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# IUPUI

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# THE BME NETWORK

Newsletter of the Department of Biomedical Engineering

**John Schild, Ph.D.**

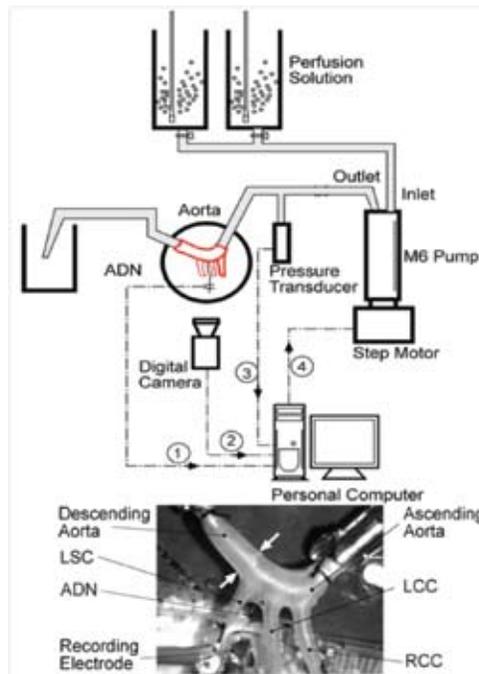
Dr. Schild obtained BS and MS degrees in Biomedical Engineering from Case Western Reserve University. While at CWRU he worked as an undergraduate and graduate research assistant in the implantable systems group of the Rehabilitation Engineering Center. The REC was just beginning clinical implementation of implantable electrical stimulation



systems for neuromuscular control of hand grasp-release in individuals with tetraplegia. These experiences led him to a program in Restorative Neurology at Baylor College of Medicine. Here he worked closely with a team of Neurologists and Neuroscientists to improve neuromuscular control and to reduce the debilitating side effects in patients with traumatic central nervous system injuries such as spinal cord lesions, stroke and autonomic dysreflexia. These clinical experiences led him to pursue a PhD in Bioengineering at Rice University, where he was a Shell Foundation Predoctoral Fellow. Here he investigated the contribution of sensory feedback in the autonomic control of the heart. These studies led to an Individual NRSA grant from

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## A Bioengineering Investigation of Neurocirculatory Control



### Schematic diagram of the *in vitro* experimental setup for single-fiber recordings from rat aortic baroreceptor fibers.

Three physical quantities (action potential, external diameter, and fluid pressure) are digitized and recorded simultaneously onto a PC. Simultaneously, feedback control commands are sent out to the M6 pump for accurate control of the fluid pressure. ADN: aortic depressor nerve that carries the baroreceptor fibers. LSC, LCC and RCC are the left subclavian and left and right common carotid arteries, respectively.

Gender differences in cardiovascular function are well known. Hormones and related receptors are critically important factors but clinical studies are revealing potential gender differences in afferent mediated autonomic nervous system (ANS) function. Some ANS assessments of cardiovascular reflexes have proven to be sexually dimorphic and as a result confound the interpretation of these longstanding clinical tests when used in women. In our lab we are investigating hypotheses related to possible neuroanatomical, neurophysiological and biophysical differences between aortic baroreceptors (BR, i.e. arterial pressure sensors) in male and female rats. We use a synergistic combination of: 1) *in vitro* patch clamp electrophysiological study of fluorescently identified BR neurons both in isolation and within an intact ganglion preparation which makes possible the reliable identification of afferent type through measure of fiber conduction velocity, 2) *in vitro* patch clamp electrophysiological study of fluorescently identified 2nd order BR neurons and neural circuits in the nucleus of the solitary tract (NTS) using brainstem tissue slices, 3) the functional properties of BR are quantified using an intact aortic arch preparation that makes possible the recording of pressure-dependent neural discharge from single BR nerve fibers (see figure), and 4) an integrated study of the parasympathetic limb of the baroreceptor reflex is carried out using an *in situ* whole animal preparation. A gender-related bias in aortic BR fiber type, pressure encoding, reflex response

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# Message from the Chair



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

The Biomedical Engineering Department continues to grow and achieve many of our initial goals. This includes the graduation of our second BSBME class of 16 students while we continue to see growth in our incoming sophomore class – 43 in the Fall 2008 class. Hence we are now beginning to develop a new constituency – ALUMNI! An article in this issue is about Lora Perry, one of our newest alumnae, and what she did on her summer vacation. Hopefully in future newsletters we will continue to highlight alumni activities. Besides discovering the achievements of our graduates, we will also need to keep in touch with them for our ABET accreditation. Our initial accreditation visit will occur in the Fall of 2010 and the key to its success will be input from our alumni, so please give us a bit of time when that survey or phone call comes your way.

The BME department has made two recent faculty hires. Bill Combs joined us in 2007 as a part time Clinical Associate Professor. Bill continues to spend the majority of his time with Medtronic, Inc., his employer for the past 30 years, and as he prepares for retirement he has been teaching our Senior Design course sequence. He brings his knowledge, insight, and managerial skill from industry to these challenging and fun projects. Dr. Sungsoo Na joined us this fall semester as an Assistant Professor. His energy and enthusiasm for BME is evident as soon as you strike up a conversation with him. His focus on cellular biomechanics will bring to both our graduate and undergraduate students unique learning and research opportunities.

Continuing the discussion on research leads us to our most recent successes in extramural research funding. In the first 3 months of this new fiscal year, the faculty members have been awarded almost \$3 million in external research funding – most from the National Institutes of Health. With the bulk of the fiscal year ahead of us we expect to receive between \$4 and \$5 million – setting a new record in the department as well as the school of engineering. This level of activity brings to us many new research faculty and trainees (grad students and post-doctoral fellows) in addition to many undergraduate research opportunities at the leading edge of the faculty expertise.

Recent staff hires in BME are Shelly Albertson as administrative coordinator and Susan Beaver as our financial grants manager. Both have added to our welcoming office ambiance and provide us with much needed skills in running a growing and complex department.

Since the birth of our department in 2004 we have had a small group of industry based advisors who have provided us with their viewpoints and wisdom. A special thanks goes to the group chair Ken Green (Spring Mill Ventures), Mike Hiles (Cook Biotech), Brian Heald (Roche Diagnostics), Jim Mason (Zimmer), and Guido Neels (consultant).

## Sungsoo Na, Ph.D.



Dr. Na joined IUPUI after working for 3 years at the University of Illinois as a Postdoctoral Research Associate. He received his Ph.D. in Biomedical Engineering from Texas A&M University. His primary research interests are: physical and molecular basis of cell migration in the cardiovascular system; the role of angiogenesis in bone development; and pro- and anti-apoptotic regulation in response to mechanical stimuli. The primary objective of his research is to understand the biophysical and molecular mechanism by which cells sense and respond to specific physical stimuli in the environment, including dimensionality, geometry, and rigidity of the extracellular matrix as well as mechanical force. To contribute to this exciting area, his group uses experimental tools and techniques, including: optical microscopy, atomic force microscopy, magnetic tweezers, computational image analysis such as fluorescence resonance energy transfer (FRET), dynamic traction force, and intracellular displacement, extracellular matrix fabrication, and traditional biochemical methods.

Dr. Na is a member of the American Society of Cell Biology (ASCB) and the Biomedical Engineering Society (BMES).

## William Combs, MSEE



Bill joined the Department of Biomedical Engineering part time in September 2007 teaching the project oriented Senior Design Course. He received his MSEE from Purdue University where he participated in a wide variety of research efforts investigating the feasibility of implantable defibrillation. This work led him to Medtronic, Inc. where he has held a variety of roles in Design and Development including Director of Pacing Research. Bill is an inventor of 25 granted patents and has conducted extensive research in the application of chronic implantable devices and therapies to treat and monitor cardiovascular disease. In addition to teaching he continues to conduct research and support collaborative research between IUPUI and the medical device industry, serves on industrial advisory boards and participates in seminars teaching the medical device commercialization process.



## BME's Second Graduating Class

Congratulations to those who earned their bachelor's degree from Biomedical Engineering in 2009. From left: Kellen Knowles, David Sempstrott, Kevin Mauser, Lora Perry, Nate Glass, Renuka Sugumar, Kaitlin Tulloh, Mike Howard, Neha Bhargava, Nick Blacklock, Jimmy DuPriest, Matt Galley, Ahmed Bouchou, Mike Hendon, and Waqar Siddiqui

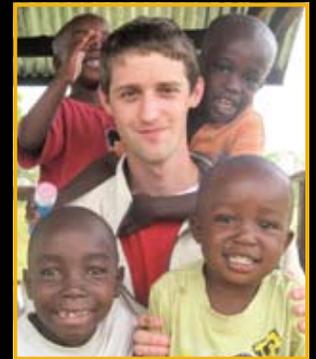
### [ Schild ] Continued from page 1

the National Institutes of Health to continue postdoctoral studies at Oregon Health Sciences University. Dr. Schild's unique use of bioengineering skills and traditional methods of experimental neurobiology led to a Scientist Development Grant from the American Heart Association. At that time he moved to IUPUI as the first faculty hire into the academic program which is now our Department of Biomedical Engineering.

### [ Neurocirculatory Control ] Continued from page 1

and neurohormonal regulation may reveal as yet unrecognized mechanisms associated with noted gender differences in integrated cardiovascular control. Our recently published studies are quantifying the differential composition of ionic channels in myelinated and unmyelinated BR afferents and the manner in which these ion channels may contribute to the strikingly different reflex control of heart rate and blood pressure evoked by these neuroanatomically distinct afferent pathways. Recent morphometric analysis of aortic BR fibers and study of fluorescently identified aortic BR neurons (ABN) has shown that female rats have ~50% more myelinated BR, revealing, for the first time, a functionally distinct subtype of low threshold myelinated ABN rarely present (~2%) in age-matched males. Using an in vitro intact aortic arch preparation for single nerve fiber recordings we have shown that estradiol (E2) can increase the pressure-dependent discharge of single myelinated aortic BR fibers from female rats. Furthermore, physiological levels of E2 (0.1 – 1 nM) acting, at least in part, via membrane bound estrogen receptors can selectively increase the excitability of this unique subtype of ABN in female rats. A recent publication from our lab is the first to document that this neuromodulatory effect upon afferent excitability may be primarily mediated through activation of the recently discovered G protein coupled estrogen receptor 1 (GPR30). Gender-related differences in the neural integration of BR sensory information from the afferent terminal through to 2nd-order BR neurons in the NTS could potentially lead to novel advances in the management of cardiovascular health and disease in the female population. These studies are presently funded through grants from the National Heart, Lung and Blood Institute of the NIH (HL081819 and HL072012).

# BME STUDENTS SPEND SUMMER IN AFRICA



**Lora Perry**, (TOP LEFT) a biomedical engineering 2009 graduate from IUPUI, recently returned from Tanzania, Africa where she had been working with Engineering World Health's (EWH) Summer Institute. Through this program, Lora spent two months helping disadvantaged hospitals and patients while gaining hands-on repair and design experience. Her first month was spent learning the local language, Swahili, and receiving technical lab training in the operation and repair of lab equipment. The second phase of the trip consisted of work at two hospitals, where Lora and her partner worked to repair and install badly needed equipment. She and her partner tried to save the equipment that could be repaired and maintained, while identifying unusable equipment that could be removed to make space for expanding medical services. During this time, she was able to utilize her engineering skills and feel that she was making a difference in the hospitals she was serving. Upon arriving back in the U.S., Lora started work as a volunteer engineer for EWH in North Carolina. She had an amazing time on her trip to Africa, and hopes to be involved in something like it again in the future.

**Sam Whipple**, (TOP RIGHT) a Biomedical Engineering senior at IUPUI, left for Kenya this past July. He participated in a project called "Understanding Kenya through Partnership and Service: Focus on Curriculum Development" which aimed to foster an understanding of Africa through direct experience, dialogue with Africans, and collaborative service projects. While in Kenya, Sam learned several things, but most significantly he learned about the multitude of ways to look at things. He found it interesting to hear the different views of the Kenyan professors in order to be presented with a full picture of a topic. Many of the issues being discussed dealt with human rights and Sam found it enlightening to view some of these perspectives first hand. Having already planned to attend law school after graduation, he now may focus on international law with an emphasis on human rights. Sam recommends this trip to everyone and hopes that a permanent study abroad program to Kenya will be established in the near future.

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## BME Seminar Schedule 2009-10

Sep 18	Dr. Sungsoo Na	BME, IUPUI
Oct 16	Dr. Mike Grey	Panum Institute, Copenhagen University, Denmark
Nov 20	Dr. Lia Stanciu	BME, Purdue University
Dec 4	Dr. Gabriel Gruionu	Vascular Surgery, IUSM
Jan 15	TBA	
Feb 19	TBA	
Mar 26	TBA	
Apr 23	TBA	

## 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*

Sungsoo Na, 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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