Biomedical Engineering and Biotechnology

Faculty and Fields of Interest

Balasubramanian, Ramprasad Assistant Professor of Computer and Information Science (2000), BSc 1989 University of Madras, India, MS 1991 University of Toledo, MSOperRes 1993 University of Kentucky, PhD 1999 University of South Florida. *Specializations:* Computer vision, image processing, pattern recognition, artificial intelligence. rbalasubrama@umassd.edu

Bhowmick, Sankha Assistant Professor of Mechanical Engineering (2002), BE 1992 Jadavpur University, MS 1996 Villanova University, PhD 2000 University of Minnesota. *Specializations:* Heat and mass transfer, bioengineering. sbhowmick@umassd.edu

Boerth, Donald W Chancellor Professor of Chemistry and Bio-chemistry and Marine Science and Technology (1978), BS 1969 North Dakota State University, PhD 1974 University of Minnesota. *Specializations:* Organic chemistry: theoretical and physical organic chemistry, interactions of nucleic acids with mutagens, modeling in drug and agrochemical design, theoretical studies of acidity and isotope exchange in nucleic acid components, allylic nucleophilic displacements, halogen oxidation of oxopurines—kinetics and mechanism. dbeorth@umassd.edu

Cai, Shuowei Assistant Professor of Chemistry and Biochemistry (2005), BS 1990, MS 1993, Nankai University, china, MS 1998, University of Massachusetts Dartmouth, PhD 2001, University of Massachusetts Amherst. *Specializations:* Bioanalytical and biophysical chemistry, protein chemistry, drug formulation, and pharmaceutical biotechnology. scai@umassd.edu

Carreiro-Lewandowski, Eileen Professor of Medical Laboratory Science (1981), BS 1975 Rhode Island College, Certified 1975 Memorial Hospital of Rhode Island School of Medical Technology, MS 1979 University of Kentucky. *Specializations:* clinical chemistry, biochemistry, laboratory regulation ecarreiro@umassd.edu

Chen, Chi Hau Chancellor Professor of Electrical and Computer Engineering (1968), BS 1959 National Taiwan University, Taiwan, MS 1962 University of Tennessee, PhD 1965 Purdue University. *Specializations:* Pattern recognition, neural networks, image processing and machine vision, communications theory, ultrasonic NDT. cchen@umassd.edu

Cory, Lester W Chancellor Professor of Electrical and Computer Engineering (1963), BS 1963 Bradford Durfee College of Technology (UMass Dartmouth), MS 1970 Northeastern University, MEd 1974 Bridgewater State College, DS (Hon) University of Rhode Island. *Specializations:* Rehabilitation engineering, computer systems, HF/VHF communications. lcory@umassd.edu

Costa, Antonio H Professor of Electrical and Computer Engineering (1985), BS 1983, MSEE 1985 Southeastern Massachusetts University (UMass Dartmouth), PhD 1994 University of Rhode Island. *Specializations:* Mixed time-frequency representations, spectral estimation, signal processing, image processing. acosta@umassd.edu

Dills, Jr, William L Chancellor Professor of Chemistry and Biochemistry (1982), BS 1967 Juniata College, PhD 1973 University of Vermont. *Specializations:* Biochemistry: metabolism of xylitol, chemistry and biochemistry of carbohydrate analogs, biosynthesis of polysaccharides such as cellulose, chitin, and glycogen, hands-on science exercises for K-12 classrooms. wdills@umassd.edu

Fan, **Qingou** Associate Professor of Textile Science (1998), BS 1982, MS 1988 China Textile University, PhD 1995 University of Leeds. *Specializations:* Textile chemistry, dyeing and finishing, chemical analysis, organic synthesis. qfan@umassd.edu

Fowler, Alex J Associate Professor of Mechanical Engineering (1994), BA 1987 Wesleyan University, PhD 1993 Duke University. *Specializations:* Fluid flow in porous media, heat transfer, thermodynamics, bioengineering/biomaterials. afowler@umassd.edu

Goodson, David Z Associate Professor of Chemistry (2002), BA 1980 Pomona College, PhD 1987 Harvard University. *Specializations:* Physical chemistry: theoretical and computational chemical physics, atomic and molecular physics, quantum chemistry methods development, chemical reaction rate theory, quantum molecular dynamics simulation of hydrogen in combustion chemistry and materials science.

Griffith, James T Chancellor Professor of Medical Laboratory Science (1974), BS 1970 Southeastern Massachusetts University (UMass Dartmouth), Certified 1970 The Memorial Hospital of Rhode Island School of Medical Technology, MS 1976 Southeastern Massachusetts University (UMass Dartmouth), PhD 1992 Walden University. *Specializations:* microbiology, antimicrobial agents, health legislation jgriffith@umassd.edu

Guo, Maolin Assistant Professor of Chemistry and Biochemistry (2003), BSc 1989, MSc 1992 Shanxi University, PhD 2002 University of Edinburgh. *Specializations:* Biochemical processes, drug design. mguo@umassd.edu

Hart, Peter Assistant Professor of Biology (2003), BS 1990, MA 1992 Bridgewater State College, PhD 1977 University of Maryland. *Specializations:* Genetics, cell biology, developmental biology, biotechology. phart@umassd.edu

Hable, Whitney Assistant Professor of Biology (2004), BA 1990 University of Virginia, PhD 1996 University of Arizona. *Specializations:* plant and algal biology, developmental and marine biology. whable@umassd.edu

Kasilingam, Dayalan P Professor of Electrical and Computer Engineering and Marine Science and Technology (1993), BA 1981 University of Cambridge, England, MS 1982, PhD 1987 California Institute of Technology. *Specializations:* Remote sensing, applied electromagnetics, adaptive signal processing and wireless communications. dkasilingam@umassd.edu

Kim, **Yong Ku** Professor of Textile Sciences (1981), BS 1970, MS 1974 Seoul National University, Korea, PhD 1980 North Carolina State University. *Specializations:* Fiber/polymer physics, composite materials, structural mechanics of fibrous structures, medical textiles. ykim@umassd.edu

Meressi, Tesfay Associate Professor of Mechanical Engineering (1993), BS 1985 Addis Ababa University, MS 1990 PhD 1993 University of California/Santa Barbara. *Specializations:* Robotics, control theory, machine design. tmeressi@umassd.edu

Mikolajczak, Boleslaw Professor of Computer and Information Science (1987), MS 1970 Technical University Poznan, MS 1972 Adam Mickiewicz University, PhD 1974, Dr Habil 1979 Technical University of Poznan. *Specializations:* Parallel and distributed computations, computer architecture, foundations of computer science, algorithms and complexity. bmikolajczak@umassd.edu

Neto, Catherine C Associate Professor of Chemistry and Biochemistry (1995), BS 1983 Southeastern Massachusetts University (UMass Dartmouth), PhD 1987 Brown University. *Specializations:* Antioxidants, anticancer, and antimicrobial agents in cranberries and other plant sources, structure and mechanisms of bioactivity, purification and structure elucidation of natural products, effects of agricultural

Listed are the currently appointed UMass Dartmouth program faculty for Biomedical Engineering and Biotechnology (BMEBT). This interdisciplinary program invites participation of other faculty from across the UMass Dartmouth campus, and faculty also participate from the UMass Boston, Lowell, and Worcester campuses.

practices on phytochemical content in fruits, food science, chemical education in the organic laboratory. cneto@umassd.edu

Notaros, Branislav Associate Professor of Electrical and Computer Engineering (1999), BS 1988, MS 1992, PhD 1995 University of Belgrade. *Specializations:* Computational and applied electromagnetics, antennas, scattering, microwaves, biomedical applications of electromagnetic waves, characterization of mobile telephone antennas and human head interaction. bnotaros@umassd.edu

Ojadi, Emmanuel C A Associate Professor of Chemistry and Biochemistry (1988), BSc 1979 University of Ife, MA 1982, PhD 1986 Brandeis University. *Specializations:* Physical chemistry: chemical physics, synthesis, photophysics, and photochemistry of porphyrins and other biologically important molecules and their analogs, electron and energy transfer processes in the excited states; porphyrimers and laser spectroscopy. eojadi@umassd.edu

Payton, Karen L Professor of Electrical and Computer Engineering (1989), BS 1977 Carnegie-Mellon University, MSEE 1981, PhD 1986 The Johns Hopkins University. *Specializations:* Digital signal processing, speech processing, speech acoustics, auditory perception. kpayton@umassd.edu

Shen, Li Assistant Professor of Computer and Information Science (2004), BS 1993 Xi'an Jiao Tong University, MS 1996 Shanghai Jiao Tong University, PhD 2004 Dartmouth College. *Specializations:* Computer vision, shape analysis, medical imaging. lshen@umassd.edu

Singh, Bal-Ram Professor of Chemistry and Biochemistry and Marine Science and Technology (1990), BSc 1977 Kamla Nehru Institute of Science and Technology, MSc 1979, MPhil 1982 Jawaharlal Nehru University, PhD 1987 Texas Tech University. *Specializations:* Physical biochemistry: structure-function relationship of biological macromolecules, spectroscopy of proteins and membranes, protein-membrane interactions, mode of action of botulinum and tetanus neurotoxins, enzymatic activity in non-aqueous solvents, light signal reception and signal transduction by a biosensor, phytochrome for anthocyanin biosynthesis, molecular mechanism of phytophthora root rot in cranberry plants, guatathione-s-tranferases of quahog xenobiotic metabolism. bsingh@umassd.edu

Stahl, Eli Assistant Professor of Biology (2003), BSc 1993 University of California Davis, PhD 2000 University of Chicago. *Specializations:* Plant adaptations, ecological and evolutionary genetics. estahl@umassd.edu

Tandon, Amit Assistant Professor of Physics and Marine Science and technology (1999), BTech 1987 Indian Institute of Technology, PhD 1992 Cornell University. *Specializations:* Fluid dynamics, physical oceanography, environmental and computational physics. atandon @umassd.edu

Valova, Iren T Assistant Professor of Computer Information Science (2000), MSc 1991 Technical University, Sofia, Bulgaria, PhD 1997 Tokyo Institute of Technology. *Specializations:* Artificial intelligence, neural networks, pattern recognition. ivalova@umassd.edu

Wang, **Jay (Jianyi)** Associate Professor of Physics (1998), BSc 1983 Lanzhou University, China, PhD 1992 University of Tennessee, Knoxville. *Specializations:* Theory and simulations of electronic, atomic and optical processes, ion-solids and ion-surface interactions, computational physics. jwang@umassd.edu

Warner, **Steven** Professor of Textile Sciences (1994), SB 1973, SM 1973, ScD 1976 Massachusetts Institute of Technology. *Specializations:* Fibers, composites, nonwovens, microscopy, wicking, and wetting. swarner@umassd.edu

Zuo, Yuegang Associate Professor of Chemistry and Marine Science and Technology (1999), BS 1982 Wuhan University, China, MS 1984 Chinese Academy of Science, PhD 1992 Swiss Federal Institute of Technology. *Specializations:* Analytical chemistry: separation, identification, and utilization of naturally occuring antioxidants and biopolymers; environmental chemistry, marine chemistry, and photochemistry. yzuo@umassd.edu

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The Boston, Dartmouth, Lowell, and Worcester Campuses of the University of Massachusetts offer a joint PhD degree program in Biomedical Engineering and Biotechnology. The program's purpose is to offer a nationally recognized PhD that is at the intersection of biology and engineering; that will be readily accessible to individuals with a wide range of science/engineering undergraduate degrees; that will address contemporary biomedical/health research problems; and that will contribute significantly to meeting the workforce needs of allied biomedical industries.

The program aims to provide its doctoral recipients with the following knowledge, skills, and abilities:

- The ability to formulate/test multiple, original scientific hypotheses related to their dissertation research based on careful observations and a comprehensive review of past and current literature in their field;
- The ability to design/carry out detailed experiments or develop theoretical models/numerical simulations;
- Competency in cutting-edge technical/laboratory/computer skills related to a wide range of instrumentation/procedures;
- The application of their research in solving current biomedical/health problems especially in relationship to new discoveries in nanoscience and technology;
- The ability to function as independent researchers with strong critical thinking, inquiry-based analytical skills;
- The ability to work on integrated problems in multidisciplinary research teams;
- The ability to critically interpret their research results, synthesizing findings from other investigators/previous studies, that will serve as the basis for developing new hypotheses;
- Written/oral presentation skills resulting in publication of their findings and presentation of results at professional research conferences;
- The development of advanced problem solving skills using a multidisciplinary approach;
- Appreciation of the challenges of conducting/publishing research associated with contemporary biomedical ethical issues;
- Grantsmanship skills that will allow them to obtain pre-doctoral and post-doctoral extramural private/federal research funding;
- Knowledge about intellectual property/patents/regulatory issues;
- The understanding of how theory/concepts are related to applied research;
- The understanding of how applied research is conducted in an industrial setting;
- The understanding of how industry applies experimental research to equipment design/manufacturing/product development.

Program Structure and Administration

The following UMass Dartmouth departments are active in the BMEBT program:

College of Arts and Sciences
- Biology
- Chemistry and Biochemistry
- Medical Laboratory Science

College of Engineering
- Computer and Information Science
- Electrical and Computer Engineering
- Mechanical Engineering
- Physics
- Textile Sciences

Two Graduate Program Co-Directors perform administrative coordinating tasks for the UMass Dartmouth campus, one from each participating College. Also, a BMEBT coordinator is identified in each participating department.

Campus policy implementation for the program is guided by the UMass Dartmouth Advising/Admissions/Curriculum Committee (AACC), which provides advising, approves admissions, and otherwise gives campus-level oversight including campus curriculum development. The AACC reviews the credentials of new faculty members who wish to participate in the program.

At the university (system-wide) level, the Intercampus Academic Coordinating Committee (IACC) is charged with the responsibility of maintaining uniform academic standards across the four campuses, establishing academic policy, approving program faculty, and acting in roles analogous to those undertaken by a "program" or "curriculum" committee in an academic department.

Also at the university (system-wide) level, the Program Oversight Committee (POC) consists of graduate deans from the four campuses, who interact regularly with the respective deans of colleges participating in the program to review campus compliance with system-wide academic standards and to resolve any administrative issues that may arise. The POC submits periodic status reports to the UMass President's Office, chancellors, provosts, and college deans.

Program Faculty are identified specifically for the Biomedical Engineering and Biotechnology program. Program faculty have a research doctorate in a field relevant to biomedical engineering or biotechnology and an active research record in an aspect of biomedical engineering or biotechnology. Other faculty may be involved in the program, as members of a dissertation committee or in teaching courses that some program students take. Participating faculty are members of academic departments, engaged in their academic disciplines as well as in making interdisciplinary connections.

Admissions Requirements

Applicants from many different science/engineering undergraduate programs are invited to apply. Because the degree brings together biomedical engineering with biotechnology, it is designed equally for students with life sciences or engineering/physical science backgrounds. One's specific background will be of less interest in determining qualification for entrance than will be one's personal and career goals, demonstrated academic ability and research potential, and commitment to an interdisciplinary, team-work approach.

Applications will be accepted from individuals holding appropriate bachelor's degrees or master's degrees (or the US baccalaureate equivalents from a foreign institution). Applicants should have a background in life science, physical science, or engineering. All applicants must have taken a full year (two semester or three quarter sequence) of calculus, and the successful applicants will normally have had undergraduate coursework in statistics/experimental design and in life science/biomedical science.

Applicants are strongly encouraged to contact participating faculty to explore how they might fit into a specific specialization option before submitting their application and to report on the results of those contacts in their Statement of Purpose (see below).

Admission Standards

Applicants submit the following and are expected to meet the standards indicated:

- In general students with an overall undergraduate grade point average of 3.0 or higher will be considered for admission. Applicants must present official undergraduate and graduate transcripts from all schools attended.
- Applicants accepted into the program

should present a minimum Graduate Record Exam (GRE) combined verbal + quantitative score of 1100. The AACC will also pay particular attention to the applicant's score on the new GRE analytical writing section of the general examination because of the emphasis placed on strong writing skills in this program. Only official GRE scores from the Educational Testing Service will be considered acceptable.
- Applicants must have a minimum of two semesters of calculus and have strong quantitative skills.
- International applicants should present a minimum Test of English as a Foreign Language (TOEFL) score of 550 (paper version) or 213 (computer version). Only official TOEFL scores from the Educational Testing Service will be considered acceptable.
- Three letters of recommendation, from individuals familiar with the applicant's academic ability and potential to conduct original research at the doctoral level, will be required.
- Applicants will also be required to submit a Statement of Purpose (personal essay). This statement is an important element in the application packet. It has two related roles:
  (1) Indication of an applicant's qualifications and motivation for the program. Applicants should indicate their qualifications for and motivation to undertake this program as well as their personal and career goals. Specifically, the statement should indicate the applicant's background, research credentials, and career plans as they relate to the multidisciplinary nature of the doctorate, and discuss research experience (academic, industrial) and any publications, grants, or patents;
  (2) Indication of how an applicant will fit into the program. Applicants should indicate their specific areas of interest within Biomedical Engineering and Biotechnology, so that a fit between their interests and qualifications and the specific specialization options that the program offers can be determined. If the applicant has a specific interest in working with one or more of the program's faculty, s/he should describe that specific interest and identify those faculty members. The Statement of Purpose should also exemplify the applicant's writing skills.
- We invite applicants also to submit a personal résumé.

Individual circumstances can be taken into account, and extraordinary qualifications in some areas can be used to outweigh weaknesses in others. The GRE can be waived by petition to the AACC for applicants with a prior graduate degree from an accredited US institution; an application without the GRE must demonstrate exceptional potential.

Admissions decisions are made at the campus level, under the purview of each campus's Admissions/Advising/Curriculum Committee (AACC). Each campus will follow the admissions standards agreed on for the program and ratified through the Intercampus Academic Coordinating Committee (IACC). However, a campus wishing, for special reasons, to accept an applicant who does not meet minimum admissions standards set for the program by the IACC may request from the IACC a waiver of those standards in that specific case.

Along with an admissions decision comes consideration of the appropriate program of courses for the applicant. The interdisciplinary nature of our program gives special importance to the advising relationship in forming a specific academic program to meet each student's specific goals. Applicants may be offered admission with a number of courses identified as conditional requirements that they will need to take to fill in for gaps in preparation or knowledge. Each admitted student is assigned to a faculty advisor, who is identified in the letter of admission. Acceptance into the program is subject to the availability of appropriate advisors.

Admission Process

It is a UMass BMEBT program principle that applicants apply to the graduate admissions office of the campus that they seek as their "home campus." This will be the campus of the faculty member anticipated to be the student's major advisor and possible future dissertation research director. Generally, applicants will apply only to one campus. Those applicants who are unsure of their intended campus should engage in conversations with prospective faculty mentors in order to make a probable determination. Applicants unsure of their choice of campus may trust that the four participating campuses will cooperate in sharing information about applicants. The participating campuses will take special care that the applications of well-qualified applicants who would not fit the specific specializations or faculty availability of the campus to which they apply will be forwarded for consideration by faculty on other participating campuses.

Those considering the UMass Dartmouth campus should learn about campus options by contacting the program co-directors. Applicants should discuss any plans that they form through those discussions in their Statement of Purpose in the application packet.

UMass Dartmouth will announce admissions decision dates for fall and spring semester entrance. Although applications may be accepted by the campus after those dates, available spaces in the program may have already been committed. The same dates will serve as preferred deadlines for financial assistance consideration, after which applicants will risk significant reductions in the availability of assistantship support. We reserve the right to offer admission and assistantships to top applicants before the announced deadlines.

Transfer of Credits/Advanced Standing

Students who have previously completed graduate course work may transfer up to six credits, following the UMass Dartmouth graduate transfer policies. The transfer credit may replace core or specialization course requirements. The project/directed studies, seminar, and dissertation research credits will not be accepted for transfer from institutions outside of the UMass system.

Students may also have core courses waived without transfer of course credit. Students would still be responsible for the full credits required of each degree (31 credits for the MS and 63 credits for the PhD), but would not have to take the waived course.

Students who join the program with an earned master's degree may receive Advanced Standing in the doctoral program. The number of credits required to complete the PhD will be determined in individual advisement, but at a minimum 9 course (core or specialization) credits, the capstone project course (3 credits), doctoral seminar (taken twice, 1 credit each) and 30 dissertation research credits will be required. Advanced Standing students will be required to pass the Qualifying Examination before progressing to the dissertation stage. Students who enter the program with advanced standing will not earn the MS degree.

Advising

Campus AACC's are responsible for overseeing the advising components of the program, which are initiated while each student is still an applicant. Students will be assigned a faculty advisor when they are accepted into the program. The initial faculty advisor will either

be a member of the AACC or a program faculty member appropriate to the applicant's Statement of Purpose.

After the student's first year in the program, s/he may want to change to a new advisor who fits the student's research interest and is likely to become the chair of the student's dissertation committee. Occasionally, a student may ask to change to a new advisor on a different home campus. The AACC of the new campus must assent to the move and verify that an advisor is assigned and other appropriate arrangements are made. The transfer should then be presented to the IACC for its approval, and if it does approve, notification will go to the POC so that the administrators for the campuses affected can arrange for transfer of registration and academic records, and address other student status issues.

Registration Across Campuses

UMass campuses collaborate to permit joint-program students, like those in the BMEBT, at one campus to take courses at another with a minimum of effort. In brief, UMass Dartmouth BMEBT students go to our Registrar's Office to register and pay for a course offered at another campus (offered either on that campus or by distance learning). That campus provides evidence of course completion, and grades as well as credit are shown on the UMass Dartmouth transcript.

Financial Assistance

A limited number of assistantships are available on a competitive basis. Applicants desiring teaching or research assistantships should submit completed applications by March 15th. Other assistance, such as loans or work study, may be available to you. Please refer to the chapter on "Expenses and Financial Assistance."

Almost all assistantship support in this program comes in the form of Research Assistantships. Applicants are invited to contact faculty about opportunities for Research Assistantships.

The curriculum of this UMass joint program is organized around common experiences, including core courses, a capstone project, and intercampus graduate research presentations. The program makes some use of distance learning/on-line/faculty exchange for delivery of courses and seminars, and the campuses are close enough to permit commuting between them. The program encourages a multidisciplinary team approach during the Instrumentation and Laboratory Experience, the capstone project, and in the selection of the dissertation committee. Industry representation occurs in an introductory core course, in the capstone project, in the doctoral seminar series, and from an outside advisory group. In addition, each student pursues a sequence of courses and then completes a focused research project leading to a doctoral dissertation in one of the program's specialization options.

General Program Requirements

The program of courses includes a core requirement, a specialization requirement, and a capstone requirement. As students advance, they will have to meet requirements in addition to satisfactory completion of courses, including participation in seminars and symposiums, passing a qualifying examination, defending a dissertation proposal, completing a dissertation, and defending it.

The PhD requires completion or transfer of at least 63 total credits (or a minimum of 44 credits for students with advanced standing due to an existing MS degree). Students must meet the specific UMass Dartmouth requirements of for such matters as grade averages, documentation of completion of requirements, registration for program continuation, and submitting the final dissertation to the library. No course receiving a grade below C can receive credit; C- grades cannot receive credit. Grades earned below C are still calculated in the student's grade point average.

Students are limited in the number of Directed or Independent Study course credits that they can apply toward their program. No more than 6 credits of coursework below the level of dissertation registrations may be in the form of Directed or Independent Study. All courses must be conducted at the graduate level.

Students must pursue and complete a program of study approved by their assigned advisor. The interdisciplinary nature of this program makes close contact between each student and his or her advisor important.

Curriculum Overview

The chart on the facing page gives the curriculum in tabular form.

Core Requirements

The core courses provide a common foundation for all students, either from life science or physical science/engineering backgrounds.

Introduction to Biomedical Engineering & Biotechnology should be taken in a student's first semester if possible. Instrumentation and Laboratory Experience (3 credits) is designed to give students exposure to cutting-edge research methodology in a number of different areas, with a balance between biomedical engineering and biotechnology areas. The core mathematics requirement offers a choice for those from a physical science, engineering, mathematics background or a life sciences background. Quantitative Physiology (3 credits) helps integrate the curriculum for individuals with life science and engineering undergraduate backgrounds, permitting engineers and physical scientists an appreciation of how organisms function from the organ/system perspective and giving life scientists a more rigorous quantitative approach to physiology than is usual in undergraduate courses. Bioethics (1 credit) and Advanced Cell and Molecular Biology (3 credits) fill out the core requirements.

Specialization Course Requirements

Specialization courses help the student attain depth in focused areas. The BMEBT program organizes specialization opportunities under various options:

Biomedical Engineering Specialization Options

- Biomaterials: Tissue Engineering, Polymers/ Plastics, Fibers/Textiles, Nanotechnology
- Biomedical Information Systems: Bioinformatics, Genomics, Proteomics
- Biomedical Instrumentation: Clinical Sciences, Signal Processing, Sensors, Microprocessing, Manufacturing/Quality Control
- Biomechanics: Biotransport, Cell Mechanics, Tissue/Organ Mechanics, Joint/Muscle Mechanics
- Medical Imaging: Optics, NMR, MRI, Acoustics, Cell Imaging
- Medical Physics/Radiological Sciences: Dosimetry, Shielding/Protection, Nuclear Instrumentation

Core Course Requirements (16 credits)

Introduction to Biomedical Engineering/Biotechnology (3 credits)
Instrumentation and Laboratory Experience (3 credits)
Mathematics: (Engineering) Advanced Numerical Methods
or (Life Sciences) Applied Mathematics for Life Scientists (3 credits)
Quantitative Physiology (3 credits)
Bioethics (1 credit)
Advanced Cell and Molecular Biology (3 credits)

Specialization Options (12 credits)
Student selects program according to interests and background, with approval of Advisory Committee. Minimum of four courses, from within or between specialization areas.

Biomedical Engineering Specialization Options

Biomaterials: Tissue Engineering, Polymers/Plastics, Fivers/Textiles, Nanotechnology

Biomedical Information Systems: Bioinformatics, Genomics, Proteomics

Biomedical Instrumentation: Clinical Sciences, Signal Processing, Sensors, Microprocessing, Manufacturing/Quality Control

Biomechanics: Biotransport, Cell Mechanics, Tissue/Organ Mechanics, Joint/Muscle Mechanics

Medical Imaging: Optics, NMR, MRI, Acoustics, Cell Imaging

Medical Physics/Radiological Sciences: Dosimetry, Shielding/Protection, Nuclear Instrumentation

Biotechnology Specialization Options

Agricultural Biotechnology: Therapeutics, Pharmacology, Nutritional Biochemistry, Food Science Technology, Plant Tissue Culture

Bioprocessing/Applied Microbiology: Bioremediation, Fermentation, Biocatalysis, Applied Genetic Engineering

Molecular Biotechnology: Biochemical Applications, Diagnostics, Clinical Sciences

Project/Directed Studies (3 credits)
Team-based cross-disciplinary collaborations with other graduate students, post-doctoral fellows, industry representatives, intracampus and/or intercampus. Capstone culminating experience based on coursework/laboratory. Prelude to dissertation topic. Written/oral presentations and multi-campus research presentation.

Master of Science degree awarded (31 credits accrued)

Doctoral Seminar (1 credit each/2 semesters)
Seminar series with intercampus emphasis, industry/outside speakers, and student presentations.

Qualifying Examination
Oral and written portions.

Dissertation proposal

Dissertation course credits (30 credits minimum)

Dissertation defense

PhD Degree awarded (63 credits total)

Biotechnology Specialization Options
- Agricultural Biotechnology: Therapeutics, Pharmacology, Nutritional Biochemistry, Food Science Technology
- Bioprocessing/Applied Microbiology: Bioremediation, Fermentation, Biocatalysis, Applied Genetic Engineering
- Molecular Biotechnology: Clinical Sciences, Biochemical Applications, Diagnostics.

Faculty involved in each specialization will see to an appropriate combination of depth and breadth in the student's selection of specialization courses. They may announce some structure to the course selections allowed within the area. With the approval of their advisor, students will select 12 credits of course work (minimum) from within one of the specializations. Any graduate course approved by the advisor may be used to satisfy this requirement. Some specialization options will require more than 12 credits.

Each campus participating in the BMEBT program offers its own emphases within this overall list of specializations. Not all of the specialization options or specific topics are available at the Dartmouth campus.

Capstone Requirement

As students transition from coursework to dissertation research, they undertake a capstone project course. This is designed to be a culminating experience in which the student synthesizes his/her course knowledge and experimental skills into a brief but detailed experimental study, which also involves cross-field interdisciplinary cooperation. Although in some cases this project may be done individually under the supervision of one faculty member, it is expected that students will join in a team-based, collaborative effort involving students from a number of different disciplines or post-doctoral fellows and industry representatives; and with intercampus participation.

Annually in May, a Biomedical Engineering and Biotechnology Research Symposium will be held, rotating each year to a different campus, at which the students from all four campuses will present their projects in a poster session and/or orally. Participation in this non-credit activity is required.

Earning the MS Degree

Following successful presentation of the capstone project and with a minimum of 31 credits of completed or transferred in required and approved courses, the student will be awarded the Master of Science degree as a

credential along the way toward the doctorate. Students must have at least a cumulative B average to receive the MS degree and advance to the Qualifying Examination.

Selection of the Doctoral Dissertation Committee

As they move through this stage of their program, students will select their Doctoral Dissertation Committee, with one person as the major advisor. A committee must be formed in accordance with the guidelines for doctoral programs at UMass Dartmouth, as presented in this Catalogue. The advisor and at least one other dissertation committee member must be chosen from the approved Program Faculty of the Biomedical Engineering and Biotechnology program. Having one member of a dissertation committee be an outside industry scientist or engineer is encouraged. Also, strongly recommended is for one's committee to have one faculty member from a campus other than the candidate's home campus. It is expected that all three members will not represent the same academic departmental affiliation. Each student's committee is approved by the campus AACC, which will also approve any changes to a previously-approved committee.

Qualifying (Written) Examination

Students must pass a written qualifying examination that will cover questions on course work as well as experimental procedures the student has utilized. The qualifying examination will be administered and evaluated by program faculty selected by the AACC. The examination must be taken within one year after completion of the MS Biomedical Engineering and Biotechnology requirements, or, for a student with advanced standing, within two years of entering the program.

Doctoral students, in consultation with their advisor, will identify two topic areas in which to be examined. One of the topics must be primarily engineering/technological in nature (for example, solid mechanics), and another primarily biological in nature (for example, pathophysiology of musculoskeletal disorders). The examination will be in written form and given during two one-half days within a one-week period. Examinations for a given topic area will be designed to be completed within a three to four-hour period. The material covered by the exam may be designated as specific portions of courses, textbooks, and journal articles. Emphasis will be placed on the student's ability to integrate information in the areas examined.

Examinations for a given topic area will be graded Pass or Fail. Students who are unsuccessful in their first attempt in a given topic area may repeat it once. Failure to pass the examination on any topic area on the second attempt results in overall failure on the Qualifying Examination and dismissal from the PhD program.

Doctoral-level Credit Requirements

Doctoral Seminar (1 credit - required twice)
Doctoral students will present research in progress. The seminar will emphasize not only research but also communication and writing. Every active doctoral candidate will present her or his work in progress in the seminar, and in addition there will be at least two presentations from external speakers. Students will write summaries of each presentation. Course is graded pass-fail or satisfactory-unsatisfactory (depending on grading system in use on the campus). Students must complete this course in at least two different semesters.

Dissertation Research (variable credit each semester, 30 credits minimum)
Doctoral students will register for a minimum of 30 credits of doctoral research with their faculty advisor (dissertation chair). They will use these credits during preparation and defense of the dissertation proposal, carrying out their dissertation research and preparation and defense of the doctoral dissertation.

Dissertation Proposal (Oral Preliminary Examination)

Students must present for approval a written dissertation proposal and then defend it in an oral presentation to his or her dissertation committee. The dissertation proposal will follow the format established for NIH proposals, including the page limits, and will perform an extensive review of the literature on the student's chosen topic, present original hypotheses, design experiments to test the hypotheses, document the appropriate methodology that will be used, project anticipated results, and indicate how such results might be interpreted. The proposal must show application to a current biomedical/biotechnological problem. After successfully defending the dissertation proposal, the student attains the designation "doctoral candidate." Failure to pass the defense of the dissertation proposal (oral examination) results in dismissal from the PhD program.

Dissertation Defense

The doctoral candidate will defend his/her written dissertation before the doctoral dissertation committee, the university, and the outside community. The specific format of the defense is usually decided by the committee chair, but a typical format consists of the PhD candidate first presenting an overview of the thesis research, then answering specific questions asked by the committee members. Questions may test anything from knowledge of the existing literature, to scrutinizing of the material and methods or experimental design, to the assumptions in the research, to the interpretation of the results, to recommendations for future work. If the candidate has worked closely with his or her advisor, and committee, it is likely that there will be no surprises at this final stage of the process. It is common, however for the committee to ask that certain minor revisions be made to the written dissertation before final submission to the library. Successful defense of the dissertation and presentation of the finished work to the library will result in the awarding of the PhD in Biomedical Engineering and Biotechnology. Dissertations must be filed with Dissertation Abstracts International.

Dismissal and Continuation

Students must meet the UMass Dartmouth requirements for progression and quality. Faculty advisors monitor the progress of each Biomedical Engineering and Biotechnology student through his or her core and specialization courses. If requirements are not met, a recommendation for dismissal is made by the AACC of the student's campus to the administrators on the Program Oversight Committee (POC), and if the POC approves the dismissal the appropriate member will carry that action through on the student's campus. A student thus dismissed may appeal the dismissal to the IACC, which will similarly recommend to the POC.

Biomedical Engineering and Biotechnology Courses

Specialization courses are found among the many graduate course offerings in participating departments. Only specific Biomedical Engineering and Biotechnology courses are listed here.

BMB 510 three credits
Introduction to Biomedical Engineering and Biotechnology
Prerequisite: BMEBT degree candidate or permission of a program co-director
Team-taught introductory course that emphasizes a multidisciplinary approach to current topics in the range of academic disciplines and gives students their first exposure to faculty research areas. The course, as much as possible, will involve faculty from all participating campuses, will involve outside industry speakers to present topics of contemporary importance, and will offer joint lectures from guest speakers. This course should be taken in a student's first semester in the program if possible.

BMB 520 three credits
Quantitative Physiology
Physiology at the organ system level with a quantitative approach. The course helps integrate the curriculum for individuals with life science and engineering undergraduate backgrounds, permitting engineers and physical scientists an appreciation of how organisms function from the organ/system perspective and giving life scientists a more rigorous quantitative approach to physiology than is usual in undergraduate courses.

BMB 530 three credits
Instrumentation and Laboratory Experience
Prerequisite: Permission of BMEBT advisor
A practical, hands-on lab rotation course giving students exposure to cutting-edge research methodology in a number of different areas, with a balance between biomedical engineering and biotechnology areas. A team approach is encouraged as students employ various laboratory techniques to carry out short-term projects. Students will either rotate through a number of different experimental procedures within a single investigator's laboratory or rotate through multiple faculty laboratories, learning a particular type of methodology for which the laboratory may be noted and uses frequently. The course may also provide laboratory experiences/demonstrations at sister campuses and industrial sites where faculty members have affiliations.

BMB 540 three credits
Advanced Cell and Molecular Biology
Rigorous treatment of topics in advanced cell and molecular biology, illustrating applied research through examples and presenting biochemistry concepts at the cell/molecular level.

BMB 570 three credits
Applied Math for Life Scientists
This course provides an intense treatment of the subject matter designed to achieve applied math literacy for students with life science and related backgrounds.

BMB 573 three credits
Graduate Directed Study
Prerequisites: Graduate standing; permission of instructor, graduate director, and college dean
Study under the supervision of a faculty member in an area covered in a regular course not currently being offered. Terms and hours to be arranged.

BMB 620 three credits
Capstone Project
Prerequisites: Approval of instructor and student's graduate committee
A culminating experience in which the student synthesizes his/her course knowledge and experimental skills into a brief but detailed experimental study, which also involves cross-field interdisciplinary cooperation. Although in some cases this project may be done individually under the supervision of one faculty member, it is expected that students will join in a team-based, collaborative effort involving students from a number of different disciplines, post-doctoral fellows, and industry representatives; and with intercampus participation.

BMB 630 variable credits
Independent Research
Prerequisites: Approval of instructor and student's graduate committee
Investigations of a fundamental and/or applied nature. Independent Research is often work on a future dissertation undertaken before the student has satisfied the qualification steps for BMB 720. With approval of student's graduate committee, up to 15 credits of BMB 630 may be applied to the 30-credit requirement for dissertation research.

BMB 710 one credit
Doctoral Seminar
Doctoral students' research in progress, emphasizing not only research but also communication and writing. Every active doctoral candidate will present her or his work in progress in the seminar, and in addition there will be at least two presentations from external speakers. Students will write summaries of each presentation. Students must complete this course in at least two different semesters. Course is graded pass-fail.

BMB 720 variable credits
Doctoral Dissertation Research
Prerequisites: Successful completion of PhD comprehensive examination and approval of doctoral dissertation proposal by the student's graduate committee
Investigations of a fundamental and/or applied nature representing an original contribution to the scholarly research literature of the field. PhD dissertations are often published in refereed journals or presented at major conferences. A written dissertation must be completed in accordance with the rules of the Graduate School. Admission to the course is based on successful completion of the PhD comprehensive examination and submission of a formal proposal endorsed by the student's graduate committee and submitted to the appropriate BMEBT Graduate Program Director.