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BME Seminar Schedule 2008-09

Sept. 19	Dr. Fengyu Song	IUSD Oral Biology
Oct. 17	Dr. Julie Liu	Purdue Chemistry
Nov. 21	Dr. Debbie Thurmond	IUSM Biochemistry
Dec. 5	Dr. Yoon Yeo	Purdue Industrial & Physical Pharm
Jan. 16	Dr. Richard Li	IUPUI Biology
Feb. 20	Dr. Xiaoxi Qiao	IUSM Ophthalmology
March 27	Dr. Angela Bruzzaniti	IUSD Oral Biology
April 17	Dr. Brandon Seal	Purdue Biomedical Eng.

Research Areas of BME Faculty

BIOMATERIALS
Dong Xie, Ph.D., *Associate Professor*

BIOMEDICAL INSTRUMENTATION
Edward Berbari, Ph.D.,
Professor and Chairman

BIOMOLECULAR ENGINEERING
Hiroki Yokota, Ph.D., *Professor*

CARDIOVASCULAR ENGINEERING
Ghassan Kassab, Ph.D., *Professor*
Julie Ji, Ph.D., *Assistant Professor*
Bill Combs, MSEE, *Clinical Assoc. Professor*

MECHANOBIOLOGY
Charles Turner, Ph.D., *Professor*

MOLECULAR IMAGING
Evan D. Morris, Ph.D., *Assistant Professor*

NEUROENGINEERING
John Schild Ph.D., *Associate Professor*
Ken Yoshida Ph.D., *Associate Professor*
Karen Alfrey Ph.D., *Instructor*

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IUPUI - Purdue School of Engineering & Technology

THE BME NETWORK

Newsletter of the Department of Biomedical Engineering

Dr. Hiroki Yokota, Ph.D.

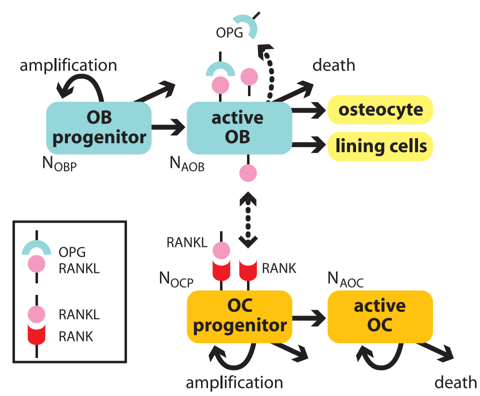
Dr. Hiroki Yokota, professor of biomolecular engineering and biomechanics emphasizing mechanisms.

Dr. Yokota received a Ph.D. in Astronautics from the University of Tokyo, and another Ph.D. in Molecular Biology from Indiana University in Bloomington. He came to IUPUI in 1998 after working for five years in The Department of Molecular Biotechnology at the University of Washington, School of Medicine In 2008, he became a Professor in the Department of Biomedical Engineering. Dr. Yokota teaches courses in biomolecular engineering and biomechanics emphasizing mechanisms at the molecular and cellular levels. His research interests include molecular/cellular biomechanics and systems biology.

Skeletal Control Research at IUPUI

Bone and Joints

Unlike a construction crane's arm, our long bones are constantly remodeled by a series of destruction events followed by rebuilding. Also unlike a crane's hinge in which a ball bearing may easily be replaced, our joint surface is in a stable equilibrium and is non-replaceable. This simplified comparison of our major skeletal components to the counterparts in mechanical devices highlights two independent design principles. Key research questions are: Why does living bone in the elderly tend to lose weight, while dead bone remains stable? Why can a living joint maintain its surface structure while in its dead form it rapidly degrades? The answer relates to "homeostasis" - in modern control theories, a bone-joint system is controlled by a regulator that constantly reduces a bias of state variables from a reference point which includes minimizing a cost function. Inputs to this regulator include biophysical and chemical signals (control variables) as well as disturbances (noise), which depend on a set of initial conditions (genetic make-ups), various boundary conditions (external and internal stimuli), and time (age). My research focuses on understanding the role of various inputs to the system (specifically, mechanical stimulation), identifying systems dynamics, and promoting systems behaviors.



Differentiation of osteoblasts (OB) and osteoclasts (OC) focusing on interactions with three signaling molecules (OPG, RANKL, and RANK).

Continued on page 3

Message from the Chair

Edward J . Berbari
Professor, Chair
Biomedical Engineering

Congratulations go to the department's charter class of BSBME graduates who are completing their undergraduate studies in 2008. This class of 12 students *(pictured on page 3)* represents a culmination of many efforts. Certainly the efforts of the students and their supporting families are foremost in this accomplishment. It is always a great and true reward for a faculty member to be part of the growth and development of these exciting and hard working young people. Additionally the efforts of the faculty to design the curriculum and develop the 16 required courses and 8+ elective courses over the course of the past few years was an outstanding achievement. Together with our assessment based accreditation process we have begun to implement a set continual improvement approaches to keep our curriculum current and meeting the needs of all of our constituencies. In addition, there has been significant growth in the program as this year's sophomore class has now reached the initial goals of admitting 35 new students into the program. If demand continues to grow we will also have the opportunity to become a more competitive program in the near future.

We had two milestones achieved this year in faculty advancement. Dr. Hiroki Yokota was promoted to Professor and Dr. Dong Xie, Associate Professor, earned tenure. Dr. Yokota's research activity is featured on the cover of our newsletter. Dr. Yokota currently has two NIH-R01 grants in the areas outlined in the article. He teaches courses in the area of tissue/cell mechanics as well as graduate courses in biomolecular engineering. Of some note is the fact that Dr. Yokota has two Ph.D. degrees: Astronautics, (University of Tokyo) and Biology (Indiana University). He obviously brings a unique perspective to our students. Dr. Xie teaches biomaterials at both the undergraduate and graduate level. He has an NIH grant in the area of dental biomaterials.

Since our last newsletter the department resources have increased considerably with the remodeling of 3,700 sq ft of computer labs into wet labs dedicated to research and teaching. In addition, we have just begun remodeling another 2,400 sq ft to wet lab functionality. This will allow us to begin moving faculty members who have used research space in the medical school complex to the School of Engineering space. Much of this research space is to accommodate our growing research portfolio. During the past fiscal year BME faculty were awarded almost $2.9 million in externally funded grants. This effort not only enhances our department profile but provides for many undergraduate research projects directed by well funded faculty members. These opportunities provide our students with unique experiences which poise them well for their future career prospects.

FACULTY SPOTLIGHT

John Schild | Ph.D. | Associate Professor

Dr. John H. Schild is a charter faculty member of the Department of Biomedical Engineering. Dr. Schild's research interests are in computational neuroscience, sensory neuron and synapse electrophysiology, neural coding in cardiovascular afferents and patch clamp instrumentation. His lab utilizes a combination of experimental and computational techniques in developing a functional understanding of how individual cardiac sensory neurons and brainstem neural circuits both encode and process cardiovascular information.

Dr. Schild is a member of the Society for Neuroscience, American Physiological Society, IEEE, and Sigma XI. ■

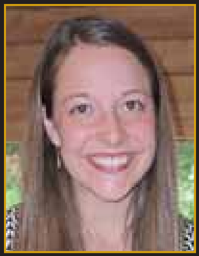
Evan Morris | Ph.D. | Assistant Professor

Dr. Evan Morris joined the Department of Biomedical Engineering in 2005. Dr. Morris' primary interest is in developing PET models to explain the dynamic behavior of receptor and transmitter molecules in brain. With the proper model he and colleagues can ask such questions as: How many receptors of a given type are there? How do these receptors change with age or disease? What is the response of a neurotransmitter to drug or cognitive stimulation? Does the temporal response of a neurotransmitter encode the likelihood of future alcohol drug abuse?

Dr. Morris also holds academic appointments in Radiology, Medical Neurobiology, Psychiatry (adj) in the Indiana University School of Medicine and in Biomedical Engineering (courtesy), at Purdue University, W. Lafayette. ■

GRADUATE PROFILE

Sara Mantila Roosa



Sara Mantila Roosa is a Ph.D. student in Dr. Charles Turner's lab.

Sara Mantila Roosa is a Ph.D. student in Dr. Charles Turner's lab. The primary goal of her research is to identify mechanical loading-induced gene expression patterns, and the governing regulatory mechanisms, that are most important in bone. To accomplish this, they will isolate RNA from the bones and analyze it with microarrays to determine how genome-wide gene expression patterns change after the bones are loaded for varying lengths of time. The microarray data is further evaluated with bioinformatics techniques, to identify the transcriptional mechanisms that contribute to the gene expression pattern changes.

Sara grew up in the Upper Peninsula of Michigan, and received her B.S. in Biomedical Engineering from Michigan Tech. She went on to the University of Michigan where she received a M.S.E. in Biomedical Engineering.

Sara and her husband, Scott, were married on September 1, 2007. Scott is a geotechnical engineer and works for Earth Exploration, Inc. in Indianapolis. ■

First BME Undergraduate Class Graduates

The Department of Biomedical Engineering began in 2004 on the IUPUI campus and this past May saw its first undergraduate class receive their diplomas.

Congratulations to Eddie Shmukler who was accepted into the IU School of Medicine, Hazel Gomes and Rachel Meyer who were accepted into the BME Graduate School and Jennifer Doyle, Mark Williamson, Megan Bess, and Sarah Brown who are now working. Fellow seniors, Corinne Wood and Sophia Vinci-Booher will receive their degrees this winter. ■

Continued from page 1

Control Theories for Homeostasis

Modern control theories work remarkably well when applied to launching a rocket or controlling spacecraft altitudes. They are not suited, however, to regulate a large-scale flexible satellite in space. Although bone and joints are less flexible, we do not know whether existing control theories can fit to skeletal control. In my lab, the main efforts are placed on characterization of systems dynamics and behaviors through determination of biomechanical parameters (strain, pressure, etc.), biomolecular expression levels (mRNA and proteins), and phenotypic outcomes (bone thickness, bone formation rate, etc.). One approach for enhancing homeostasis might be to derive a set of nonlinear differential equations, apply perturbation theories, and solve matrix Riccati equations. It is not clear, however, whether this strategy is appropriate for developing a therapeutic strategy for patients with bone metabolic diseases. We may need to use adaptive, heuristic approaches with and without evolutionary algorithms, or a completely novel approach using network theories, thermodynamic principles, number theories, or something we have not even yet developed.

Challenges in BME

After 100 years of flight in air and 50 years in space, aerospace engineers have established their own niche in areas such as fluid dynamics, orbital designs, and systems analyses in collaboration with mathematicians, physicists, and EE/ME engineers. BME engineers certainly could benefit from ties to clinical physicians, molecular biologists, computer scientists, etc. It is still unclear, however, which of these synergies would best exploit our unique strengths. I believe that development of multiscale theories for homeostasis, in collaboration with other disciplines, could represent one of the most needed directions. ■