

# BIOMEDICAL ENGINEERING



## GRADUATE STUDENT HANDBOOK

2009-2010 Academic Year

# RUTGERS

School of Engineering



*\*August 21, 2009 Edition\**

URL: [biomedical.rutgers.edu/graduatesplash.php](http://biomedical.rutgers.edu/graduatesplash.php)

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# Graduate Program Administration

## **PROGRAM DIRECTOR (Rutgers)**

Prabhas V. Moghe

## **PROGRAM CO-DIRECTOR (UMDNJ)**

Richard S. Nowakowski

## **PROGRAM ADMISSIONS DIRECTOR**

David Shreiber

## **STUDENT OMBUDSPERSON**

Thomas Papathomas

*Graduate Program Assistant*

Larry Stromberg

## **DEPARTMENT ADMINISTRATION**

### **CHAIR**

Noshir Langrana

### **VICE CHAIR**

Helen Buettner

## **DEPARTMENT STAFF**

*Undergraduate Program Assistant*

Linda Johnson

*Departmental Administrator*

Robin Yarborough

*Computer Systems Manager*

Stratos Loukidis

Department of Biomedical Engineering

599 Taylor Road

Piscataway, NJ 08854

(732) 445-4500 X6111

<http://biomedical.rutgers.edu>

# Biomedical Engineering History and Overview

Biomedical Engineering at Rutgers University was initially established in 1965 as a track within electrical engineering, offering M.S. degrees with a biomedical engineering emphasis. In 1986, the State of New Jersey formally chartered the Rutgers Department of Biomedical Engineering as an independent entity within the School of Engineering with exclusive responsibility for granting M.S. and Ph.D. degrees in Biomedical Engineering. The Department developed its graduate programs in collaboration with the University of Medicine and Dentistry of New Jersey (UMDNJ) to provide a strong foundation in the basic biomedical and clinical sciences along with rigorous training in engineering fundamentals. The undergraduate program in Biomedical Engineering was inaugurated in 1991 under the “applied sciences” option within the School of Engineering; a formal undergraduate B.S. degree in BME was approved by the University in 1997 and by the State in 1999.

The graduate program in Biomedical Engineering now includes over 75 faculty from Rutgers science and engineering departments, UMDNJ basic biomedical and engineering clinical science departments, other academic institutions in the area, and researchers from local industry.

As of June 2009, the department census was as follows:

- 25 core departmental faculty
- over 50 graduate program faculty
- 6 educational and research staff members
- more than 225 undergraduate students
- 23 M.S. students, 4 BS/MS students
- 69 Ph.D. students, 3 MD/Ph.D. students

The new BME building (shown on the cover) was dedicated on April 18, 2007 and has about 80,000 square feet of high quality educational and research space and houses state-of-the art micro fabrication, tissue culture, and microscopy laboratories, including small animal facilities. The BME department is located on the Busch Campus in Piscataway.

The Department hosts and co-hosts a number of nationally recognized research and training programs including:

- NIH Biotechnology and Bioengineering Ph.D. Training Program
- NIH Postdoctoral Training Program in Tissue Engineering and Implant Science
- IGERT Training Program on Integrated Science and Engineering of Stem Cells
- IGERT Training Program on NanoPharmaceutics
- IGERT Training Program in Perceptual Science

Faculty within the Department of Biomedical Engineering hold prominent positions in the following university-wide “Centers-of-Excellence”:

- NJ Center for Biomaterials
- Rutgers Engineering Research Center on Structured Organic Compounds
- Rutgers-UMDNJ Center for Advanced Biotechnology and Medicine
- Rutgers Center for Computational Bioengineering, Imaging and Modeling
- Rutgers Center for Pharmaceutical Science and Engineering
- Princeton-Rutgers Center for Biomolecular Imaging
- Rutgers Center for Packaging Science and Engineering
- Rutgers Laboratory of Vision Research
- Rutgers Center for Advanced Information Processing
- BioMAPS Institute for Quantitative Biology
- Stem Cell Institute of New Jersey

The Graduate Program in Biomedical Engineering is a joint program with Rutgers University and University of Medicine and Dentistry of New Jersey - Graduate School of Biomedical Sciences (UMDNJ-GSBS). The graduate degrees in Biomedical Engineering are given from Rutgers and UMDNJ. Both Graduate Deans sign the Diploma. No matter which university a BME student is enrolled in, the course curriculum and procedures will be the same. UMDNJ-GSBS has a website with a plethora of information and a handbook to look through that is similar to the one you are reading. <http://www2.umdnj.edu/gsbspweb/>

# Graduate Program Description

The mission of the graduate program is to provide outstanding graduate level training in six critical areas of biomedical engineering and technology. Thesis projects may straddle multiple areas given that these areas are broadly defined and overlapping.

- Biomaterials and Tissue Engineering
- Biomechanics and Rehabilitation Engineering
- Computational Bioengineering and Biomedical Imaging
- Molecular, Cellular, and Nanosystems Bioengineering
- Neuroengineering
- Physiological Systems and BioInstrumentation

All graduate students (M.S. and Ph.D.) must take: three of four BME core courses; one advanced engineering mathematics course; one advanced course in molecular biology of cells; bioengineering electives; Clinical Practicum; Survival Skills; and Journal Club. PhD students are required to take Life Science/Medical electives. Students are expected to attend the Biomedical Engineering Seminar Series throughout their graduate careers. The breakdown of the M.S. and Ph.D. curriculum can be found starting on page 10.

The M.S. degree requires 6 research credits or 3 non-thesis study credits depending on the M.S. option chosen and the Ph.D. requires at least 37 research credits. The department wants each student to excel in their studies and to facilitate that, grades of “C” or below in any core BME course will be handled as follows: One C=written notification of probation. Two C’s=written warning that upon the third C grade, the student must leave the Program. Three or more C’s=Immediate de-registration and failure to register in future semesters.

During the first academic year, students are required to select their dissertation research advisor. Selection must take place no later than the end of the first summer (beginning of next summer for students entering in January). During the first summer of the M.S. and Ph.D. programs, each student has the option to complete a one-month research rotation with three different principal investigators if they are unable to determine an advisor by that time. All Ph.D. students must undergo an Annual Research Meeting and have a form signed by the committee and advisor and submitted for the Graduate Program Director. Information for this procedure starts on page 19.

At the end of the first academic year (June), Ph.D. students must take the written graduate qualifying exam. In exceptional circumstances, a student may get an extension for the qualifying date for a maximum of 1 year to take additional preparatory courses. The qualifying exam consists of tests in 3 out of 4 core course areas. The evaluations are conducted by the Qualifying and Tracking Committee and announced by the Graduate Program. If a student fails any portion of the exam, he or she will re-take that portion of the exam at the end of the following academic year, or by arrangement with the Graduate Program Office. Students who fail the exam twice will be advised of alternative educational and career options. **Please note: A non-PhD student may NOT take the qualifier unless he/she has approval from Graduate Program Director.**

In collaboration with the research advisor, the Ph.D. student will formally defend a proposed dissertation topic, preferably by the end of the second academic year and in any case no later than at the end of the fall semester of the third academic year. Ph.D. students should plan to defend their thesis dissertation by the end of their fifth year. **It is a Graduate School regulation that students must complete all of their Ph.D. work no later than 7 years after entering the program.** Rutgers BME students are expected to maintain the highest academic standards. Beyond the requirements of the Graduate School of New Brunswick, the BME Graduate Program permits no more than 2 grades below a B: students whose grades fall below this standard will be required to leave the program. The department is committed to being flexible to meet our students' needs in reaching these goals, however, we seek at the same time to advance our students toward robust and successful scientific and engineering careers, and for this reason we believe in setting goals and monitoring student progress to achieve these goals.

### **MD/PhD Combined Program**

Students who are interested in this Dual Degree program will take their medical training at Robert Wood Johnson Medical School and PhD training at one of three collaborating institutions: RWJMS, Rutgers, or Princeton. The program provides 3 years of graduate training and 4 years of Medical training. Year 3 starts the graduate training years. In order to apply to this program, students complete an MD/PhD application from the website [http://www2.umdnj.edu/gsbpsweb/md\\_phd\\_program/index.htm](http://www2.umdnj.edu/gsbpsweb/md_phd_program/index.htm) and simultaneously apply to UMDNJ-RWJ Medical School through the American Medical College Application Service (AMCAS) at [www.aamc.org](http://www.aamc.org). This program is highly competitive and only about 6 students are accepted each year into the MD/PhD program.

Students who are admitted into this program may substitute some of their MD courses as BME Program Requirements subject to written approval of the Graduate Program Director. A passing score on the USMLE step 1 is accepted in lieu of the Physiology course requirement and its associated portion on the Qualifying Exam. Typically M.D. students will also have taken graduate-level Molecular Biology and Biochemistry courses that may be substituted for the BME requirement on this topic with the BME Graduate Director's approval. Finally, M.D. students may have taken courses that can be used as Life Science or other electives as appropriate. M.D. /PhD students should meet with the BME Graduate Director as soon as they are admitted into the joint program to clarify what requirements may be waived in their case.

### **MASTERS DEGREE REQUIREMENTS, Option A and B**

Students have two M.S. degree options. All M.S. students should seek to complete Option A; students who have not completed this option by the end of their third year will be required to leave the graduate program with Option B. The options consist of the following course requirements

#### **Option A (thesis option): 27 Course Credits + 6 Research Credits:**

3 BME Core Courses (9); Math (3); Molecular Biology and Biochemistry (3); BME Seminar/Developmental (3); 3 Electives (9), Research Credits (6). Total 33 credits.

#### **Option B (non-thesis option): 30 Course Credits + 3 Non-Thesis Study Credits:**

3 BME Core Courses (9); Math (3); Molecular Biology and Biochemistry (3); BME Seminar/Developmental (3); 4 Electives (12), Non-Thesis Study (3). The Plan B M.S. is considered a terminal degree that does not lead to a Ph.D. This totals 33 credits.

In both degree programs there is a final comprehensive examination (thesis defense or paper), normally taken during the term that will complete the student's course of study, which will emphasize the student's area of concentration.

**Final Comprehensive Examination:** A final comprehensive examination will be taken by all students enrolled in the M.S. program. The examination will be conducted by the student's committee. This committee will be composed of at least three members of the BME graduate faculty. For Option A, the student must defend his or her written M.S. dissertation by oral examination. For Option B, the student must defend his or her independent study or research based final paper. The final paper can be a critical analysis of a current research topic, a laboratory research based report, or an NIH style research proposal. It is recommended that the final paper consists of 40-60 double spaced pages.

# “Bill of Rights” For Graduate Students in Biomedical Engineering Rutgers University

Guidelines for the education and mentoring of PhD students were adopted by the faculty of Rutgers Biomedical Engineering on February 17, 2006. It is not possible or desirable to specify rigid criteria for mentorship that will fit all situations; nevertheless these guidelines were endorsed as goals that all faculty and students should strive for. As a matter of policy, the Rutgers BME faculty believes that mentors have a responsibility to educate, guide, and support their students in a scholarly and respectful manner. Students for their parts are expected to uphold the highest standards of scholarship and academic integrity. Specifically,

1. PhD students should meet with their advisors on their research projects frequently enough so that guidance toward meaningful scientific and education progress is made. Typically, students should meet with their advisors weekly or once every two weeks, depending on the stage of their research.
2. Faculty should evaluate their graduate students' progress in a timely and constructive way. There will be exceptions, but it is reasonable for students to expect to receive feedback every week or two.
3. All PhD students should expect to attend and present at national meetings and publish in peer-reviewed papers in leading journals. At a minimum, the expectation of our graduate program is that all PhD students will give at least one presentation at a national meeting, and publish at least one first author paper in a peer-reviewed journal before they graduate.
4. Students can expect exposure to and some experience in grant and progress report writing, paper reviewing, and other responsibilities involved in an active, modern lab.
5. It is the responsibility of the PhD advisor to financially support their PhD students who are in good standing. Funding can never be guaranteed; nevertheless faculty members make a commitment to the students when they enter the program that they will receive tuition and competitive stipends, and insofar as it is at all possible, members of the faculty must uphold this commitment. It is the responsibility of students to maintain the highest achievable productivity and academic standing.

In most situations, if these guidelines are not met, the problem can be resolved by open discussion between the student and advisor. If a resolution cannot be achieved after these discussions, the Graduate Program Director – or failing that, the Department Ombudsman – will make every effort to help either resolve the problem or direct the student to an alternative advisor.

# BME M.S. Program Curriculum rev. Aug 2009

## FALL Year 1

16:125:xxx	BME Core Course (3cr)
16:125:xxx	BME Core Course (3cr)*
16:148:514	Molecular Biology of Cells (3cr)
16:xxx:xxx	Advanced Engineering Math Course (3cr)
16:125:601	Journal Club and Seminar in BME (1cr)

## SPRING Year 1

16:125:xxx	BME Core Course (3cr)
16:125:xxx	BME Core Course (3cr)*
16:125:xxx	Bioengineering Elective (3cr)
16:125:602	Survival Skills in BME (1cr) <i>or</i>
16:115:556	Ethical Sci Conduct (1cr)
BME Seminars	(attendance required)

## FALL & SPRING Year 2 (As needed)

16:125:xxx	Bioengineering Electives
16:125:628	Clinical Practicum (1cr)
16:125:601/602	Journal Club/Survival Skills (1cr/1cr) <i>or</i>
16:115:556	Ethical Science Conduct (1cr)
16:125:701/702	Research (6cr)
16:125:699	Non-Thesis Study (3cr) <b>(PLAN B MS ONLY)</b>
BME Seminars	(attendance required)

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### BME Core Courses **\*Must take 3 out of 4:**

1)	16:125:571	Biosignal Processing and Biomedical Imaging (3cr) Fall
2)	16:125:572	Biocontrol, Modeling and Computation (3cr) Spring
3)	16:125:573	Kinetics, Thermodynamics and Transport in Biomedicine (3cr) Fall
4)	16:125:574	Biomechanics Systems (3cr) Spring

### Physiology

Students **must** have taken an UG level Physiology course previously or the following courses must be taken.

1)	14:125:355/6	BME Systems Physiology (undergraduate course-3cr) Fall/Spring
2)		Other Rutgers or UMDNJ Physiology Courses – Contact the Graduate Program for information

### Advanced Engineering Mathematics

1)	16:155:507	Analytical Methods Chem/Bioengineering (3cr) Fall
<u>Or</u>	16:642:527	Methods of Applied Math (3cr) Fall

### Molecular Biology

1)	16:148:514	Molecular Biology of Cells (3cr) Fall
<u>Or</u>	16:115:511	Molecular Biology and Biochemistry (3cr) Fall

### Developmental Courses **Must take 1, 2 and 5...3&4 are optional**

1)	16:125:601	Journal Club and Seminar (1cr) Fall
2)	16:125:602	Survival Skills and Seminar in BME (1cr) <i>or</i> 16:115:556 Ethical Sci Conduct (1cr)
3)	16:125:607	Preparing Future Faculty I (1cr) Fall
4)	16:125:608	Preparing Future Faculty II (1cr) Spring
5)	16:125:628	Clinical Practicum (1cr) Spring

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## Summary of Minimum M.S. Requirements

<b>3 out of 4 BME Core Courses</b>	<b>9 credits</b>
<b>Advanced Engineering Math Course</b>	<b>3 credits</b>
<b>Molecular Biology Course</b>	<b>3 credits</b>
<b>3 Bioengineering Electives</b>	<b>9 credits</b>
<b>3 out of 5 Developmental Courses</b>	<b>3 credits</b>
<b>Research (Plan A ONLY)</b>	<b>6 credits</b>
<b>Non-Thesis Study (Plan B ONLY)</b>	<b>3 credits (MUST take an additional 3 credit elective)</b>
<b>Total</b>	<b>33 credits</b>

# BME Ph.D. Program Curriculum rev. Nov 2008

## FALL Year 1

16:125:xxx	BME Core Course (3cr)
16:125:xxx	BME Core Course (3cr)*
16:148:514	Molecular Biology of Cells (3cr)
16:155:507	Analytical Methods Bioengineering (3cr), <i>or</i>
16:642:527	Methods of Applied Math
16:125:601	Journal Club in BME (1cr)
BME Seminars	(attendance required)

## SPRING Year 1

16:125:xxx	BME Core Course (3cr)
16:125:xxx	BME Core Course (3cr)*
16:125:xxx	Bioengineering Elective (3cr)
16:125:628	Clinical Practicum (1cr)
16:125:702	Research (3+cr)
BME Seminars	(attendance required)

## SUMMER Year 1

**Qualifying Exam for Doctoral Studies (June)**

## FALL Year 2

16:125:xxx	Bioengineering Elective (3cr)
16:125:xxx	Bioengineering Elective (3cr)
16:125:607	Preparing Future Faculty I (1cr)
16:125:701	Research (3+cr)
BME Seminars	(attendance required)

## SPRING Year 2

16:125:xxx	Life/Medical Sciences Elective (3cr)
16:125:608	Preparing Future Faculty II (1cr)
16:125:702	Research (3+cr)
BME Seminars	(attendance required)

## SUMMER Year 2

**Prepare Thesis/Dissertation Proposal**

## FALL Year 3

BME Seminars	(Attendance required)
16:125:701	Research (3+cr)
Electives	(As required)

**Deadline for Defense of Thesis/Dissertation Proposal**

## SPRING Year 3

16:125:602	Survival Skills in BME (1cr)
16:125:702	Research (3+cr)
Electives	(As required)

## Years 4-6

16:125:701/2	Research (3+cr)
BME Seminars	(Attendance required)
Electives (Optional)	

**Final Thesis/Dissertation and Defense (Year 5)**

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**BME Core Courses** \* **Must take 3 out of 4:**

- 1) 16:125:571 Biosignal Processing and Biomedical Imaging (3cr) Fall
- 2) 16:125:572 Biocontrol, Modeling and Computation (3cr) Spring
- 3) 16:125:573 Kinetics, Thermodynamics and Transport in Biomedicine (3cr) Fall
- 4) 16:125:574 Biomechanics Systems (3cr) Spring

**Physiology**

Students **must** have taken an UG level Physiology course previously or the following courses must be taken.

- 1) 14:125:355/6 BME Systems Physiology (undergraduate course-3cr) Fall/Spring
- 2) Other Rutgers or UMDNJ Physiology Courses – Contact the Graduate Program for information

**Advanced Engineering Mathematics**

- 1) 16:155:507 Analytical Methods Chem/Bioengineering (3cr) Fall
- Or 16:642:527 Methods of Applied Math (3cr) Fall

**Life Science and Medical Foundational Course**

- 1) 16:148:514 Molecular Biology of Cells (3cr) Fall  
or  
16:115:511 Molecular Biology and Biochemistry (3cr) Fall

And

- 2) At least one Life Science electives from the list in the Graduate Handbook

**Developmental Courses**

- 1) 16:125:601 Journal Club (1cr) Fall (**Required during 1<sup>st</sup> year**)
- 2) 16:125:602 Survival Skills (1cr) Spring (**Required after 2<sup>nd</sup> year**)
- 3) 16:125:607 Preparing Future Faculty I (1cr) Fall (**Required**)
- 4) 16:125:608 Preparing Future Faculty II (1cr) Spring (**Required**)
- 5) 16:125:628 Clinical Practicum (1cr) Spring (**Required**)

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**Summary of Minimum Ph.D. Requirements**

<b>3 out of 4 BME Core Courses</b>	<b>9 credits</b>
<b>Advanced Engineering Math Course</b>	<b>3 credits</b>
<b>Molecular Biology Course</b>	<b>3 credits</b>
<b>Life Science/Medical Elective</b>	<b>3 credits</b>
<b>4 Bioengineering Electives</b>	<b>12 credits</b>
<b>5 Developmental Courses</b>	<b>5 credits</b>
<b>Research (minimum)</b>	<b>37 credits</b>
<b>Total</b>	<b>72 credits (35 course credits)</b>

**Notes:**

- **3 core courses must be taken during the first year to prepare for the written qualifying exam.**
- Prerequisite work, e.g., 14:125:356 BME Systems Physiology may not count as an elective. Contact graduate program for details
- The core courses 571 and 573 are offered in the fall, and 572 and 574 in the spring semester. Since only 3 out of 4 core courses are required, this usually leaves room for an elective.

# Ph.D. Qualifying Exam

**Please note: Non-PhD students may NOT take the qualifier unless he/she has approval from the Graduate Program Director.**

The first part of the Ph.D. qualifying procedure is a written examination that is administered during the first week of June, during the first year of studies. The exam consists of tests in 3 out of the 4 required core courses.

The second part of Ph.D. qualifying exam involves a satisfactory defense of a thesis proposal as early as 6 months after passing the qualifying exam and no later than the end of the fall semester of year 3.

To successfully give you post-qualifying status, both the written qualifier and oral proposal, have to be completed in a satisfactory manner.

For PhD students, a guide to progress is as follows:

1. Take the written qualifier in June at the end of your first year.
2. Schedule and defend your Ph.D. proposal as early as 6 months after passing the written qualifier and no later than the fall semester of your third year.
3. Schedule and successfully defend the Ph.D. thesis within 2 years after the Ph.D. proposal.
4. Corrections on the Ph.D. thesis should not take longer than 1 semester.
5. The graduate school mandates that a student finish the Ph.D. within 7 years after the student's enter date. However, our program expects you to finish within 5 - 6 years, which students should be able to accomplish.

**You must stay in touch with the BME Graduate Program Director and Program Assistant to request and receive the proper forms and documentations required by the program and graduate school, to keep them informed and updated on your progress, and to verify that you are on track by taking the right courses and making progress in your area of research.**

# Life Science/Medical Electives

The following 3 BME courses can count as a Life Science/Medical Elective. Note that these courses may be offered only every alternate year.

16:125:582	NANO-AND MICRO-ENGINEERED BIOINTERFACES
16:125:583	BIOINTERFACIAL CHARACTERIZATION
16:125:584	INTEGRATIVE MOLECULAR AND CELL BIOENGINEERING

Acceptable life science/medical electives that are regularly offered by other Departments:\*

16:148:514	MOLECULAR BIOLOGY OF CELLS
16:148:519	CELLULAR AND GENETIC MECHANISMS
16:148:530	HUMAN GENETICS
16:148:550	ADVANCED DEVELOPMENTAL BIOLOGY
16:148:556	SYSTEMS HISTOLOGY
16:148:565	GROSS AND DEVELOPMENTAL ANATOMY
16:681:502	MOLECULAR GENETICS
16:681:530	INTRODUCTION TO MOLECULAR MEDICINE
16:681:555	MOLECULAR VIROLOGY
16:681:585	CANCER MOLECULAR BIOLOGY
16:761:515	MEDICAL PHYSIOLOGY

For further information on elective courses, please check the appendix.

\*Other courses not listed may be acceptable with PRIOR approval from the Graduate Director

# Masters Thesis Guidelines

## **Procedures for Filing for a Master's degree:**

An application for Admission to Candidacy must be completed by all Master's students, listing courses that will be applied toward the Master's degree. The application can be picked up from the program assistant in BME-111. For Option A, the student is required to list at least 27 course credits and 6 research credits, for Option B, 30 course credits and 3 non-thesis study credits. The Graduate Program Director must approve any course not in the curriculum that will be used to satisfy the degree requirements. This includes any courses that can be transferred from a previous institution. Prior to the Master's thesis defense, the student MUST confirm with the BME Graduate Program Administrator that all requirements are satisfied. Application for Diploma must also be filled out during the semester of intended graduation. That form can be picked up from Larry in BME-111 or filled out online at: <https://www.ugadmissions.rutgers.edu/Diploma>

## **Selection of M.S. Thesis Advisor and Committee:**

The M.S. thesis committee consists of at least three members: the thesis advisor and two members of the graduate faculty. No outside member is required for the M.S. thesis committee. Additional members are permitted. The student should choose committee members who can help the student either in the research topic or in his or her future career. For example, a student interested in clinical research could benefit from a member of the Medical School; likewise a student interested in industry may want to include committee members with industrial contacts.

## **Master's Comprehensive Examination**

For either Option A or Option B Master's degrees, the student must pass a comprehensive examination. This examination consists of a presentation of a thesis (Option A) or a report (Option B) and an oral examination on the research by the three committee members. 2 weeks prior to the oral exam (thesis defense), the student MUST submit to the program administrator: Title, location, committee members and abstract.

The candidate's thesis advisor and committee must agree unanimously. Students submitting a thesis must follow the required format defined in the Graduate School's Thesis and Dissertation Style Guide, and must meet all deadlines prescribed by the Graduate School.

Final approval for the M.S. degree must come from the Graduate Director, verifying that the candidate has satisfied all program requirements for the degree, including coursework, research, and the completed and signed M.S. comprehensive examination. At that point, the Graduate Director signs the candidacy form and the student submits the form and the thesis abstract to the Graduate School-New Brunswick at 25 Bishop Place on College Avenue Campus. The thesis is submitted electronically here: <https://etd.libraries.rutgers.edu/login.php>

# Doctoral Dissertation Guidelines

## General Dissertation Information

The doctoral dissertation topic may be chosen in virtually any research area at the interface of physical science/engineering and the biomedical sciences. Students are encouraged to begin research activities early in their graduate career (generally in the second semester of their first year); research work towards the thesis may be done on campus, at teaching hospitals or at other research sites (for example, in one of our associated industrial or clinical research laboratories). The Program encourages students to explore areas that are relevant to clinical medicine, but this is not an absolute requirement. The candidate pursues the thesis under the direction of a research supervisor and is guided by a thesis committee.

## Laboratory Rotations

To facilitate the advisor selection process, new graduate students have the option of rotating through available laboratories. These rotations typically last for one month and can start as soon as a student is accepted into the program. Laboratory rotations must be arranged by the student in consultation with the laboratory director. The Graduate Program Director or knowledgeable faculty can direct the student to laboratories accepting rotations.

## The Dissertation Committee: Composition and Function

***Dissertation Committee:*** Doctoral dissertation work is performed under the guidance of a dissertation committee consisting of at least four faculty members (including a chair and a research supervisor) who will help guide the research and act as readers of the thesis. At least three of the committee members should represent the disciplines of engineering and science that are relevant to the student's proposed research. These three members must be affiliated with the BME Graduate Faculty. The list of acceptable faculty members can be found on page 28. A final committee member from outside of the department, the fourth member, is included to broaden the student's perspective. This outside member must be approved by the BME Graduate Director and the Graduate School for the final dissertation defense. The dissertation committee should be formed early in the course of the research and in no case later than six weeks prior to the dissertation proposal date. The BME Graduate Director must approve the composition of the dissertation committee. Normally, this is done at the time the thesis proposal is approved. The student should choose committee members who can help the student either in the research topic or in his or her future career. For example, a student interested in clinical research could benefit from a member of the Medical School; likewise a student interested in industry may want to include committee members with industrial contacts.

***Dissertation Chair:*** A chair, who must be a full member of the graduate faculty, heads each dissertation committee. The role of the chair is to ensure that all policies and procedures of the thesis committee are followed correctly, and particularly that dissertation committee meetings are scheduled each year.

***Dissertation Research Supervisor:*** The research supervisor from the BME graduate faculty is ordinarily a faculty member of Rutgers or UMDNJ. A senior research staff member may act as the dissertation supervisor with special permission by the BME Graduate Program Director (examples of thesis committee composition are found later in this booklet). The research supervisor may also be, but need not be, the chair of the committee.

## **Dissertation Proposal and Proposal Defense**

***The proposal:*** Each candidate writes a dissertation proposal that must be approved by his/her committee before the end of the fall semester of the third year. The proposal should reflect the guidance of the dissertation committee. The proposal should contain sufficient detail to clearly define the research problem, describe the proposed research plan, and defend the significance of the work. Preliminary results are expected. The maximum length excluding figures, tables, and references is 25 pages.

***Format of the proposal:*** The proposal package should include the following:

- The proposal with properly formatted title page signed by the student;
- An abstract of the proposal (maximum length 300 words) that serves as a concise description of the proposed work and can be read independently of the full proposal. The BME Dissertation Tracking Committee will use the abstract when reviewing the proposal for final approval. The abstract should be comprehensible to a general scientific audience, yet should contain sufficient information for evaluation of the project. The components of the abstract are 1) a brief description of the project background and significance, explaining why the work is important; 2) the specific aims of the proposal; and 3) a summary of the methods to be used to accomplish the specific aims. Headings within the abstract (Background, Specific Aims, and Methods) are optional;
- A supervision agreement signed by the thesis supervisor;
- Signed agreements from each reader (member of thesis committee) as well as an agreement signed by the chairman of the committee (if the chairman is not also the thesis supervisor);
- A cover letter signed by the chairman of the committee documenting the time and place of the thesis proposal defense and the committee's assessment of the proposal.

***Proposal Defense:*** The student obtains the candidacy form from the BME graduate program office and fills out the requested information. The student must formally defend the written dissertation proposal before the full dissertation committee. The proposal title, date, abstract and committee members **MUST** be submitted to the Graduate Program Assistant, Larry Stromberg, in BME-111 *two weeks* before the proposal defense. After the defense, the student corrects deficiencies in the proposal identified by the committee, and the committee then reviews the amended proposal. When the committee deems the proposal acceptable, the proposal package is forwarded to the Graduate Director for final approval. The student is responsible for obtaining the required signatures from the dissertation committee at the time of the defense or shortly thereafter. After the committee has signed the candidacy form, this form must be submitted to the Graduate School-New Brunswick, 25 Bishop Place, College Avenue Campus.

## **Dissertation Committee Meetings and Reports**

While the student should freely seek the advice and counsel of thesis committee members on an individual basis, periodic thesis committee meetings must be held to review progress and guide the ongoing research. These meetings must occur at least once per year; typically, students will receive weekly or bi-weekly feedback from committee members engaged in the ongoing research. An Annual Research Verification form must be submitted to the graduate program office by August 15<sup>th</sup> of each year. New incoming PhD students have until August 15<sup>th</sup> of the SECOND year to submit this form. More information is on the following page.

***Dissertation Defense:*** When the written dissertation is substantially complete and acceptable to the dissertation committee, a public dissertation defense will be scheduled at which the student presents his/her work to the dissertation committee and other members of the Rutgers-UMDNJ community. Through the defense, the dissertation committee judges the adequacy of the dissertation research. Formally, the candidate meets with the dissertation committee privately following a public question period. During this private meeting, the committee may perform an oral examination or may request additional materials. The committee will then adjourn for a discussion of the candidate's performance, after which it will agree by majority vote that the candidate has (a) successfully defended the work, (b) needs to perform specified additional work by a defined date, or (c) has not adequately defended the work. Graduate School regulations apply in all of these cases.

Once the dissertation is satisfactorily defended and the final written dissertation document (signed by the dissertation supervisor) and candidacy form and title page of the dissertation (signed by the entire dissertation committee) is submitted to the Graduate Director's Office for approval and signature. At that point, the Graduate Director signs the candidacy form and the student submits the form and 3 copies of the thesis abstract to the Graduate School-New Brunswick at 25 Bishop Place on College Avenue Campus. The thesis is submitted electronically here: <https://etd.libraries.rutgers.edu/login.php>

### ***Procedures:***

In summary, procedures for a dissertation defense are as follows:

- The dissertation committee, working with the student and reviewing dissertation drafts, concludes at some point before the end of the 7<sup>th</sup> year of study that the doctoral work is complete;
- The student requests that an "Outside Committee Member" letter be prepared by the Graduate Program Assistant with approval from the Graduate Director. This is for the 4<sup>th</sup> committee member.
- A complete final draft of the dissertation document is due to the dissertation committee no less than two weeks prior to the dissertation defense to allow the committee time to review;
- A dissertation defense is held to which the public is invited. The Graduate Program Administrator will assist the student by making a flyer and announcing the date of the dissertation via e-mail;
- Immediately following the public dissertation presentation, the student and committee members have a follow-up discussion in which additional questions can be explored at the discretion of the faculty;
- The dissertation committee meets in executive session to decide whether the thesis defense was satisfactory. Additions or editorial changes to the thesis document may be suggested to the student by the committee at this point;
- The student makes final corrections on the written dissertation and follows the guidelines set by the Graduate School regarding the timely submission of all forms, the collection of signatures on the candidacy form and title page and the submission of all dissertation materials, as outlined in the Dissertation Style Guide.

# Annual Research Progress

Timely progression to completion of the Ph.D. is a goal of all students and faculty within Biomedical Engineering. A reasonable goal is for the Ph.D. to be completed within five years; however the rules of the Graduate School of New Brunswick allow a maximum of seven years. In order to promote timely progression, effective January 3, 2008, the Biomedical Engineering Graduate Program requires that the progress of all Ph.D. candidates be reviewed annually, so that students and their research mentors will have adequate feedback to assist them in making progress towards degree completion. This will be done through a required annual meeting with the student and her/his committee. The meeting involves having an Annual Research Verification form signed and returned to the Graduate Program Office in BME\*. This completed and signed form will be due for submission to the office by August 15th of each year following the first year. If the form is not submitted to the office by this date, the student's registration in subsequent semesters will be put on hold. The form is on the following page.

Students are required to form their research advisory committees by the end of the spring semester of the 1st year. The advisory committee can be equivalent to or slightly different from the PhD. thesis committee. The advisory committee should consist of the thesis advisor; two other faculty of the BME graduate program; and an "outside" member (not a faculty of BME graduate program. The outside member can be from an outside institution or organization.

The intended format of the meeting is for the student to present:

- An overview of her/his thesis project;
- Progress since the last Research Advisory Committee meeting;
- Proposed work for the next one-year period;
- An evaluation of the student's progress and prospects is to be written on the Annual Research Verification form by the Chair of the Committee immediately following the meeting and distributed to the student, committee members, the director of the student's Graduate Program with all required signatures.

\*A thesis proposal form can be substituted for the verification form if the student has successfully defended his/her thesis proposal no more than six months prior to the August deadline, or if the student has scheduled her/his thesis proposal defense within four months after the August deadline.



## Joint Graduate Program in Biomedical Engineering

### ANNUAL RESEARCH VERIFICATION FORM

*(To be completed by Student's advisor and/or committee, and submitted to BME Graduate Program Office by 8/15 every year)*

Student's Name: \_\_\_\_\_

Date of Research Committee Meeting: \_\_\_\_\_

Progress of Thesis/Dissertation:

\_\_\_ Satisfactory

\_\_\_ Unsatisfactory

#### *Comments and Recommendations for the Student:*

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Committee:

Name (please print)

Signature

Concur

Dissent

\_\_\_\_\_  
Research Advisor

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\_\_\_\_\_  
Student Signature

\_\_\_\_\_  
Anticipated Proposal OR Defense Date (circle one)

\_\_\_\_\_  
Graduate Program Director Signature

# MAKEUP OF THESIS COMMITTEES

## EXAMPLE #1

<u>Committee Member</u>	<u>Discipline</u>	<u>Institution</u>
1. Chair	BME Graduate Faculty: BME Professor	Rutgers or UMDNJ
2. Research Supervisor	BME Graduate Faculty: Hospital-based MD	UMDNJ
3. Reader #1	BME Graduate Faculty: Engineering Professor	Rutgers
4. Reader #2	Approved Outside Member*	As Desired

## EXAMPLE #2

<u>Committee Member</u>	<u>Discipline</u>	<u>Institution</u>
1. Chair/Research Supervisor	BME Graduate Faculty: BME Professor	Rutgers or UMDNJ
2. Reader #1	BME Graduate Faculty: Engineering Professor	Rutgers
3. Reader #2	BME Graduate Faculty: MD faculty member	UMDNJ
4. Reader #3	Approved Outside Member*	As Desired

## EXAMPLE #3

<u>Committee Member</u>	<u>Discipline</u>	<u>Institution</u>
1. Chair	BME Graduate Faculty: BME Professor	Rutgers or UMDNJ
2. Research Supervisor	BME Graduate Faculty: Cell Biology Professor	Rutgers or UMDNJ
3. Reader #1	BME Graduate Faculty: Engineering Professor	Rutgers
4. Reader #2	Approved Outside Member*	As Desired

\* The Graduate School requires an “Outside Member Letter”, obtained from the Graduate Program Administrator.

# Appendix

## Core Course Descriptions

### **16:125:571      Biosignal Processing (3)**

*Prerequisites: Graduate Standing*

Application of basic signal analysis to biological signals and the analysis of medical image. Extensive use of the MATLAB language in example and problems.

### **16:125:572      Biocontrol, Modeling, and Computation (3)**

*Prerequisites: Graduate Standing*

Application of control theory to the analysis of biological systems. As foundation for other biomedical engineering courses, topics include (biocontrol) control systems principles, Nyquist and root locus stability analysis; (modeling) Nernst membrane model, action potential, cardiac and vascular mechanics, accommodation and vergence eye movements, saccades, pharmacokinetic models; and numerical solutions to differential equations, computer methods using C++, and image processing of biological systems.

### **16:125:573      Kinetics, Thermodynamics, and Transport in Biomedicine (3)**

*Prerequisites: Graduate Standing*

Intended for those seeking familiarity with the effects of, and tools to deal with, fluid, multiphase, chemical, and thermal transport and kinetics problems in biological systems.

### **16:125:574      Biomechanics and Biomaterials (3)**

*Prerequisites: Graduate Standing*

Foundation in basic engineering statics, dynamics, and strength of materials is expected. An introduction to graduate level continuum mechanics with an emphasis on biomedical and biomaterial applications.

### **16:125:581      Mammalian Physiology (3)**

*Prerequisites: undergraduate physiology and general biology*

This advanced physiology course is organized around integrative issues, i.e., focus is on the physiological parameter to be controlled and to show how the different systems (nervous, endocrine, respiratory, cardiovascular, renal, gastrointestinal) contribute to homeostasis of a particular parameter.

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### **16:148:514      Molecular Biology of Cells (3)**

*Prerequisites: 01:119:380 and 460, or equivalents. Corequisite: Graduate course in biochemistry.*

Fundamentals of the molecular organization and functions of cells.

### **16:155:507      Analytical Methods Chem/Bioengineering (3)**

*Prerequisites: Differential, integral and multivariable calculus; differential equations*

This course introduces analytical methods needed to model physical situations commonly encountered in engineering, including problems in heat, mass and momentum transport, reaction kinetics, thermodynamics, signal processing, and control. Primary topics include ODE's, PDE's, linear theory and complex analysis. Separation of variables, Laplace transform and Fourier transform solution methods are covered. The emphasis is on methods of solution. However, a basic framework for understanding the mathematical principles underlying these methods is also developed. Because the successful application of analytical techniques frequently involves a computational component, attention is devoted to basic computational issues where possible.

### **16:642:527      Methods of Applied Mathematics (3)**

*Prerequisite: Permission of instructor*

Appropriate topics from linear algebra, linear operators in Hilbert space, linear integral equations, boundary-value problems, calculus of variations, numerical solution of ordinary and partial differential equations.

# Other Graduate Course Electives\* (offered in BME)

## **16:125:582 NANO-AND MICRO-ENGINEERED BIOINTERFACES (3)**

*Prerequisites: Background in undergraduate chemistry, general biology, physics, and interest in integrative studies of biological interfaces. Students concerned about their preparation should contact the instructor.*

This course introduces students to the methods and mechanisms for engineering interfaces on the nano- and micro-scale. Two approaches to engineering interfaces, generally classified as synthesis and fabrication, specifically include: i) preparing substrates that have nano- and/or micro-scale features; and ii) creating nano and/or micro-scale substrates. The substrate materials discussed will typically consist of ceramics, polymers, and metals whereas biological systems will comprise cells, genes and ligands.

## **16:125:583 BIOINTERFACIAL CHARACTERIZATION (3)**

*Prerequisites: Background in undergraduate chemistry, general biology, physics, and interest in integrative studies of biological interfaces. Students concerned about their preparation should contact the instructor for guidance.*

This course will introduce students to various physical, chemical, and biological methods of characterizing biointerfaces, broadly defined. Biointerfaces will include conventional interfaces of biomolecules (e.g., proteins) on artificial substrates, as well as interfaces of submicroscopic and nanoscale particles with biomolecules and cells.

## **16:125:584 INTEGRATIVE MOLECULAR AND CELL BIOENGINEERING (3)**

*Prerequisites: Some background in biochemistry, molecular biology, thermodynamics and kinetics. Students concerned about their preparation should contact the instructor.*

This course provides an integration of engineering and mathematical principles with molecular and cell biology entities for the understanding of physiology and solution of medical problems.

*\* These electives can also be used to substitute the life sciences requirement. Check with graduate program about the schedule; note that these courses may be offered during alternate years. For a more comprehensive list of electives, refer to pages 24-26.*

# Developmental Courses and Descriptions

## **16:125:601 Journal Club and Seminar (1)**

Each Fall semester all students are expected to attend the Journal Club and Seminar Series. Every other week, students will review the current literature and have a discussion. On the alternating weeks, students will hear speakers from within and outside the Rutgers/UMDNJ community present their research results.

## **16:125:602 Survival Skills and Seminar (1)**

Each Spring semester all students are expected to attend the Survival Skills and Seminar Series. Every other week, students will listen to speakers share their experiences and get advice in how to be a successful graduate student.

## **16:125:607, 608 Preparing Future Faculty I,II (1,1)**

During the second year of studies, all Ph.D. candidates will take two one-credit courses over the span of the year. These courses cover basic concepts in teaching and learning. Students will be exposed to different styles of learning and teaching methods and their application to Biomedical Engineering. Students will be expected to apply the principles to laboratories and lectures in the undergraduate program.

## **16:125:628 Clinical Practicum (1)**

Students are introduced to clinical aspects of biomedical engineering by attending regular grand rounds given by clinical specialists from medical schools and hospitals. Selected demonstrations of clinical procedures with applications of modern technology are also arranged.

## **16:115:556 Ethical Scientific Conduct (1)**

Introduction to ethical issues of scientific investigation, including intellectual property, plagiarism, conflict of interest, human and animal subjects, record keeping, etc. Intended for Ph.D. candidates in the biomedical sciences.

# Elective Courses and Descriptions

(Please check the schedule of classes <http://www.acs.rutgers.edu:8880/soc> for availability)

## **16:148:519 CELLULAR AND GENETIC MECHANISMS (Fall)**

Beginning with a consideration of basic cellular constituents and cell and tissue types, this course reviews cellular processes in the cytoplasm, cell and organellar membranes and the nucleus. Uses of recombinant DNA technology in investigating gene structure and function and in diagnosing genetic diseases complement examination of inheritance patterns in humans and review of genetic loci that underlie human disease.

## **16:148:530 HUMAN GENETICS (Fall)**

*Prerequisite: By Permission of Instructor*

Examination of molecular and chromosomal bases for human inherited diseases. Molecular approaches to gene identification, including position cloning and linkage analysis. Role of mutations, evaluation of repetitive sequences in the human genome.

## **16:148:550 ADVANCED DEVELOPMENTAL BIOLOGY (Spring)**

Molecular mechanisms of cell type differentiation and body part specification. Cell-cell interaction, signal transduction during development, morphogenetic gradients, pattern formation, focusing on three experimental organisms: the nematode *C. elegans*, *Drosophila*, and the mouse. Genetic experimental approaches will be emphasized.

## **16:148:556 SYSTEMS HISTOLOGY (Spring)**

*Prerequisite: 16:148:519; By Permission of Instructor*

Analysis of the microscopic structure of the cells making up the tissues and organs of the body provides a foundational knowledge for future studies in the area of histopathology. In addition to normal histological structure, the course exposes students to relevant histopathologies, which illustrate changes in normal architecture produced by diseases.

## **16:148:565 GROSS AND DEVELOPMENTAL ANATOMY (Fall)**

*Prerequisite: Permission of instructor; class begins mid-August*

Study of macroscopic structure of the human body by dissection and other methods with reference to functional mechanisms and changes during development and clinical correlations.

## **16:150:532 KINETICS OF MATERIALS SYSTEMS (Spring)**

Diffusion in solids. Solutions to Fick's first and second laws under important boundary conditions. Ionic diffusion. Diffusion applied to sintering. Solid-state reaction kinetics. Nucleation, crystal growth, and precipitation.

## **16:155:501 ADVANCED TRANSPORT PHENOMENA I (Fall)**

Momentum transport processes in laminar and turbulent flow systems. Development and application of steady and unsteady boundary layer processes including growth, similitude principles, and separation. Potential flow theory coupled with viscous dissipation at boundaries. Momentum transport in fixed and fluid bed exchangers and reactors.

## **16:155:502 ADVANCED TRANSPORT PHENOMENA II (Spring)**

Energy balances derived from first and second law approaches to open systems, with reaction. Conduction in fluids and solids, both steady and unsteady examples. Convection in laminar and turbulent flow systems. Diffusion and its treatment in stagnant and flowing media. Two phase systems, coupled reaction and mass transfer. Interphase transport.

## **116:155:514 KINETICS, CATALYSIS, AND REACTOR DESIGN (Spring)**

*Prerequisites: 16:155:501 and 507, or equivalent.*

Principles of applied chemical kinetics, reaction mechanisms and rate laws, and engineering design of reactor vessels. Applications to homogeneous and heterogeneous process reaction systems with internal, transphase, and external mass transfer. Noncatalytic gas-solid reaction and gas-liquid absorption with reaction. Micromixing and macromixing in reactor systems.

## **16:155:531 BIOCHEMICAL ENGINEERING (Spring)**

Integration of the principles of chemical engineering, biochemistry, and microbiology. Development and application of biochemical engineering principles. Analysis of biochemical and microbial reactions.

## **16:155:541 PHARMACEUTICAL MATERIALS ENGINEERING (Fall)**

Introduction to pharmaceutical materials and its application to designing and manufacturing drug products. Focus is on materials encountered in the pharmaceutical industry and how the materials affect processes they are used in. The course focuses on the choice of materials, troubleshooting and optimization.

**16:155:551 POLYMER SCIENCE AND ENGINEERING I (Spring)**

Physical and chemical structure of polymers; morphology of polymer crystals; microscopic texture. Mechanical properties; influence of orientation; effects of temperature and environment; engineering applications.

**16:155:552 POLYMER SCIENCE AND ENGINEERING II (Fall)**

Emphasis on a modern treatment of polymers, including statistical mechanics scaling concepts and polymer properties and characterization.

**16:155:588 SPECIAL TOPICS: FUNDAMENTALS OF NANOSCALE THERMODYNAMICS (Fall)**

Covers the theoretical and multiscale simulation methods which bridge macroscopic thermodynamics and continuum transport theories with atomistic quantum mechanics and molecular dynamics

**16:160:537 BIOPHYSICAL CHEMISTRY I (Fall)**

Introduction to the physical chemistry of proteins, nucleic acids, and their complexes. Forces that determine biopolymer structure. Principles of protein and nucleic acid structure. Transitions and interactions of biopolymers.

**16:198:503 COMPUTATIONAL THINK (Fall)**

Intended for students who have not had undergraduate preparation in the subject. May not be taken for credit toward a graduate degree in computer science. Models of computation and complexity. Sorting, stacks, queues, linked lists, trees, search trees, hashing, heaps, graphs, and graph algorithms.

**16:198:510 NUMERICAL ANALYSIS (Fall)**

Derivation, analysis, and application of methods used to solve numerical problems with computers; solution of equations by iteration, approximation of functions, differentiation and quadrature, differential equations, linear equations and matrices, least squares.

**16:198:535 PATTERN RECOGNITION THEORY AND APPLICATIONS (Fall)**

Pattern recognition as an inductive process, statistical classification, parametric and nonparametric methods, adaptive methods, error estimation, applications in image processing, character, speech recognition, and diagnostic decision making.

**16:198:580 TOPICS IN COMPUTERS IN BIOMEDICINE (Fall)**

*Prerequisite: 16:198:513 or 520*

A survey of computational methods in biology or medicine; topics vary from instructor to instructor and may include computational molecular biology, medical reasoning, and imaging.

**16:332:521 DIGITAL SIGNALS AND FILTERS (Fall)**

*Corequisite: 16:332:501*

Sampling and quantization of analog signals; z-transforms; digital filter structures and hardware realizations; digital filter design methods; DFT and FFT methods and their application to fast convolution and spectrum estimation; introduction to discrete-time random signals.

**16:332:527 DIGITAL SPEECH PROCESSING (Fall)**

Acoustics of speech generation; perceptual criteria for digital representation of audio signals; signal processing methods for speech analysis; waveform coders; vocoders; linear prediction; differential coders (DPCM, delta modulation); speech synthesis; automatic speech recognition; voice-interactive information systems.

**16:332:583 SEMICONDUCTOR DEVICES I (Fall)**

Charge transport, diffusion and drift current, injection, lifetime, recombination, and generation processes, p-n junction devices, transient behavior, FET's, I-V, and frequency characteristics, MOS devices C-V, C-f, and I-V characteristics, operation of bipolar transistors.

**16:332:584 SEMICONDUCTOR DEVICES II (Spring)**

Review of microwave devices, O- and M-type devices, microwave diodes, Gunn, IMPATT, TRAPATT, etc., scattering parameters and microwave amplifiers, heterostructures and III-V compound-based BJTs and FETs.

**16:332:591 OPTOELECTRONICS I (Fall)**

Principles of laser action, efficiency, CW and pulse operation, mode locking, output coupling, equivalent circuits, gaseous and molecular lasers, solid-state lasers, single and double heterojunction lasers, different geometrics, fabrication, degradation, and application to holography, communication, medicine, and fusion.

**16:642:573, 574 NUMERICAL ANALYSIS (Fall/Spring)**

Ideas and techniques of numerical analysis illustrated by problems in the approximation of functions, numerical solution of linear and nonlinear systems of equations, approximation of matrix eigen-values and eigenvectors, numerical quadrature, and numerical solution of ordinary differential equations.

**16:650:512 ROBOTICS AND MECHATRONICS (Fall)**

*Prerequisites: Undergraduate vibrations, controls, and design of mechanisms.*

Introduction to robotics, including mechanisms and control theories as well as applications; manipulator mechanics; design considerations; control fundamentals; adaptive and sensory controls; algorithm development; robotic assembly techniques.

**16:650:518 BIOMECHANICAL SYSTEMS (Spring)**

Selected topics from the study of the human body as a mechanical system, with emphasis on modeling, analysis, and design. Investigation of biomechanical systems frequently encountered in orthopedic surgery and physical rehabilitation.

**16:650:606 MICROFLUIDIC AND NANOFUIDIC SYSTEMS (Fall)**

Understand the major categories, tools, components and applications of microfluidic and nanofluidic systems. Microfabrication, physicochemical description of hydrodynamics, low Reynolds number flows and other phenomena will be discussed.

**16:681:502 MOLECULAR GENETICS (Spring)**

*Prerequisites: 16:115:501 and 502.*

Prokaryotic and eukaryotic molecular genetics. Bacteria, bacterio-phage, yeast, Drosophila, and mammals.

**16:681:530 INTRODUCTION TO MOLECULAR MEDICINE (Spring)**

Application of molecular and cell biology to a wide variety of human diseases; recent advances in understanding basic mechanisms.

**16:681:543 CURRENT CONCEPTS OF IMMUNOLOGY (Spring)**

Cellular basis of immunology; analysis, activation, and function of lymphoid cells; regulatory mechanisms, relevance to tumor and transplantation immunity.

**16:681:555 MOLECULAR VIROLOGY (Spring)**

*Prerequisite: 16:681:501 and 502 or permission of instructor*

Detailed consideration of fundamental physical-chemical properties, schemes of classification, genetics, and modes of replication of selected animal viruses.

**16:681:585 CANCER MOLECULAR BIOLOGY (Spring)**

Emphasis on the molecular, cellular, and genetic basis for cancer. Oncogenes and tumor suppressor genes. Signal transduction and cell cycle control in cancer cells. Metastasis. Diagnosis and therapy. Recent understanding of the molecular basis of selected human cancers. Lectures and critical discussion of the current literature.

**16:761:513 CARDIOVASCULAR PHYSIOLOGY (Spring)**

Comprehensive study of the cardiovascular system in mammals. Special consideration given to coronary circulation, myocardial-oxygen consumption, and cardiac arrhythmias.

**16:761:515 MEDICAL PHYSIOLOGY (Spring)**

*Prerequisite: Starts in early January*

Study of human physiology from the molecular to the systems level. Emphasis is on the integration of the systems within the healthy individual. Teaching modalities include lectures, small discussion groups, and laboratories in pulmonary and cardiovascular physiology.

**16:960:584 BIOSTATISTICS I (Fall)**

Statistical techniques for biomedical data. Analysis of observational studies emphasized. Topics include measures of disease frequency and association; inferences for dichotomous and grouped case-control data; logistic regression for identification of risk factors; Poisson models for grouped data; Cox model for continuous data; life table analysis; and SAS used in analysis of data.

**16:960:585 BIOSTATISTICS II (Spring)**

Statistical techniques used in design and analysis of controlled clinical experiments. Topics include introduction to four phases of clinical trials; randomization, blocking, stratification, balancing, power, and sample-size calculation; data monitoring and interim analyses; baseline covariate adjustment; crossover trials; brief introduction to categorical and event-time data; and SAS used in analysis of data.

# Industrial Interactions

Rutgers is located in central New Jersey, which is the worldwide epicenter of pharmaceutical and biotechnology research, and has been termed “the Medicine Chest of the World”. In 2005 more than half of the new drugs approved by the FDA were produced in New Jersey. The proximity of Rutgers to a rich variety of pharmaceutical, medical device, biotechnology and affiliated industries uniquely positions the Department of Biomedical Engineering to train students who are expertly prepared for dynamic careers in numerous areas at the forefront of modern Science and Engineering.

To facilitate the transition from the university to the workplace, the Department has dedicated several custom-designed programs to strengthen existing ties to local industry while at the same time forging new relationships, both of which will translate into invaluable opportunities for BME students.

## **Industrial Internship Program**

The Biomedical Engineering Industrial Internship Program, or BEIIP, provides support to students seeking summer internships and to companies seeking Rutgers University BME graduate and undergraduate students seeking internships, to establish a mutually beneficial internship experience. These internships can be: research oriented (academic) or more applied (practical) in nature; highly selective or more liberal in the selection process; highly structured or very flexible in terms of the program; paid or unpaid

All internships are guided – the students are assigned a mentor by the industrial partner and the BEIIP follows progress of the intern periodically throughout the summer session. Finally, evaluation reports are completed, student resumes updated, and programs improved for future student candidates. <http://biomedical.rutgers.edu/internships/>

## **Industrial Seminar Series**

Leading members of the industrial community are invited to speak to students about real-life experiences in industry during the fall and spring seminar series. Students are encouraged to meet with the speakers for more informal and in-depth discussions.

## **Annual Senior Design Conference with Career Fair**

Each year, the undergraduate BME Seniors present their final research projects at the Annual Senior Design Conference. In conjunction with a BME Industrial Relations Program, this conference provides students with career as well as scientific exposure. All students are invited to attend the fair, and to bring resumes to distribute to the numerous companies present.

## **Annual Biomedical Engineering Showcase**

In March 2010, the annual Biomedical Engineering Showcase will be sponsored by Rutgers University with collaboration with New Jersey Institute of Technology. Over 350 students, faculty and industry representatives participate in this showcase. Each year’s Showcase has a central theme and the goal is to foster interactions between universities with BME programs, and local industry. Students are encouraged to network, and those engaged in research projects present posters at the event.

# BME Graduate Faculty

## **BME Department Faculty**

Y. Androulakis  
F. Berthiaume  
N. Boustany  
H. Buettner  
L. Cai  
W. Craelius  
G. Drzewiecki  
S. Kim  
N. Langrana  
J. Li  
A. Madabhushi  
A. Mann  
E. Micheli-Tzanakou  
P. Moghe  
T. Papathomas  
C. Roth  
J. Semmlow  
T. Shinbrot  
G. Shoane  
D. Shreiber  
M. Yarmush  
J. Zahn

## **Rutgers Faculty**

H. Berman  
D. Denhardt  
R. Ebright  
B. Firestein  
M. Grumet  
C. Kalodimos  
J. Kohn  
E. Kowler  
C. Kulikowski  
K. Lee  
D. Metaxas  
B. Michniak-Kohn  
S. Murthy  
W. Olson  
M. Plummer  
A. Shatkin  
P. Sinko  
J. Tischfield  
K. Urich  
W. Young

## **Engineering Faculty**

G. Amatucci  
J. Bernstein  
G. Burdea  
B. Coleman  
S. Danforth  
Z. Guo  
M. Ierapetritou  
J. Khinast  
D. Knight  
Y. Lu  
F. Muzzio  
R. Riman  
J. Scheinbeim  
M. Tomassone

## **UMDNJ Faculty**

M. Dunn  
S. England  
D. Foran  
R. Foty  
S. Ganesan  
C. Gatt  
P. Georgopoulos  
R. Lehman  
M. Lewis  
J. Ma  
G. Nackman  
J. Neubauer  
R. Nowakowski  
P. O'Connor  
R. Parsons  
N. Partridge  
F. Ramirez  
F. Silver  
H. Weiss  
P. Yim

## **Industry**

H. Alexander  
J. Ricci  
C. Glass

# BME Faculty By Research Thrusts

## BIOMATERIALS AND TISSUE ENGINEERING

H. Alexander	D. Knight	P. O'Connor	P. Sinko
F. Berthiaume	A. Mann	R. Parsons	K. Uhrich
H. Buettner	B. Michniak-Kohn	R. Riman	M. Yarmush
M. Dunn	P. Moghe	C. Roth	D. Zhang
R. Foty	S. Murthy	D. Shreiber	M. Zimmerman
J. Kohn	G. Nackman	F. Silver	

## BIOMECHANICS AND REHABILITATION ENGINEERING

H. Alexander	M. Dunn	R. Parsons	D. Zhang
G. Burdea	C. Gatt	D. Shreiber	M. Zimmerman
B. Coleman	N. Langrana	F. Silver	
W. Craelius	P. O'Connor	W. Young	

## COMPUTATIONAL BIOENGINEERING AND BIOMEDICAL IMAGING

I. Androulakis	D. Foran	C. Kulikowski	W. Olson
H. Berman	S. Ganesan	M. Lewis	T. Papatomas
N. Boustany	P. Georgeopoulos	J. Ma	J. Semmlow
G. Burdea	Z. Guo	R. Mammone	T. Shinbrot
L. Cai	M. Ierapetritou	A. Madabhushi	G. Shoane
B. Coleman	C. Kalodimos	D. Metaxas	M. Tommasone
	J. Khinast	E. Micheli-Tzanakou	J. Wilder
	E. Kowler	F. Muzzio	

## MOLECULAR CELLULAR AND NANOSYSTEMS BIOENGINEERING

F. Berthiaume	R. Ebright	K. Lee	J. Tischfield
H. Buettner	B. Firestein	A. Mann	K. Uhrich
B. Coleman	M. Grumet	P. Moghe	M. Yarmush
S. Danforth	C. Kalodimos	F. Ramirez	J. Zahn
D. Denhardt	S. Kim	R. Riman	
	C. Kulikowski	C. Roth	

## NEUROENGINEERING

L. Cai	B. Firestein	J. Semmlow	W. Young
W. Craelius	E. Micheli-Tzanakou	M. Plummer	

## PHYSIOLOGICAL SYSTEMS AND BIOINSTRUMENTATION

G. Burdea	N. Langrana	N. Partridge	E. M-Tzanakou
W. Craelius	R. Lehman	J. Scheinbeim	H. Weiss
G. Drzewiecki	J. Li	J. Semmlow	Y. Lu
S. England	J. Neubauer	G. Shoane	J. Zahn

# BME GRADUATE FACULTY INFORMATION

## **HAROLD ALEXANDER**

Ph.D., New York University  
President

Orthogen Biomaterials Division; BioLok International, Inc.

Phone: 973 467-2404

Fax: 973 467-1218

E-mail: [halexander@orthogencorp.com](mailto:halexander@orthogencorp.com)

Web: [www.orthogencorp.com](http://www.orthogencorp.com)

505 Morris Avenue

Suite 104

Springfield, NJ 07081

### *Tissue Engineering*

I study the response of bone and soft tissue to orthopaedic and dental implants that utilize a new type of laser microtextured surface based on tissue engineering principles, designed to enhance bone fixation by controlling cell attachment, spreading, orientation, and growth at the implant interface. I am also involved in the design, fabrication and testing of a new type of transcaneous implant with tissue-specific laser microtextured regions designed to interface with bone and soft tissue.

## **IOANNIS P. ANDROULAKIS**

Ph.D., University: Purdue University  
Associate Professor

Biomedical Engineering Department  
Chemical & Biochemical Engineering Department

Phone: 732-445-4500 X6212

Fax: 732-445-3753

E-mail: [yannis@rci.rutgers.edu](mailto:yannis@rci.rutgers.edu)

599 Taylor Road

Room 212

Piscataway, NJ 08854

### *Systems-based Approaches for Analyzing Complex Biological and Chemical Systems*

Research in our lab aims at developing systems-based approaches for analyzing complex biological and chemical systems. Our main thrust is the development of novel computational algorithms for upgrading the information content of massive amounts of data (either computational or experimental), thus enabling the translation of observations into interpretable and testable hypotheses. Of particular interest are biological systems, with emphasis on the analysis of microarray experiments and molecular dynamics simulations, and large chemical reaction systems, such as those describing combustion phenomena. Our research is at the interface of chemistry, biology, and computational sciences merging fundamental calculations, experiments and recent advances in modeling, optimization and systems analysis.

## **HELEN M. BERMAN**

Ph.D., University of Pittsburgh  
Professor

Department of Chemistry

Phone: 732-445-4667

Fax: 732-445-4320

E-mail: [berman@rcsb.rutgers.edu](mailto:berman@rcsb.rutgers.edu)

610 Taylor Road

Piscataway, NJ 08854

### *Bioinformatics, genomics, proteomics, biophysics*

Our goal is to understand the structural properties of biological molecules and to relate these structures to their biological functions. Our work on nucleic acids has focused on the effects of base modification of the structure and on the interrelationships of hydration structure, crystal packing, and conformation. Our studies of DNA-protein complexes will help to elucidate the principles that underlie interactions between these macromolecules. Studies on collagen peptides have allowed us to define the structure of the triple helix at atomic resolution and to understand the role of water in mediating intermolecular interactions.

## **FRANCOIS BERTHIAUME**

Ph.D., Penn State  
Associate Professor  
Department of Biomedical Engineering

Phone: 732-445-4500 X6217  
Fax: 732-445-3753  
E-mail: [fbertthia@rci.rutgers.edu](mailto:fbertthia@rci.rutgers.edu)

599 Taylor Road  
Room 217  
Piscataway, NJ 08854

*Tissue, stem cell and metabolic engineering for tissue regeneration*

My major research areas are in metabolic and tissue engineering. We use various animal models and organ perfusion techniques in conjunction with systems-based models to capture the metabolic derangements that accompany certain diseases. We also apply these tools to alter the metabolic state of donor organs that were rejected from the donor pool so that they can be made suitable for transplantation. We are also interested to develop techniques that promote the recruitment of stem cells to damaged or injured tissues to improve wound healing and reduce scarring.

## **NADA N. BOUSTANY**

Ph.D., MIT  
Assistant Professor  
Department of Biomedical Engineering

Phone: 732-445-4500 X6320  
Fax: 732-445-3753  
E-mail: [nboustan@rci.rutgers.edu](mailto:nboustan@rci.rutgers.edu)

599 Taylor Road  
Room 320  
Piscataway, NJ 08854

*Cell analysis, optical microscopy and spectroscopy, apoptosis, cancer, subcellular structure and dynamics*

Our research is focused on developing novel, minimally invasive optical imaging technology to track signaling pathways and analyze the function of genes within living cells. Our work lies at the interface of optics and cell biology and combines instrumentation design, microscopy, tissue culture, genetic manipulation, and numerical simulation of optical phenomena, such as light scattering by cells and organelles. We are currently engaged in defining optical parameters that characterize mitochondrial morphological alterations during cell death. One of our long-term goals is to understand the relationship between gene expression and subcellular structure and dynamics during cell death and early cancer development.

## **HELEN M. BUETTNER**

Ph.D., University of Pennsylvania  
Professor  
Department of Biomedical Engineering

Phone: 732-445-4500 X6318  
Fax: 732-445-3753  
E-mail: [buettner@sol.rutgers.edu](mailto:buettner@sol.rutgers.edu)

599 Taylor Road  
Room 318  
Piscataway, NJ 08854

*Mechanisms of effect of acupuncture, cellular and tissue engineering, nerve growth and regeneration, modeling of biological processes*

Our primary research emphasis is on the application of engineering principles to understand and solve fundamental problems in cell biology. We are currently looking at mechanisms by which acupuncture exerts its therapeutic effect. Recent experimental evidence for the biological mechanisms underlying acupuncture has shown that acupuncture needle insertion and manipulation causes subcutaneous connective tissue fibrils to wind around the needle. The mechanical coupling between fibrils and needle enables force transmission to the connective tissue. We are using three-dimensional, in vitro connective tissue equivalents to study the transduction of these forces into effects on cellular and tissue function. We are also investigating the use of acupuncture-like needling to manipulate cell and tissue behavior in engineered tissue constructs, with a focus on grafts for nerve regeneration. Finally, we are interested in the fundamental mechanisms by which axonal growth and regeneration occurs in the complex environment of the nervous system. Our basic approach combines experimental investigation with mathematical models. Experimental data is examined to suggest theoretical models for the interactions of a cell with its environment based on first principles of mass transport, reaction kinetics, thermodynamics, and fluid mechanics. Results from the models drive further experimental work. This interplay between experiments and theory provides a systematic means of addressing questions of critical importance concerning structure-function relationships in the nervous system.

## **GRIGORE C. BURDEA**

Ph.D., New York University  
Professor

Department of Electrical and Computer Engineering

Phone: 732-445-5309  
Fax: 732-445-4775  
E-mail: [burdea@caip.rutgers.edu](mailto:burdea@caip.rutgers.edu)

CoRE Building, Room 721  
96 Frelinghuysen Road  
Piscataway, NJ 08854

### *Virtual reality, telerehabilitation*

Our research program employs virtual reality as a means of physical therapy and rehabilitation. We design systems that simultaneously provide physical therapy, entertain the patient, and allow doctors to monitor the patient's progress through measurements transmitted to a remote location. Virtual reality investigations of patients with neuromotor disorders should also serve as a very useful tool for understanding the nature of the disorders and for clinical diagnosis of diseases which affect the motor systems of the brain.

## **LI CAI**

Ph.D., Rutgers University  
UMDNJ – Robert Wood Johnson Medical School  
Assistant Professor  
Department of Biomedical Engineering

Phone: 732 445-4500 X6208  
Fax: 732 445-3753  
E-mail: [lcai@rutgers.edu](mailto:lcai@rutgers.edu)

599 Taylor Road  
Room 208  
Piscataway, NJ 08854

### *Neural Stem Cell Bioengineering*

Neural stem cells give rise to all of the different cell types in the mature nervous system. How these stem cells differentiate into variety functional neurons is a major issue for modern developmental neuroscience/stem cell biology. The Cai lab focuses on photoreceptors in the vertebrate retina, a tractable model for the rest of the central nervous system that is easily accessible to experimental manipulation. Photoreceptors are specialized type of neurons that are highly sensitive to light, and are essential for vision. They are also most vulnerable to degeneration. Many genetic lesions that lead to their degeneration can cause blindness. Therefore, the study of photoreceptor development from neural stem cells is of great clinical importance. The generation of functioning photoreceptors requires that the appropriate genes are expressed in a precise temporal and spatial fashion. We are using both computational and molecular genetic approaches to elucidate the genetic mechanism that regulates retina development. A thorough understanding of the mechanism will provide a basis for the development of therapeutic treatments for diseases ranging from retinal degeneration and Parkinson's disease to heart failure and spinal cord injury. Current projects:

1. Computational prediction of genetic regulators for gene expression.
2. Experimental verification and characterization of the predicted regulators.
3. Analysis of transcription/gene regulatory networks.

## **BERNARD D. COLEMAN**

Ph.D., Yale University  
W. Gibbs Professor  
Department of Biomedical Engineering

Phone: 732-445-5558  
Fax: 732-445-0085  
E-mail: [bcoleman@jove.rutgers.edu](mailto:bcoleman@jove.rutgers.edu)

98 Brett Road  
Piscataway, NJ 08854

### *Continuum mechanics, thermodynamics, biophysics*

We investigate the physical basis for biological phenomena using mechanical and thermodynamic modeling. Our current interests involve topics in molecular biology, such as DNA topology, and elastic rod model of DNA flexibility and stability, and DNA-protein interactions.

## **WILLIAM CRAELIUS**

Ph.D., Northwestern University  
Professor  
Department of Biomedical Engineering

Phone: 732-445-2369  
Fax: 732-445-3753  
E-mail: craelius@rci.rutgers.edu

98 Brett Road  
Room EN C110  
Piscataway, NJ 08854

*Membrane biophysics, cellular mechano-electric systems, prosthetics, rehabilitation engineering*

We study mechano-electrical feedback in biological systems from the molecular to the organ system level. At the cellular and molecular level, we are investigating mechanically-activated ion channels as potential mediators of electrical currents that may modulate cellular growth in the heart. We are also developing a means of quantifying the mechano-regulatory response of cells to changes in osmolarity. At the macroscopic level, we have developed a multi-finger robotic hand to aid in restoring reduced limb function.

## **STEPHEN C. DANFORTH**

Ph.D., Brown University  
Professor  
Department of Ceramics and Materials Engineering

Phone: 732-445-2211  
Fax: 732-445-5595  
E-mail: danforth@rci.rutgers.edu

607 Taylor Road  
Piscataway, NJ 08854

*Powder processing science for advanced structural and functional ceramics, rapid prototyping, nano-sized powders*

Our primary biomedical research involves the use of solid free-form fabrication methods in the design of hard tissue implants such as hydroxyapatite as well as other tissue engineering applications. This technique is able to create three dimensional objects with irregular geometry by a layering technique.

## **DAVID T. DENHARDT**

Ph.D., Caltech  
Professor  
Department of Cell Biology and Neuroscience

Phone: 732-445-4564  
Fax: 732-445-0104  
E-mail: denhardt@biology.rutgers.edu

604 Allison Road  
Piscataway, NJ 08854

*Cell Mediated Immunity; Bone Remodeling*

A major research goal of our laboratory is to elucidate the role of osteopontin (OPN) in mammalian physiology. This secreted cytokine, which confers metastatic ability on many transformed cell lines, perhaps by inhibiting apoptosis, is also a matrix protein in bone. OPN-deficient(knock-out) mice have defects in cell-mediated immunity and in stress-induced bone remodeling. Ongoing projects include studies on the different structural forms of OPN, the result of post-translational modifications, and the signaling pathways OPN activates downstream of its receptors, which includes certain integrins and CD44 variants. We are characterizing a set of anti-OPN monoclonal antibodies to assess their potential as functional inhibitors of OPN. Studies on the systems physiology of tissue inhibitor of metalloproteinases are also underway.

## **GARY DRZEWIECKI**

Ph.D., University of Pennsylvania  
Professor  
Department of Biomedical Engineering

Phone: 732-445-4500 X6304  
Fax: 732-445-3753  
E-mail: drzewiec@biomed.rutgers.edu

599 Taylor Road  
Room 304  
Piscataway, NJ 08854

### *Cardiovascular mechanics and dynamics*

Current research examines the growth patterns of the left ventricle and cardiac failure. Research looks at the mechanisms behind ventricular shape changes in response to external loading. Also examined is blood flow in collapsible vessels using nonlinear fluid dynamics.

## **MICHAEL G. DUNN**

Ph.D., Rutgers University  
Associate Professor  
UMDNJ: Orthopedics

Phone: 732-235-7972  
Fax: 732-235-6002  
E-mail: dunnmg@umdnj.edu

Medical Education Building 428  
1 Robert Wood Johnson Place  
New Brunswick, NJ 08903

### *Orthopaedics, biomaterials, biomechanics, tissue engineering, collagen*

Our primary focus is tissue engineering for regeneration of musculoskeletal soft tissues such as tendon, ligament, and meniscus. One goal is to develop collagen, synthetic, and hybrid resorbable scaffolds with functional mechanical properties to reconstruct the bulk tissue. We also use these scaffolds as delivery vehicles for genes, growth factors, or living cells in our efforts to regenerate soft tissue. A second focus is on decellularization and sterilization of musculoskeletal allograft tissue. Finally, we are involved in osteoinduction studies using demineralized bone matrix in combination with various carriers.

## **RICHARD H. EBRIGHT**

Ph.D., Harvard University  
Professor  
Department of Chemistry and Chemical Biology

Phone: 732-445-5179  
Fax: 732-445-5735  
E-mail: ebright@waksman.rutgers.edu

Waksman Institute Of Microbiology  
190 Frelinghuysen Road  
Piscataway, NJ 08854

### *Structural biophysics, gene transcription*

Our group is interested in the first step in gene expression: i.e., transcription. Our objectives are: (i) to understand the structure, function, and regulation of transcription complexes, and (ii) to identify and characterize small-molecule inhibitors of bacterial transcription for use as antibacterial agents.

## **SANDRA J. ENGLAND**

Ph.D., Dartmouth University  
UMDNJ: Pediatrics

Phone: 732-235-6188  
Fax: 732-235-6890  
E-mail: englansj@umdnj.edu

Medical Education Building  
1 Robert Wood Johnson Place  
New Brunswick, NJ 08854

### *Pediatric Sleep Medicine; Respiratory Control Mechanisms*

Our research focuses on sleep disorders in children such as sleep apnea and Periodic Limb Movements in sleep. The research is based in the clinical sleep laboratory at Robert Wood Johnson University Hospital. We are presently studying the effects of comorbidities such as renal disease, Attention Deficit Disorder, and autism on sleep in children.

## **BONNIE L. FIRESTEIN**

Ph.D., University of California  
Associate Professor  
Department of Cell Biology and Neuroscience

Phone: 732-445-8045  
Fax: 732-445-5870  
E-mail: firestein@biology.rutgers.edu

604 Allison Road  
Room D411  
Piscataway, NJ 08854

### *Dendrite branching in forebrain and spinal cord neurons*

Our research focuses on two processes that are important for proper communication to occur in the brain. The first is the mechanism underlying proper patterning of dendrites on a neuron. Since the way that a neuron receives information is determined by the branching pattern of its dendrites, understanding this process will help us to understand why disorders occur in which dendrites are patterned incorrectly. The second process that we study is how signaling molecules, such as neurotransmitter receptors and enzymes, are targeted to synaptic sites on the dendrites of neurons. Again, a number of disorders occur when there is improper targeting of these proteins in neurons.

## **DAVID FORAN**

Ph.D., Rutgers University  
Professor  
UMDNJ: Pathology

Phone: 732-235-4858  
Fax: 732-235-4825  
E-mail: djf@pleiad.umdj.edu

671 Hoes Lane  
Piscataway, NJ 08854

### *Computer Assisted Diagnoses*

Research focuses on development of new approaches in statistical pattern recognition, data fusion, and evolutionary computing for problems in computational biology, pathology and radiology. Other interests include biomedical informatics, high performance computing, and mathematical modeling.

## **RAMSEY A. FOTY**

Ph.D., U of Toronto  
Associate Professor  
UMDNJ: Surgery  
CINJ

Phone: 732-235-7482  
Fax: 732-235-6003  
E-mail: fotyra@umdj.edu

125 Patterson Street  
CAB 7319  
New Brunswick, NJ 08901

### *Self-Assembly in embryonic development and tissue engineering*

The physical forces underlying cell-cell cohesion and cell-substratum adhesion and their molecular determinants, are powerful mediators of embryonic development, cancer progression, and tissue-biomaterial interaction. Our laboratory employs a novel *in vitro* method, tissue surface tensiometry (TST), to simultaneously measure various biophysical properties of tissues including elasticity (a measure of a tissue's ability to deform in response to an applied stress), viscosity (an indication of cellular motility within a tissue), and cohesivity (a dynamic and complex manifestation of the binding energy between cells). Our laboratory has four major areas of interest all focusing on the application of this technology to explore fundamental issues regarding cell-cell and cell-substratum interaction in morphogenesis, cancer progression and tissue engineering. Ongoing projects in the lab include (1) application of TST to study the biophysical, cellular and molecular changes accompanying the transition of prostate cancer from androgen dependence to androgen independence; (2) development of a novel *in vitro* liquid miscibility assay to explore endothelial cell-tumor cell interaction in bone-specific metastasis of prostate cancer; (3) assessment of whether tumor physical properties are predictive of aggressiveness in brain cancer; (4) exploring the molecular and biophysical basis of self-assembly in pancreatic islets. We have also established a collaboration with the laboratory of Dr. Siobhan Corbett to study the contribution of integrin-fibronectin interaction in mediating strong cell-cell cohesion of three-dimensional cellular aggregates in normal and malignant tissues.

## SHRIDAR GANESAN

Ph.D., Yale  
Assistant Professor  
UMDNJ: Medicine and Pharmacology  
CINJ

Phone: 732-235-5211  
Fax: 732-235-5331  
E-mail: [ganesash@umdnj.edu](mailto:ganesash@umdnj.edu)

195 Little Albany Street  
CINJ 3554  
New Brunswick, NJ 08901

### *Biology of breast cancer subtypes*

Our laboratory is focused on identifying clinically relevant molecular subtypes of breast cancer. One area of interest is the analysis of multimodal data sets that include gene expression data, histological images and radiographic images of individual tumors to build robust classifiers. The overall hypothesis is that distinct classes of breast cancer will have unique combinations of histologic, radiographic and gene-expression based signatures that can be used for clinical classification, prognostication and development of targeted therapy. Our laboratory collaborates extensively with the Madabhushi laboratory and the Bhanot laboratory in this project.

## CHARLES J. GATT

M.D., UMDNJ  
Professor  
Department of Orthopaedic Surgery

Phone: 732-545-0400  
Fax: 732-445-4011  
E-mail: [gattcj@umdnj.edu](mailto:gattcj@umdnj.edu)

215 Easton Avenue  
New Brunswick, NJ 08901

### *Sports Medicine*

Knee arthroscopy with local anesthesia; Cartilage transplant; Hip arthroscopy; Shoulder arthroscopy; Adolescent sports medicine; Pediatric sports medicine. Dr. Gatt is interested in Tissue engineering for meniscus replacement and Enhancements of allografts for knee ligament reconstruction.

## PANOS GEORGOPOULOS

Ph.D., Caltech  
Associate Professor  
UMDNJ: Environmental and Community Medicine

Phone: 732-445-0159  
Fax: 732-445-0116  
E-mail: [panosg@fidlio.rutgers.edu](mailto:panosg@fidlio.rutgers.edu)

EOHSI  
681 Frelinghuysen Road  
Piscataway, NJ 08855

### *Computational chemodynamics, thermodynamics,*

My research group applies chemical engineering concepts and methods of transport phenomena, thermodynamics, and chemical kinetics/reactor design, in combination with state-of-the-art numerical analysis and programming tools, to develop computational models of complex environmental and biological systems. The products of this research are utilized in a variety of industrial, environmental, and medical applications that involve the interfacing of chemical engineering with the evolving disciplines of health, ecological, risk and information engineering.

## **MARTIN GRUMET**

Ph.D., Johns Hopkins University  
Professor  
Department of Cell Biology and Neuroscience

Phone: 763-445-6577

Fax: 732-445-2063

E-mail: mgrumet@rci.rutgers.edu

604 Allison Road

Piscataway, NJ 08854

### *Molecular Mechanisms of Cell Adhesion*

The major focus of our laboratory is to study cell adhesion, a fundamental process that is critical for embryo development and maintenance of mature tissues. Cell adhesion molecules (CAMs) are anchored in the surface of cells and can link cells to adjacent cells and to the extracellular scaffold that surrounds cells by binding to specific receptors. In the nervous system, CAMs are important for cell adhesion as well as cell migration; both processes are critical for the formation of intricate neural networks that mediate higher brain function. Our experiments are providing a better understanding of the function of CAMs and they have implications for the design of new strategies to repair damage to the nervous system.

## **ZHIXIONG (JAMES) GUO**

Ph.D., Polytechnic University, Brooklyn, NY  
Associate Professor  
Department of Mechanical and Aerospace Engineering

Phone: 732-445-2024

Fax: 732-445-3124

E-mail: guo@jove.rutgers.edu

98 Brett Road

Piscataway, NJ 08854

### *Thermodynamics, Biomedical applications of laser technology*

My research involves different applications of lasers to biomedical problems. We are especially interested in biomolecular sensing, laser tissue treatment and recovery, bioheat transfer, biomedical imaging techniques and laser-biomaterial interactions. Our research has many intriguing possibilities for designing new surgical instruments employing lasers and for exploring innovative cellular and molecular imaging tools.

## **MARIANTHI IERAPETRITOU**

Ph.D., Imperial College  
Associate Professor

Phone: 732-445-2971

Fax: 732-445-2421

E-mail: Marianthi@sol.rutgers.edu

98 Brett Road

Piscataway, NJ 08854

### *Process operations involving scheduling, planning and supply-chain management comprising of deterministic and stochastic approaches*

We have developed a novel continuous time model for the short-term scheduling of batch and continuous plants which has outperformed all other existing models. This is the result of achieving an orders of magnitude reduction of the computational requirements of the solution procedure, thus enabling the optimization of large-scale problems. Our recent work addresses the limitations of this earlier approach by devising a decomposition-based methodology using the fundamental ideas of Lagrangean decomposition. This approach makes feasible the solution of the integrated planning and scheduling problem which has been a subject of increasing interest over the last decade. To move the boundaries from scheduling to planning and achieve the integration of these different time scales problems, we recently suggested a new iterative methodology based on hierarchical decision making structure where at the planning level the timing constraints are only considered through a single parameter value that is updated in the scheduling level to achieve convergence.

## **CHARALAMPOS (BABIS) KALODIMOS**

Ph.D., Inst Curie, Paris & U of Ioannina, Greece  
Assistant Professor  
Department of Chemistry and Chemical Biology  
Department of Biomedical Engineering

Phone: 732-445-4500 X6209  
Fax: 732-445-3753  
E-mail: [babis@rutgers.edu](mailto:babis@rutgers.edu)

599 Taylor Road  
Room 209  
Piscataway, NJ 08854

*Structural Biology, Protein trafficking, Cell signaling, Gene population*

The main research interests of the lab have been focused on the elucidation of the molecular and mechanistic basis of a wide range of important biological phenomena. Our current and future efforts are directed towards understanding how central biological processes, such as transcription regulation, protein translocation and secretion, cell signaling, and protein folding take place. A detailed characterization of biomolecular interactions necessarily involves investigation of the inter-relationship between function, structure, dynamics, kinetics and energetics of a system. Towards this challenging goal, we employ state-of-the-art NMR spectroscopy methodologies complemented by many other biochemical and biophysical techniques. NMR spectroscopy in particular is a very powerful methodology that allows the study of the three-dimensional structure of biomolecules in semi-physiological conditions. Furthermore, NMR spectroscopy can provide a unique insight into the dynamic aspects of the macromolecules and their interaction with ligands over time.

## **JOHANNES G. KHINAST**

Ph.D., Graz University of Technology  
Associate Professor  
Department of Chemical and Biochemical Engineering

Phone: 732-445-2581  
Fax: 732-445-2421  
E-mail:

98 Brett Road  
Piscataway, NJ 08854

*Reactive mass transfer at dynamic interfaces, multiphase flows, chiral catalysis, pharmaceutical engineering, catalyst manufacture, numerical analysis of large dynamical systems.*

The objective of our work is the development of novel chemical reactors and a fundamental understanding of complex chemical reaction / mass-transfer systems with an emphasis on pharmaceutical and environmental applications. Research projects usually include experimental and numerical studies.

## **SOBIN KIM**

Ph.D., Columbia University  
Assistant Professor

Departments of Biomedical and Chemical and Biochemical Engineering

Phone: 732-445-4500 X6207  
Fax: 732-445-3753  
E-mail: [sobinkim@rci.rutgers.edu](mailto:sobinkim@rci.rutgers.edu)

599 Taylor Road  
Room 207  
Piscataway, NJ 08854

*DNA sequencing, Genotyping and haplotyping, Genetic mutation detection, Mass spectrometry, Gene expression analysis, Mass spectrometry, Micro-or Nano-scale devices, disease gene discovery*

Our research is focused on developing new methods for studying nucleotide variations in the genome and on utilizing these methods in the discovery of genetic factors that are linked to common human diseases. We are currently investigating several DNA analysis systems that are based on MALDI-TOF (Matrix Assisted Laser Desorption/Ionization Time-Of-Flight) mass spectrometry. The systems allow simultaneous characterization of multiple genetic variations such as SNPs (Single Nucleotide Polymorphisms) and mutations. Furthermore, we are developing tools for rapid and specific isolation of DNA fragments to increase the throughput of DNA analysis.

## **DOYLE KNIGHT**

Ph.D., California Inst. Tech  
Professor

Department of Aerospace and Mechanical Engineering

Phone: 732-445-4454  
Fax: 732-445-3124  
E-mail: doyleknight@gmail.com

98 Brett Road  
Piscataway, NJ 08854

*Modeling bioresponse and drug binding/ release to polymeric biomaterials*

Prof. Doyle Knight is the Director of the Center for Computational Design in the School of Engineering. The Center focuses on computational analysis and design of biomaterials for biomedical research and clinical application. Recent projects include modeling protein adsorption and cellular response to polymers, and prediction of drug binding to polymeric nanoparticles. The Center operates a 48-processor Linux cluster for biomaterials research. A wide range of software is available including Autodock, DL\_POLY, Molecular Operating Environment and NAMD.

## **JOACHIM B. KOHN**

Ph.D., Weizmann Institute  
Professor

Department of Chemistry  
Director of NJ Center for Biomaterials

Phone: 732-445-0488  
Fax: 732-445-5006  
E-mail: joakohn@rutchem.rutgers.edu

145 Bevier Road  
Room 101  
Piscataway, NJ 08854

*Biomaterials, polymer synthesis, tissue engineering*

The work of this group is focused on tissue engineering and biomaterials science with a unique focus on the development of new degradable polymers. We have identified a number of new polymers that have exhibited optimal engineering and physicomechanical properties, as well as a high degree of biocompatibility. The insights gained from these studies are used to create optimized polymeric scaffolds (sponge-like implants) for tissue reconstruction and tissue engineering. Our long-term goals are to contribute to a better understanding of the interactions of polymers with living tissues and to use the knowledge gained to develop optimized polymeric implant materials for a wide range of medical applications.

## **EILEEN KOWLER**

Ph.D., University of Maryland  
Professor

Department of Psychology

Phone: 732-445-2086  
Fax: 732-445-2263  
E-mail: kowler@rci.rutgers.edu

152 Frelinghuysen Road  
Piscataway, NJ 08854

*Visual perception, attention, eye movements, planning, memory*

Visual processing of scenes requires saccadic eye movements. We study the planning and control of saccades, with emphasis on sensory inputs, the role of attention, and optimal planning strategies.

## CASIMIR KULIKOWSKI

Ph.D., University of Hawaii  
Professor  
Department of Computer Science

Phone: 732-445-2006  
Fax: 732-445-0537  
E-mail: kulikows@cs.rutgers.edu

CoRE  
110 Frelinghuysen Road  
Piscataway, NJ 08854

*Bioinformatics, neural networks, artificial intelligence*

My major areas of research are artificial intelligence, biomedical informatics, and the societal impact of computers, especially from biomedical technologies. In AI, my concentration is on expert problem solving and knowledge representation, pattern recognition, clustering, visual reasoning and image interpretation. In medical informatics I am working on models for clinical guidelines, on methods of medical decision support, biomedical imaging and predictive data mining. In bioinformatics I am working on pattern recognition and clustering methods for genomics and proteomics. On societal impact, I am investigating the effects of computer technology on medical practice, biomedical research, bioethics, and the history of technology.

## NOSHIR A. LANGRANA

Ph.D., Cornell University  
Professor  
Department of Biomedical Engineering

Phone: 732-445-4500 X6113  
Fax: 732-445-3753  
E-mail: langrana@rutgers.edu

599 Taylor Road  
Room 113  
Piscataway, NJ 08854

*Biomechanics and Rehabilitation Engineering, DNA crosslinked gel, tissue engineering*

Our laboratory currently has three major foci: (1) experimental and computational investigations of lumbar vertebral bone properties related to osteoporosis and compression fracture: (2) an experimental investigation on DNA-Polyacrylamide hybrid materials related to the development of active biological materials: and (3) Computational and Experimental study on Biomechanics of Shoulder joints during wheelchair propulsion.

## KIBUM LEE

Ph.D. Northwestern University  
Assistant Professor  
Chemistry and Chemical Biology

Phone: 732-445-2081  
Fax: 732-445-5312  
E-mail: kblee@rci.rutgers.edu

610 Taylor Road  
Piscataway, NJ 08854

*Nanobiomaterials, Biosensors, Chemical/functional Genomics*

At Rutgers, as an independent researcher, I am interested in leading an interdisciplinary research group to develop and integrate nanotechnology and chemical functional genomics to modulate signaling pathways in cells (e.g. stem cells and cancer stem cells) towards specific cell lineages and to probe biological behaviors/interactions during dynamic cell processes, such as adhesion, proliferation, differentiation and migration.

## RICHARD M. LEHMAN

M.D., Temple University  
Professor  
UMDNJ: Neurosurgery

Phone: 732-235-7909  
Fax: 732-235-7095  
E-mail: lehmanrm@umdnj.edu

Clinical Academic Building, Suite 4100  
125 Patterson Street  
New Brunswick, NJ 08901

*Epilepsy, Parkinson's disease, stereotactic surgery*

We develop and use methods to quantitatively assess the location electrical activity in the brain during surgery. We use this stereological information to direct lesion sites for surgical intervention in pathological conditions such as Parkinson's disease.

## JOHN K-J. LI

Ph.D., University of Pennsylvania  
Professor II  
Department of Biomedical Engineering

Phone: 732-445-4500 X6305  
Fax: 732-445-3753  
E-mail: [johnkqli@rci.rutgers.edu](mailto:johnkqli@rci.rutgers.edu)

599 Taylor Road  
Room 305  
Piscataway, NJ 08854

*Heart and vascular mechanics, biomedical devices and computer modeling, drug delivery systems*

Research centers on cardiovascular engineering, hypertension, myocardial ischemia, cardiac arrhythmias and cerebrospinal perfusion. Investigative tools include computer modeling, noninvasive and wireless sensors, near-infrared and interventional devices, controlled drug delivery and ultrasound.

## YICHENG LU

Ph.D., University of Colorado  
Professor  
Department of Electrical and Computer Engineering

Phone: 732-445-3466  
Fax: 732-445-2820  
E-mail: [ylu@ece.rutgers.edu](mailto:ylu@ece.rutgers.edu)

94 Brett Road  
EE-217  
Piscataway, NJ 08854

*Semiconductors, piezoelectrics, and quantum devices*

In our laboratory we are currently working on ZnO Thin Films grown on SiO<sub>2</sub>/Si substrates. We are studying the development, morphology and orientation of these films. We are also working to implement this technology for use in ultraviolet photodetectors.

## JIANJIE MA

Ph.D., Baylor College of Medicine  
Professor  
Department of Physiology and Biophysics

Phone: 732-235-4494  
Fax: 732-445-4484  
E-mail: [maj2@umdnj.edu](mailto:maj2@umdnj.edu)

661 Hoes Lane  
Room 110  
Piscataway, NJ 08854

*Structure-function studies of ion channels, signal transduction*

Our current research interest focuses on understanding how SOCE contributes to the growth and death of cells by detecting a balanced retrograde signal from the ER to the cytosol and to the plasma membrane.

## **ANANT MADABHUSHI**

Ph.D., University of Pennsylvania  
Assistant Professor  
Department of Biomedical Engineering

Phone: 732-445-4500X6213  
Fax: 732-445-3753  
E-mail: anantm@rci.rutgers.edu

599 Taylor Road  
Room 213  
Piscataway, NJ 08854

*detection, diagnosis, and understanding of breast and prostate cancer via quantitative data and statistical analysis techniques*

Our research focuses on developing novel computer-aided diagnostic (CAD) systems that can assist the doctor by automatically detecting suspicious regions in medical images, such as those obtained from the MRI, CT, and ultrasound scanners. CAD can help in early detection of malignant and pre-malignant lesions, in targeted cancer treatment, and in reducing the number of unnecessary biopsies. By combining sophisticated computer vision, medical image processing, and novel classification tools we have been able to develop highly accurate CAD methods for detecting breast and prostate cancer on ultrasound and high-resolution MRI that in some instances are able to out-perform expert radiologists. Work is also currently underway to develop powerful CAD methods for detecting lung cancer on multi-slice CT and prostatic adenocarcinoma from digitized histological sections. Another research thrust is in the use of sophisticated machine learning and biomedical image analysis methods for understanding tumor progression and identifying tissue classes that are intermediate between normal and malignant.

## **ADRIAN B. MANN**

D.Phil., University of Oxford  
Assistant Professor  
Department of Materials Science & Engineering  
Department of Biomedical Engineering

Phone: 732-445-8421  
Fax: 732-445-3258  
E-mail: abmann@rci.rutgers.edu

607 Taylor Road  
Room 135  
Piscataway, NJ 08854

*Nanomechanics of biological materials*

The primary theme of my research is examining how nanostructure and chemistry determine the nanomechanical behavior of biological materials. Most recently the focus has been on mineralized tissues (teeth and bones) and thin protein films. In particular we are identifying the effects of diseases and treatments on the nanoscale properties of these biological materials. The ultimate aim is gain a better understanding of the diseases and hence to develop better treatments.

## **EVANGELIA MICHELI-TZANAKOU**

PhD, Syracuse University  
Professor II  
Department of Biomedical Engineering

Phone: 732-445-2037  
Fax: 732-445-3753  
E-mail: etzanako@rci.rutgers.edu

617 Bowser Road  
Room 137  
Piscataway, NJ 08854

*Neural engineering, neural networks, image-guided surgery, electrophysiology*

We develop algorithms to record and process electrophysiological signals such as EEG and Evoked Potentials. We use these algorithms to improve our understanding and methods of detection of abnormal function, such as visual processing in multiple sclerosis. We are also combining our analytical tools with imaging techniques to guide neurosurgery for operative intervention of Parkinson's disease. Similar algorithms are used to improve face and speech recognition. Face familiarity is used with evoked potentials as a new Biometric measure.

## **BOZENA "BO" MICHNIAK-KOHN**

Ph.D., DeMontfort University

Associate Professor, Ernest Mario School of Pharmacy, Rutgers University

Director, Laboratory for Drug Delivery, New Jersey Center for Biomaterials

Phone: 732-445-3589

Fax: 732-445-5006

E-mail: michniak@biology.rutgers.edu

New Jersey Center for Biomaterials

145 Bevier Rd.

Piscataway, NJ 08854

### *Topical and Transdermal Drug Delivery*

I am currently working on the design and testing of novel dermal penetration enhancer and retardant compounds, investigation of their mechanisms of action and transport through the skin layers, molecular and computational modeling of enhancers as well as optimization and testing of topical and transdermal formulations. Other studies involve novel carrier systems, nanospheres and polymeric micelles and investigation of skin pathways with confocal microscopy and Raman /FTIR. Physical drug delivery enhancement techniques are studied such as iontophoresis and microneedles. Additionally, I have developed a novel organotypic full-thickness human skin model that shows similar morphology, stratum corneum lipid composition and drug permeability to human skin.

## **PRABHAS V. MOGHE**

Ph.D., University of Minnesota

Professor

Department of Biomedical Engineering

Department of Chemical & Biochemical Engineering

Phone: 732-445-4500 X6315

Fax: 732-445-3753

E-mail: moghe@rci.rutgers.edu

599 Taylor Road

Room 315

Piscataway, NJ 08854

### *Nanobiotechnology and Nanomedicine; Cellular Bioengineering; Cell-Interactive Biomaterials*

The Moghe laboratory has four broad research areas. Two of the areas focus on the design, synthesis, characterization, and mechanisms of interactions of nanoscale materials with cellular and matrix proteins. Applications include wound repair and skin tissue engineering, and strategies for de-escalating atherosclerosis. The third area is focused on cell reporter-based biological profiling of synthetic polymeric biomaterials for regenerative medicine using high content imaging and high throughput evaluation methods. The fourth effort is on studies of human embryonic stem cell pluripotency and differentiation behaviors on biomaterials.

## **SANJEEVA MURTHY**

Ph.D., University of Connecticut

Associate Research Professor

Department of Chemistry and Chemical Biology

Phone: 763-445-0488 X40020

Fax: 732-445-5006

E-mail: murthy@biologyi.rutgers.edu

Life Sciences Building

Room 306

Piscataway, NJ 08854

### *Structure-property relationships; polymer processing and characterization; and x-ray and neutron scattering*

Dr. Murthy's research is broadly concerned with physical modification of polymeric materials, exploring new applications, and investigating the many ways in which the intermolecular interactions in new materials are expressed in their properties. Currently he is interested in the molecular basis of deformation, aging and failure of biomedical materials, modification of polymer surfaces for use as tissue scaffolds, structural evolution in copolymers used for drug delivery, and the influence of hydration on mechanical behavior and biological activity of polymers.

## **FERNANDO J. MUZZIO**

Ph.D., University of Massachusetts  
Professor

Director of Nano-pharmaceutical IGERT and Director of the ERC for Structured Organic Particulate Systems  
Department of Chemical and Biochemical Engineering

Phone: 732-445-3357

98 Brett Road

Fax: 732-445-6758

E-mail: [fjmuzzio@yahoo.com](mailto:fjmuzzio@yahoo.com)

Piscataway, NJ 08854

*Mixing in reactive and multiphase flows, blending of dry powders, applications of the fundamental concepts of chaos theory, pharmaceutical engineering*

Our research involves an experimental and computational investigation of mixing in several reactive systems including: stirred tank reactors, partitioned pipe mixers and roller bottles. We apply fundamental concepts from chaos theory to enhance powder blending performance in industrial applications and on the development of accurate particle sampling techniques and methods for quantifying the extent of mixedness in powder systems. Much of our research has direct applications in pharmaceutical packaging.

## **GARY B. NACKMAN**

MD: Albany Medical College  
Associate Professor  
UMDNJ: Surgery

Phone: 732-235-7816

125 Paterson Street

Fax: 732-235-8538

E-mail: [nackmagb@umdnj.edu](mailto:nackmagb@umdnj.edu)

New Brunswick, NJ 08091

*Limb salvage, redo limb revascularizations, carotid surgery, angiography*

The focus of our program in vascular biology research is understanding cell-material interactions in the context of hemodynamic loading. We have developed a unique model that allows the study of the interactions of vascular smooth muscle cells co-cultured opposite endothelial cells on biomaterials under shear stress. This model has been utilized to identify how heterotypic smooth muscle cell interactions with endothelial cells improve endothelial adaptation to shear stress. The application of the model to material and drug testing is an additional strength. Dr. Nackman is an active consultant to a variety of medical device corporations and has received significant industrial support in addition to NIH funding.

## **JUDITH A. NEUBAUER**

Ph.D., Rutgers University  
Associate Professor  
UMDNJ: Medicine

Phone: 732-235-5371

Office of the Dean

Fax: 732-235-5534

675 Hoes Lane

E-mail: [neubauer@umdnj.edu](mailto:neubauer@umdnj.edu)

Piscataway, NJ 08854

*Neurobiology of respiratory control; neuronal responses to hypoxia and CO<sub>2</sub>*

We examine the mechanisms by which the brain senses oxygen levels and subsequently controls the respiratory system. We use cellular and molecular analytical tools to characterize our in vitro and in vivo models of hypoxia. We identify the signal transduction pathways that lead from a particular locus of neurons in the brain chemically sensing low oxygen levels to reflexes such as gasping.

## **RICHARD S. NOWAKOWSKI**

Ph.D., Harvard University  
Professor

Department of Neuroscience and Cell Biology

Phone: 732-235-4981  
Fax: 732-235-4029  
E-mail: [rsn@umdnj.edu](mailto:rsn@umdnj.edu)

675 Hoes Lane

Piscataway, NJ 08854

### *Cell proliferation and migration during the development of the mammalian central nervous system.*

During the development of the vertebrate CNS cell proliferation occurs, for the most part, in specialized proliferative zones that line the lateral ventricles. In this laboratory we are investigating the behavior of the cells that comprise these proliferative zones with an emphasis on understanding the output of the proliferative zones. Cell production in the cerebral cortex occurs over a period of time that extends over several days (or, in some species, weeks), resulting in the set of "postmitotic" cells, both neurons and glia, that comprise the adult nervous system. As development proceeds, the output of the proliferative zones varies in both cell number and cell class. Using the S-phase labels tritiated thymidine, bromodeoxyuridine and iododeoxyuridine (singly and in combination) we have documented changes in the length of the cell cycle and regional and microheterogeneity in the distribution of the proliferating population in phases of the cell cycle, and we have correlated changes in the direction and rate movements of cell nuclei with phases of the cell cycle. Recently, we have determined that during the 6 day neuronogenetic period of the mouse that there are 11 cell cycles that lengthen from about 8 hours on E11 to about 20 hours on E16. In addition, we have determined that the proportion of daughter cells that leave the proliferative populations (the Q-fraction) as opposed to those that re-enter the proliferative populations (the P-fraction) increases systematically during these 11 cell cycles. The principle that there is an increase in Q has provided considerable insight into the mechanisms of cortical development. For example, we have been able to calculate the number of founder cells in mouse at the onset of neuronogenesis and the relative expansion of the average proliferating cell. This idea has been extended to other species, particularly to primates, and represents a new way to think about the evolution of the CNS.

## **J. PATRICK O'CONNOR**

Ph.D., University of Pittsburgh  
Assistant Professor

UMDNJ: Biochemistry & Orthopaedics

Phone: 973-972-5011  
Fax: 973-972-5294  
E-mail: [oconnojp@umdnj.edu](mailto:oconnojp@umdnj.edu)

185 South Orange Ave.

Newark, NJ 07103

### *Orthopaedics*

Our laboratory is studying the role of arachidonic acid signaling in bone regeneration. Arachidonic acid is the common substrate for cyclooxygenase-2 (COX-2) and 5-lipoxygenase (5-LO) which synthesize prostaglandins and leukotrienes, respectively. We have found that COX-2 and 5-LO have diametric regulatory effects on bone regeneration, whereas COX-2 function promotes regeneration, 5-LO function impairs regeneration. Using in vivo and in vitro methods and a combined pharmacological and genetic approach, we are testing methods to accelerate normal fracture healing and other bone regenerative processes.

## **WILMA K. OLSON**

Ph.D., Stanford University  
Professor  
Department of Chemistry

Phone: 732-445-3993  
Fax: 732-445-5958  
E-mail: olson@rutchem.rutgers.edu

610 Taylor Road  
Piscataway, NJ 08854

*DNA, RNA, and protein biophysics*

The goal of our research is to understand the influence of chemical architecture on the conformation, properties, and interactions of nucleic acids. The work attempts to clarify the role of local structure and ligand binding on the overall folding of DNA and RNA. A second goal is to uncover structural details of nucleic acid structural transitions, such as those involving different DNA duplexes. The research combines a variety of computational approaches with new developments in polymer theory. Problems of current interest include: (1) new computational methods to generate and analyze the folding of RNA, the junctions of DNA and RNA helices, and the sequence-dependent supercoiling of the DNA double helix; (2) computer simulation of the DNA conformational transitions; (3) improved procedures to analyze local structural morphology and to model the effects of base sequence and electrostatics on macromolecular flexibility; (4) new computational models of protein-nucleic acid interactions.

## **THOMAS V. PAPATHOMAS**

Ph.D., Columbia University  
Professor  
Department of Biomedical Engineering

Phone: 732-445-6533  
Fax: 732-445-6751  
E-mail: papathom@rci.rutgers.edu

Psychology Annex  
Room A127  
Piscataway, NJ 08854

*Computational models of neural mechanics, mechanisms of visual perception, pattern recognition*

Our current research involves building neural models for motion and depth perception in the human brain, as well as interactions in auditory and visual perception. In addition, we study the role of attention in perception. These models include properties of both chromatic and luminance pathways. We compare our models to results obtained in strategic experiments in psychophysics and neurophysiology. We hope to point to new research directions in computational vision and to enhance the biological relevance of these models. A new research direction deals with humans' ability to perceive a stable world under self-motion. This includes studying the causes of some compelling depth-reversing 3-D stimuli that appear to move as viewers move in front of them, as well as developing models that incorporate bottom-up and top-down mechanisms to explain these powerful illusions.

## **JOHN RUSSELL PARSONS**

Ph.D., University of Pennsylvania  
Professor  
UMDNJ: Orthopaedics

Phone: 973-972-5293  
Fax: 973-972-5294  
E-mail: parsonjr@umdnj.edu

Medical Science Building  
185 South Orange Avenue  
Newark, NJ 07103

*Orthopaedic applications of biomaterials*

We investigate and characterize different materials and methods of manufacture of orthopaedic implant materials. We are especially interested in how the mechanical environment affects integration and performance of different implants. We are also studying new ways improving the interface between bone and implants.

## **NICOLA C. PARTRIDGE**

Ph.D., University of Western Australia  
Professor and Chair  
Department of Physiology and Biophysics  
UMDNJ

Phone: 732-235-4552  
Fax: 732-235-3977  
E-mail: [partrinc@umdnj.edu](mailto:partrinc@umdnj.edu)

675 Hoes Lane  
Room 561  
Piscataway, NJ 08854

*Signal transduction, molecular endocrinology, transcriptional regulation, metalloproteinases*

We have shown that parathyroid hormone (PTH) induces the transcription of many genes in osteoblastic cells. This involves the protein kinase A (PKA) pathway. One gene whose transcription we have studied in-depth is collagenase-3. This requires induction of activator protein-1 (AP-1) transcription factors as well as phosphorylation of another transcription factor, core binding factor a1 (Cbfa1). Thus, PTH regulates both transcription factors through PKA, either by increasing their expression or altering their phosphorylation. We now know that PTH regulates nucleosomal structure, probably by phosphorylated Cbfa1 recruiting other proteins such as co-activators, modifiers of the nucleosome and the general transcription factors. In another project, we are investigating the genes whereby PTH induces anabolic effects on bone. We have found 125 genes and 30 ESTs are regulated by PTH. Several of these are being pursued including growth factors and cytokines. In a third project we have shown that extracellular concentrations of collagenase-3 are regulated by the existence of a specific receptor which binds the enzyme. Subsequent internalization and degradation of collagenase-3 require transfer to the endocytotic receptor, low-density lipoprotein receptor-related protein-1. We have recently purified the specific receptor as a 170 kDa protein. We are now further characterizing the collagenase-3 removal process in osteoblasts.

## **JOHN L. RICCI**

Ph.D., UMDNJ  
Associate Professor  
Department of Biomaterials and Biomimetics  
NYU

Phone: 212-998-9623  
Fax: 212-995-4244  
E-mail: [john.ricci@nyu.edu](mailto:john.ricci@nyu.edu)

345 East 24<sup>th</sup> Street  
Room 816a  
New York, NY 10010

*Biomaterials*

Cell and tissue response to permanent and resorbable biomaterials • Tissue-engineered scaffolds for bone and soft tissue repair • Controlled microtexture surfaces for dental implants • Bone graft substitutes • Methodologies for analyzing and imaging bone and soft tissue structure

## **RICHARD E. RIMAN**

Ph.D., Massachusetts Institute of Technology  
Professor  
Department of Materials Science and Engineering

Phone: 732-445-4946  
Fax: 732-445-6264  
E-mail: [riman@rci.rutgers.edu](mailto:riman@rci.rutgers.edu)

607 Taylor Road  
Room CCR 106  
Piscataway, NJ 08854

*Synthesis, processing, characterization of ceramic powders for optical, electronic, catalytic, and refractory applications*

Synthesis and materials chemistry for ceramic powders for optical, electronic, structural and biomedical applications. Our biomedical work is focused on the synthesis of hydroxyapatite ceramics and its composites to fine tuning its physical and chemical characteristics to control its bioactivity.

## **CHARLES M. ROTH**

Ph.D., University of Delaware  
Associate Professor  
Department of Biomedical Engineering

Phone: 732-445-4500 X6205  
Fax: 732-445-3753  
E-mail: [cmroth@rci.rutgers.edu](mailto:cmroth@rci.rutgers.edu)

599 Taylor Road  
Room 205  
Piscataway, NJ 08854

*Oligonucleotide therapeutics, systems biology of liver, biomolecular thermodynamics and kinetics*

Our work involves the development of gene-based probes and therapeutics and applying these entities to functional genomics, tissue engineering and cancer. We perform both modeling and experimental studies of oligonucleotide interactions with polymeric delivery agents and target mRNA species. We are using antisense oligonucleotides and short interfering RNAs to modulate integrated molecular systems, such as (1) regulatory molecules controlling inflammatory and differentiation states of hepatocytes and (2) signaling and repair pathways controlling the response of tumors to chemotherapy.

## **JERRY SCHEINBEIM**

Ph.D., University of Pittsburgh  
Professor  
Department of Chemical and Biochemical Engineering

Phone: 732-445-3669  
Fax: 732-445-0654  
E-mail: [jis@rci.rutgers.edu](mailto:jis@rci.rutgers.edu)

98 Brett Road  
Piscataway, NJ 08854

*Biomaterials*

In the Polymer Electroprocessing Laboratory of the Department of chemical and Biochemical Engineering, we have discovered the importance of electroprocessing the thermal, mechanical, chemical and electric field history of a polymer to a polymers ability to express desired electroactive properties. This approach allows us to develop the structure-electroactive properties relationships in these materials and has led to several important discoveries and patents, including:

The direct oriented crystallization from solution of a ferroelectric polymer under high electric fields.

The discovery of the second known class of ferroelectric polymers the odd and odd-odd numbered nylons.

The creation of a new type of composite ferroelectric material, a bilaminate, made from the two known classes of ferroelectric polymers (polyvinylidene fluoride and nylon 11). Interfacial effects result in a large enhancement in piezoelectric response.

The discovery of the enormous electrostrictive response available in certain polyurethane thermoplastic elastomers.

## **JOHN L. SEMMLOW**

Ph.D., University of Illinois  
Professor  
Department of Biomedical Engineering

Phone: 732-445-4500 X6214  
Fax: 732-445-3753  
E-mail: [semmlow@gmail.com](mailto:semmlow@gmail.com)

599 Taylor Road  
Room 214  
Piscataway, NJ 08854

*Physiological motor control, Medical Instrumentation, Magnetic resonance imaging -functional MRI*

My research combines information from medical imaging techniques such as MRI with computer models to understand physiologic motor control of the eye. We specifically study the control of vergence eye movements, where the two eyes move in opposition to track targets moving in depth, and changes in the control of focusing mechanisms during aging. We are also investigating alternative imaging techniques to improve detection of breast cancer.

## **AARON J. SHATKIN**

Ph.D., Rockefeller University  
Professor

Department of Molecular Genetics and Microbiology

Phone: 732-235-5311

Fax: 732-235-5318

E-mail: shatkin@cabm.rutgers.edu

679 Hoes Lane West

Piscataway, NJ 08854

### *mRNA Processing, Transcription*

One of the earliest steps in the cascade of controls that regulate mRNA formation and function is the addition of a 5'-terminal "cap." This structural hallmark is present on all eukaryotic cellular mRNAs and is essential for viability. The cap enhances several downstream events in gene expression including splicing of pre-mRNAs in the nucleus, initiation of protein synthesis, and mRNA stability. These important effects have fostered many studies that have defined the enzymatic mechanisms of capping. Recently we have cloned and sequenced the mouse and human capping enzymes and mapped the human protein to 6q16, a region implicated in tumor suppression.

## **TROY SHINBROT**

Ph.D., University of Maryland  
Professor

Department of Chemical Engineering

Phone: 763-445-4500 X6310

Fax: 732-445-3753

E-mail: shinbrot@soemail.rutgers.edu

599 Taylor Road

Room 310

Piscataway, NJ 08854

### *Noise Induced Pattern Formation*

#### Cellular Morphogenesis

A first area of research concerns the formation of structures during development of tissues and organs, especially in the central nervous system. This work involves several projects including a study of neuronal pathfinding following spinal cord injury and a simulation of the development of folds, for example in the mammalian cerebellum. All of these studies involve direct comparisons between in silico and in vitro models.

#### Granular Flow and Mixing

A second area of investigation deals with the flow and mixing of both dry and wet grains. Work in this area has shown both parallels and significant differences between dry grains and viscous fluids. These results have applications spanning a broad range from pharmaceutical formulation to geophysical pattern formation.

## **GEORGE K. SHOANE**

Ph.D., University of California, Berkeley  
Professor

Department of Biomedical Engineering

Phone: 732-445-4500 X6306

Fax: 732-445-3753

E-mail: shoane@rci.rutgers.edu

599 Taylor Road

Room 306

Piscataway, NJ 08854

### *Visual motor control*

Our laboratory investigates the neural and motor processes of oculomotor control. We are exploring the complex interactions that control one's ability to focus and converge the eyes, which have important implications for the remediation of visual motor deficits. Recently, we developed a theory of myopia which predicts the effect of a change in visual optics on neurochemical transmission and scleral tissue growth. Finally, we are studying the coordinated relationship between eye and head motions during the putting stroke of the beginner and expert golfers.

## **DAVID I. SHREIBER**

Ph.D., University of Pennsylvania  
Associate Professor  
Department of Biomedical Engineering

Phone: 732-445-4500 X6312  
Fax: 732-445-3753  
E-mail: [shreiber@rci.rutgers.edu](mailto:shreiber@rci.rutgers.edu)

599 Taylor Road  
Room 312  
Piscataway, NJ 08854

*Tissue and Cellular Biomechanics, Tissue Engineering, Brain and Spinal Cord Injury, Microfluidics*

Our laboratory has three primary research areas that focus centrally on tissue and cellular biomechanics. First, we use in vivo, in situ, and computational models to understand the underlying biomechanics that trigger an injury cascade in nervous system tissue following trauma. Second, we spatially pattern the mechanical and adhesive properties of three-dimensional, collagen-based, tissue equivalents to control cell behavior, with specific applications in guided nerve and spinal cord regeneration and directed stem cell differentiation. Third, we study tissue mechanics and mechanotransduction during acupuncture with three-dimensional in vitro models and finite element analysis.

## **FRED H. SILVER**

Ph.D., Massachusetts Institute of Technology  
Professor  
UMDNJ: Pathology and Laboratory Medicine

Phone: 732-235-4027  
Fax: 732-235-4825  
E-mail: [silverfr@umdnj.edu](mailto:silverfr@umdnj.edu)

675 Hoes Lane  
Piscataway, NJ 08854

*Soft tissue microstructure structure and mechanics, viscoelasticity, biomaterials*

My laboratory has been involved in applying physical techniques to the analysis of biological tissues. We are interested in analyzing how forces experienced by extracellular matrices lead to changes in the composition and organization of tissues. It is clear that mechanochemical transduction occurs in tissues as a result of the effect of forces due to gravity, locomotion and pulsatile blood flow. Key to understanding mechanochemical transduction at the cellular level is the analysis of how forces are borne by the matrix. The ability of forces to be borne by extracellular matrix arises from the ability of this tissue to store elastic energy. The ability of tissue to store elastic energy in turn is a consequence of collagen self-assembly.

## **PATRICK J. SINKO**

Ph.D., University of Michigan  
Associate Professor  
Department of Pharmaceutics

Phone: 732-445-3839  
Fax: 732-445-4271  
E-mail: [sinko@rci.rutgers.edu](mailto:sinko@rci.rutgers.edu)

160 Frelinghuysen Road  
Piscataway, NJ 08854

*Pharmacokinetics and Biopharmaceutics*

I am currently investigating the mechanisms of intestinal transport and metabolism and oral delivery of pharmaceutical macromolecules (carbohydrate- and protein-derivatives, genes, and vaccines) and drug analogues of natural compounds such as organic cations/anions, peptides and nucleosides.

## **JAY A. TISCHFIELD**

Ph.D., Yale University  
Professor  
Department of Genetics

Phone: 732-445-1027  
Fax: 732-445-1147  
E-mail: [jay@biology.rutgers.edu](mailto:jay@biology.rutgers.edu)

145 Bevier Road  
Piscataway, NJ 08854

*Medical and Human Genetics*

Our primary research interests include studies of both somatically heritable and transient genetic changes in somatic cells that predispose to disease in humans. In addition, we are engaged in several large projects whose ultimate goal is the identification of genes that have major contributions to complex oligogenic disorders.

## **M. SILVINA TOMASSONE**

Ph.D., Northeastern University  
Assistant Professor  
Department of Chemical and Biochemical Engineering

Phone: 732-445-2972  
Fax: 732-445-2421  
E-mail: [silvina@sol.rutgers.edu](mailto:silvina@sol.rutgers.edu)

98 Brett Road  
Piscataway, NJ 08854

*Molecular dynamics, thermodynamics and statistical mechanics of fluids, self assembly and dynamics of surfactants*

As a unifying thread, our group is interested in understanding the most fundamental phenomena controlling properties of composite materials. Our approach combines theory, atomistic simulations of nano and microstructures, continuum-based simulations of meso and macrostructures, and experiments.

## **KATHRYN E. UHRICH**

Ph.D., Cornell University  
Professor  
Department of Chemistry

Phone: 732-445-0361  
Fax: 732-445-5312  
E-mail: [uhrich@rutchem.rutgers.edu](mailto:uhrich@rutchem.rutgers.edu)

610 Taylor Road  
Piscataway, NJ 08854

*Biomaterials, polymer chemistry, micropatterning,*

My research program encompasses three main projects: 1) hyperbranched, water-soluble polymers that encapsulate, then release, hydrophobic drugs; (2) polymers that biodegrade into aspirin-like components to locally reduce inflammation and pain; and (3) micropatterned polymeric substrates for evaluation of nerve cell growth mechanisms.

## **HARVEY R. WEISS**

Ph.D., Duke University  
Professor  
UMDNJ: Physiology and Biophysics

Phone: 732-235-4626  
Fax: 732-235-5038  
E-mail: [hweiss@umdnj.edu](mailto:hweiss@umdnj.edu)

675 Hoes Lane West  
Piscataway, NJ 08854

*Coronary and cerebral circulation and microcirculation, nitric oxide, natriuretic peptides, myocardial signal transduction*

My laboratory has two main research interests. I. How natriuretic peptides and nitric oxide and their second messenger cyclic GMP serve as a "brake" on myocardial function and how this changes in disease. II. The relationship between excitatory amino acid receptors and cerebral oxygen supply and consumption balance and the changes that occur in disease.

## **JOSEPH WILDER**

Ph.D., University of Pennsylvania  
Research Professor

Department of Electrical and Computer Engineering

Phone: 732-445-3439

Fax: 732-445-4775

E-mail: wilder@caip.rutgers.edu

Center for Computer Aided Industrial Processes

96 Frelinghuysen Road

Piscataway, NJ 08854

*Human and machine vision with emphasis on biometrics, vision-based biomedical instrumentation, and multimodal human/machine interaction*

We develop computer vision techniques and broadly apply these methods to biomedical applications. We are investigating ways of improving medical imaging and 3D microscopy. We are also working on developing a better understanding of the human visual system. Finally, we are employing computer vision in face recognition systems.

## **MARTIN L. YARMUSH**

M.D., Yale University, Ph.D., The Rockefeller University; MIT  
Professor

Department of Biomedical Engineering

Phone: 732-445-4500 X6203

Fax: 732-445-3753

E-mail: kma@soemail.rutgers.edu

599 Taylor Road

Room 203

Piscataway, NJ 08854

*Tissue Engineering, metabolic engineering, stem cell bioengineering, applied immunology*

We apply engineering principles to investigate a variety of biomedical problems on molecular, cell and tissue levels. The majority of our current studies involve: 1) developing technology for efficient production of differentiated cells from stem cells and 2) the use of these differentiated cells in tissue engineering and regenerative medicine applications. We also are developing diagnostic and therapeutic tools that involve cells and tissues in microfabricated devices. Finally, we are using principles and techniques of metabolic engineering to understand the changes in energy handling that accompany major injury and/or chronic diseases such as cancer and AIDS.

## **PETER J. YIM**

Ph.D., University of North Carolina at Chapel Hill  
Assistant Professor

Department of Radiology, UMDNJ-Robert Wood Johnson Medical School

Phone: 732 235-8911

Fax: 732 235-6889

E-mail: yimpj@umdnj.edu

Medical Education Building 404

One R New Brunswick, NJ 08903

Robert Wood Johnson Place

*Medical Image Analysis*

My research focus is on the development of computational methodology for interpretation of radiologic images. My research emphasizes pattern recognition and physiologic modeling approaches to radiology.

## WISE YOUNG

M.D., Stanford University, Ph.D., University of Iowa  
Professor  
Department of Cell Biology and Neurosciences

Phone: 732-445-2061  
Fax: 732-445-2063  
E-mail: wisey@pipeline.com

Nelson Biological Labs  
604 Allison Road  
Piscataway, NJ 08854

### *Brain and spinal cord injury and regeneration*

Our laboratory studies brain and spinal cord injury using a wide variety of techniques to assess mechanisms and treatments of tissue damage; apoptosis, demyelination, degeneration, and dysfunction. These techniques include molecular and genetic analyses of the injury response, atomic absorption spectroscopy to measure tissue damage, immunohistochemistry, and ELISA to assess proteins, behavioral assessments of locomotor and other functions. Physical modeling and computer simulations of injury and animal (rat) models of brain and spinal cord injury. Therapies studies include glucocorticoids, neurotransmitter and other receptor blockers, growth factors such as neurotrophins and fibroblast growth factors, enzyme inhibitors such as selegiline, cellular adhesion molecules such as L1 and ngCAM, glycolipids such as gangliosides, and small molecules that block ionic channels such as Na, K, and Ca channels, cell transplants, and proteins.

## JEFFREY D. ZAHN

Ph.D., University California, Berkeley  
Assistant Professor  
Department of Biomedical Engineering

Phone: 732-4454500 X6311  
Fax: 732-445-3753  
E-mail: jdzahn@rci.rutgers.edu

599 Taylor Road  
Room 311  
Piscataway, NJ 08854

### *Microfluidic devices for medical therapeutics and diagnostics*

Dr. Zahn also has several ongoing research projects related to medical diagnostics. The first project created miniaturized microfluidic microdialysis arrays for continuous glucose sensing applications with higher recovery rates over current microdialysis probes. These microdialysis systems have had a very rapid response time showing an equilibration time of less than 2 minute lag from a glucose solution whose concentration continuously fluctuates. An organic-aqueous two phase flow system for a miniaturized DNA extraction module is also being developed. The system is based upon miniaturizing the standard molecular biology technique of liquid-liquid phenol extraction. Finally, a blood handling device to continuously separate blood plasma from blood cells coupled with an immunosensing system for continuous monitoring of systemic inflammation during cardiopulmonary bypass (CPB) procedures has been developed. The blood skimming device has shown tremendous promise, and has been successfully integrated with a heart-lung machine CPB pump. These projects are currently supported by the ADA, NSF, Coulter Foundation and NIH.