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IUPUI - Purdue School of Engineering & Technology

# THE BME NETWORK

Newsletter of the Department of Biomedical Engineering

## IUPUI

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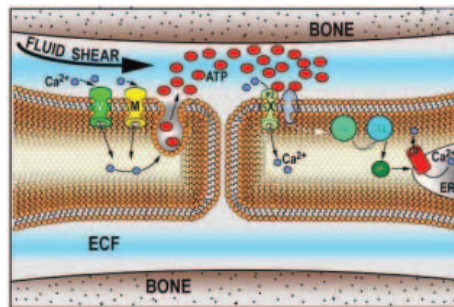
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[www.engr.iupui.edu/bme](http://www.engr.iupui.edu/bme)

# Orthopaedic Research at IUPUI

## Mechanobiology

Mechanobiology merges the older science of mechanics with the newer and emerging disciplines of molecular biology and genetics. At the center of mechanobiology is the cellular process of mechanotransduction, or the way cells sense and respond to mechanical forces. Many, if not most, of the tissues in the body contain mechanosensitive cells. These include osteocytes in bone, chondrocytes in cartilage, myocytes in the heart, endothelial cells in blood vessels, epithelial cells in renal tubules, and many others. Of the five senses defined by Aristotle - sight, hearing, taste, smell and touch - two require cellular mechanotransduction. In addition what is often called the sixth sense, our sense of space and location called proprioception, relies on mechanosensors as does the sense of balance. There are many clinical applications of mechanobiology, orthodontic tooth movement,



distraction osteogenesis, artery stents, artificial heart valves, as well as promising new treatments for diabetes, muscular dystrophy and osteoporosis. Another use of mechanobiology is the development of new pain killers. Many pain sensing nociceptors are in fact mechanosensors that detect local tissue deformation and send signals to the brain that are perceived as pain. Blockers of mechano-transduction in nociceptors show promise for treatment of chronic pain syndromes.

Our work focuses on mechano-transduction in bone tissue. Exercise causes bones to increase bone mass and strength. More importantly the mechano-sensing apparatus in bone directs new bone formation to where it is most needed for improving bone strength. We working to identify the molecular events involved in strengthening bone.

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**Dr. Charles H. Turner, Professor of Orthopaedic Surgery, Director of Orthopaedic Research**

Dr. Turner received a B.S.M.E., in Mechanical Engineering from Texas Tech University and his Ph.D. in Biomedical Engineering from Tulane University in New Orleans, LA. He came to IUPUI in 1991 after working for four years at the Osteoporosis Research Center at Creighton University. In 2001, he became a Professor in the Department of Biomedical Engineering at Purdue University.

Dr. Turner was the recipient of the Fuller Albright Award, American Society for Bone and Mineral Research. In 2002, he was elected Fellow of the American Institute for Medical and Biological Engineering.

Dr. Turner teaches courses in biomechanics emphasizing how form follows function in the musculoskeletal system. The tissues that make up bones and joints are structurally complex but elegantly designed. Students of biomechanics learn about anisotropic failure analysis, hierarchical organization, structural optimization, joint lubrication, muscle performance, and prosthesis design.

Dr. Turner works on treatments for the bone disease osteoporosis. Osteoporosis occurs when bone becomes porous due to aging or poor health. In addition, some medications like corticosteroids or immune suppressant drugs can cause osteoporosis. Numerous medications have been developed to fight osteoporosis and several of these were tested in Dr. Turner's laboratory. His current research focuses on molecular genetics using transgenic and congenic mice to identify new ways to make bone stronger. ■

# Message from the Chair



**Edward J. Berbari**  
Professor, Chair  
Biomedical Engineering

Because Biomedical Engineering is such a new department it seems as if every accomplishment of a student or faculty member is a milestone. Hence we tend to celebrate each accomplishment as a “first” rather than for its individual merit. For example, the faculty in the department have been successful in bringing an ever increasing amount of external funding, generally from the most competitive (and most prestigious) funding agency, the National Institutes of Health. During the past fiscal year this amounted to over \$3 million. This accounts for 50% of the School of Engineering and Technology’s total research budget. This is a significant accomplishment for our young department and on a per investigator basis puts us in the top quartile of BME departments nationally – truly a meritorious accomplishment. Dr Charles Turner, highlighted on the front page of the newsletter, is our recognized leader in external funding from NIH.

In the past year we were successful in recruiting two new faculty members, Drs Julie Ji and Ken Yoshida. Both have excellent academic and research credentials and will add significantly to our department’s efforts as we grow both our educational and research programs. This brings our total faculty count to 12 and with this growth we relocated the entire BME faculty to the SL-220 suite. This large suite accommodates all of our faculty and provides us with an expanded conference room (the views from the 2nd floor offices are much improved over the brick wall of the garbage pit of my old office!). We are also completing Phase II of our laboratory remodeling project. We will have 4 new wet labs for teaching and research, also on the 2nd floor of the SL building.

Another evolving milestone is the fact that our charter class has now reached their senior year and will graduate in May. We are so proud of these hardworking and accomplished students – we hope to note their accomplishments and career progress as our first alumni from the undergraduate program in future issues. We not only see their day to day efforts in class but also their efforts in building our department culture which includes the BME Club. The BME Club will continue to be highlighted in our newsletter and the standard set by our charter class will continue as they turn over the mantle of leadership to the next class of our students.

The graduate program continues to grow and improve. We currently have 14 PhD students in the joint campus (with Purdue, West Lafayette) program and about the same number of MS students. The graduate students are hard at work in a wide variety of laboratories on campus and we invite you to our home page [www.engr.iupui.edu/bme](http://www.engr.iupui.edu/bme) to further explore our faculty and student activities. ■

## FACULTY SPOTLIGHT

### Ken Yoshida | Ph.D. | Associate Professor



Dr. Yoshida joined our department in November 2006. His primary focus is the development of selective neural interfaces, in particular, intrafascicular peripheral nerve devices, and the application of these devices to study natural neuromuscular control and to investigate natural sensor based FNS systems.

Dr. Yoshida is a member of the Society for Neuroscience, the International Functional Electrical Stimulation Society, the Biomedical Engineering Society, the IEEE-Engineering in Medicine and Biology Society, and Tau Beta Pi. ■

### Julie Ji | Ph.D. | Assistant Professor



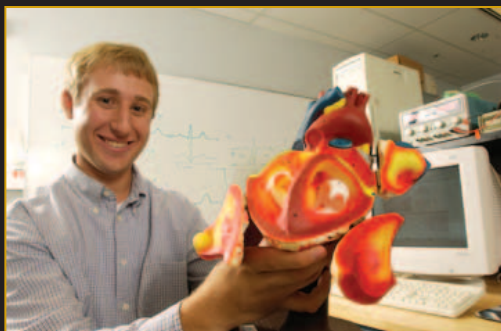
Dr. Ji received her B.S. degree in Chemical Engineering from Massachusetts Institute of Technology, and her Ph.D. in Bioengineering from the University of Pennsylvania. She joined the faculty at IUPUI upon completing her post-doctoral training at Brigham and Women’s Hospital in Boston. Her areas of interests include: endothelial mechano-biology, cell and nuclear mechanics, and signal transduction in human disease models.

Currently, Dr. Ji’s research focuses on understanding dynamic and temporal cellular responses to physiological mechanical forces. For example, at the inner lining of blood vessels, the endothelium actively participates in maintaining vessel tone, wall permeability, and cell adhesion, while responding to hemodynamic forces of blood flow. Understanding the impact of various *in vivo* flow conditions on endothelial biology would aid in the analysis of vascular disease mechanisms and treatments. Using techniques such as gene manipulation, protein analysis, and fluorescent confocal imaging, analysis of structural activities are done at the cellular and sub-cellular scale in response to external forces. Studies on processes such as cell migration, division, and inflammatory responses can be integrated into multi-cellular, 3-D tissue models. ■



## GRADUATE PROFILES

### Mark Svendsen, Ph.D.



Mark Svendsen is a Ph.D. student in the BME labs of Dr. Edward Berbari and Dr. Ghassan Kassab. His area of research involves the study of mechano-electric feedback mechanisms in failing hearts. Animal models (swine) are used in the study of local mechano-electric feedback in normal and experimentally induced diseased states. Simultaneous mechanical and electrical measurements are recorded using echocardiography and electrocardiography. The long term goal for his study is to gain an understanding about the mechanisms of heart failure which can be later translated into useful technologies for the treatment of the disease.

In addition to his Ph.D. study, Mark is involved with the BME undergraduate students. He helps the undergraduates with the bio-instrumentation and bio-mechanics courses as a teaching assistant. Also, he assists a BME senior design group with the issues related to the design and implementation of heat shaped catheters.

Although he started his Ph.D. study this summer, Mark is not a stranger to IUPUI and the BME department. He graduated from IUPUI with a B.S. in Mechanical Engineering and a M.S. in Biomedical Engineering.

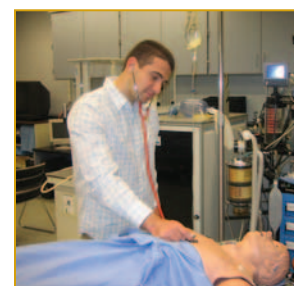
When he isn't involved in his BME study, Mark is involved with his church and likes to play tennis and golf. ■

## BME Club News

The BME Club of IUPUI had quite a busy start for the fall 2007 semester. Several goals were set in the beginning of the year and all of them are on their way to be met:

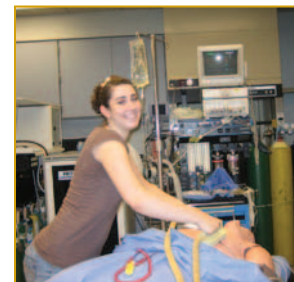
- Promote the Biomedical Engineering major
- Provide opportunities for community service projects, especially ones that involve engineering and medicine.
- Promote and provide opportunities for biomedical research.
- Create a stronger BME community at IUPUI via meetings, events, and involvement in campus activities.
- Create an IUPUI BMES chapter

Our monthly meetings featured speakers within a broad spectrum of interests. Dr. Ed Berbari, the BME department chair, discussed the ABET accreditation process, as well as new labs opening up in the SL building. The second meeting featured Dee Rainey and Aaron Glauberman from Clarian Health Volunteering Services, providing the BME Club members with opportunities to serve the community in a clinical setting. Also, the club co-sponsored a meeting with Mr. Robert Stump, the IU School of Medicine Director of Admissions. Apart from attending meetings, members of the club volunteered in the United Way Day of Caring and the ETSC sponsored Career Connection Fair.



In the following months, we look forward to providing more research opportunities to our members under the supervision of BME faculty, as well as participating in community service events such as the Evan Bayh Leadership Summit and Martin Luther King Day.

Our hope is that all students interested in Biomedical Engineering will be able to take advantage of the exciting academic and social opportunities provided by the club and get more involved in campus and community life while promoting the Biomedical Engineering major. ■



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### Skeletal Genetics

We are working to identify the genes that influence skeletal density and strength. We are currently mapping genes that affect bone in rats and mice. We use second filial offspring from inbred rodent strains to identify quantitative trait loci (QTLs) that contains genes influencing skeletal traits. After QTLs are identified, they are transferred onto a background inbred strain using a series of backcrosses and we use the growing arsenal of genetics data and new bioinformatics techniques to identify genes that regulate skeletal biology.

### Osteoporosis/biomechanics

Osteoporosis is a disease in which bones become weak and brittle. In the vertebrae of the spine, bone mineral is lost with age and the bone breaking strength is reduced. In some people, the vertebrae are so weak that their spine will fracture even during normal daily activities.

Osteoporosis is a multifaceted disease. Bone becomes porous - hence the name of the disease - but in addition there are many changes to bone tissue that alter bone strength. Changes occur in the dimensions of the mineral crystals, in the rigidity of the

collagen matrix, in the microarchitecture of trabecular struts, and in the size and shape of the bones. All of these factors contribute to make bone more fragile.

Drug treatments for osteoporosis do not only affect bone porosity but also affect bone size, architecture and mineral. New treatments under development will make the skeleton stronger by stimulating new bone formation to augment weakened structures within bones. We investigated a new drug called PTH(1-34) or teriparatide. This drug substantially improved bone structure after several months of treatment. ■



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# BME Seminar Schedule 2007

Sept. 14	Jiliang Li Assistant Professor	IUPUI Biology
Oct. 19	Kevin Otto Assistant Professor	Purdue Biomedical Engineering
Nov. 16	Christopher Naumann Assistant Professor	IUPUI Chemistry
Dec. 12	Xiao Lu Assistant Professor	IUPUI Biomedical Engineering

## 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., *Associate Professor*

**CARDIOVASCULAR ENGINEERING**

Ghassan Kassab, Ph.D., *Professor*

Julie Ji, Ph.D., *Assistant Professor*

Bill Combs, MSEE, *Clinical Professor*

**MECHANOBIOLOGY**

Charles Turner, Ph.D., *Professor*

**MOLECULAR IMAGING**

Evan D. Morris, Ph.D., *Associate Professor*

**NEUROENGINEERING**

John Schild Ph.D., *Associate Professor*

Ken Yoshida Ph.D., *Associate Professor*

Karen Alfrey Ph.D., *Instructor*

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