BIOMEDICAL ENGINEERING PROGRAM

Academic Director:
Richard A. Gross

THE MASTER OF SCIENCE IN BIOMEDICAL ENGINEERING

GOALS AND OBJECTIVES

The primary goal of the MS in Biomedical Engineering Program is to provide students with an in-depth, advanced education that gives them the tools needed to perform fundamental and applied research in biomedical engineering. Alternatively, students gain the requisite technical knowledge that they may wish to apply to management, marketing, sales and other entrepreneurial activities related to biomedical engineering. Specific objectives include:

• To enroll students who come from a wide array of disciplines and bring different skill sets to solve a broad range of biomedical engineering problems. The program is constructed to accommodate students that have a BS or a more advanced degree from: i) Chemical Engineering, ii) Mechanical Engineering, iii) Electrical Engineering, iv) Computer Science Engineering, v) Physics, vi) Chemistry, vii) Biology, viii) Premedical, ix) Bioengineering and x) Biotechnology.

• To provide students with a cutting edge program that integrates engineering, biological and medical sciences. Students will acquire the skills to participate in technological innovations that provide people with longer, healthier and more productive lives.

• To merge the leadership and talents found at Polytechnic in Chemistry, Biology, Engineering, Computer science, Management, Humanities with the expertise in Medical sciences at SUNY Downstate Medical Center.

• To give students an opportunity to focus on a wide range of contemporary topics that are all important to various aspects of Biomedical Engineering. Students can choose courses in topics that include biomedical instrumentation, biomaterials, drug delivery, orthopedic devices, protein engineering, anatomy, biochemistry, immunology, bioinformatics and material science.

• To give students the option of doing research in the laboratories at Polytechnic and/or SUNY Downstate Medical Center. Students may also substitute research credits with course electives.

In the years ahead, health and human productivity can be vastly improved through major advances in medicine. These advances will happen through the successful, seamless integration of biology and modern engineering. Scientists anticipate future breakthroughs ranging from the design of drugs customized to an individual’s genome to the perfection of artificial implantable organs. Aggressive and intelligent integration of engineering and the biological and medical sciences will hasten the realization of these and other innovations, leading to longer, healthier and more productive lives. Scientists can now visualize structures inside the body with a level of clarity thought impossible only a decade ago. With the improved diagnosis that comes from these advances and those that will follow, further discoveries in the area of treatment will be added.

Today, miniature devices can be manipulated through endoscopes, making it possible to perform surgical procedures with minimal invasion and thus minimal trauma to the patient. In the future, the microfabrication of biomedical devices at Polytechnic and elsewhere will further enable surgery and increase the functionality of the physically impaired in applications ranging from congenital defects to improving the function of major organs, such as the heart, kidneys and liver. Other areas show similar promisebreakthroughs in human tissue research point to the possibilities of replacing damaged or diseased bone, cartilage, and other tissues with newly engineered materials. Biodegradable materials will substitute for permanent implants allowing recovery of tissues with subsequent clearance from the system of the degraded implant material. New imaging systems are emerging that provide new information and monitoring possibilities. Wireless technology will integrate into medical devices and homecare systems. There is little doubt that these and other extraordinary developments will dramatically impact lives over the next few decades.

By merging the leadership and talents found at Polytechnic in Engineering, Chemistry, Biology, Computer science, Management, Humanities with the expertise in Medical sciences at SUNY Downstate Medical Center, the Biomedical Engineering Program provides its students a broad range of opportunities. The partnership between Polytechnic and SUNY Downstate is dedicated to this new mode of biomedical education, and to the development of students with both practical and fundamental knowledge. Students in the program move freely between the Polytechnic University and SUNY Downstate, taking advantage of both facilities, their faculty and associated research programs. Polytechnic’s goal is to provide students with the best in classroom and laboratory education, to give them the skills to succeed in the wide range of opportunities that will be open to them upon graduation.
A Perfect Formula for a Successful Biomedical Engineering Program

The strategic alliance between SUNY Downstate Medical Center and Polytechnic University created the framework that has resulted in Downstate’s important contribution to Polytechnic’s Masters of Science in Biomedical Engineering Program. The two institutions have coextensive research interests with complementary technological expertise. Noteworthy common areas of scientific investigation include:

• Biosensors
• Telemetry
• Neurorobotics
• Optical imaging
• Bioreorbable Biomedical Materials
• Drug Delivery
• Protein and Glycolipid Therapeutics
• Tissue Engineering
• Microchip Sensors

FULL AND PART-TIME STUDENTS

Students entering this master’s program may wish to complete their degree rapidly by taking a full course load, or proceed at a slower pace if they are working professionals with other full or part-time commitments. The curriculum structure and class schedule for this program accommodate both part-time and full-time students. Thus, most 3-credit courses offered are given as two and-a-half hour lectures one evening per week during a 15-week semester. Evening research opportunities are also available.

ADMISSION AND DEGREE REQUIREMENTS

The Master of Science degree is intended for students from various backgrounds seeking in-depth knowledge in Biomedical Engineering. Students may apply to the master’s program if they have one or more of the following: (1) BS or a more advanced degree in any engineering discipline, (2) BS or more advanced degree in mathematics or (3) BS or more advanced degree in any of the natural sciences. Students entering the program should have a minimum of 2-semesters of college level calculus (see POLY course descriptions for mathematics, MA 1012, 1022, 1122 and 1122), two semesters of college-level physics (see POLY course descriptions for physics, PH 1004 and PH 2004, 2-semesters of college level chemistry (see POLY course descriptions for Chemistry, CM 1014 and CM 1024).

For students choosing to focus on the Biomaterials and Polymer Therapeutics track, additional background in organic chemistry is desirable. For students choosing to focus on the Bioimaging and Neuroengineering track, additional advanced courses in mathematics (e.g. POLY courses MA 2132, ordinary differential equations; and MA 2112/2122 in multi-variable calculus). Students that lack undergraduate courses described above may be admitted to the program contingent upon the student satisfying certain course work deemed necessary for the student’s success in the MS in Biomedical Engineering program. To help students in the program raise their level of knowledge in chemical and biochemical concepts specific to advanced courses in the Bioimaging and Neuroengineering track, BE 6653, Principles of Chemical and Biochemical Systems for Engineers, was developed and is offered. A program advisor will review with successful applicants what undergraduate courses, if any, must be taken. Such courses will not count towards the master’s degree.

THE CURRICULUM

REQUIREMENTS FOR THE MASTER OF SCIENCE

Biomedical Engineering - Biomaterials and Polymer Therapeutics track

To meet graduation requirements, students must have an overall B average in all courses (including MS Thesis, Research or Guided Studies) and must not obtain more than two grades of C in required (core) subjects.

Required (core) courses for all students in the Biomaterials and Polymer Therapeutics track who are fulfilling their requirements for an MS in Biomedical Engineering.

Core required courses (3 credits each):

(1) Choose one of the following:
BE 6003 Principles of Biological Systems
(1-listed as CM 9503)
BE 6023 Cellular and Molecular Neuroscience
CM 9413 Biochemistry I
CM 9423 Biochemistry II

(2) BE 6703 Materials in Medicine

(3) Choose one of the following courses:
CM 7723 Synthesis of Macromolecules
CM 7813 Characterization of Macromolecules
CBE 7263 Engineering Properties of Polymers
BE 6723 Natural Polymers and Materials (co-listed as CM 7923)
CBE 7283 Polymer Composites

(4) Choose one of the following courses:
BE 6603 Drug Delivery
CBE 8373 Engineering Principles of Drug Delivery

(5) Choose one of the following:
BE 6253 Biosensors
BE 9433 Protein engineering

(6) BE 9443 Tissue Engineering

(7) BE 6753 Biomechanics and Biomaterials in Orthopedics
In addition, during at least two semesters, Biomedical engineering MS students are required to register for Colloquium in Biomedical Engineering (BE 8730, 0-credits) and attend seminars.

For all students in the Biomaterials and Polymer Therapeutics track, remaining credits (9) must be selected from the following list of electives unless permission is granted by the Biomedical Engineering Graduate Advisor to substitute a course not on the list below. The student may also choose to take the remaining 9 credits to do research and complete a Masters thesis (see below). This requires that students take 9-credits of BE 997x and then write/defend their Master thesis according to University guidelines. Students may also elect to take Research in Biomedical Engineering courses (BE 873x, 3 to 6 credits) without writing a thesis.

9 credits selected from the following courses or research credit options:
BE 6003 Principles of Biological Systems (Co-listed as CM 9503)
BE 6013 Molecular Immunology
BE 6023 Cellular and Molecular Neuroscience
BE 6203 Biomedical Imaging I
BE 6213 Biomedical Imaging II
BE 6253 Biosensors
BE 6503 Biomedical Instrumentation
BE 6603 Drug Delivery
BE 9433 Protein Engineering
BE 9503 Enzyme-Catalysis in Organic Synthesis (Co-listed as CM 9053)
BE 6723 Natural Polymers and Materials (Co-listed as CM 7923)
BE 6813 Bio-optics
BE 871x Guided Studies in Biomedical Engineering
BE 873x Special Topics in Biotechnology (3 credits)
CM 7723 Synthesis of Macromolecules
CM 8033 Physical Organic Chemistry
CM 8073 Organic Spectroscopy
CM 8113 Advanced Inorganic Chemistry
CM 8423 Biochemistry II
CM 9413 Biochemistry I
MT 6003 (3 credits) Structure-Property Relationships in Materials
BE 873x Research in Biomedical Engineering
BE 875x Thesis for Degree of Master of Science in Biomedical Engineering

Students who choose the Masters thesis option must register for at least 9-credits of BE 997x, and then write/defend a master thesis according to University guidelines. Alternatively, students may choose to take up to six credits in Biomedical Engineering Research (BE 873x) without writing/defending a masters thesis.

Total: 30 credits

**REQUIREMENTS FOR THE MASTER OF SCIENCE**

**Biomedical Engineering - Bioimaging and Neuroengineering track**

To meet graduation requirements, students must have an overall B average in all courses (including MS Thesis, Research or Guided Studies) and must not obtain more than two grades of C in required (core) subjects.

Required (core) courses for students in the Bioimaging and Neuroengineering track fulfilling their requirements for an MS in Biomedical Engineering are listed below.

Core required courses (3 credits each course, 21 credits total):

1. Choose one of the following:
   - BE 6003 Principles of Biological Systems (Co-listed as CM 9503)
   - CM 9413 Biochemistry I
   - BE 6023 Cellular and Molecular Neuroscience
2. (2) BE 6703 Materials in Medicine
3. (3) BE 6203 Biomedical Imaging I
4. (4) BE 6253 Biosensors
5. (5) BE 6503 Biomedical Instrumentation (Co-listed with EL 5813)
6. (6) Choose one of the following:
   - BE 6603 Drug Delivery
   - CBE 8373 Engineering Principles of Drug Delivery
7. (7) Choose one of the following:
   - BE 6213 Biomedical Imaging II
   - BE 6353 Image Processing (Co-listed as EL 5123)
   - BE 6403 Signals and Systems (Co-listed as EL 6113)
   - BE 6453 Probability (Co-listed as EL 6303)
   - BE 6483 DSP laboratory (Co-listed as EL 6183)

In addition, during at least two semesters, Biomedical engineering MS students are required to register for Colloquium in Biomedical Engineering (BE 8730, 0-credits) and attend seminars.

For all students in the Bioimaging and Neuroengineering track, remaining credits (9) must be selected from the following list of electives unless permission is granted by the Biomedical Engineering Graduate Advisor to substitute a course not on the list below. The student may also choose to take all 9 of the remaining credits to do research and complete a Masters thesis (see below). This requires that students take 9-credits of BE 875x and then write/defend their Master thesis according to University guidelines. Students may also elect to take one or
two Research in Biomedical Engineering courses (873x) without writing a thesis.

Choose 3 courses or a total of 9-credits from the following list:

BE 6003 Principles of Biological Systems (Co-listed as CM 9053)
BE 6023 Cellular and Molecular Neuroscience
BE 6013 Molecular Immunology
BE 6653 Principles of Chemical and Biochemical Systems
BE 6213 Biomedical Imaging II
BE 6503 Biomedical Instrumentation
BE 6603 Drug Delivery
BE 9433 Protein Engineering
BE 9503 Enzyme Catalysis in Organic Synthesis (co-listed as CM 9053)
BE 6723 Natural Polymers and Materials (co-listed as CM 9723)
BE 6900 Bio-optics
BE 873x Research in Biomedical Engineering
BE 997x Thesis for Degree of Master of Science in Biomedical Engineering

Students who choose the Masters thesis option must register for at least 9-credits of BE 997x, and then write/defend a master thesis according to University guidelines. Alternatively, students may choose to take up to six credits in Biomedical Engineering Research (BE 873x) without writing/defending a masters thesis.

Total: 30 credits

ADVANCED CERTIFICATE PROGRAMS

The Biomedical Engineering Program administers two certificate programs: (1) Biomedical Materials and (2) Bioinstrumentation. The Advanced Certificates in Biomedical Materials and Bioinstrumentation are intended for students from various backgrounds seeking in-depth knowledge in a specialty area within Biomedical Engineering. Students may apply to the certificate program if they have one or more of the following:

(1) BS or a more advanced degree in any engineering discipline, (2) BS or more advanced degree in mathematics and/or (3) BS or more advanced degree in any of the natural sciences. The program adviser reviews with successful applicants pre-requisites that may be required for successful completion of certificate courses. A certificate program requires four courses (12 credits), designed for working professionals who seek advanced training in a specific subject area within Biomedical Engineering. Students may apply to the certificate program if they have one or more of the following:

1. Certificate Requirements for an Advanced Certificate in Biomedical Materials

   Required:

   (1) BE 6703 Materials in Medicine
   (2) BE 6723 Natural Polymers and Materials
   (3) One of the following courses:
      CM 7723 Synthesis of Macromolecules
      CM 7813 Characterization of Macromolecules
      CBE 7263 Engineering Properties of Polymers
   (4) One of the following courses:
      BE 6603 Drug Delivery
      BE 6253 Biosensors
      BE 9433 Protein engineering
      BE 9443 Tissue Engineering
      BE 6753 Biomechanics and Biomaterials in Orthopedics

2. Certificate Requirements for an Advanced Certificate in Bioinstrumentation

   Required:

   (1) BE 6703 Materials in Medicine
   (2) BE 6203 Biomedical Imaging I
   (3) BE 6253 Biosensors
   (4) BE 6503 Biomedical Instrumentation

THE DOCTOR OF PHILOSOPHY IN BIOMEDICAL ENGINEERING

The primary goal of the PhD in Biomedical Engineering is to provide students with an in-depth, advanced education that will give them
the tools needed to perform fundamental and applied research in biomedical engineering. Alternatively, students will gain the requisite technical knowledge that may wish to apply to management, marketing, sales and other entrepreneurial activities related to biomedical engineering.

Specific Objectives include:

- To allow students entrance into the program that have a BS or a more advanced degree in any engineering discipline, BS or more advanced degree in mathematics, or a BS or more advanced degree in any of the natural sciences.
- To provide students with a cuttingedge program that integrates engineering, biological and medical sciences. The result will be that students will acquire the requisite skills to participate in technological innovations that provide people with longer, healthier and more productive lives.
- To better accomplish the above, to merge the leadership and talents found at the Polytechnic University in chemistry, engineering and computer science with the expertise in medical sciences at the Health Sciences Center at SUNY Downstate Medical Center.
- To give students an opportunity to participate in technological innovations that provide people with longer, healthier and more productive lives.
- To better accomplish the above, to merge the leadership and talents found at the Polytechnic University in chemistry, engineering and computer science with the expertise in medical sciences at the Health Sciences Center at SUNY Downstate Medical Center.
- To give students an opportunity to participate in technological innovations that provide people with longer, healthier and more productive lives.
- To give students the option of doing research in the laboratories at Polytechnic University and/or SUNY Downstate Medical Center. Students may also substitute research units with course electives.

**STRUCTURE AND REQUIREMENTS FOR DEGREE COMPLETION:**

While the MS in Biomedical Engineering consists of 30 course credits, the PhD in Biomedical Engineering program consist of 39 course credits, excluding the required thesis research, for the SUNY students and 72 credits for Poly students. The program has three separate, entry-level pathways to accommodate students entering with a bachelor’s degree in any of the following disciplines: (1) chemical engineering; (2) mechanical engineering; electrical engineering; computer science engineering or physics; and (3) chemistry, biology or premedical studies. By accommodating these students with varying academic backgrounds, we intend to further encourage communication, in keeping with the interdisciplinary nature of biomedical engineering. Students will be required to take at least one, but not more than two, of Polytechnic’s management of technology courses. Students will be obligated to participate in a short course on responsible conduct in research, as required by the National Institutes of Health (NIH) for training grant funding joint institutionally; to participate in Journal Clubs; and to attend a the jointly sponsored SUNY/Poly Biomedical Engineering Seminar Series. The required PhD thesis research may be conducted under the supervision of a faculty member from either institution. We expect that these students will need five to six years to complete the doctoral program.

In keeping with the goal of preparing our graduates for the changing career marketplace, students will be required to complete two complementary laboratory rotations, each of approximately three months’ duration, prior to selection of a thesis laboratory. At least one rotation should be in an industrial setting; the other should be in an academic setting, i.e., in a laboratory of a Downstate Medical Center clinical department engaged in translational research, or in a basic science laboratory of either Polytechnic or Downstate. Both types of settings will provide mentor-based, individualized training of the highest quality. Both basic science and clinical faculty with active research and graduate school appointments may supervise rotations, and ultimately, thesis projects. Senior scientists in companies of the new Advanced Biotechnology Park, located adjacent to the Downstate campus, and in Poly’s planned I/UCR & EP will be eligible for adjunct faculty status and, as such, may be supervisors of rotations and co-supervisors of thesis projects. In order to become a thesis supervisor, a sufficient level of extramural funding (i.e., grants, contracts or clinical revenues) must be demonstrated.

Regarding award of research units, Polytechnic awards minimum of 36 credits for the required PhD thesis research (with a minimum of 30 credits for courses, a total of 72 units for courses plus research), and therefore charges tuition for the same. SGS, in contrast, does not award research units and therefore does not charge tuition for the required thesis research, but the financial support for the student stipend comes from NIH grants in which stipend is overheaded. Thus the total expense for a doctoral student is approximately the same. But by adhering to the strategy mentioned in Section A (page 3, bottom of paragraph 2) in which matters of bookkeeping are in accordance with the regulations and culture of the campus at which the student is registered, the potential conundrum will be avoided. Specifically, candidates whose thesis research advisers are Polytechnic faculty will be required to register at Polytechnic and will accumulate a total of 72 credits; whereas those candidates whose thesis research advisers are Downstate faculty will be required to register at Downstate and will accumulate only the 36 course credits. The same joint PhD will be conferred regardless of the campus at which the student registers; the research requirements for all graduate students in the program are identical. 15 credits is the minimum number of biomedical engineering course units needed with the total course credit amount.
Each student will be required to register for all of the courses through the standard registration process at student’s own institution, irrespective of where the courses are actually held. The Registrars at each institution will keep accounts of the number of units taken by their PhD in Biomedical Engineering students at the alternate institution. Those units will be tallied at the close of every two academic years, or every other June.

A single qualifying examination, scheduled within the two first two years, is required to advance to candidacy for the PhD degree. Students must submit a formal application to take the exam during registration of the selected semester. The application should include the names of three of more faculty who are willing/assigned to serve on qualifying examination committee. Prior to the examination, the student will submit to the examination committee a short paper that is related to the potential thesis project. The students are encouraged to submit this in the form of a grant application that would be appropriate for the field of interest (NSF, NIH) and the paper should be limited to 15 pages or less. The examination is not intended to describe preliminary results, but rather to inform committee members of the scientific areas most relevant to student’s research. The paper must be presented to the members of the committee at least one week prior to the examination. During the examination, questions from the committee will not necessarily be limited to the student’s presentation, but may cover other aspects of the student’s academic training up to that point. The intent of the student paper is to focus committee’s attention and to make the members aware of the areas of interest in which the student might be expected to have particular interest. The Committee will consist of at least three members, one of whom must be a member or designee of the executive committee. The examination will be graded as high pass, pass or fail by majority vote. In the case of failure, the right to a second examination is the discretion of the executive committee and the graduate dean or associate dean from biomedical engineering of the campus at which the student is enrolled. The results of each student’s examination will be delivered to the Graduate School, in writing, no later than one week following the exam.

PROGRAM ADMISSION

PhD in Biomedical Engineering applications will be reviewed by an admissions committee composed of faculty from both SGS and Polytechnic. Requirements for acceptance to the program will include (1) academic excellence, (2) interests congruent with those of program faculty, and (3) positive recommendations from former research advisers. All viable candidates will be interviewed by admissions committee member and faculty members whose research interests match those of the candidate, either in person or by a conference call.

Bachelor’s level students accepted into the PhD in Biomedical Engineering will be expected to register at the campus where the faculty research best matches their own interests. While this early commitment to a research area is dissimilar to other doctoral programs at Downstate, it is essential given the early tuition and stipend obligations at Polytechnic. Students with an MS who wish to enter the PhD in Biomedical Engineering must be accepted by a faculty thesis adviser before they will be allowed to enroll.

Several years ago, the School of Graduate Studies began a concerted effort to recruit more students from groups that have been underrepresented in biomedical science. Enrollment, applicant pool and minority recruitment at both Downstate and Polytechnic are discussed in detail later in this document.

Thesis Research

BME 998-9 PhD Thesis Research in Biomedical Engineering

Procedures for academic advising, and for supervision and evaluation of students’ progress through degree completion.

Members of an Executive Committee of each program track will monitor the individual student’s progress through the PhD in Biomedical Engineering, as in the other doctoral programs at Downstate and Polytechnic. At each stage of a student’s career it is important to determine if they are progressing at a rate sufficient for success as a doctoral candidate. This includes the successful and timely completion of course work and examinations. In addition, research progress will be monitored by a series of committees. To accommodate the changing needs of each student based upon his or her research project, the composition of the committees is designed for flexibility. The following schedule is suggested:

Year 1:

For students entering at the bachelor’s level, the appropriate PhD in Biomedical Engineering track’s Executive Committee will assign a member to each first year student until he/she chooses a thesis adviser.

Year 2:

The qualifying examination committee will be formed. This committee will consist of three members, one of whom must hold a PhD in engineering.

Year 3:
The thesis/advisory committee will be formed. This committee will consist of six members, selection of which will be based primarily on the area of the student's research. All attempts should be made to include at least two members from the student’s qualifying exam committee; one member should be from the track executive committee (or a designee); one member should have a PhD in engineering; two members should be from a department other than the one in which the thesis adviser is affiliated. While the sixth member, an outside examiner, is currently required by Downstate's SGS to be present at the thesis predefense, they may also become involved in the proposal defense, at the student and adviser’s invitation.

Year 4:

The thesis/advisory committee, including the external member, will monitor student progress during the thesis predefense. Internal members of the thesis/advisory committee monitor the thesis defense; attendance by the external member at the thesis defense is optional.

Below is a chronological description of the process by which a student will progress from thesis proposal to thesis defense.

1) Student submits written version of thesis proposal to the committee two weeks in advance of the Oral Proposal Defense.
2) Oral Proposal Defense. This is a formal presentation by the student before the program’s students and faculty.
3) Chair of committee writes a letter to student containing the committee’s determination of the proposal defense (Acceptable, Acceptable with Modifications or Unacceptable). The letter should describe what experiments are required for completion of the thesis work. This is a “contract” with the student.
4) Student submits written thesis to committee, including to the outside examiner, two weeks in advance of the Predefense of the thesis.
5) Predefense. Student must defend written document and respond to questions regarding research. (The format is oral. A formal presentation on the part of the student is discouraged; a brief, informal presentation may occur if desired by the chairman.)
6) Chair of committee writes a letter to student containing the committee’s determination of what changes are required for the final document.
7) Student submits final document to committee members two weeks prior to the defense, or one week if agreed upon by all committee members.
8) Defense. First there is a formal, public presentation by the student, with questions from the audience. Following the public presentation, the student meets privately with the committee members for questions. A decision is made by the committee in camera.

GRADUATE COURSES

Course descriptions of biomedical engineering courses as well as CM and CBE courses associated with the MS in Biomedical Engineering Program are given below. Other courses that are not described below but are listed in the biomedical engineering program can be found in the description of courses from their respective departments in other sections of this catalog.

BE 6003 Principles of Biological Systems
3:0:0:3

Physiology is defined as the science which deals with the functions of the body. It logically follows, therefore, that a sound, comprehensive knowledge of human physiology should occupy a significant part of the academic training of personnel in Medicine and related fields. In this particular course the emphasis will be on normal functions, but to some extent we shall consider the consequences of disease and injury, and deal with the body’s potential for recovery and for compensation. Behavioral responses to environmental conditions will be considered, but in this area our chief concern will be with the regulation and control of fundamental reflexes or neuro-endocrine mechanisms.

BE 6013 Molecular Immunology
3:0:0:3

Familiarizes students with the body of research that forms the foundation of our present understanding of the molecular basis and the cellular interactions that regulate the immune responses. The principal tool of learning is the reading and discussion of research papers in immunology by a small group of students supervised by a faculty member who is active in the specific research area. The topics to be covered include antibody structure, B-cell development, T-cell structure and development, T-cell-MHC interaction, MHC structure and antigen processing, complement chemistry, complement and Fc receptor structure and function, transplantation immunogenetics, mucosal immunology and allergic reactions. Prerequisites: CM 9503 or its equivalent and undergraduate biochemistry.

BE 6023 Cellular and Molecular Neuroscience
3:0:0:3

A comprehensive overview of cellular neuroscience that consists of 20 lectures and two exams. Course is roughly divided into three parts: (1) the physiology and biophysics of neurons; (2) neuronal signal transduction, gene expression and transport of RNA and protein; and (3) synaptic transmission and plasticity. Prerequisite: CM 9506 or its equivalent and undergraduate biochemistry.
BE 6203 Biomedical Imaging I

3:0:0:3

This course introduces the physics, instrumentation, and signal processing methods used in X-ray imaging (projection radiography), X-ray computed tomography, nuclear medicine (SPECT/PET), ultrasound imaging, and magnetic resonance imaging. Prerequisite: Multivariable calculus (MA 2112, MA 2122), physics (PH 2004), probability (MA 3012). Open to graduate students and upper level UG students. Co-Requisite: signals and systems (EE 3054, preferred but not required).

BE 6253 Biosensors

3:0:0:3

Discussion of various biosensors, which consist of bio-recognition systems, typically enzymes or binding proteins such as antibodies, immobilized onto the surface of physico-chemical transducers. Immuno-sensors, which use antibodies as their biorecognition system, are also discussed. Other biorecognition systems discussed are nucleic acids, bacteria, and whole tissues of higher organisms. Specific interactions between the target analyte and the complementary biorecognition layer that undergoes a physicochemical change is ultimately detected and measured by the transducer. Various transducers, which can take many forms depending upon the parameters being measured-electrochemical, optical, mass and thermal changes are also part of the course. Co-listed as BT 6253. Prerequisite: CM 1004, CM 2214, CM 2614 and CM 9413.

BE 6303 Bio-optics

3:0:0:3

Recent growth in the use of optics technology for biomedical research and health care has been explosive. New applications are made possible by emerging technologies in lasers, optoelectronic devices, fiber optics, physical and chemical sensors and imaging—gall of which are being applied to medical research, diagnostics, and therapy. This sequence course on optics for biomedical students combines fundamental knowledge of the generation and interaction of electromagnetic waves with applications to the biomedical field. It is hoped that this approach will not only provide tools for researchers in bio-physics, but also familiarize researchers, technologists and premed students with cutting-edge approaches. Prerequisite: an undergraduate course in physics that includes electricity, magnetism and waves such as PH 109.

BE 6403* Signals, Systems and Transforms

3:0:0:3


BE 6453 Probability Theory

3:0:0:3


BE 6483 Digital Signal Processing Laboratory 1:5:1:5:0:3

This course includes hands-on experience with a set of laboratory experiments, lectures and projects relating to real-time digital signal processing (DSP) systems using a DSP microprocessor. Students will gain experience in the implementation of common algorithms used in a variety of applications, and will learn tools and functions important for the design of DSP-based systems. Students are required to complete project and provide an oral presentation. This course is suitable for students interested in DSP and Embedded Systems. Co-listed as EL 6183. Prerequisites: EL 6113 or Equivalent, C/C++

BE 6603 Drug Delivery 3:0:3

Provides an integrated approach to the basic and clinical science of drug delivery. This course discusses the following: highlights of the historical development of drug delivery; kinds of drugs to be delivered, including genes and proteins; various targeting mechanisms; pharmacokinetics and pharmacodynamics of drug delivery systems, polymeric drug delivery systems; various devices developed for controlled delivery. Prerequisite: introductory undergraduate courses in biology, chemistry, and physiology (minimum grade C).

BE 6653 Principles of Chemical and Biochemical Systems 3:0:3

Introductory course for graduate engineering students that focuses on providing fundamental knowledge of chemical and biochemical reactions. Students learn structure and function of biological molecules such as proteins, carbohydrates, DNA. They master basic concepts of structure-property relationships of macromolecules, Chemistries critical to biosensor technologies such as, linking biological molecules to various supports, is described. Students gain an appreciation and understanding of the wide-range of chemical and biological molecules that are critical to living systems. Prerequisite: Instructor’s permission.

BE 6703 Materials in Medicine 3:0:3

Focuses on the following: the basic principles behind human tissue response to artificial surfaces and materials; the general types of polymeric and metallic materials used in soft and hard tissue replacements; tissue engineering and drug delivery devices; current approaches directed toward the engineering of cell based replacement for various tissues; techniques utilized to control the physiologic response to artificial surfaces; critical review of the current biomaterials literature; current

BE 6753 Biomechanics and Biomaterials in Orthopedics 3:0:3

Provides students with fundamental knowledge of the relevant background science, theory, practice, and materials required to provide modern orthopedic and trauma care. Students learn about biomaterials used in orthopedics and how they have become increasingly sophisticated through materials engineering. The course covers important clinical applications as well as fundamental concepts in biomechanics of bone and other tissues, materials used, wear and corrosion during use, dental implants, joint replacement devices and more. Prerequisite: BE 6703 Materials in Medicine

BE 8703 Materials in Medicine 3:0:3

Focuses on the following: the basic principles behind human tissue response to artificial surfaces and materials; the general types of polymeric and metallic materials used in soft and hard tissue replacements; tissue engineering and drug delivery devices; current approaches directed toward the engineering of cell based replacement for various tissues; techniques utilized to control the physiologic response to artificial surfaces; critical review of the current biomaterials literature; current
research in the field; and evaluation of the design criteria which a material must meet for a given biological application and what is required for “biocompatibility.”

BE 871X Guided Studies in Biomedical Engineering

6 total, each 3 credits

Selections, analyses, solutions, and presentations of biomedical engineering reports for problems in products, processes or equipment design, or other fields of biomedical engineering practices under supervision of a faculty member. Conferences scheduled. Master’s degree candidates are required to submit three unbound copies of their reports to advisers one week before the last day of classes. Prerequisite: degree status.

BE 9433 Protein Engineering

3:0:0:3

This course will introduce students to the modern protein engineering techniques available to researchers to understand protein structure and function and to create entirely new proteins for a variety of purposes. This a new field that lies on the interface of chemistry, biology and engineering. The first part of the course will discuss the protein composition and structure, various genetic, biochemical and chemical techniques required to engineer proteins, which then will be followed by specific topics. Topics will include designing proteins that are highly structured; active at high temperatures and in non-aqueous solvents; that selectively interact with other proteins, small molecules and nucleic acids for therapeutic purposes; and that catalyze new reactions. Co-listed CM 9433, BT 9433, Prerequisite: CM 9413 or adviser’s approval.

BE 9443 Tissue Engineering

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This courses instructs students in the following: i) basic biological processes that occur during blood contact with artificial surfaces, ii) methods by which differentiation of stem cells can be directed, iii) material scaffolds and how they are constructed, iv) in-vitro versus in-vivo tissue engineering strategies, v) recent advances directed toward the engineering of cell-based replacements for various tissue types. Co-listed BT 9443, Prerequisite: adviser’s approval.

BE 9503 Enzyme-Catalysis in Organic Synthesis

3:0:0:3

Students focus on how to do organic chemistry using biocatalysts. Enzymatic reaction types and mechanisms discussed include cleavage and formation of C-O bonds, P-O bonds, C-N bonds, C-C bonds, reduction reactions, oxidation reactions and isomerizations. Concepts in reaction engineering include protein immobilization methods and protein stability/activity in various reaction media. Basic principles of whole cell biotransformations including culturing microbes, fermentation reaction parameters and product isolation are discussed. Students are also taught of the importance of integrating chemical and enzymatic reaction strategies. Co-listed as CM 9053, BT 9053, Prerequisite: CM 2214, CM 2614 and CM 3314.

BE 9703 Materials In Medicine

3:0:0:3

Focuses on the following: the basic principles behind human tissue response to artificial surfaces and materials; the general types of polymeric and metallic materials used in soft and hard tissue replacements; tissue engineering and drug delivery devices; current approaches directed toward the engineering of cell based replacement for various tissues; techniques utilized to control the physiologic response to artificial surfaces; critical review of the current biomaterials literature; current research in the field; and evaluation of the design criteria which a material must meet for a given biological application and what is required for “biocompatibility.” Co-listed as CM 7923, Prerequisite: CM 1004 and LC 1004.

PROJECTS, THESES AND SEMINARS

BE 873X Research in Biomedical Engineering

Credits: 6 total, each 3 credits

Fundamental or applied research in biomedical engineering that is performed under supervision of a faculty member. Conferences scheduled. Master’s degree candidates are required to submit three unbound copies of their reports to advisers one week before the last day of classes. Prerequisite: degree status.

BE 9730 Colloquium in Biomedical Engineering

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Recent developments in biomedical engineering are presented by engineers and scientists from industry and academia. Two and four semesters are required for Masters and Ph.D. students, respectively. Prerequisite: none

BE 997X Thesis for Degree of Master of Science in Biomedical Engineering

9 total, each 3 credits

Theses for the master’s degree in biomedical engineering should give results of original investigation of problems in biomedical engineering or application of physical, chemical or other scientific principles to biomedical engineering. Theses may involve experimental research, theoretical analyses
or process designs, or combinations thereof. Master’s degree candidates are required to submit four unbound copies to advisers before the seventh Wednesday prior to commencement. Registration of at least 9 credits required. *Prerequisite: degree status.*
FACULTY

PARTICIPATING FACULTY FROM SUNY DOWNSTATE MEDICAL CENTER

Randall Barbour, Professor of Pathology, SUNY Downstate; Research Professor of Electrical Engineering, Polytechnic University
PhD, Syracuse University.
Development of optical tomographic imaging methods for the evaluation of tissue function.

Martin H. Bluth, M.D., Ph.D., Director of Research, Assistant Professor of Surgery, Medicine and Pathology, SUNY Downstate Medical Center.
Peripheral blood mononuclear cell and immunoglobulin regulation in inflammatory disease; Intracellular adhesion and selectin mediated leukocyte circulation and migration patterns in inflammation; biomarker development and novel therapeutics in inflammatory disease.

John K. Chapin, Professor, Department of Physiology and Pharmacology
PhD, University of Rochester, School of Medicine and Dentistry.
Emerging computer and electronic technologies are used to establish real-time control of a robotic prosthesis using signals derived from neuronal population recordings in motor cortex. The goal is to restore motor functions to paralysis patients by extracting “motor” commands from their brains, and using the “motor” commands to control robots, or their own limbs. A long-range goal is to combine motor prostheses with somatosensory prostheses that could substitute for the information normally provided by the skin. Similarly technology will make it possible to remotely control the navigational goals of animals that can carry sensors into otherwise inaccessible areas.

Miriam H. Feuerman, Associate Professor, Department of Biochemistry
PhD, University of California at Irvine.
Molecular mechanisms that separate controlled normal growth from carcinogenesis; regulation of gene expression in liver regeneration and tumorigenesis

Bre hon C. Laurent, Assistant Professor, Department of Microbiology and Immunology
PhD, Massachusetts Institute of Technology
The control of two cellular processes in the context of chromatin structure: transcriptional initiation and progression through the mitotic cell division cycle.

Josef Michl, Associate Professor, Department of Pathology; Associate Professor, Department of Anatomy and Cell Biology; Associate Professor, Department of Microbiology and Immunology
MD, Johannes Gutenberg University Mainz (Germany)
Cells involved in host defense mechanisms against infectious agents and tumors; the process of carcinogenesis in the exocrine pancreas in animals and humans using tissue culture and cell cloning, immunological, ultrastructural and biochemical as well as cell and molecular biological approaches and techniques.

Andr A. Fenton, Assistant Professor, Department of Physiology and Pharmacology
PhD, State University of New York Downstate Medical Center.
Neural Coordination: The brain stores memories, associations between stimuli and between stimuli and responses in neural representations of experience and knowledge. We study the physiology of the hippocampus to understand how memory is stored and how neural activity is coordinated to selectively activate and suppress these representations.