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Proposal for a Certificate in Biointerfacial & Biomaterials Science and Engineering

Program Offered: Certificate in Biointerfacial & Biomaterials Science and Engineering (BBSE)

Director of Certificate Program in Biointerfacial & Biomaterials Science and Engineering:

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Participating Graduate Programs and Faculty

Currently, the following graduate programs are participants in the Biointerfacial & Biomaterials Science and Engineering (BBSE) program:

Chemistry and Chemical Biology (160); Physics and Astronomy (750); Cell Biology and Neuroscience (710); Biomedical Engineering (125); Chemical and Biochemical Engineering (155); Mechanical and Aerospace Engineering (650); Ceramic and Materials Science and Engineering (150); and the several graduate programs under the Molecular Biosciences umbrella (<http://lifesci.rutgers.edu/%7Emolbiosci/>). Interested students from other graduate programs are encouraged to contact the BBSE Director (listed above) about their possible eligibility.

The following members of the graduate faculty, identified more fully under their respective home graduate programs, are among those who participate regularly in this certificate program. Additional faculty members may be included upon consultation with and concurrence of the Director.

Robert Bartynski	Physics and Astronomy
Gary Brewer	Microbiology and Molecular Genetics
Helen Buettner	Chemical and Biochemical Engineering
Edward Castner	Chemistry and Chemical Biology
Yves Chabal	Biomedical Engineering, Chemistry and Chemical Biology
William Craelius	Biomedical Engineering
David Denhardt	Cell Biology and Neuroscience
Bonnie Firestein	Cell Biology and Neuroscience
Eric Garfunkel	Chemistry and Chemical Biology
Martin Grumet	Cell Biology and Neuroscience
Samuel Gunderson	Biochemistry
Ronald Hart	Cell Biology and Neuroscience
Joachim Kohn	Chemistry and Chemical Biology
Doyle Knight	Mechanical and Aerospace Engineering
Noshir Langrana	Biomedical Engineering, Mechanical and Aerospace Engineering
Jing Li	Chemistry and Chemical Biology
Adrian Mann	Ceramic and Materials Science and Engineering, Biomedical Engineering,
Prabhas Moghe	Biomedical Engineering, Chemical and Biochemical Engineering
Richard Riman	Ceramic and Materials Science and Engineering
Charles Roth	Biomedical Engineering, Chemical and Biochemical Engineering
Jerry Scheinbeim	Chemical and Biochemical Engineering
David Shreiber	Biomedical Engineering
David Talaga	Chemistry and Chemical Biology

Kathryn Uhrich	Chemistry and Chemical Biology
William Welsh	Pharmacology
Lawrence Williams	Chemistry and Chemical Biology
Frank Zimmerman	Physics and Astronomy

Certificate Program

Biointerfacial and biomaterials science and engineering is focused at the confluence of the three major constituents of biological substrates: cells, biomolecules (proteins, DNA, RNA, and other extra-cellular and sub-cellular entities) and biomaterials (synthetic materials such as typically found in surgical implants, sensors, and medical devices). The Certificate Curriculum in Biointerfacial & Biomaterials Science and Engineering (BBSE) aims to equip a new generation of scientists and engineers who will be able to cross freely among the disciplines of life sciences, engineering, and physical sciences and to address complex biointerfacial systems. The many and varied research opportunities not only extend basic knowledge of biointerfacial phenomena but also have technological relevance to society (for example: biomimetic materials, drug delivery, biosensors and bioactuators, tissue engineering, regenerative and rehabilitative medicine, and cell- and gene-based therapies).

The certificate requirements emphasize the integration and application of scientific and engineering principles across (i) size scales of biological interfaces (nanoscale through microscale) and (ii) systems of organization (physical/chemical/biological; proteins/genes; cells/tissues; etc.). Additionally, the curriculum stresses the close and continual integration of coursework with research experience. This approach is based on the philosophy of the NSF's Integrative Graduate Education and Research Traineeship (IGERT) program and draws upon specific experiences gained in the Rutgers IGERT program on Integratively Engineered Biointerfaces (<http://www.igert.rutgers.edu>).

Certificate Requirements:

To receive the Certificate in Biointerfacial & Biomaterials Science and Engineering, students must complete all the requirements for the M.S or Ph.D. in their home graduate programs, and also fulfill the requirements listed below. (Note: many of the latter will add no extra load because they may be used to satisfy the student's graduate degree requirements.)

- (1) Minimum of 12 credits (4 courses @ 3 credits) from BBSE Core Courses and from a menu of cross-disciplinary electives (shown below).
- (2) Active participation for at least two academic semesters in the BBSE- Integrative Research Interchange Forum (IRIF), consisting of regularly scheduled presentations and discussions among participating BBSE students and faculty.
- (3) Pursuit and completion of a relevant M.S. or Ph.D. thesis research project in the field of biointerfacial science and engineering – including a distinctly cross-disciplinary and integrative component (also described below).

The Certificate Program can be tailored to the needs and experience of each student. For example, courses already taken before admission to the BBSE can be recognized retroactively.

BBSE Course Requirement

Students must take 12 credits (4 courses @ 3 credits) , including at least two BBSE Core Courses. The remaining two courses may be any combination of other Core Courses and/or Cross-Disciplinary Electives (XDE's).

Core Courses:

125:582: Nano- and Micro-engineered Biointerfaces (Spring)

Lead instructor: K. Uhrich; Prerequisite: permission of instructor

Methods and mechanisms for engineering interfaces on the nano- and micro-scale: i) preparing substrates that have nano- and/or micro-scale features; and ii) creating nano and/or micro-scale substrates.

125:583 Biointerfacial Characterization (Fall)

Lead instructor: P.Moghe; Prerequisite: permission of instructor

Physical, chemical, and biological methods of characterizing biointerfaces, broadly defined. Conventional interfaces of biomolecules (e.g., proteins) on artificial substrates, as well as interfaces of submicron and nanoscale particles with biomolecules and living cells.

125:584: Integrative Molecular and Cellular Bioengineering (Spring)

Lead instructor: C. Roth; Prerequisite: permission of instructor

Integration of engineering and mathematical principles with molecular and cell biology entities for the understanding of physiology and solution of medical problems.

161:544:03 Special Topics in Chemistry: Degradable Polymers in Medicine (Alternate Spring)

Lead instructor: J. Kohn; Prerequisite: permission of instructor

Introduction to polymeric biomaterials; biologically relevant polymer properties; processing and fabrication of degradable polymers; self-assembled polymeric systems; biocompatibility; drug and gene delivery systems; clinical applications; tissue engineering; new product development and regulatory affairs and quality control and sterilization.

BBSE Cross-Disciplinary Electives (XDE's):

Suggested electives, already approved, are listed below. Students are not limited to the listed courses and may propose others for approval by the Director.

Engineering Courses: Extra-Disciplinary for Students in Physical and Life Sciences

16	125	504	Design of Biomedical Instrumentation
16	125	571	Biosignal Processing, Biomedical Imaging
16	125	572	Biocontrol, Modeling Computation
16	125	573	Kinetics, Thermodynamics, Transport in Biomedicine
16	125	574	Biomaterials and Biomechanics
16	155	514	Kinetics, Catalysis, and Reactor Design
16	155	551	Polymer Science and Engineering
16	642	527	Methods of Applied Mathematics

16	650	451	Fluid Mechanics (advanced undergraduate level)
16	650	530	Fluid Mechanics

Life Sciences Courses: Extra-Disciplinary for Students in Engineering and Physical Sciences

16	115	511	Biochemistry
16	148	504	Developmental Biology
16	148	514	Molecular Biology of Cells
16	681	502	Molecular Genetics
16	681	548	Cell Surface Receptors
16	695	601	Advanced Cell Biology
16	761	580	Molecular Basis of Physiology

Physical Sciences Courses: Extra-Disciplinary for Students in Engineering and Life Sciences

16	150	529	Introduction to Colloid and Surface Chemistry
16	160	509	Organic Chemistry of Polymers
16	160	537	Biophysical Chemistry
16	750	506	Modern Experimental Techniques
16	750	627	Surface Science I
16	750	628	Surface Science II

Other Courses: Extra-Disciplinary for any Student

16	663	505	Drugs, Structure and Function (Medicinal Chem./Pharmaceutics)
16	960	586	Data Interpretation I (Statistics)
UMDNJ course			Introduction to Bioinformatics
UMDNJ course			Protein Homology Modeling

BBSE Related MS or Ph.D. Thesis of Dissertation Research Requirement:

Students pursue and demonstrate completion of Master's research or doctoral dissertation research with BBSE participating faculty in the field of biointerfaces and biomaterials, broadly defined. The thesis or dissertation should be advised by a primary advisor and a co-advisor who: (i) is an expert in a markedly different discipline from that of the student's primary advisor and (ii) will provide, together with the primary advisor, significant input and mentoring for the student's research. For the thesis or dissertation to be considered to be cross-disciplinary, two documents should be provided: (a) a document demonstrating an initial, introductory immersion/rotation of at least three weeks, or an equivalent experience, in the co-advisor's research discipline; (b) evidence of cross-disciplinary manuscripts or journal papers coauthored by students with their primary and co-advisors.