**BOSTON UNIVERSITY**
**COLLEGE OF ENGINEERING**

# ENGMEDIC PROGAM INFORMATION

## Introduction

The ENGMEDIC program was created in 1990 by the Department of Biomedical Engineering in the College of Engineering and the School of Medicine. It is an early selection program designed for biomedical engineering students who are interested in becoming physicians. A small number of highly qualified students, who have completed two years of the pre-medical option of the undergraduate biomedical engineering curriculum, are admitted to the program each year. The program integrates elements of pre-clinical medical training with upper division requirements for the B.S. degree in biomedical engineering, thus enabling students to fulfill some of the medical school curriculum during the last two years of undergraduate study. The program utilizes a series of instructional modules which include biochemistry, immunology, microbiology, socio-medical sciences, medical histology, human physiology, public health, and humanities.

The ENGMEDIC program is not designed to accelerate either the undergraduate degree or medical training, but rather to effect a better transition from undergraduate engineering to graduate medical study. The B.S. in Biomedical Engineering is normally earned after four years of undergraduate study, the M.D. after an additional four years of study at the School of Medicine.

Tuition for the first two years of ENGMEDIC (i.e., the third and fourth years of study in the College of Engineering) is the same as that charged to other College of Engineering students. Tuition for the remaining years of ENGMEDIC (i.e., all post-baccalaureate study at the School of Medicine) is the same as that charged to students enrolled in the regular curriculum of the School of Medicine.

## Eligibility and Admission

The ENGMEDIC program accepts a small number of highly qualified students who have completed two years of the pre-medical option of the undergraduate biomedical engineering curriculum. Students apply to the program in the spring semester of the sophomore year. Applications are available on-line. Applications must be submitted to the Undergraduate Programs Office by March 11, 2011.

To be considered for admission, students must have completed or be taking the following courses:

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| CAS MA 225 | Multivariate Calculus |
| CAS MA 226 | Differential Equations |
| CAS PY 212 | Physics II |
| CAS BE 209 | Principles of Molecular Cell Biology |
| CAS CH 203 | Organic Chemistry I |
| CAS CH 204 | Organic Chemistry II |
| ENG EK 301 | Engineering Mechanics |
| ENG EK 307 | Electric Circuit Theory |
| ENG BE 200 | Introduction to Probabilistic Systems |
| ENG EK102 | Introduction to Linear Algebra |
| or CAS MA 142 | Introduction to Linear Algebra |

Applications are evaluated by the ENGMEDIC Joint Admissions Committee composed of representatives from the Department of Biomedical Engineering and the School of Medicine. After an initial review, the most competitive applicants will be contacted for personal interviews with two members of the Admissions Committee. Interviews will take place during April and early May. Admission decisions will be made by June 15th.

Admission to the program is based on the student's academic record, interviews, letters of recommendations (one of which must be from a College of Engineering faculty member), and a statement of interest in pursuing the dual professions of engineering and medicine. Involvements in college and community activities, as well as less tangible qualities of personality, character, and maturity, are also considered in the assessment process.

At the end of each curricular year, the ENGMEDIC Program and Promotions Committee will request a report from the Office of Judicial Affairs and Student Safety Programs to determine if ENGMEDIC students have violated University policies, as well as from the Dean's Office of the students' college to determine whether students have engaged in academic misconduct. The content of these reports will be considered in all promotions decisions, including the decision of promotion to the School of Medicine. Any student who has violated University policies or engaged in academic misconduct will have the opportunity to submit a written explanation to the ENGMEDIC Program and Promotions Committee.

In addition, medical students may, in accordance with federal and state law, or institutional policy, be asked to consent to a criminal background check. For students in the ENGMEDIC Program, this may occur at the time of promotion to the School of Medicine and/or at other times in the course of the medical school curriculum. The results of this criminal background check will be considered in promotion decisions.

**Program Requirements**

ENGMEDIC students must demonstrate their ability to master engineering concepts and the modules of instruction, and must exhibit a high degree of maturity and emotional stability to be promoted to the medical phase of the program. The ENGMEDIC Program and Promotions Committee reviews each student's academic progress each semester.

Students are expected to obtain a GPA of at least 3.20 each semester after entering the program. They must also obtain a 3.00 cumulative average in science/engineering courses taken after entry into the program. In addition to maintaining a cumulative average of 3.20 or higher, students must also earn grades of B or better in the following courses: BE 401, BE 402, BE 420/BE 436, BE 491, BE 492, and EK 424. Students in the ENGMEDIC program are subject to the rules and regulations of the College of Engineering until they receive their B.S. degrees. Students are expected to take a full-time course load each semester.

Students must take the Medical College Admission Test (MCAT), usually in the spring of the third year of undergraduate study. ENGMEDIC students are expected to earn a combined score equal to or greater than 30 on the three numerically scored sub-sections of the MCAT before being promoted to the School of Medicine. The writing sample component of the MCAT must also be completed. The academic record of each student is reviewed by the ENGMEDIC Program and Promotions Committee before the student can begin the School of Medicine curriculum. Formal admission to the School of Medicine is granted upon satisfactory completion of the first two years of the ENGMEDIC program. (Please note that the School of Medicine does not accept AP credits to fulfill its admissions requirements. If you have questions regarding

AP credits and medical school requirements, please consult the Pre-professional Advising Office in CAS B-2.)

A student who for any reason (academic, motivational, or emotional) is found to be ill-suited to continue the ENGMEDIC program will be terminated from the program but can remain in the College of Engineering without loss of credit. Such students may apply for entry to the School of Medicine or any other medical school by the conventional premedical route. Students may voluntarily leave the program at any point and continue working towards a B.S. degree in Biomedical Engineering.

**Module Requirements for ENGMEDIC Students**

Four modules of instruction must be completed in order to be eligible for promotion to Medical School. Normally, students use GMS PH730/731 and PH 750 and humanities electives to fulfill these modules. However, students who enter Boston University with AP credit or who take courses over the summer may satisfy this requirement in other ways.

Things to bear in mind, when choosing modules:

- Students must complete both GMS PH 730/731 and 750 with no grade below B- and at least a B average in the three course sequence to fulfill the MED Physiology requirement.

- The two semester sequence GMS BI 555 and GMS BI 556 or the one semester course GMS BI 751 can fulfill the MED Biochemistry requirement

- Newly admitted ENGMEDIC students are strongly encouraged to take a genetics or advanced biology course during the summer between the sophomore and junior years, either at Boston University or at another school. (Students who wish to take a course at another institution must complete a transfer credit approval form in the College of Engineering prior to registering for the course in order to ensure that the credits will transfer upon successful completion of the course.)

- Two of the modules must be in biochemistry, physiology, or microscopic anatomy (histology).

**College of Engineering (ENG) Requirements for ENGMEDIC Students**

The Biomedical Engineering undergraduate program leads to a B.S. in Biomedical Engineering. and is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET). An ENGMEDIC program planning sheet is available which illustrates a course sequence incorporating the ENGMEDIC/MMEDIC modules that will assure that all Biomedical Engineering B.S. requirements are met. There are several ENGMEDIC / MMEDIC modules offered, which may be interesting to ENGMEDIC students, but that do not satisfy either engineering requirements or medical school requirements. ENGMEDIC students with AP credit or who have taken courses during the summer session will find that they have additional flexibility in their programs, and may elect to take additional ENGMEDIC / MMEDIC modules. Course descriptions for the ENGMEDIC / MMEDIC program are also available on this web-site.

1. **General Education Requirements**

See the College of Engineering Student Handbook (www.bu.edu/eng/ugrad/handbook/) for details of the general education requirements for all engineering students. It is recommended that ENGMEDIC students use the Humanities ENGMEDIC / MMEDIC courses (Medical Ethics, Ethics of Health Care) to satisfy these requirements.

ENGMEDIC/MMEDIC courses CAS PH 251, Medical Ethics, and CAS PH 452, Ethics of Health Care, are humanities courses. If both are taken, they will satisfy the ENG depth requirement in the humanities. However, these courses do not meet any medical school requirements.

2. **Biomedical Engineering Course Requirements:**

**Professional Electives**

In general the Biomedical Engineering curriculum requires two Professional Electives. These are satisfied by Organic Chemistry I and II, which are required for ENGMEDIC applicants.

The following additional courses are required during the junior and senior years for the Biomedical Engineering degree:

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|---|---|
| ENG BE 401 Signals and Systems in Biomedical Engineering | 4 credits |
| ENG BE 491 Engineering Physiology Laboratory I | 2 credits |
| GSM PH 730 Intro. To Human Physiology | 4 credits |
| | |
| ENG EK 424 Energy and Thermodynamics | 4 credits |
| ENG BE 402 Control Systems in Biomedical Engineering | 4 credits |
| ENG BE 492 Engineering Physiology Laboratory II | 2 credits |
| ENG BE 436 Fundamental of Fluid Mechanics or BE 420 Introduction to Solid Biomechanics | 4 credits |
| | |
| Biomedical Elective 1 (GMS PH 730) | 4 credits |
| Biomedical Elective 2* | 4 credits |
| Biomedical Elective 3* | 4 credits |
| Engineering Elective* | 4 credits |
| | |
| ENG BE 465 Senior Project | 2 credits |
| ENG BE 466 Senior Project | 4 credits |
| ENG BE 467 Design, Development, Marketing and Entrepreneurship in BME | 2 credits |

*One of these must be from the design elective list.

**Biomedical and Engineering Electives**

The Biomedical Engineering curriculum requires two Biomedical Electives and one Engineering Elective. GMS PH731/750 satisfies one BME elective (see above). The engineering elective or the remaining Biomedical Elective must be chosen from the list of acceptable design electives that appears on the back of the junior and senior Biomedical Engineering program planning sheets.

**Medical School Requirements for ENGMEDIC Students**

All ENGMEDIC students must complete 2 courses in English. These are typically completed through CAS WR 100 and CAS WR 150. Additionally, ENGMEDIC students must complete 2 humanities courses. These cannot be fulfilled by AP credits; they must be posted on a college or university transcript.

**Program Administration**

The administration of the ENGMEDIC Program is the joint responsibility of the College of Engineering and the School of Medicine. Associate Dean Eisenberg and Assistant Dean Zamansky are responsible for overseeing the day-to-day administrative tasks associated with advertising and running the program.

**ENGMEDIC Joint Admissions Committee**

The ENGMEDIC Joint Admissions Committee is composed of faculty appointed by the Deans of the College of Engineering and the School of Medicine. This committee is responsible for reviewing applications, interviewing applicants, and admitting students into the program. Admissions decisions are made by June 15, so that grades from the spring semester are available for consideration in the decision making process.

**ENGMEDIC Program and Promotions Committee**

The ENGMEDIC Program and Promotions Committee is composed of faculty from both the School of Medicine and the College of Engineering, who serve at the pleasure of their respective Deans. This committee is charged with two tasks: 1) to review the academic component of the ENGMEDIC program periodically for the purposes of improving program quality, and 2) to review the records of ENGMEDIC students to monitor each students program and academic progress.

**COURSE DESCRIPTIONS***
**2010-2011**

## A. MEDICAL SCIENCES

**GMS AN 705. Medical Histology A.** Prereq: junior or senior standing, and consent of MMEDIC Director, Room B-2, CAS. Study of basic cells and tissues followed by study of the histology of circulatory system and the gastrointestinal system and its associated glands. Emphasis is on functional morphology at the light and electron microscope levels. Computer-based virtual microscopy in laboratory exercises and discussions supplements companion lectures. Fall semester. 3 credits. (Students must register for both GMS AN 705 and AN 706 to complete equivalency to *MED Medical Histology.)*

**GMS AN 706. Medical Histology B.** Prereq: GMS AN 705 and consent of MMEDIC Director, Room B-2, CAS. Includes study of the histology of respiratory, lymphoid, and renal systems, male and female reproductive systems, integument, cartilage and bone, and endocrine organs. Emphasis is on functional morphology at the light and electron microscope levels. Computer-based virtual microscopy in laboratory exercises and discussions supplements companion lectures. Spring semester. 3 credits. (Students must register for both GMS AN 705 and AN 706 to complete equivalency to *MED Medical Histology.)*

**GMS BI 555/556. Biochemistry A, B.** Prereq: Organic Chemistry or equivalent, and consent of MMEDIC Director, Room B-2, CAS. This two-semester sequence provides the biochemical foundation for advanced studies in basic and clinical sciences. Topics presented in the first semester include the structure and function of macromolecules, the mechanisms of enzyme action, the metabolism of carbohydrates and lipids, and biochemical energetics. The second semester continues with the metabolism of lipids, amino acids and nucleotides, the control of metabolic processes, hormone action, biochemical genetics, and transcriptional and translational events. Fall and Spring semesters. 4 credits each semester. (Students must register for both semesters to complete equivalency to *MED Biochemistry and Cell Biology*.)

**GMS BI 751. Biochemistry and Cell Biology**. Prereq: Organic Chemistry and consent of MMEDIC Director, Room B-2, CAS. Basic principles and concepts of medical school Biochemistry and Cell Biology in a one-semester course. Topics include protein structure and function; mechanisms of enzyme action; nutrition and metabolism; membrane structure and receptor signaling; cell cycle regulation; DNA and RNA structure and function; regulation of gene expression and techniques in Molecular Medicine. Clinical correlations are provided throughout the course. Fall semester. 6 credits. (Completes equivalency to *MED Biochemistry and Cell Biology.*)

**GMS BN 779 Beginning Basic Neurosciences.** Prereq: consent of MMEDIC Director, Room B-2, CAS. Overview to include neurophysiology, neurochemistry, neuroanatomy, neurobehavior, and neuro-psychopharmacology. Processes occurring at the cellular and physiological levels are related to known central nervous system dysfunction. May not be taken concurrently with GMS BN 778. Fall semester. 2 credits.

**GMS MH 701 Counseling Theory.** Prereq: consent of MMEDIC Director, Room B-2, CAS. This course will review the foundations of counseling theory including psycholo-analytic theory, Rogerian theory, self psychology, behavioral theory, and cognitive approaches to counseling. Techniques and

strategies such as Rational-Emotive therapy, Dilectical Behavior theory and group therapy will also be examined. Fall semester. 3 credits.

**GMS MI 700 Concepts in Microbiology.** Prereq: consent of MMEDIC Director, Room B-2, CAS. This course provides a fundamental understanding of the world of microbes and the concepts and mechanisms involved as microbes interact/adapt in changing environments. Lectures are taught in an interactive manner and are supplemented through discussions and analyses of the primary literature. Fall semester. 4 credits.

**GMS MI 713. Comprehensive Immunology.** Prereq: GMS BI 555, GMS BI 556, or GMS BI 751 and consent of MMEDIC Director, B-2, CAS. Comprehensive introduction to immunologic principles and applications. Consists of interactive lectures and discussion sessions. Emphasis is on analysis and interpretation of data from primary literature. Prior coursework in genetics and biochemistry is strongly recommended. Fall semester. 4 credits. (Completes equivalency to *MED Immunology.)*

**GMS PA 600 Introduction to Pathology and Pathophysiology of Disease**. Prereq: consent of MMEDIC Director, Room B-2, CAS. Lectures and discussion sessions presenting the basic morphologic and functional changes of major disease processes: cell injury and death, inflammation, cell and tissue response to microbial organisms, atherosclerosis, cancer, etc. Spring semester. 4 credits.

**GMS PH 730. Human Physiology A.** Prereq: consent of MMEDIC Director, Room B-2, CAS. Cellular and organ physiology. Lectures and discussions examine the function of nerves, muscles, blood and the cardiovascular and digestive systems. Emphasis is placed on the regulation of organ function and on integrative aspects of human physiology. Fall Semester. 4 credits. (Students must register for GMS PH 730, PH 731 and PH 750 to complete equivalency to *MED Physiology*.)

**GMS PH 731. Human Physiology B.** Prereq: GMS PH 730 and consent of MMEDIC Director, Room B-2, CAS. Lectures, laboratories and discussions examine function and regulation of the respiratory and renal systems with emphasis on integrative aspects. Spring semester. 2 credits. (Students must register for GMS PH 730, PH 731 and PH 750 to complete equivalency to *MED Physiology*.)

**GMS PH 750. Endocrinology**. Prereq: GMS PH 730 and 731 and consent of MMEDIC Director, Room B-2, CAS. This is an integrated treatment of human endocrinology: biosynthesis of hormones, regulation, receptor interactions, and physiological effects. The course is presented in lecture format and in small group discussion sessions where clinical cases are used to exemplify the mechanisms of endocrine function. A background in biochemistry is helpful. Spring semester. 2 credits. (Students must register for GMS PH 730, PH 731 and PH 750 to complete equivalency to *MED Physiology*.)

**GMS PM 730 Introduction to Medical Pharmacology**. Prereq: Premedical courses in the sciences and consent of MMEDIC Director, Room B-2, CAS. Principles of pharmacology are covered and several major classes of therapeutic agents, with attention to their mechanisms of action. Issues of current and future concern in medical pharmacology are addressed including problems of drug abuse, the ethics of human experimentation, the pricing of new drugs, and new biotechnological approaches to drug design and development. Fall semester. 4 credits.

## B. HUMANITIES

**CAS PH 251. Medical Ethics.** Prereq: one philosophy course or sophomore standing. Examination of a number of value problems arising within the context of medicine and health care. Particular ethical problems of euthanasia, abortion, human experimentation, reproduction, and allocation of scarce resources; critiques of contemporary medicine as an institution. Fall or Spring semester. 4 credits.

**CAS PH 452. Ethics of Health Care.** Prereq: CAS PH 350 and two other philosophy courses, or consent of instructor (PH 150 and PH 251 are recommended). Medicine and health care offer a unique opportunity to explore the nature of humanity and the world and to ask fundamental questions concerning the nature of birth, life, and death, and what it is to be a person. Readings from both classical and contemporary writings in ethics, medicine, law, and public health policy. Spring semester. 4 credits.

## C. PUBLIC HEALTH AND OTHERS

**SPH BS 701. Elementary Biostatistics.** Prereq: consent of MMEDIC Director, Room B2, CAS. For students who have not had prior experience with statistics or biostatistics. Topics include the collection, classification, and presentation of descriptive data; the rationale of estimation and hypothesis testing; correlation and regression analysis; analysis of variance; and analysis of contingency tables. Special attention is directed to the ability to recognize and interpret statistical procedures in articles from the current literature. Students will also learn statistical computing techniques using Microsoft Excel. Fall or Spring semester. 3 credits.

**SPH BS 703. Biostatistics.** Prereq: consent of MMEDIC Director, Room B2, CAS. This course is for students who have had classroom or work-related exposure to biostatistics, or have a strong background in mathematics. Topics include confidence intervals and hypothesis testing; sample size and power considerations; analysis of variance and multiple comparisons; correlation and regression; multiple regression and statistical control of confounding; logistic regression; and survival analysis. This course gives students the skills to perform, present, and interpret basic statistical analyses, using the R statistical computing package. For the more advanced topics, the focus is on interpretative skills and critically reading the literature. Fall or Spring semester. 4 credits.

**SPH EP 711. Epidemiology.** Prereq: consent of MMEDIC Director, Room B2, CAS. Introduces the basic principles and methods of epidemiology and demonstrates their applicability in the field of public health. Provides an introduction to the basic skills needed to critically interpret the epidemiologic literature relevant to public health professionals. Fall or Spring semester. 3 credits.

**SPH EP 712. Epidemiologic Methods.** Prereq: consent of MMEDIC Director, Room B2, CAS. Covers the same materials as EB 711, but does so in greater depth, with more emphasis on methodologic issues, and with increased focus on critical assessment of contemporary substantive epidemiologic research. This course is intended for those students who have an interest in a more intensive exploration of the basic principles of epidemiology, with greater rigor and with a more quantitative orientation. This course is recommended particularly for students who intend to

concentrate in Epidemiology and Biostatistics and others whose public health interests entail quantitative skills. Fall semester. 4 credits.

**SPH PM 702 Introduction to Health Policy and Management.** Prereq: consent of MMEDIC Director, Room B2, CAS. The course's main, over-arching aim is to empower students to better understand the 303-million-person, $2.4 trillion, 5,000-hospital, 19,000-nursing-home, 775,000-physician, 2.3-million-nurse, 45- to 60-million-uninsured world of U.S. health care delivery, finance, management, and policy. That $2.4 trillion per year in spending amounts to just over $1,000,000,000 for each minute of class time in PM702. You will be working in public health for many decades. No matter where in public health you work, you could be blindsided by the 18-wheel truck of changes in health care delivery and finance in the United States—if you don't watch out for those changes and understand how they might affect you. The course's aim is not to persuade you that this answer or that answer to a big policy question is the right one, but rather to help you decide. It will fairly present both (or more) sides of the main policy debates in health care delivery and finance. The course seeks to present all materials in ways that are interesting and relevant to those of you who care deeply about health care delivery and policy—and also to those whose interests point mainly in other directions.. Fall or Spring semester. 3 credits.

**SPH SB 710 Nutrition and Public Health**. Prereq: consent of MMEDIC Director, Room B2, CAS. Examines the principles of public health nutrition and explores the nutritional status of individuals throughout the life cycle. Faculty focus on nutrition assessment, the development of nutrition policy, the role of diet in obesity and chronic diseases of an affluent society, nutrition program planning, and national and local nutrition surveillance. In addition, the course reviews the components of administering nutrition services on a local, national, and international level. The impact of overall socioeconomic development on nutrition and health status, infectious disease, and public health policy is considered. No previous coursework in nutrition is required; a basic introduction to nutrition is provided. Fall semester. 4 credits.

*Courses listed as MMEDIC modules are subject to change at the discretion of the Oversight Committee for Early Selection Pathways to the School of Medicine.

(03/08)