Blue Marble University

Doctor of Science (D.Sc.) in Biomedical Engineering

(3 Year Program You Can Complete Entirely Online)

Pre-requisite: A minimum of a Bachelor Degree (or equivalent in education and training) with demonstrated competency in science, engineering, computer science, and math.

This is a broad and exciting field which combines applied engineering with current rapid advances in Biology and Medicine. The major goal of this interdisciplinary field is to use design and problem solving engineering skills to improve health care. Examples of biomedical applications include the development of biocompatible prostheses, medical devices, imaging equipment, and regenerative tissue growth.

We believe that the most important medical observation of our time is that repair stem cells taken from a patient's blood can heal damaged tissue and can repair bodily functions. Stem cell science has opened a whole new and exciting area for biomedical engineers. New designs of equipment and processes are needed in the areas of batch preparation of stem cells, labeling and sorting of cells, cell preservation techniques, clinical diagnostic imaging devices to find such cells, scaffolding and other techniques for tissue creation, nanotechnology, as well as cellular delivery devices.

Fermentation Biotechnology: An exploding field where biotech engineers are said to be able to create ***any*** chemical using advances in this field.

Yet, even though tissue engineering and fermentation biotechnology are our focus, our program is rock solid in all the other hot new fields of nanotechnology, imaging systems, fiber optics and bio-sensors, biophotonic instrumentation, bioinformatics, robotics, medical devices and implants.

It is intended that a graduate of our program will be equally at home in an academic or industrial/pharmaceutical research lab, teaching setting, medical device manufacturer, medical imaging developer, clinical stem cell treatment clinic, clinical engineering environment, or in hospital administration.

We have an exciting program, and it is not as difficult as you think!! Dissertation topics are always open to the student to select what he/she would like to research (with faculty guidance and approval). We are currently encouraging dissertations that relate to Fermentation Biotechnology, the batch processing of human stem cells, growth media, and nanotechnology for labeling and sorting of cells, but this topic in biomedical processes is not a requirement.

We operate on a trimester schedule, which means that our academic year is divided into 3 segments of 4 months each. In each 4 month period, students take three courses. For some terms, or as determined by the University, students may be assigned courses in sequence, lasting about 1 month each. In that event, for any approximate one month period, a student will be studying one course.

TOTAL: 72 SEMESTER CREDITS
(More Than Equivalent to the USA 60 Credit Minimum Requirement for a Doctoral Degree)

D.Sc. Biomedical Engineering
Year 1
Term 1
Stem Cell Biology – The course begins with an overview of stem cells and the early history of embryonic stem cell research. We then proceed to a review of the techniques of using stem cells derived from human fetal tissue and from a patient's blood and bone marrow, and what diseases can be particularly controlled or cured. The course also includes a review of the current status of human embryonic stem cell treatments, why the international medical community has abandoned its interest in using embryonic stem cells, and also covering the two major drawbacks to embryonic stem cell therapy: Tendency toward proliferation (differentiation), making stem cells almost impossible to control once injected into another body, resulting in a differentiated cell ball of many types referred to as a teratoma; and the problem of cell rejection due to having "foreign" cell membrane antigenic determinants requiring a patient to take immune suppressing drugs. 3 credits.
Practical Stem Cell Clinical Lab- The Collection, Purification, and Use of the PRP and SVF Fractions. This is a laboratory course in which the student will learn step by step, through use of videos and other material, how the Platelet Rich Plasma (PRP) and Stormal Vascular Fraction (SVF) are collected from the patient's blood or fatty tissue, concentrated through various centrifugation steps and enzymatic clean up, and final preparation for use in patients, with emphasis on equipment. 3 Credits..
Physiology for Engineers. Introduction to the basic physiology of cells and tissues, and the analysis and study using imaging, mathematics, and measurrements. The course covers the application of engineering to medicine. 3 Credits.
Term 2
Physiological Control Systems Lab Analysis, Simulation, and Estimation. The course emphasizes the physiological applications of control engineering, focusing in particular on the analysis of feedback regulation, with the goal being to study in depth advanced signal processing skills as applicable to bioengineering. 3 Credits.
Tissue Engineering: Creation of artificial organs and tissue from biological materials, including an investigation of bio-artificial organs which use synthetic and biological components. Use of case studies to explore pathologies of tissue, current clinical treatment, and the role of engineers in developing new technologies to diagnose and treat these pathologies. 3 Credits.
Genetic Engineering: We cover recombinant DNA technology, genetic modification and manipulation and gene splicing. The production of human synthetic insulin from modified bacteria is studied. 3 Credits.
Term 3
Bioreactors in Stem Cell Biology. Using two great texts, we dive into the development and current use of bioreactors in stem cell biology. Although bioreactors have been used for many years in the pharmaceutical industry, it is only recently that the need for large numbers of stem cells for human therapy as arisen based on advances in stem cell biologics. 3 Credits.

Implants and Biomaterials: Overview of biomaterials, including prosthetics, ceramics, metal implants, and polymers, with specific emphasis on properties and applications. The immunology of material-tissue interactions and the issues of biocompatibility are also covered. 3 Credits.

Bio-nanotechnology: Preparation and use of nanometer size particles in biological systems, with emphasis on cellular labeling, and cell separation via nano-particle recognition. The course includes nano-particle, and optical cellular labeling and separation techniques as well as **Immunofluorescence Labeling Techniques,** one of the most important imaging systems in modern medicine.3 Credits.

Year 2

Term 1

Fermentation Biotechnology I. An exploding field in which it is said one can make ***any*** chemical using fermentation biotechnology. Fermentation technology is a field which utilizes microorganisms and enzymes to produce compounds that find use in pharmaceutical, chemical, energy, material and food industries. The 3 main types of fermentation (and several others, beside): lactic acid fermentation, ethanol fermentation, and hydrogen and methane gas production. 3 Credits

Biophotonics I- Fundamentals. The underlying principles of light and biology are presented, including optical fiber light guiding, and then optical sources and photodetection methods. 3 Credits.

Biophotonics II- Applications.Covers the concepts of light–tissue interactions, various optical probes and photonic sensing techniques, the principles of microscopy and spectroscopy, and biophotonic imaging modalities. Also presented are smartphone spectrometers, wearable biophotonic body sensors. The course concludes with intensity measurements for therapeutic laser and LED devices in medical use. 3 Credits.

Term 2

Biosensors and Signal Processing: Biosensors represent a newly arising frontier in biomedical engineering. The course offers a solid preparation on sensors (theory, physical principles, and applications) so valuable in industry and R&D. Emphasis is placed on **Wearable Biosensors.** Merging biomedical engineering with advanced signal processing skills can create professional competencies that most companies are looking for, and most engineers are not able to give. We look at sensing principles and algorithms taken from neural networks, radar, and space communication as made relevant to biological systems. 3 Credits.

Medical Devices and Regulations: Many categories of devices are covered, with emphasis on devices for people with disabilities. 3 Credits.

Biomedical Engineering Instrumentation Lab. The purpose of this course is to develop a working knowledge- a skill set-in instrumentation and equipment including: **Medical and Biological Imaging**: Physical principles and signal processing techniques used in thermographic, ultrasonic, and radiographic imaging, including image reconstruction from projections such as CT scanning, MRI, and millimeter wave determination of temperature profiles. “How to” instruction in NMR, Laser Optics, UV spectrometry, IR spectrometry, Mass spectroscopy, Gas chromatography, and HPLC. 3 Credits.

Term 3

Technical Reports. The practicalities of technical report writing to summarize a problem, to make fact based suggestions, to file reports respecting production. How to write reports in the pharmaceutical industry, including GMP data reviews, analytical data reviews, and reviews of SOP (standard operating procedures). The course relaes to the handling of data and compliance. The course uses pharmaceutical processes as a framework to study **Streamlining Pharmaceutical Processes** using Corrective and preventive action (CAPA). Root Cause Analysis. CAPA Inputs: NCMR's, Complaints, Internal/External Audits. Clinicals, Validation from CAPA sources: Man, Machine, Material, Method, Environment. A study of the CAPA process. 3 Credits.

Artificial Intelligence Overview. This course introduces the student to some current approaches and developments in AI systems. This is an "overview" course seeking to give a broad view of where AI development is, and where it is going, as well as practical applications. 3 Credits

Robotics Lab: For this course, we have selected robotics lab exercises created under the auspices of Virtual Labs, Ministry of Education, National Mission on Education, Government of India. As noted on the website: "Mechanism and Robotics are the two vital and broader area of study and research within Mechanical Engineering. Mechanisms are used in variety of fixed motion generation applications in Engineering, where as Robots are used in applications where programmable motion is required." 3 Credits.

Year 3

Term 1

AI & Robotics Independent Study: Robotics has now become paired with AI, and the purpose of this course is to highlight some of the advances and allow the student to make their own inquiry as to certain applications. We start the course with a discussion of of Google Robotics: Gemini Robotics, and Gemini Robotics-ER, and proceed to other less advanced though possibly more apropos topics to Biomedical Engineering 3 Credits.

The Scientific Method: What it is, how to create a hypothesis, how to create an experiment, how to evaluate reports in the scientific literature, the components of a "research paper", how scientific literature is indexed, ICH and FDA guidance. Applied research has the focus of solving problems of the world, while basic research is seeking knowledge for knowledge sake The student will learn the principles of generating various types of research reports. How to analyze research reports also covered. This course differs from "Technical Reports" in that it emphasizes the creation of data. 3 Credits.

Dissertation Preparation. There is nothing more important to show a prospective employer or institution than an elegant written research paper or literature review that is published. With staff guidance, the student will select and outline a thesis topic paying careful attention to the current state of the literature. Guidance is thorough and publication outlets are also reviewed. 3 Credits

Terms 2-3

Dissertation Preparation (continued), including Completion, Publication, and Presentation. Every student at Blue Marble University has their dissertation published, most in a peer reviewed journal. Normally completed within 1 year or less, the student may take longer depending on the circumstances. 9 Credits.

Credits:.The program comprises 72 semester credits (60 semester credits of coursework and 12 semester credits for dissertation), and consequently is more than equivalent to the minimum 60 semester credits for a USA regionally accredited college or university.