 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 arranged time.

*L. A. Celi, J. Raffa, T. Pollard, A. Johnson*

**HST.962 Medical Product Development and Translational Biomedical Research**

Prereq: Permission of instructor

G (Spring; first 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[] Strategic Decision Making in the Life Sciences**

Same subject as 15.363[]

Prereq: None

G (Fall)

3-0-6 units

See description under subject 15.363[].

*J. Fleming, A. Zarur*

**HST.972[] Medicine for Managers and Entrepreneurs Proseminar**

Same subject as 15.132[]

Prereq: None

G (Spring)

3-0-6 units

See description under subject 15.132[].

*R. J. Cohen*

**HST.973[] Evaluating a Biomedical Business Concept**

Same subject as 15.124[]

Prereq: None

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.977[J] Critical Reading and Technical Assessment of Biomedical Information**

Same subject as 15.122[J]

Prereq: SB degree in Biological Science or permission of instructor  
G (Spring; first half of term)

1-0-2 units

Gain experience in critical reading of scientific literature, including patents, journal articles and FDA labels, with an emphasis on analyzing clinical controversies and emerging technologies in subject areas that have been or could become sources of entrepreneurial activity. Students required to analyze a variety of topics in the scientific literature, including screening for and cost-effectiveness of early detection of cancer, therapeutic opportunities in oncology, evaluation of immunotoxins and antibody therapies, and new prospects for the treatment of autoimmune disorders. To support the discussion of these topics, outside experts may be invited to participate as facilitators.

*S. Lapidus, J. Karp*

**HST.978[J] Healthcare Ventures**

Same subject as 15.367[J]

Prereq: 15.910; 15.390 or 10.391[J] or 10.579[J]

G (Spring)

3-0-9 units

Focuses on entrepreneurship, with emphasis on startups bridging digital health and high-tech. Explores US and global macro trends and case studies. Features lectures by leading healthcare entrepreneurs and venture investors, and provides practical experience in networking through team projects. Evaluation based on team participation and assignments, including two team presentations. Video conference facilities provided to facilitate remote participation by Executive MBA and traveling students. Enrollment by application only. Enrollment by application only

*M. Gray, Z. Chu*

**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 MIT faculty advisor.

*HST 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 Division of Health Sciences and Technology, and may continue over several terms. Registration requires submission of a written proposal, signed by the faculty supervisor. 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 Division of Health Sciences and Technology, and may continue over several terms. Registration requires submission of a written proposal, signed by the faculty supervisor. A summary report must be submitted at the end of each term.

*J. Greenberg*

**HST.S14 Special Subject: Health Sciences and Technology**

Prereq: None

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 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.S15 Special Subject: Health Sciences and Technology**

Prereq: None

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 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.S16 Special Subject: Health Sciences and Technology**

Prereq: None

G (Spring; first half of term)

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 HST faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.

*M. Hernan*

**HST.S17 Special 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 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.S18-HST.S19 Special 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 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.S46 Special Subject: Health Sciences and Technology**

Prereq: None

U (IAP)

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.

*B. Walker, H. Heller*

**HST.S47 Special Subject: Health Sciences and Technology**

Prereq: None

U (IAP)

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.

*HST Faculty*

**HST.S48-HST.S49 Special Subject: Health Sciences and Technology**

Prereq: None

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.

*HST Faculty*

**HST.S52 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 MEMP faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.

*HST Faculty*

**HST.S53 Special Subject: Medical Engineering and Medical Physics**

Prereq: None  
 G (Spring)  
 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 MEMP faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.

*D. Sontag*

**HST.S54 Special Subject: Medical Engineering and Medical Physics**

Prereq: None  
 G (Fall, IAP, Spring)  
 Not offered regularly; consult department  
 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 MEMP faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.

*HST Faculty*

**HST.S55 Special Subject: Medical Engineering and Medical Physics**

Prereq: None  
 G (IAP)  
 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 MEMP faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.

*J. Collins*

**HST.S56 Special Subject: Medical Engineering and Medical Physics**

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 the Medical Engineering and Medical Physics Program not otherwise included in the curriculum. Offerings are initiated by MEMP faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.

*HST Faculty*

**HST.S57 Special Subject: Medical Engineering and Medical Physics**

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 the Medical Engineering and Medical Physics Program not otherwise included in the curriculum. Offerings are initiated by MEMP faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.

*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 MEMP faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.

*Staff*

**HST.S59 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 MEMP faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.

*HST Faculty*

**HST.S76 Special Subject: Speech and Hearing Sciences**

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 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.

*SHBT Faculty*

**HST.S77 Special Subject: Speech and Hearing Sciences**

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 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.

*SHBT Faculty*

**HST.S78 Special Subject: Speech and Hearing Sciences**

Prereq: Permission of instructor  
G (IAP)  
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.S79 Special Subject: Speech and Hearing Sciences**

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 Speech and Hearing Sciences not otherwise included in the curriculum. Offerings initiated by members of the SHBT faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.

*SHBT Faculty*

**HST.S96 Special Subject: Biomedical Enterprise**

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 enterprise 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.

*S. Lapidus, T. C. Meyers, M. Gray*

**HST.S97 Special Subject: Biomedical Enterprise**

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 enterprise 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-HST.S99 Special Subject: Biomedical Enterprise**

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 enterprise 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*