

Tufts University School of Medicine

Description of Required Courses and Core Clerkships

First Year Courses*

Scientific Foundations of Medicine I (MedFoundations I)

Clinical Presentations

A series of six presentations create a framework for learning clinically-relevant basic science. An expert clinician discusses a disease entity (cystic fibrosis, breast cancer, diabetes mellitus, coronary artery disease, HIV/AIDS, and rheumatoid arthritis) and then interviews a patient with the condition.

Biochemistry

Biochemistry is designed to provide an understanding of the biochemical basis of physiological processes. While the emphasis is on functional and regulatory aspects of biochemistry that inform clinical reasoning, a solid knowledge of the structure of major biological substances and of enzymatic reactions is also required to understand physiological function. Biochemistry covers topics in genetic material and molecular cloning and diagnosis, protein and enzyme structure and function, carbohydrate metabolism, lipid metabolism, protein metabolism, nucleic acid metabolism, cellular energy, and integrative sessions in cancer, diabetes, and starvation. Biochemistry is concerned primarily with the biochemical basis of normal processes, but disease states are used to show how specific biochemical defects can lead to illness. Diseases are highlighted in patient forums (mitochondrial disease, phenylketonuria, lipid catabolism, carnitine transport) and in small groups (chronic myelogenous leukemia, glycogen storage disease, hypercholesteremia, and urea cycle disorders). Finally, biochemistry is integrated with other disciplines being taught contemporaneously, by focusing course material and assessment around the six disease topics covered in the Clinical Presentations.

Teaching format: lectures, patient presentations, small groups

Cell Biology

Cell Biology is a 15-hour course that consists of three integrated “units.” In each unit, the relationship between cellular and subcellular concepts and mechanisms is related to human health conditions. Whenever possible, the cell biological principles underlying the pathological basis for the six diseases (Clinical Presentations) are brought into the lecture. Several dozen diseases or other human health conditions are discussed in terms of the underlying cellular pathobiology involved, which prepares the students for the organ-based systems covered during the latter part of first year (the Brain) and throughout second year (Health to Disease). Students are regularly exposed to the research principles and methods that underpin the concepts taught. The social and ethical issues involved in the application of research and treatment advances are highlighted throughout the course.

In the first unit, we build a cell from its component parts: the nucleus, membrane structure and function, organellar biogenesis, and the function of the cytoskeleton in health and disease. The next unit covers more complex cell functions such as cell proliferation and apoptosis, along with cell-cell and cell-matrix interactions. The final unit builds on the first two using early development as a paradigm. This unit includes discussion of the cell biology of gametogenesis, fertilization, and early embryonic development (through gastrulation). Using infertility as the clinical focus, this unit discusses the cellular basis for

infertility and the most common treatments available, building on what the students have learned in the Genetics course and preparing them for both the Core Physiology and Reproductive courses that come later in Year 1 and in Year 2, respectively. The unit concludes with a discussion of stem cells and the ethical implications of their use. The cell biology of early development portion of the course provides the background needed for students when they take the embryology unit in Medical Clinical Anatomy. Optional small-group sessions are offered in which students read articles on the ethics of stem cells and assisted reproductive technologies. The students in each session decide which topic they would like to discuss.

Teaching format: lectures, small group

Genetics

The Medical Genetics course introduces the basic principles of human genetics and their application to clinical medicine. Topics include genetic patterns of inheritance, DNA diagnostic methods, chromosome abnormalities, dysmorphology, anomalies, teratogens, multifactorial inheritance, cancer genetics, prenatal genetics, arrays, and next-generation sequencing. The course consists of lectures and problem solving sessions. One of the important skills taught in this course is the translation of a verbal family history into a pedigree diagram that can be used to determine the most likely mode of inheritance of a genetic disorder. Students are guided through calculating the risk of a genetic disorder in a family by working through problems in class. The course provides the framework for students to recognize who might benefit from genetic counseling and provide it if the problem is straightforward, or know to whom to refer patients if the problem is complex.

Teaching format: lectures, problem solving sessions

Immunology

The Immunology Course introduces students to the most important principles governing the functions of the human immune system and how these relate to human disease. The principal goal of this course is to demonstrate the relevance of immunology to normal function and its relationship to human disease. The course begins with a discussion of innate immunity, the complement system and B-cell function and on the formation, role, and function of antibodies. This is followed by consideration of the role of the thymus and the development of T-cells. This leads to discussion of cell-mediated immunity and incorporates consideration of the major histocompatibility system, various aspects of transplantation immunology and the immunologic basis of tumor immunology. The second half of the course concentrates on clinically applied immunology including the immunologic basis of auto-immune disease and the hypersensitivity disorders. There is discussion of acute and chronic inflammation as a bridge to further studies in pathology. The last part of the course covers various congenital and acquired immune deficiency states including HIV infection and ageing.

Teaching format: lectures

Introduction to Microbiology

The Introduction to Microbiology course seeks to increase student understanding of the basic biology of bacteria and viruses as causative agents of human disease. The first section covers bacterial structure and growth, with emphasis on how these processes provide therapeutic targets, as well as control of gene expression. Emphasis is placed on adaptation to growth and survival in the human host and on virulence gene regulation. Bacteriophage biology, both lytic and lysogenic, is described in the context of the expression and horizontal transfer of phage-encoded virulence factors. The role of phage- and transposon-mediated genetic exchange, including antibiotic resistance determinants and virulence factors, in the generation of highly pathogenic bacteria (i.e. “superbugs”), is presented with some mechanistic description.

The virology section of the course describes the interaction of human viruses with mammalian cells. The life cycles of two viruses with different RNA genomes and two viruses with different DNA genomes are used as paradigms for entry, uncoating, viral gene expression, assembly and egress. The role of viruses in human oncogenesis is covered. Finally, the above topics are revisited and synthesized by describing the use of microbes in modern medicine. The utilization of recombinant DNA technology is discussed including the production of recombinant proteins of medical significance and more recent efforts to utilize engineered viruses in human gene therapy.

Teaching format: lectures, small groups

Tissue & Organ Biology (Histology)

Tissue & Organ Biology (Histology) is the study of form and function of cells, tissues, and organs at the microscopic level. The course begins with coverage of the four phenotypes of adult tissues: epithelium, connective tissue, muscle, and nervous tissue. The course concludes with coverage of all of the body systems, which are composed of these primary tissues. All teaching sessions stress the relationships between structural composition and function, and relate microscopic anatomy to other biomedical disciplines. Important correlations that are relevant to clinical medicine are also provided. Information is mainly derived from light and electron microscopy, histochemistry, cell and molecular biology, and biological chemistry.

The important overall goals of this course are to: 1) develop the concept of the inseparable relationship of form and function, 2) provide adequate perspective and preparation in order to integrate the knowledge of cells, tissues, and organs into the scheme of other basic and clinical biomedical sciences--especially physiology and pathology, and 3) demonstrate that *Tissue & Organ Biology* is an important approach to the study of the human body--a strategy that can assist in strengthening the powers of critical observation, problem solving, diagnostic reasoning, and judgment.

Teaching format: lectures, problems solving session (flipped classroom), histology conferences (virtual laboratory)

Scientific Foundations of Medicine II (MedFoundations II)

Medical Clinical Anatomy (MedFoundations II) and Head and Neck Anatomy (The Brain) Courses

The Medical Clinical Anatomy and Head and Neck Anatomy courses are part of the MedFoundations II and Brain units, respectively. The two sequential courses involve lectures, laboratory dissections and small-group sessions taught by approximately twelve full-time basic science faculty and several part-time clinical faculty. These courses cover the basic anatomy of the upper and lower extremities, back, thorax, abdomen, pelvis, and head and neck with emphasis on the clinical significance of the structures and processes of each region. Lectures provide an overview of the surface anatomy, osteology, blood supply, innervation and lymphatic drainage of each organ system and are coordinated with cadaveric dissection in the gross lab. Principles of medical imaging techniques are presented through a series of radiology lectures and by study of computerized tomography (CT), magnetic resonance imaging (MRI) and cross-sectional anatomical images in the gross anatomy lab and online. The basic development of the cardiovascular, respiratory, gastrointestinal and urogenital systems, and of the head and neck, with emphasis on developmental anomalies that lead to congenital defects, is also covered in a series of embryology lectures. Evaluation of student performance is assessed via a small-group oral quiz, lab practical and written examination at the end of each section.

Teaching format: lectures, small groups, laboratory

Core Pathology

The first part of the Core Pathology course focuses on the cellular and tissue alterations caused by pathologic stimuli in most tissues. Since it is the cellular response to injury (either adjustment or failure to adjust to the newly imposed conditions) that produces the typical manifestation of disease, the course begins with discussion of cell injury. The cellular response to radiation injury is covered with reference to the therapeutic use of radiation. The course then moves to basic pathologic processes including inflammation (acute and chronic), regeneration and repair. With the background gained in these areas, atherosclerosis and circulatory diseases are then covered.

The second part of the course devotes several sessions to neoplasia. Areas of discussion range from basic concepts such as neoplastic transformation to molecular diagnosis of neoplasms. The last portion of the course covers pathologic processes found in the musculoskeletal system. Themes covered in earlier lectures, from cell injury to inflammation to neoplastic changes, recur in these last lectures and they illustrate the importance of understanding the core concepts before moving onto systemic pathology.

Teaching format: lectures

Core Pharmacology

The Core Pharmacology course introduces basic principles important for students to understand the pharmacokinetics and pharmacodynamics of medications and their use in clinical medicine. This course builds a conceptual foundation for further learning of more disease-specific pharmacology, which is taught in an integrative manner in the organ-based system courses that follow.

In addition to teachings on drug pharmacokinetics and dynamics, Core Pharmacology includes material on sources of drug information, drug development, and pharmacogenomics. Additionally, an introduction to the pharmacology of drugs affecting the autonomic nervous system is provided. Specific pharmacology related to the use of neuromuscular blocking agents and both local and general anesthetics are also included. This material is taught primarily through the use of a series of interactive lectures.

Teaching format: lectures

Core Physiology

Core Physiology was designed to provide a basic overview of medical physiology. Particular attention is paid to the integration of the material being presented with Anatomy. Clinical vignettes are used to illustrate how deviation from normal function causes disease. A part of each session is set aside for quiz questions that are used for student self-evaluation on concepts presented in the lecture. This course vertically integrates with the physiology component of The Brain and the organ-based system courses of the Health to Disease Unit in second year.

The Core Physiology course is comprised of three general areas. The first block focuses on how membrane potentials are developed and form the basis for the generation of action potentials and synaptic transmission, axonal transport of vesicles required for synaptic transmission, the autonomic nervous system (sympathetic and parasympathetic), understanding neurotransmitters, monosynaptic reflexes and electro-cardiology. These sessions provide a basis for the importance of ion gradients on cell function and how the nervous system uses these gradients to propagate synaptic transmission within the body. The second block includes sessions on homeostasis, muscle function, microcirculation and hemodynamics. These build upon those concepts taught in the beginning of the course and shows how these principles function on a larger stage. Microcirculation involves the normal development of vessels and how this process goes awry in cancer and diabetes. The last portion of the course introduces the physiology of the pulmonary, endocrinology, gastrointestinal, renal and reproductive systems, in concert with coverage of these areas in Anatomy.

Teaching format: lectures

The Brain

Medical Clinical Anatomy and Head and Neck Anatomy Courses

(see above)

Neuroscience

The Neuroscience course presents an orderly view of neuroanatomy starting with the spinal cord and ascending up the neuroaxis to the brainstem, cerebellum, basal ganglia diencephalon and cerebral cortex. The presentation of the anatomy of each major nervous system region is followed by sessions relating the anatomy to localization of lesions and disease in that region of the central nervous system. A final segment of the course covers clinical and pathologic features of neurologic diseases such as Parkinson's Disease, Huntington's Disease, dementias, multiple sclerosis, epilepsy, stroke, brain tumors, head trauma, disturbances of consciousness, and malformations. The anatomy sessions are primarily given by the course directors, and the clinical sessions are presented by neurologists, neurosurgeons, and neuropathologists.

Clinical-anatomic correlations are reinforced throughout the course in five problem-solving small-group sessions in which students meet with neurologists. Students are asked to localize lesions and to predict the etiology based on case histories of patients with neurologic diseases. In addition, there are five anatomy laboratories for the course that are based on computer programs developed by the course directors. These laboratory exercises are designed to further reinforce clinical-anatomic correlations.

Teaching format: lectures, small groups, virtual laboratory

Principles of Addiction Medicine

The Principles of Addiction Medicine course addresses the mechanism of action of major classes of drugs of abuse (alcohol, opioids, psychostimulants, cannabinoids), particularly their acute and chronic effects on central neurotransmitter systems and pathways, and their receptor targets. The course further introduces the foundations of the clinical practice of Addiction Medicine, from differential diagnosis of drug-associated toxidromes to tools for patient interviewing, screening and evaluation, levels of clinical care of addiction, group addiction recovery programs, and methods and approaches to address prescription drug abuse and pseudoaddiction.

The course includes sessions with patients who have successfully addressed their addiction, with physicians who play a prominent role in 12-step and cognitive/behavioral intervention addiction recovery programs, and with the directors of the Physician Health Services of the Massachusetts Medical Society who discuss the special challenges facing the chemically-dependent physician. These sessions also introduce gender and diversity issues in addiction and addiction recovery. The students actively integrate the material by attending at least one addiction recovery meeting either through the AA or a cognitive and behavioral intervention program, as observers in small groups and record and discuss their experience.

Teaching format: lectures, patient presentations, panel discussions, clinical experience

Introduction to Clinical Psychiatry

Introduction to Clinical Psychiatry focuses on known neurobiological aspects of psychopathology and its treatment. Though it introduces medical students to the diagnosis of major psychiatric conditions, it also demonstrates the phenomenology of the conditions. Major conditions that are discussed include depression, bipolar disorder, anxiety disorder, schizophrenia, somatoform disorders, personality disorders, childhood disorders, cognitive disorders, sleep disorders, and eating disorders. Each of these sessions is closely integrated with sessions on psychopharmacology. In this manner, students learn to diagnose and,

then, treat the conditions in an organized and coherent manner. The course also emphasizes the developmental perspectives that contribute to psychopathology including sessions on the development of personality and character, and theories of psychological development.

Teaching format: lectures, small groups

Scientific Foundations of Social & Behavioral Medicine

The goals of Scientific Foundations of Social & Behavioral Medicine are to (1) place the determinants of health and the management of disease in their proper genetic, environmental, developmental, behavioral and sociocultural contexts, (2) draw causal connections between individual behavior, human systems and public health, emphasizing the clinical relevance of these relationships, (3) demonstrate how systems of care determine a population's health status by influencing the behavior of consumers, providers, payers, suppliers and policymakers in the health care sector, (4) show how physician-led community-oriented practices can directly impact the health status of populations and the quality of life for its individual members, and (5) explore the processes and challenges of human development through the life cycle, highlighting the influences of relationships, families, communities and the health care system.

To achieve these goals, the course employs a combination of reading materials, lectures, small group interactive discussions, group projects, and self-assessment quiz questions. Broadly speaking, topics include determinants of health, stress and health, principles of behavioral medicine, preventive medicine, complementary and alternative medicine, culturally competent care, organization of the US health care system, health care economics, access to care, quality improvement, comparative health systems, and challenges through the lifecycle. The latter topics includes adaptive and maladaptive psychosocial development of children and adolescence, adult transitions and crises, chronic pain, sociobiology of aging, threats to independence, and end-of-life care.

Teaching format: lectures, group projects, small groups

Foundations of Patient Care

Medical Interviewing and the Doctor-Patient Relationship (MIDPR)

MIDPR is designed to introduce students to the art and science of the medical interview. The goals of the course include: providing an introductory experience in talking to patients, learning about the doctor-patient relationship, learning basic interviewing and history taking techniques, learning about the patient's experience of illness, introducing the write-up and presentation of the clinical experience, increasing awareness of and ability to talk about topics that are difficult (nutrition, sex, drugs, spirituality, death), and learning to talk with children, the elderly, and the dying.

The specific competencies that the course aims to develop includes: professionalism, rapport, empathy, medical history, patient-centered perspective, growth towards physician role, oral presentations, written documentation, group participation, constructive feedback, and reflective practice. The course is offered on Thursdays from the end of August through the middle of November, and consists of morning presentations/demonstration interviews followed by afternoon small group sessions where, under the supervision of a section leader, students interview patients in hospitals and at elderly housing sites.

The course also includes a practical experience of interviewing with an interpreter as well as a practical experience interviewing simulated patients in the Clinical Skills and Simulation Center (CSSC). An Objective Structured Clinical Examination (OSCE) serves as a final examination with all students having to demonstrate competence in the course's learning objectives before progressing to the next part of the Foundations of Patient Care.

Teaching format: lectures, patient presentations and demonstration interviews, small groups in clinical settings, standardized (simulated) patient interviews in the CSSC.

Physical Diagnosis

The Physical Diagnosis Course teaches the clinical skills of the basic, normal physical examination, as well as serving as an introduction to the abnormal physical examination. The course closely follows those areas studied in Medical Anatomy during MedFoundations II. Students systematically learn the physical examination of the following regions: lower extremity, back and spine, upper extremity, cardiovascular, pulmonary, abdominal, genito-urinary, mental status, otorhinolaryngologic, ophthalmologic and neurologic. Lectures emphasize basic techniques and clinical correlations. Evening sessions in the Clinical Skills and Simulation Center begin with a demonstration following by practice under faculty supervision. Simulation task trainers (manikins) are used to learn normal and abnormal findings. Students further refine their skills through practice sessions with standardized patients.

Teaching format: lectures, case presentations, physical exam demonstrations, small groups in the CSSC, standardized patient practice sessions.

Competency-based Apprenticeship in Primary Care (CAP)

The CAP course builds on the foundation established in the interviewing and physical diagnosis courses. Working in pairs, students spend one full day a week (approximately 3 weeks per month) in an outpatient clinic or office in Family Medicine, General Internal Medicine or Pediatrics. CAP starts during the last 5 week of first year and continues through early March of second year. Students refine their clinical skills in taking an accurate medical history and performing both complete and focused physical examinations. Students learn how to structure a differential diagnosis, counsel patients, document the medical encounter (usually with an electronic medical record), organize and deliver concise oral presentations, and how to perform basic office procedures.

The ambulatory experience is supplemented by full-day interactive workshops including introduction to office setting, documentation and presentation, basic office procedures, lifestyle modification counseling, physical diagnosis review, breast and pelvic examination, caring for children and adolescents, and advanced communication.

Teaching format: clinical work in primary care setting, interactive workshops

Foundations of Evidence-based Medicine and Clinical Reasoning

Epidemiology and Biostatistics

The primary goal of the course is to teach students the skills to read, understand and critique the medical literature. This course covers descriptive epidemiology, randomized controlled trials, cohort studies, case control studies, external and internal validity, bias and confounding, screening, sources of bias in epidemiologic studies, and a series of sessions on biostatistics.

Extensive use is made of the small group setting to reinforce and apply concepts. Considerable time during small group is used to analyze key examples from the medical literature. Using a target article, students write a paper critique where they discuss: sources of bias, the effect each source of bias had on the study results, whether the authors fairly acknowledged limitations of the study, the internal and external validity of the study, the evidence for/against causal associations and, a statement regarding the attributable risk and the related public health significance of such data. The course lays the foundation for the Introduction to Evidence-Based Medicine Course.

Teaching format: lectures, small groups

Problem-Based Learning

This year long course uses a small group learning venue (5 or 6 students plus one tutor/‘facilitator’) to introduce students to medical evidence and clinical reasoning. Virtual patient cases are explored that contain embedded elements inspired by the basic science principles contained within the curriculum of that semester. Students work collaboratively to discuss, explore, and understand clinical issues present in common health care problems that illustrate and integrate these basic science principles. In this environment of active learning students demonstrate the ability to acquire new knowledge, apply new skills, and convey new attitudes required of a medical professional.

The members of each small group meet together for two-hours each week and remain together over the course of one semester. At the change of semester the membership of each small group is reconstituted with a different collection of students and a new tutor/‘facilitator’. The principal learning goals are the same for both semesters: (1) students will demonstrate the ability to direct their own learning independently and their group learning collaboratively as members of a team; (2) students will demonstrate the ability to actively engage in analysis and discussion of health care problems with a group of peers; (3) students will demonstrate the ability to research clinical questions effectively utilizing a variety of information resources; (4) students will demonstrate the ability to present information to a group of peers and to teach effectively; and, (5) students will demonstrate the ability to give and to receive constructive feedback with a group of peers and with a facilitator.

Teaching format: small groups, independent research

Introduction to Evidence-Based Medicine

The Evidence-Based Medicine course is designed to build on the information taught in the Epidemiology and Biostatistics and Problem-based Learning, and to prepare students for the second year Introduction to Clinical Reasoning course. The course uses an interactive team-based learning approach. Students are taught the difference between disease-oriented evidence and patient-oriented evidence. Students gain experience in the critical evaluation of research evaluating treatments and diagnostic tests as well as the evaluation of clinical practice guidelines and review articles, including meta-analyses. The course also introduces students to Bayes’ theorem and dual process theory, which prepare them for further teaching in clinical reasoning.

Teaching format: lecture, team-based learning

Ethics & Professionalism

The Ethics and Professionalism Course meets monthly throughout first and second year. The goals of the course are to (1) engage students in a self-reflective process of identifying their own moral values and applying them to their future lives as medical professionals, (2) demonstrate how ethical considerations profoundly influence the practice of medicine, and their far reaching implications for patients, society and the profession, (3) facilitate the open, free and respectful exchange of opposing views by challenging simple, moralistic dichotomies and embracing the pluralistic nature of ethical decision-making in clinical practice, and (4) cultivate the development of ethically competent physicians capable of, and committed to, resolving day-to-day ethical conflicts through the reasoned and balanced application of ethical principles.

To achieve these goals, the course employs a combination of reading materials, lectures, case-based discussions in small groups, written ethical analyses, and self-assessment quiz questions. Broadly

speaking, topics include medical professionalism, principles of clinical ethics, ethical reasoning and analysis, patient-physician relationships and shared decision-making, ethical issues at the beginning of life, ethical issues at the end of life, allocation of limited resources, conflicts of interest, human subjects research, legal issues for practicing physicians, cross-cultural interactions, and public health ethics.

Teaching format: lectures, small groups

Selectives

Selectives offer a unique opportunity for students to supplement their core curriculum by sampling a wide range of experiences starting in their first semester. Through the Selective Program, students can select from a broad spectrum of various disciplines and practice settings to gain an early introduction to clinical medicine and related areas. Past students have found the Selective Program an invaluable means by which to partner with faculty role models and to identify possible future career paths. There is no standard format for a Selective. The vast majority of Selectives occur in the clinical setting but also may be in the form of seminars, laboratory, selected readings, or a combination of these. Selectives may involve one student or a group of students. Selectives are offered on Tuesday afternoons, at a variety of sites, both on and off the medical school campus. Students are required to complete one eight-week Selective, and may complete up to three. Students may arrange an independent selective, which be clinical or educational in focus.

Teaching format: experiential learning which varies based on the nature of the Selective

Second Year Courses*

Health to Disease Sequence

(integrates Physiology, Pathophysiology, Pathology and Pharmacology)

Pulmonary

The overall objectives of this course are to provide the student with a strong foundation of basic pulmonary physiology, pathophysiology, pharmacology, and pathology that will serve as a foundation for future learning. The course covers the pathophysiology, clinical and pathologic manifestations, diagnostic evaluation and therapeutic approach to a broad spectrum of pulmonary disease categories including obstructive (airways), restrictive (including parenchymal), occupational and environmental, infectious, vascular, neuromuscular, pleural, and neoplastic. Considerable time is spent learning how to interpret the major diagnostic modalities used in pulmonary medicine including pulmonary function tests, chest radiology (chest x-rays and chest CT scans) and arterial blood gases. There is a strong emphasis on clinical correlation, allowing students to link abnormal symptoms and signs with the underlying pathophysiologic processes. To reinforce concepts, the course makes use of case-based small group teaching and a series of four clinicopathologic conferences, where a pulmonary physician and a pathologist model the collaborative approach to the diagnosis of patients with pulmonary disease. The course makes extensive use of an audience response system to promote interactive learning.

Teaching format: lectures, clinicopathologic conferences, problem-solving session, small groups

Renal

The kidneys play a central role in the maintenance of the internal milieu by balancing fluid, electrolytes, and hydrogen ions to provide optimal conditions for molecular, cellular, and body system functions. They also serve as the major excretory organ for metabolic byproducts, drugs, and other organic substances. Finally, the kidneys are an important endocrine organ, producing vasoactive factors, erythropoietin, and other circulating hormones. As such, the kidneys are intricately involved in volume regulation and systemic hemodynamics. The importance of the kidneys is most clearly demonstrated in the presence of disease states. The Renal Course explores disorders that arise from primary defects in kidney function, as well as how the kidneys respond to extra-renal disturbances. We discuss the pathologic injuries to the architecture and structure of the nephron and kidneys, and the impact of immunologic, genetic, toxic, and idiopathic processes. Finally, the Renal Course explores the pathogenesis and therapy of chronic kidney disease, and the consequences of kidney failure.

The Renal Course is organized as lectures that introduce topics and provide a vocabulary. Upon this framework, suggested reading expand a student's understanding, small group sessions allow application of principals to clinical scenarios, a pathology laboratory permits student to examine specimens, and clinicopathologic conferences explore the case-based, interactive clinical presentations of pathologic processes.

Teaching format: lectures, clinicopathologic conferences, small group, pathology laboratory

Cardiovascular

This course takes an integrated approach to the diseases of the cardiovascular system. The goal is for students to develop the analytical and cognitive skills necessary for a successful transition from basic cardiovascular physiology to the care of the patients with cardiovascular disease. Clinicopathologic sessions provide interactive learning experiences that allow students to apply knowledge to clinical scenarios.

The course begins within an introduction to normal and abnormal hemodynamics directed at three major areas; shock, heart failure and valvular heart diseases. The contemporary use of hemodynamic data to help diagnose various pathophysiological states is highlighted. The course covers the epidemiology, risk factors, clinical manifestations, and management (including anti-ischemic therapy) of coronary artery disease. There is a broad review of the different types of dyslipidemias, and the pharmacological agents used to treat lipid disorders. Subsequent sessions cover the etiology, clinical manifestations, natural history and management of heart failure, valvular heart disease, and peripheral vascular disease (including cerebrovascular diseases, aortic dissection, aortic aneurysms, diseases of the vascular supply to the lower extremities and venous diseases). Two sessions are dedicated to the basics of electrocardiography and the identification of arrhythmias. Students learn the cellular pathophysiology of the latter along with clinical manifestations and pharmacologic management.

Teaching format: lectures, clinicopathologic conferences, small groups, pathology laboratory

Hematology-Oncology

The Hematology-Oncology course is divided into 3 major areas: (1) the normal physiology of the blood, including cellular and fluid phase components, (2) the major malignant diseases arising from blood and bone marrow, and (3) a conceptual framework for understanding the epidemiology, evaluation, and management of the non-hematologic malignancies (the “solid” tumors). The course also integrates pharmacology pertaining to hematology and oncology, basic concepts in pathologic diagnosis of malignancies, and blood bank and transfusion medicine. Specific topics that are covered include the physiology of the bone marrow, hematopoiesis, and coagulation, along with non-malignant diseases arising from absence or dysfunction of blood elements, transfusion medicine (including blood groups, transfusion components, and transfusion reactions), acute and chronic leukemias, Hodgkin’s and non-Hodgkin’s lymphomas, plasma cell disorders, myeloproliferative neoplasms, myelodysplastic syndromes, hematopoietic stem cell transplant, epidemiology of solid tumors, and the pharmacology of anti-coagulants, pro-coagulants, and anti-neoplastic agents. The course is integrated with the other organ-system courses, most of which provide additional coverage of malignancy.

Teaching format: lectures (including case discussions), patient presentations, team-based learning, multidisciplinary panel discussion

Dermatology

The Dermatology course is designed to introduce students to the specialty of dermatology through emphasis on the proper description of entities and the development of differential diagnosis, the pathogenesis of common dermatologic diseases and the treatment of many of these dermatologic entities. The course includes elements of physical diagnosis including understanding of the dermatologic lexicon, bedside diagnostic testing and the pathogenic mechanisms of skin disease. In addition there is a focus on such entities as acne, psoriasis and other papulosquamous disease, eczematous dermatitis, skin cancer and the dermatologic mechanisms of skin disease. Discussion of these entities includes pathogenesis, diagnosis and treatment with a focus on appropriate pharmacology as well.

Teaching format: lectures

Rheumatology

The Rheumatology course begins with a discussion of the physiology and pathophysiology of the joint. Subsequently, the core rheumatic diseases are discussed including osteoarthritis, rheumatoid arthritis as a model of inflammatory arthritis, and systemic lupus as a model of a systemic autoimmune disease. Building upon an understanding of these diseases, the spondyloarthropathies, Lyme arthritis, scleroderma and vasculitis are covered in lectures and small group sessions. A session on pediatric rheumatic diseases focuses on entities unique to the pediatric population (including juvenile idiopathic arthritis) and also

reviews how more common rheumatologic conditions may manifest in children. Finally, crystal arthritis, fibromyalgia as a model of pain amplification, and repetitive strain syndromes are covered. This course reinforces a deeper learning of the material by repeatedly comparing and contrasting the core immunologic, genetic and clinical features of the different rheumatic diseases. Application of the knowledge and themes taught in the course is promoted through small group case-based sessions and through numerous patient testimonials and demonstrations. Vertical integration is provided with the Immunology and Genetic courses taught in the first year. In addition, with the rheumatic diseases manifesting in diverse organ systems, integration with the other health to disease sections is emphasized. *Teaching format: lectures, patient presentations, small groups*

Medical Microbiology and Infectious Disease

Medical Microbiology and Infectious Disease is a highly integrated course taught by a combination of PhD microbiologists and infectious disease clinicians that summarizes the basic pathobiology of organisms and the human syndromes they cause. Highlights of physical signs and symptoms, diagnostic strategies and an overview of treatment of infectious syndromes are also covered. The material is presented in 3 ways: case-based lecture format with integrated audio-response questions, small group discussions, and hands-on laboratory exercises. Specific learning objectives include: identification of specific infectious disease syndromes and their clinical presentation, identification of the mechanisms by which specific microbial pathogens cause major infectious syndromes, and the mechanism of action, spectrum of activity and major adverse reactions of antimicrobials used to treat infections.

The course is organized to cover mechanisms of pathogen-induced host damage and specific microbial pathogens with an emphasis on identification, encounter, entry, spread/multiplication, virulence factors, damage and clinical manifestations, diagnosis and treatment/prevention. One section covers bacterial pathogens, the syndromes they cause, and the antimicrobials used to treat the pathogens. For example, *Staphylococcus aureus* is discussed in terms of its key physical features, unique properties, virulence determinants and basis for multi-drug resistance in case-based format that is then highlighted in discussions of infectious disease syndromes that are often caused by the organism such as bacteremia, osteomyelitis, endocarditis and skin and soft tissue infections. Adjoining these lectures, there is discussion of the common antibiotics that are used to treat *S. aureus* and other organisms causing the syndromes discussed. The second section covers viral pathogens, parasites, mycobacteria and fungi with some emphasis on immunocompromised hosts. While the course does not cover every pathogen, students learn the important relationship of host, pathogen and environment as the basis upon which to understand the pathophysiology of microbial pathogens, the infections they cause and the approach to diagnosis and treatment.

Teaching format: lectures, small groups, microbiology laboratory

Gastrointestinal

This course covers the physiology, pathophysiology, and pathology of the gastrointestinal system. The course is closely integrated with basic physiology. The normal physiology of the esophagus, stomach, small intestine, colon, liver, gallbladder, and pancreas is presented prior to discussing the pathophysiology and pathology of disease of these organs. A case-based approach is used both in lectures and small group sessions. Many sessions are co-taught by a clinical gastroenterologist and gastrointestinal pathologist using a clinicopathologic conference approach where the pathophysiology is presented first followed by the pathology of the particular disorder. Common disorders of luminal gastrointestinal disease and diseases of the liver, pancreas, and gallbladder are reviewed including allergic, medication-induced, autoimmune, inflammatory, and neoplastic disorders. The GI course is tightly integrated with the Nutrition course.

Teaching format: lectures, clinicopathologic conferences, small groups

Nutrition

Diet has a profound impact on maintenance of health and development of disease. In turn, acute or chronic disease substantially influences nutrient needs and the ability of patients to consume, digest and assimilate nutrients. In this course, the fundamental relationships between diet, nutrients, health and disease are addressed. The primary focus is on nutritional issues that the practicing clinician is likely to encounter. Concepts from basic science courses, including topics from biochemistry, physiology, pathophysiology and medical specialties are incorporated into class activities to provide a rationale approach to nutrition assessment and treatment.

Students receive instruction in assessment of nutrition status in the outpatient and inpatient areas, guidance on nutrition counseling, and are educated about the roles and interaction with other health professionals including dietitians and speech-language and swallowing therapists. Topics include obesity, protein calorie malnutrition, cardiovascular disease, and selected micronutrient deficiencies or excess, nutrition in intestinal failure, and enteral and parenteral nutrition.

Teaching format: lectures, patient presentations, team-based learning

Endocrine

The Endocrine course is designed to give an integrated overview of the endocrine systems of the body from the perspective of normal physiology and disease states. The course starts with an introductory session including general concepts of endocrine physiology, pathology and pathophysiology. Following this, the course is divided up into subsections based on a specific endocrine gland including adrenal, thyroid, parathyroid/calcium, endocrine pancreas and pituitary. Each of these subsections starts out with a discussion of the normal physiology of the system followed by discussions of major disease processes including hyperfunction, hypofunction and neoplasia with a clinical approach to diagnosis and treatment and relevant concepts in pathology. One session is devoted to cases in pediatric endocrinology.

Teaching format: lectures, clinicopathologic conferences, small groups

Reproductive

The Reproductive course starts with normal development of the reproductive tract and then moves to structural abnormalities such as Mullerian defects and genetic deficiencies causing disorders of sexual differentiation. The hypothalamic-pituitary-gonadal axis is discussed including disorders to this system leading to oligospermia, testosterone deficiency, anovulation and menstrual irregularity. Issues important in the menopause including menopausal symptoms, pelvic organ prolapse and urinary incontinence are covered. Normal and abnormal pubertal development is reviewed. There is comprehensive discussion about contraception methods. Management of unintended pregnancies is also reviewed. Normal and abnormal pregnancy is introduced with lectures focusing on preconception health, prenatal care, labor, birth and disorders that can develop including pregnancy-induced hypertension and antepartum bleeding. Maternal pathophysiology, first trimester bleeding, miscarriage, ectopic pregnancy, disorders of the postpartum period, breastfeeding and the effects of drugs in pregnancy and lactation are subsequently discussed. Causes of pelvic pain, genital infections and infertility are also reviewed. Female sexual response as well as sexual dysfunction and abuse are covered. Pathology of the breast, cervix, ovary, and uterus are taught along with the evaluation and treatment for disorders in these organs including uterine fibroids, polyps, hyperplasia, cancer and cervical dysplasia and cancers. The male reproductive tract is covered starting with gametogenesis, normal physiology of erection and ejaculation, disorders of male sexual function including impotence and infertility. Pathology of the male genital tract covers prostatic hyperplasia, cancer, priapism, and testicular torsion.

Teaching format: lectures

Foundations of Evidence-based Medicine and Clinical Reasoning

Introduction to Clinical Reasoning

The course introduces students to the principles of clinical reasoning. Stress is placed on the dual process model of clinical reasoning: non-analytic reasoning (e.g. pattern recognition) and analytic reasoning (e.g. hypothetico-deductive). The course is taught in nine symptom-based weeks (e.g. chest pain, dyspnea, fever, weakness). To teach non-analytic reasoning, students complete three cases for each symptom.

This provides students with an opportunity to recognize the illness scripts of many common diseases and review the differential diagnosis for a given symptom. The course highlights causes of diagnostic error within these cases, teaching students about heuristics. It encourages students to develop metacognition by having them reflect on cases and their diagnostic errors. For the analytic reasoning component, students estimate or calculate pre-test probabilities and apply likelihood ratios to determine post-test probabilities for diagnoses they are considering. Assessments include a clinical reasoning OSCE (standardized patient) station and a final exam where students apply their knowledge of illness scripts to answer clinical vignettes, complete script concordance questions, determine post-test probabilities, and explain their reasoning based on discussion of pre-test probability, likelihood ratios, and thresholds to test and treat.

Teaching format: small group, online cases, lectures

*For each course, TUSK (the TUSM online learning management system) contains the schedule, objectives, syllabus, small group and/or laboratory materials, important educational links, lecture slides, image collections and video-recorded lectures. All required courses make extensive use of live problem and case-based review sessions, interactive audience response systems, and online self-assessment quizzes and practice exam questions. Lectures for all courses place heavy emphasis on clinical correlation and the application of material to the practice of medicine.

Required Core Clerkships†

Family Medicine (6 weeks)

The Family Medicine Clerkship is an ambulatory experience that offers an opportunity for students to work with a diverse group of patients with a broad array of clinical issues. Students spend four days each week in the ambulatory setting working closely with a family medicine faculty preceptor. One day a week is spent on the medical school campus participating in case based discussions and interactive workshops. The workshops include sports medicine, dermatology, women's health, information mastery, geriatrics, and serving the underserved. Students also complete a series of online virtual cases that cover all required clinical entities.

In Family Medicine, students learn how to assess a patient, formulate a differential diagnosis, and use critical thinking to propose a patient-centered management plan for patients with common acute presentations. They assist in managing chronic illness during follow-up visits for patients with common chronic diseases. They develop an evidence-based health maintenance plans for patients and demonstrate advanced communication skills in history-taking and counseling patients.

Sites: More than 100 sites in Massachusetts and Maine

Medicine (8 weeks)

The medicine core clerkship is an inpatient experience, intended to provide students with a basic understanding of common internal medicine problems. Students see a wide array of illnesses, many of which involve interactions with other medical specialties such as surgery, obstetrics, psychiatry, emergency medicine, radiology and pathology. The mandate of the clerkship is broad, and includes ensuring the student learns: common symptoms, signs, and interpretation of laboratory findings; structuring a differential diagnosis and determining the management of common internal medicine problems; effective communication with patients, team members and consultants; discharge planning, ethical issues, documentation, and professionalism. Considerable emphasis is placed on refining clinical reasoning skills.

Students receive the same core curriculum and emerge with the same standard set of competencies at each site. Regular meetings of the site directors ensure consistency in the experiences and allow the sites to draw upon the experiences of one another. Students are required to document their experiences in an online patient log book which allows the site director to make sure that each student has had the requisite clinical encounters by the end of the clerkship. In addition, students are required to complete a series of virtual ("SIMPLE") cases to further their understanding of common medical problems and to ensure that they encounter the most important case types. Many sites include sessions in a simulation center.

Sites: Baystate Medical Center, Faulkner Hospital/Lemuel Shattuck Hospital, Lahey Hospital and Medical Center, Maine Medical Center, Newton Wellesley Hospital, North Shore Medical Center, Steward Carney Hospital, St. Elizabeth's' Medical Center, Tufts Medical Center

Obstetrics and Gynecology (6 weeks)

During the Obstetrics and Gynecology clerkship, students engage in a breadth of clinical experiences, ranging from prenatal care and childbirth to advanced gynecologic malignancy and end-of-life care. Students interact with patients across the lifespan, from young girls with precocious puberty to octogenarians looking to optimize their health into their 90s. Students care for women amidst some of the most emotional and memorable experiences of their lives, including pursuing infertility treatments, making difficult reproductive choices, and of course, going through childbirth. Students complete their clerkship at one of six clinical sites, and are expected to cover a core curriculum of basic gynecologic and

obstetrics conditions. All sites share a core curriculum of learning objectives, with case-based didactic sessions complementing the clinical education. The clerkship consists of both inpatient and outpatient experiences.

Sites: Baystate Medical Center, Cambridge Health Alliance, Maine Medical Center, Metrowest Medical Center, St. Elizabeth's Medical Center, Tufts Medical Center

Pediatrics (6 weeks)

The Pediatrics core clerkship incorporates a variety of clinical and teaching experiences to give students experience in the fundamentals of pediatric medicine, as well as exposure to the breadth of pediatrics as a career. The core clerkship consists of both inpatient and outpatient experiences, with students spending approximately three weeks in each venue. Students will gain experience in primary care pediatrics, inpatient pediatrics, newborn medicine, pediatric subspecialties, and pediatric emergency medicine. The Pediatrics clerkship uses the interactive online CLIPP cases as a standard curriculum across all sites, with a variety of site-specific case presentations and conferences which supplement the general curriculum. Pediatric clerkship objectives are adapted from the COMSEP (Council on Medical Student Education in Pediatrics) General Pediatrics Curriculum.

Sites: Baystate Medical Center, Lawrence General Hospital/Reading Outpatient, Maine Medical Center, Metrowest Medical Center, Newton Wellesley Hospital, Tufts Medical Center

Psychiatry (6 weeks)

The Psychiatry core clerkship incorporates a variety of clinical and didactic opportunities to give students experience in the fundamentals of psychiatry as well as exposure to the breadth of venues in which psychiatrists practice and contribute to the health care system. The core clerkship consists of inpatient, consultation/liason and outpatient sites, working with both adult and child patients suffering from acute and chronic psychiatric conditions. Students learn the fundamentals of the psychiatric history, mental status examination, the importance of collateral information in the treatment of psychiatric patients as well as the full range of psychiatric therapeutic modalities (psychopharmacology, verbal psychotherapies, electroconvulsive therapy). A didactic series of talks introduces students to the basics of the major topics in psychiatry through case presentations that supplement the general experiential curriculum. The competency-based goals and objectives for the psychiatry clerkship were created by the clerkship site directors. Students receive ongoing feedback about their skills particularly around interviewing.

Sites: Baystate Medical Center, Lahey Hospital and Medical Center, Lemuel Shattuck Hospital, Maine Medical Center, Newton Wellesley Hospital, Tufts Medical Center

Surgery (8 weeks)

The Surgery Clerkship provides students with an introduction to a wide spectrum of surgical diseases and their management. The formal didactics of the Surgery clerkship include 18 case studies specifically designed for core clerkship medical students. Through these case studies, the Surgery faculty teach the presentation, diagnosis, and management of common surgical illnesses. The experiential components of the clerkship include active participation in a wide variety of operative cases, surgical outpatient evaluation and follow-up visits, and as part of an inpatient surgical team. During on-call assignments, students participate in emergency consultations and emergency operations. The goal of the clerkship is to familiarize students with common surgical illnesses and their management and to give students an authentic and broad-based surgical experience.

While there is a diversity of venues, the didactic program ensures that all students are exposed to the same core curriculum and emerge with the same standard set of competencies. In addition to the core case studies, each clerkship site offers a variety of lectures and interactive sessions with faculty, fellows, and

residents. Students complete a series of online case studies that, along with core case studies, cover all required clinical entities. Regular meetings of the site directors ensure consistency in the experiences and allow the sites to draw upon the each others' experiences. Students are required to document their clinical experiences in an online patient log, which allows the site director to confirm that each student has had the requisite clinical exposure. Student performance is assessed through standardized multiple choice and oral examinations, a brief oral presentation, and faculty assessment of clinical performance.

Sites: Baystate Medical Center, Lahey Hospital and Medical Center, Maine Medical Center, Newton Wellesley Hospital, St. Elizabeth's' Medical Center, Tufts Medical Center, Winchester Hospital

Longitudinal Integrated Clerkship – Maine Track (9 months plus immersion experiences)

Maine Track students may complete a Longitudinal Integrated Clerkship (LIC), spending nine months at one of eight sites. Between two and four students are assigned to each site. Each LIC site has an overall site director and discipline-specific preceptors. Each week (on average) students have one half-day outpatient sessions in family medicine, medicine, obstetrics-gynecology, pediatrics, psychiatry and surgery. In this context, LIC students care for a panel of patients including following these patients, as needed, into the hospital, operating room, labor and delivery, and to consultants. Students have weekly shifts in the emergency department. Inpatient experiences occur as students follow their outpatients who are admitted to the hospital. Students gather monthly at one of the sites for a series of didactic sessions. Based on availability, the LIC is also open to TUSM students who are not in the Maine Track.

Each LIC student additionally completes one or two, four-week immersion blocks consisting of inpatient rotations at Maine Medical Center (or other major TUSM teaching affiliate) and elective rotations. At least one immersion (usually Medicine or Surgery) precedes the LIC portion of the year. The LIC discipline-specific objectives and required clinical encounters are identical to those used in the block core clerkship rotations at TUSM. LIC students are required to complete the same set of virtual online cases and same set of examinations as block core clerkship students.

Sites: Maine Medical Center, Franklin Memorial Hospital, Midcoast Hospital, Stephens Memorial Hospital, St. Mary's Regional Medical Center, Mount Desert Island Hospital, Redington-Fairview Hospital, Miles Memorial Hospital

†All core clerkships place emphasis on “bedside” teaching, close supervision and direct observation.

Year 1

Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
	Med Foundations I			Med Foundations II			The Brain		SFSBM	
	MIDPR			Physical Diagnosis					CAP	
	Epidemiology-Biostats			Problem Based Learning					EBM	
Ethics & Professionalism										
Selectives										

Med Foundations I: Biochemistry, Cell Biology, Genetics, Immunology, Intro to Microbiology, Tissue/Organ Biology

Med Foundations II: Anatomy, Core Pathology, Core Pharmacology, Core Physiology

The Brain: Addiction Medicine, Head & Neck Anatomy, Intro to Clinical Psychiatry, Neuroscience

MIDPR: Medical Interviewing and the Doctor Patient Relationship

CAP: Competency Based Apprenticeship in Primary Care

EBM: Introduction to Evidence Based Medicine

SFSBM: Scientific Foundations of Social & Behavioral Medicine

- Foundations of Patient Care
- Foundations of Evidence-Based Medicine & Clinical Reasoning

Year 2

Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
P U L M	R E N A L	C A R D I O	HEME ONC	MICRO-ID D E R M	R H E U M	GI NUTRIT	E N D O	R E P R O	BOARD PREP	CORE CLERKSHIPS BASIC ELECTIVES (See Year 3)
CAP										
Introduction to Clinical Reasoning										
Ethics & Professionalism										

 Health to Disease: Integrates Physiology, Pathophysiology, Pathology, Pharmacology

 Foundations of Patient Care

 Foundations of Evidence-Based Medicine & Clinical Reasoning

Year 3

Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
<p style="text-align: center;">CORE CLERKSHIPS * Family Medicine – 6 wks, Medicine – 8 wks Obstetrics-Gynecology – 6 wks, Pediatrics – 6 wks Psychiatry – 6 wks, Surgery – 8 wks BASIC ELECTIVES* - 8 wks</p>									<p style="text-align: center;">ADVANCED ELECTIVES (See Year 4)</p>	

*Includes time during Year 2

Year 4

Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
<p style="text-align: center;">ADVANCED ELECTIVES* ACTING INTERNSHIPS – 8 wk (2, 4 wk blocks) (selected from Family Medicine, General Surgery, Obstetrics-Gynecology, Medicine, Pediatrics, Psychiatry, Surgical Subspecialties, and multiple Critical Care offerings) CLINICAL NEUROSCIENCE EXPERIENCE – 4 wks (selected from Adult Neurology, Community Neurology, Neurologic Critical Care, Neurosurgery, or Pediatric Neurology,) OTHER ELECTIVES – 24 wks</p>										

*Includes time during Year 3