

### **FIU Department of Biomedical Engineering** Celebrates

- The 100th Anniversary of Wallace H. Coulter's birth
- The 10th Anniversary of **FIU's Department of Biomedical Engineering**
- The Third Annual **Undergraduate Research Day**

Friday, March 22, 2013

Florida International University **Academic Health Center 4 (AHC 4)** Miami, Florida

# Biomedical Engineering

DREAM, DISCOVER, INSPIRE, INNOVATE



FLORIDA INTERNATIONAL UNIVERSITY



**RANU JUNG** Chair, Department of Biomedical Engineering. Professor and Wallace H. Coulter Eminent Scholars Chair in Biomedical Engineering, FIU College of Engineering and Computing

### **WELCOME MESSAGE**

### Welcome all!

The Biomedical Engineering faculty would like to thank you for sharing with us this important milestone in our department's brief history as we gather together to celebrate our successes and excitement for tomorrow.

In 1997, then-Provost Mark Rosenberg invested in a Cardiovascular Engineering Center to link biomedical research with South Florida industry. That investment led to the foundation of the Department of Biomedical Engineering in 2003.

With almost 400 alumni and nearly 500 enrolled students, perhaps the three words -or maybe just one--that best describes our past decade is: Growth, Growth!

We are now ranked #1 in developing Florida's biomedical engineering workforce. Many of our graduates have been recognized by the university as being World's Ahead and have pursued further education or joined the burgeoning biomedical industry. Our dedicated faculty is supporting the quest for discovery and innovation in their students while conducting translational research that has led to novel solutions that combat disease and improve quality of life.

All along, we have been fortunate to receive essential and timely support. A gift from Norman Weidon has allowed us to support the research efforts of some of our brightest undergraduates. The Special Opportunities Award from The Whitaker Foundation enabled us to lay the foundation of our biomedical engineering curriculum. A generous gift from the Wallace H. Coulter Foundation, matched by the State of Florida, helped us to transform into a full-fledged department and

continues to provide us with the ability to support innovation and launch initiatives.

This is a special year for us and for the entire field of biomedical engineering. It is with great pleasure that we celebrate the 100th anniversary of the birth of Wallace H. Coulter with members of the Coulter Foundation and with our faculty and students—all of whom have benefited from Mr. Coulter's generosity and legacy.

We start the next decade optimistic and committed to sustainable and meaningful growth, engaging with our industrial and clinical partners to nurture a vibrant educational and research enterprise. We are excited to prepare the next generation of biomedical engineers for the complexities of tomorrow's work environment, and to pursue scientific discovery and innovative solutions that impact our community, our state, our nation and the world.

On this anniversary, we are fortunate to be joined by many individuals and organizations that have helped us succeed. It is our pleasure to welcome back our founding chair and the members of the FIU administration who have supported our growth through the years. Most importantly, we welcome our alumni and students who are FIU-BME Weidon/Whitaker/Coulter ambassadors to the world, and who are doing great work in transforming health care through technology. We thank you all for your support and we thank you for joining us in this celebration.



MARK B. ROSENBERG President. Florida International University

### PRESIDENT MARK B. ROSENBERG MESSAGE

### Dear friends.

Ten years ago we ushered in an exciting new era of research, creativity and learning when we created the Department of Biomedical Engineering at FIU. Today, I am proud to welcome you as we celebrate the department's first decade.

As part of our celebration, we are also marking the 100th Anniversary of Wallace H. Coulter's birth and recognizing our students at the Third Annual Undergraduate Research Day. Together, we are all making a difference in the very vital field of biomedical engineering.

Our faculty is creating new tools and ways to improve quality of life. Our students are learning and growing with unique interdisciplinary research and educational opportunities. And our collaboration with the Coulter Foundation enables us to continue to grow our department and make that research happen.

On behalf of FIU, it is my pleasure to congratulate the students, faculty and alumni that have helped to reach today's milestone, and I am looking forward to many, many more.

Sincerely,

Mark B. Rosenberg President, Florida International University

### MESSAGE FROM CONGRESSMAN MARIO DIAZ-BALART

Dear Dr. Jung, March 22, 2013

I would like to take the time to congratulate you and the Biomedical Engineering Department on the 100th anniversary of Dr. Wallace Coulter's birth, the Tenth Anniversary of the Department and the Third Annual Undergraduate Research Day.

It is my understanding that in only ten short years, the FIU Biomedical Engineering Department has demonstrated excellence by graduating students at the bachelor's, master's, and doctoral degree levels with the number one instate employment rates in the entire State University System of Florida. The Department is the only one in the nation offering accredited undergraduate and advanced degree programs in biomedical engineering at a public minority and Hispanic-serving institution. Enrollment currently exceeds 400 students, and alumni already number in the hundreds.

To my knowledge, biomedical engineering WORLDS AHEAD faculty has made research their priority. With research awards at over \$475,000 per faculty member, the department leads the College of Engineering and Computing. Their innovative research focusing on providing technological solutions for improving health care needs, benefits our local community as well as regional and national interests.

Sincere thanks should be given to Dr. Peter Katona, former president and CEO of the Whitaker Foundation, who was instrumental in the department's creation through the Whitaker Foundation's Special Opportunity Award for establishing the Biomedical Engineering Institute; Sue Van, Susan Racher and members of The Wallace H. Coulter Foundation whose endowment helped establish the department, and members of the FIU Academic Health Center, who are the Department's strong partners.

The South Florida community is very proud of FIU, Miami's first and only public research university, offering degrees at all levels and serving its academic and local community with pride and success. Again, congratulations and may the Biomedical Engineering Department continue its excellence in the future.

Sincerely,

Mario Diaz-Balart Member of Congress











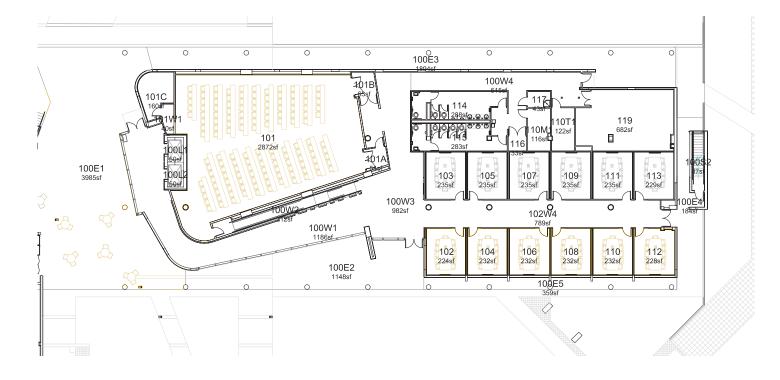
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### **AGENDA**

TIME	EVENT	SPEAKERS	LOCATION
12:00 p.m 3:00 p.m.	Undergraduate Research Posters		AHC 4 First Floor
	FIU Biomedical Engineering Patents and Prototypes		AHC 4 First Floor
3:00 p.m. – 4:15 p.m.	Welcome	Andrés Gil , Vice President for Research, FIU	
	Advancing Your Discovery to the Bedside: Early Stage Investing and Venture Capital Panel	Robert L. Crutchfield, Partner, Harbert Venture Partners; Bard Geesaman, Managing Director, MPM Capital; Clay Thorp, General Partner, Hatteras Venture Partners; John Tullis, Partner & Head of International, Tullis Health Investors; Moderator: Susan Racher, Vice President and CFO, The Wallace H. Coulter Foundation	AHC 4 Auditorium 101
4:30 p.m 6:30 p.m.	Recognition & Celebratory Program		
	Welcome & President's Video	Douglas Wartzok, Provost and Executive Vice President, FIU	
	FIU College of Engineering and Computing Overview and Vision	Amir Mirmiran, Dean, FIU College of Engineering and Computing	
	FIU Department of Biomedical Engineering Overview and Vision	Ranu Jung, Chair, Department of Biomedical Engineering, Professor and Wallace H. Coulter Eminent Scholars Chair in Biomedical Engineering	AHC 4 Auditorium 101
	Keynote	Peter Katona, Professor, Electrical and Computer Engineering, George Mason University; Former President & CEO, The Whitaker Foundation	
	Wallace H Coulter's Legacy	Susan Racher, Vice President and CFO, The Wallace H. Coulter Foundation	
	Student Awards and Closing Remarks	Andrés Gil , Vice President for Research, FIU	
6:30 p.m 8:00 p.m.	Cocktail Reception		AHC 4 Breezeway

### All events listed are located on the first floor of the Academic Health Center 4 (AHC 4) building.







WALLACE H. COULTER

### **CELEBRATING THE LEGACY OF WALLACE H. COULTER**

Like many of the students whose work you have seen today, Wallace Coulter always had an inquisitive mind. Fascinated with numbers and gadgets from an early age, Wallace turned down an offer of a bicycle for his 11th birthday and instead asked for his first radio kit.

In 1953, he was issued his first patent for an instrument known as the Coulter Counter, a simple device that increased the sample size of a blood test by 100 times the usual microscope method by counting in excess of 6,000 cells per second while also decreasing the time it took to analyze the sample from 30 minutes to 15 seconds and reducing the error by a factor of 10 times.

Five years later, Wallace and his brother Joseph Coulter Jr. founded Coulter Electronics to manufacture, market and distribute their Coulter Counters. With Joseph Sr. serving as secretary-treasurer, Wallace and Joe Jr. built the early models, which they loaded in their cars and sold themselves. By 1959, the growing company had established subsidiaries in the UK and France, and two years later the Coulter brothers relocated to the Miami area where they remained for the rest of their lives.

The company grew to become the industry leader in blood cell analysis equipment –employing almost 6,000 people, with over 50,000 instrument installations – and spawned entire families of instruments, reagents and controls in hematology, flow cytometry, industrial fine particle analysis and other laboratory diagnostics.

Coulter Electronics's success enabled Wallace to establish the Wallace H. Coulter Foundation, dedicated to improving health care through medical research and engineering. Before creating programs to support translational research in biomedical engineering, the Foundation had already begun collaborating with the colleges, universities and professional associations that had prior relationships with Wallace Coulter.

As you may know, many Coulter Corporation employees graduated from FIU, so it was here that the Foundation first turned its attention with a \$5 million grant in July 2000 to establish a new Department of Biomedical Engineering. The timing of this grant allowed the university to apply for and receive matching funds from the State of Florida, resulting in a \$10 million combined grant to the department. This created an endowment to advance research and education through the establishment of two endowed chairs, scholarship and research funds, a biomedical engineering lecture series and a young inventors program.

The fruits of the relationship between the Coulter Foundation and FIU are all around you in the work of our dedicated faculty, engaged students and successful alumni. The Coulter Foundation's generosity has truly transformed the Department of Biomedical Engineering at FIU, supporting its quest for a bright future.

## IMPACT OF THE WALLACE H. COULTER FOUNDATION ON BIOMEDICAL ENGINEERING AT FIU

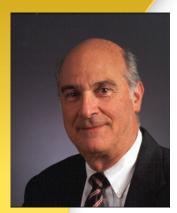
The transformational gift of \$5 million from the Wallace H. Coulter Foundation and its subsequent state match for a total impact of \$10 million have supported endowed faculty positions, scholarships and fellowships, research seed funding, a lecture series and critical infrastructure for the BME Department. The outcomes produced as a result of the Foundation's generosity include the

- Eminent Scholars Chair in Biomedical Engineering
- Distinguished Professorship in Bioinstrumentation and Biomeasurement
- Biomedical Engineering Excellence Fund
- Biomedical Engineering Research Initiation Program Endowment:
   Collaborative Technology Innovation Program (CTIP)
- Cardiovascular Engineering Center Fund
- The Young Inventor Program Endowment
- The Biomedical Engineering Lecture Series Endowment
- Graduate Fellowships in Biomedical Engineering Fund
- Biomedical Engineering Excellence Scholarship Endowment Fund

### A VIEW TO THE FUTURE

At this exciting moment in the history of biomedical engineering at FIU, the University is honored to be a partner of the Wallace H. Coulter Foundation. On behalf of the faculty and students who have benefited from the Foundation's generosity and continue to realize the vision of Wallace H. Coulter, the Department of Biomedical Engineering extends its deep and sincere appreciation for the Foundation's ongoing support. Committed to perpetuating the legacy of Mr. Coulter, the Department looks forward to developing future innovations that will enhance the well-being of South Florida residents and others for decades to come.





PETER G. KATONA, SC.D.

### **KEYNOTE SPEAKER PETER G. KATONA, SC.D.**

## PROFESSOR, ELECTRICAL AND COMPUTER ENGINEERING, GEORGE MASON UNIVERSITY FORMER PRESIDENT AND CEO, THE WHITAKER FOUNDATION

Dr. Katona received his B.S. degree in electrical engineering at the University of Michigan in 1960, and his M.S. and Sc.D. at the Massachusetts Institute of Technology in 1962 and 1965, respectively. He was on the faculty of the Department of Biomedical Engineering at Case Western Reserve University from 1969 to 1991, and served as chairman of his department from 1980 to 1988. Katona joined The Whitaker Foundation as vice president for biomedical engineering in 1991, becoming president in 2000, a position he held until the foundation's closing in 2006. He was appointed professor of electrical and computer engineering (ECE) at George Mason University in 2006, and was instrumental in establishing a Department of Bioengineering at the university in 2010. Currently he is a professor in both the bioengineering and ECE departments. Katona is the author of over 50 scientific papers on the control of the cardiovascular and respiratory systems. He served as president of the Biomedical Engineering Society in 1984-85, and received the society's Pierre Galletti Award in 2006. He is a fellow of the American Association for the Advancement of Science, American Institute for Medical and Biological Engineering (AIMBE), and the cardiovascular section of the American Physiological Society.

#### The Whitaker Foundation

The Whitaker Foundation was created and funded by U.A. Whitaker upon his death in 1975. His wife, Helen, who shared in his philanthropy during his lifetime, joined him in bequeathing a significant portion of her estate to the foundation when she died in 1982. Throughout its history, the foundation primarily supported interdisciplinary medical research, with a focus on biomedical engineering. It contributed more than \$700 million to universities and medical schools to support faculty research, graduate students, program development, and construction of facilities. Most of its efforts were directed toward the establishment and enhancement of formal educational programs and the support of especially talented students and faculty.

In November 1998, FIU was granted a \$1 million Special Opportunity Award from The Whitaker Foundation to implement the MS program in biomedical engineering along with an undergraduate minor in biomedical engineering, and to establish the Biomedical Engineering Institute. This helped to establish the educational foundation for the eventual formation of the Department of Biomedical Engineering at FIU. Rather than creating an organization that would live in perpetuity, U.A. Whitaker wished to have the principal and income of his foundation distributed within a finite period of time so as to maximize its impact. Following the wishes of its founder, the foundation closed in 2006.



### **HIGHLIGHTS OF 10 YEARS OF BIOMEDICAL ENGINEERING AT FIU**

1997	The FIU Provost's Office		
	provides a Quality Improvement		
	Program Award of \$250,000 per		
	year for three years to establish		
	the Cardiovascular Engineering		
	Center as a resource for the		
	cardiovascular device industry.		

998 Norman Weldon, co-founder of Cordis Corporation, donates a \$100,000 endowed gift to support undergraduate research assistants.

The Whitaker Foundation donates a \$1 million Special Opportunity Award to establish the Biomedical Engineering Institute.

1999 The Master of Science (M.S.) degree program is established.

The Wallace H. Coulter
Foundation donates a \$5 million
endowment matched by the
state for a total impact of
\$10 million, to improve health
care through the support of
biomedical engineering in higher
education.

The National Science
Foundation Partnership for
Innovation awards \$600,000 to
establish the BME Partnership
Program and the Institute
for Technology Innovation,
a unit of FIU's Pino Global
Entrepreneurship Center.

2002 The Bachelor of Science (B.S.) degree program is established.

2003 The FIU Department of Biomedical Engineering is established.

The Doctoral (Ph.D.) degree program is established.

2004 Miami Children's Hospital funds the MCH-FIU Professorship in Neuro-Engineering, a joint faculty position of MCH and FIU.

2006 The Ware Foundation donates a \$1.4 million endowment to permanently support a post-doctoral fellow in the Laboratory for Brain Research and Neuro-Engineering Applications.

2006 The B.S. program receives ABET accreditation in the shortest time possible.

2006 Annual research awards total over \$1.8 million, the equivalent of \$200,000 per FTE tenuretrack faculty.

The Florida 21st Century World Class Scholar Program awards \$1 million to establish a joint BME/College of Medicine faculty position for the Wallace H. Coulter Distinguished Professor.

2007 Annual research awards total over \$2.2 million, the equivalent of \$300,000 per FTE tenure-track faculty.

OO7 A BME chapter of the Alpha Eta Mu Beta Honor Society is established.

2008 Annual research awards total over \$1.8 million, the equivalent of \$250,000 per FTE tenuretrack faculty.

2009 The Department hosts the 25th Summer Biomedical Engineering Conference in Miami, and receives ABET reaccreditation for the B.S. program. Annual research awards total nearly \$1.6 million.

2009 The AEMB and BMES Societies partner to create a mentoring program for students at Miami Dade College and TERRA Magnet High School.

2011 The department hosts "EDC Biotech" in Miami, an annual life science conference of EDC, a nonprofit South Florida organization. A new chair is hired.

The department hosts PAHCE 2012-the Pan American Health Care Exchange conference.
Annual awards total nearly \$4 million, the equivalent of \$475,000 per FTE tenure-track faculty. Two new associate professors are hired.

2013 The department hosts
29th Southern Biomedical
Engineering Conference
and adds another associate
professor.

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### **PANEL PARTICIPANTS**



**CLAY B. THORP**General Partner, Hatteras Venture Partners

Clay Thorp is an entrepreneur turned venture capitalist. Since 1995, Thorp has co-founded seven companies in the life science arena and co-founded Hatteras in 2001. Since co-founding Hatteras, he has been instrumental in building the firm and has led investments in a range of life science companies, including biopharmaceutical, medical device, diagnostics, and research informatics.

Thorp was the lead investor and led the strategic transaction process for ArtusLabs that resulted in its sale to PerkinElmer in 2011. He was a co-founder and served as CEO and chairman of Synthematix, Inc., a chemistry informatics company that was acquired in April 2005 by Symyx Technologies (SMMX). Clay is a co-founder and former chairman of Phase-Bio Pharmaceuticals, Inc. He was the co-founder and head of corporate development for Novalon Pharmaceutical Corporation, where he led financing efforts and was head of business development from inception until Novalon's sale to Karo Bio in May of 2000. Prior to Novalon, Thorp was the co-founder and president of Xanthon, Inc., a bioinformatics company with electro-chemical detection technology for direct analysis of DNA, RNA and proteins.

Thorp currently serves as chairman of GeneCentric Diagnostics and lead director of Pathfinder Therapeutics. He is also on the boards of PhaseBio Pharmaceuticals, Clearside Biomedical, and G1 Therapeutics. He holds a master's of public policy from Harvard University and a B.A. in mathematics and history from the University of North Carolina at Chapel Hill.



JOHN TULLIS

Partner and Head of International,
Tullis Health Investors

John Tullis is responsible for Tullis Health Investors' international activities. His investment focus areas include international health care commercialization, healthcare services and healthcare information technology investments, where he works with and engages companies, offering guidance and global perspective. Tullis has spent more than 15 years in international business in various capacities, including venture capital, capital markets, and corporate development. Tullis has a B.A. from DePauw University. He received a graduate business certificate from the University of Virginia's McIntire Business Institute, and an M.B.A. from the University of Miami School of Business Administration. At age 15, he studied at Tse Hsui Gautzhong, a Taiwanese boarding school, where he was the school's only non-Chinese student.



### **ROBERT L. CRUTCHFIELD**

Partner, Harbert Venture Partners Roberth L. Crutchfield joined Harbert Management Corporation (HMC) in September 2008 and serves on the board of Optimal IMX, WellCentive and RegisterPatient. He also serves as the board observer for Innovative Biosensors, MaxCyte, OpenQ and Clinipace. In addition to his responsibilities at Harbert, he serves as the president of the Southeastern Medical Device Association and is a member of the Board of Directors for the Birmingham Venture Club, the Southern Capital Forum and the True Vine Foundation. He is also a member of the Investor Advisory Board for the Florida Institute for the Commercialization of Public Research, the Florida High-tech Corridor Council, and serves as the co-chairman of the Commercialization Advisory Committee of the Birmingham Business Alliance, on the Steering Committee of the Alabama Obesity Institute at the University of Alabama in Birmingham, and is a Venture Fellow at the University of Alabama in Tuscaloosa and a Visiting Executive in Residence at Auburn University.

Crutchfield is a graduate of the University of Georgia and holds Bachelor of Science degrees in political science and chemistry.



### **SUSAN RACHER (MODERATOR)**

Vice President and Chief Financial Officer, Wallace H. Coulter Foundation
The Wallace H. Coulter Foundation was established in 1999 from the estate of
Wallace Coulter, founder and chairman of Coulter Corporation. The foundation
continues Wallace's practice of providing risk capital for innovative initiatives through
its grants. The largest of the foundation's programs promotes academic translational research based in biomedical engineering. By implementing industry best
practices, this program accelerates the translation of promising technologies into
practical advances that improve patient care. The foundation also collaborates
with leading medical societies to bring the latest education and standards of care
to resource-limited countries. Finally, working with Asian American organizations,
the foundation is building a consortium that establishes one cohesive community to
promote collaboration and partnership.

Susan Racher has been vice president and chief financial officer since the foundation's formation. She manages the endowment's investment strategy and its portfolio, including a portfolio of health care venture capital investments. She also oversees tax, accounting, compliance, and IT; and is a member of the foundation's grant oversight committee.

Prior to joining the Foundation, Racher was a senior managing director of Bank of America, where she ran the bank's Florida corporate banking division and also managed the bank's extensive relationship with Coulter Corporation. She has served as chair of the Miami-Dade County Public Schools Treasury Advisory Committee, and is a member of the Public Schools Superintendent's Business Advisory Board, as well as a VP and board director of Foundation Financial Officers' Group. Racher earned a B.A. in English and economics from Smith College, and an M.B.A. in finance and accounting from the University of Chicago.



### **BARD GEESAMAN**

Managing Director, MPM Capital

Dr. Bard Geesaman began working with MPM in 2001 as part of the management team for the portfolio company Elixir Pharmaceuticals. In 2006 he became a venture partner at MPM and co-founded Solasia, a specialty pharmaceutical company in Asia developing oncology products. Prior to working at MPM, Geesaman was a General Partner at F2 Ventures, a U.K. based investment firm where he managed the private investments. Geesaman received his Ph.D. in systems biology from M.I.T., his M.D. from Harvard Medical School, and his B.S. in neurobiology from U.C. Berkeley. He is board certified in internal medicine and did his residency at Massachusetts General Hospital.

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### **UNDERGRADUATE RESEARCH POSTERS**

	TITLE	NAME	FACULTY ADVISOR
1	Design and Development of Hand-Opening and Pinch Forces Sensors	Andres Pena, Sathyakumar S. Kuntaegowdanahalli, James Abbas	Ranu Jung
2	Determination of PGMD Molecular Weight	Douglas Wright	Anthony McGoron
3	Large Scale Analysis of Ion Channel Gene Expression in Rat Aortic Smooth Muscle Cells and Rat Aortic Microvascular Endothelial Cells	Florencia Goluboff, Daniel Rodriguez, Mahesh Joshi, Adam Kapela	Nikolaos Tsoukias
4	Pharmacokinetics and Biodistribution of PGMD Nanoparticles in Mice	Azael Sarmiento	Anthony McGoron
5	Trafficking the Intracellular Pathway of Multi- functional Nanoparticles in Cancer Cell Lines	Christopher Emerson, Sai Hemchandra, Tingjun Lei	Anthony McGoron
6	The Assessment of Azulenyl Nitrone as a Sensing Material for Gamma Radiation Ster- ilization Dosimetry of Healthcare Products	Kenneth Riggott	David Becker
7	Micro-Fluidics Meningitis Diagnostic Device	Priscilla Torres	Yen-Chih Huang
8	Three-Dimensional Tomographic Image Analysis of Resolution Using a Hand-Held Optical Imager	Rad Akhter, Manuela Roman, Jean Gonzales, Sarah Erickson	Anuradha Godavarty
9	Various Implementations 3-D Printing Techniques for the Development of Biological Tissue and Scaffolds	Rudy Rodriguez	Yen-Chih Huang
10	Computer Simulations to Evaluate the Role of Cytomegalic Neurons in the Genesis of Seizures in FCD	Eric Benk	Jorge Riera
11	Quasi-Static Analyses of Shear Stress Distributions on a Tri-Leaflet Valve Structure	Gina Brignola, Makensley Lordeus	Sharan Ramaswamy
12	Real-Time Impedance Analysis of Epithelial Breast Cancer Cells	Celisse Zabalo, Frank A. Alexander Jr.	Shekhar Bhansali
13	Gene Expression of Ion Channels from Salt-Sensitive Dahl Rat Mesenteric Artery by RT-PCR	Natalie Cortes, Mahesh S. Joshi	Nikolaos Tsoukias
14	Selection of Blood Contacting Materials for use in Vascular Access Device Applications	Danique Stewart, Manuel Dugrot	Norman Munroe, Sharan Ramaswamy
15	Investigation of Cognition in Motor Skills for Healthy Adult individuals using Simultaneous Kinematics and Near Infrared Spectroscopy studies	Bryant Thompson, Ujwal Chaudhary, Young-Jin Jung, Leonard Elbaum	Anuradha Godavarty

### 1. Design and Development of Hand-Opening and Pinch Forces Sensors

## ANDRES PENA, SATHYAKUMAR S. KUNTAEGOWDANAHALLI, JAMES ABBAS FACULTY ADVISOR: RANU JUNG

### Abstract:

There is growing interest in developing prosthetic limbs capable of providing sensory feedback to amputees. The development of such advanced systems requires accurate, quantitative assessment of the sensation perceived by the amputee. We have designed and fabricated robust devices to track and record hand-opening distance and pinch force during a series of structured tasks performed by unilateral amputees using their intact hand to mirror perceived sensation in the amputated limb. For hand-opening distance measurement, the subject's thumb and forefinger are coupled to linear potentiometers. While subjects open and close their hand freely, the distance between the thumb and forefinger is estimated in real time by recording the voltage output. For pinch force measurement, a commercially available mini compression load cell is mounted on a custom-designed aluminum assembly that is adjustable to enable measurement at different hand-opening distances. The load cell generates a voltage signal proportional to the applied pinch force. Calibration was accomplished by applying incremental forces using a compression load testing device while monitoring the voltage output. These measurements will help to quantify the amputee's perception of hand-opening and pinch force and thereby serve towards developing a subject-specific sensor-stimulation map that can be programmed into an advanced prosthesis.

### **2.** Determination of PGMD Molecular Weight DOUGLAS WRIGHT

### **FACULTY ADVISOR: ANTHONY MCGORON**

### Abstract:

As the second leading cause of death in the U.S., cancer is estimated to kill over 500,000 Americans in this year alone. The use of nanoparticles as drug vehicles is an exciting new field that shows great promise of improving screening and targeted treatment efficiencies of this disease. Ranging in size from 110 – 140nm, these particles exhibit extended persistence times and can be loaded with targeting moieties that seek diseased cells, at which they are readily endocytosed. The use of poly-glycerol-malic aciddodecanedioic (PGMD) as the substrate of the vehicle bestows an array of beneficial properties. However, these properties, which include vehicular loading capacity, particle size and degradation rate, cellular permeability, and binding and release kinetics, are highly dependent on PGMD's molecular weight. This work determined the number average molecular weight of one formulation of this polymer using high-performance liquid chromatography combined with a sensitivity analysis of the determination procedure. It was found that PGMD's molecular weight is approximately 3500 Da, lending nanoparticles formed from this polymer high cellular permeability, high binding and release efficiencies, and high biodegradability. Future research will measure the molecular weight of multiple formulations of this polymer.

### 3. Large Scale Analysis of Ion Channel Gene Expression in Rat Aortic Smooth Muscle Cells and Rat Aortic Microvascular Endothelial Cells

FLORENCIA GOLUBOFF, DANIEL RODRIGUEZ, MAHESH JOSHI, ADAM KAPELA FACULTY ADVISOR: NIKOLAOS TSOUKIAS

#### Abstract:

Background: Membrane bound proteins such as ion channels, transporters and receptors found in vascular endothelial cells (ECs) and smooth muscle cells (SMCs) have been recognized as key regulators of vascular tone and may contribute to the hypertensive phenotype. This study aims to examine the mechanisms that regulate gene expression of membrane proteins associated with Ca2+ mobilization, cell electrophysiology and vessel tone. A large-scale expression study (i.e. 50-100 genes) will be performed in cultured SMCs and ECs. Methods: Cultured rat aortic microvascular smooth muscle cells (LRASMC) and rat aortic microvascular endothelial cells (RAMEC) were used at a confluence of roughly 80% between passages 5 and 7. Approximately 800,000 cells were harvested in order to obtain approximately 25 µg of mRNA. Accordingly, mRNA was isolated and purified (Qiagen's Rneasy RNA purification kit). cDNA was then synthesized and purified. Primers were constructed for genes associated with specific cell components such as inositol trsiphosphate receptors (IP3R), Transient Receptor Potential ion channels (TRPM, TRPC), inward rectifier Potassium channels (Kir), Voltage regulated Calcium channels (Cav), sarco-endoplasmic reticulum calcium-ATPase (SERCA2a), and Housekeeping genes, (Acta2, \( \beta \)-actin. PECAM-1). A Real-Time PCR System (Applied Biosystems' StepOne™) was used to record gene amplification/expression. A detailed mathematical model will assess the effect of altered gene expression on cell phenotype. This study will investigate a) expression changes in cells exposed to stresses and b) the regulatory mechanisms of expression following gene inhibition with siRNA.

This work has been supported by an NIH-MBRS and NIH grant (SC1HL95101).

## **4.** Pharmacokinetics and Biodistribution of PGMD Nanoparticles in Mice

AZAEL SARMIENTO

**FACULTY ADVISOR: ANTHONY MCGORON** 

### **Abstract:**

To date, cancer is still a looming menace as shown by an estimate that 1.6 million new patients will be diagnosed with cancer in 2012. Chemotherapy is one of the most common treatments but its severe adverse effects can outweigh the therapeutic ones. Drug delivery systems involving nanoparticles show promise in correcting these deficits. Polyglycerol malate co-dodecandioate (PGMD) has been studied in vitro and results show that it increases the retention of doxorubicin and the dye IR820 in multidrug-resistant cancer cell lines. To assess its usefulness as a nanoparticle platform, the

pharmacokinetics and biodistribution of PGMD-encapsulated IR820 and doxorubicin were studied in mice. The nanoparticles were delivered by tail vein injection, and the concentration of IR820 and doxorubicin in blood and organs of the reticuloendothelial system were measured by spectrofluorometry at 15, 30 and 60 minutes and 24 hours. A mathematical model was used to fit the data and obtain the plasma clearance time, half-life, area under the curve and mean residence time. The results show that PGMD nanoparticles improved the pharmacokinetic characteristics of IR820 and doxorubicin, and decreased the accumulation of IR820 in the kidneys.

## **5.** Trafficking the Intracellular Pathway of Multifunctional Nanoparticles in Cancer Cell Lines

## CHRISTOPHER EMERSON, SAI HEMCHANDRA, TINGJUN LEI

FACULTY ADVISOR: ANTHONY MCGORON

#### Abstract:

Recently, nanomedicine has become a new platform to diagnose and treat cancer. Nanoparticles (NPs) have been formulated to safeguard specific content, such as anticancer drugs, and are designed for targeted delivery to cancer cells. NPs have been successfully designed to increase circulation time, protect the cargo from degradation, reduce off-target toxic side effects, and increase the uptake of particles by cancer cells; however, there has been less investigation as to the endocytosis pathways and intracellular trafficking and fate of these NPs. Studies have also shown that NPs are able to bypass the overexpression of P-glycoprotein (P-gp) in multidrug resistant cancer cells. In our studies, we prepared novel polyglycerol-malic acid-dodecanedioic (PGMD) NPs containing an imaging/hyperthermia agent (IR820) and a chemotherapeutic agent (doxorubicin, DOX). For maximum drug delivery efficacy, NPs must not only be tailored to specifically reach their cellular target, but they must also be able to reach the desired subcellular target. Cellular entry through endocytosis pathways generally results in lysosomal degradation of the NPs. The purpose of this research is to characterize the endocytosis pathway of PGMD NPs in MES-SA/Dx5 and MES-SA cell lines using endocytosis chemical inhibitors, with future aims to modify the PGMD NPS if needed so they are able to overcome the degradation in endosomes or lysosomes. Our research group suspects that cellular entry of the PGMDNPs is through the clathrin-mediated endocytosis or the caveolae mediated endocytosis. It has been shown that chlorpromazine inhibits the clathrin mediate endocytosis and genistein inhibits the caveolae-mediated endocytosis. These chemical inhibitors, along with potentially other chemical inhibitors will be used to determine the specific route of PGMD NPs in to the MES-SA/ Dx5 and MES-SA cancer cell lines.

# **6.** The Assessment of Azulenyl Nitrone as a Sensing Material for Gamma Radiation Sterilization Dosimetry of Healthcare Products

KENNETH RIGGOTT
RESEARCH MENTOR: DAVID BECKER

### **Abstract:**

Since its initiation in the late 1950's, processing products with gamma radiation has become standard procedure as a result of its advantages which include immediate use of product after treatment, minimal temperature rise in product during treatment, ability to treat products while in packages, precision and reproducibility, and ease of control. To measure radiation exposure levels required for sterilization of medical products, alanine pellets and ceric cerous solution are traditionally used as dosimeters. Alanine pellets respond to ionizing radiation with changes in electron spin resonance, and ceric cerous solutions respond to ionizing radiation with changes in optical absorbance within the ultraviolet spectrum. Azulenyl Nitrone (AZN) is a green solid derived from the non benzenoid aromatic compound azulene. Azulenyl nitrones have been demonstrated to constitute a class of nitrone based spin traps with the capacity to tag free radicals by yielding colored spin adducts. In the presence of free radicals created by exposure to gamma radiation AZN changes from green to red. The resulting red compound is Azulenyl Amide (AZAM). AZN will be dissolved in acetone and coated onto celluloid surfaces, then exposed to gamma radiation between 15 and 30 kGy. Visual inspection and colorimetric analysis are expected to show that the AZN changes into AZAM when the celluloid surfaces are exposed to gamma radiation within the indicated ranges. The data should support the usage of AZN as a sensing material for gamma radiation sterilization dosimetry of healthcare products, and this is important because of the significance of being able to accurately and cost effectively detect gamma radiation dosage during the sterilization of medical products.

# 7. Micro-Fluidics Meningitis Diagnostic Device PRISCILLA TORRES FACULTY ADVISOR: YEN-CHIH HUANG

Abstract:

The utilization of microfluidics has become an emerging and innovative topic in the biological and chemical field. The application of microfluidics in a diagnostic aspect has provided a feasible approach to detect diseases. The use of microfluidics in the detection of diseases has become more widespread in the field of infectious diseases. Currently, its use as "Lab on a Chip" to detect infections in developing nations has been a popular approach to address global health in countries that do not have necessary laboratorial conditions for disease detection. For this reason, it would be beneficial to develop a form of diagnosis for patients in developing world countries that can detect Meningitis in an expedited and feasible manner, without requiring a laboratorial setting. Meningococcal Meningitis is considered a widespread bacterial infection that has caused deaths around the globe for many years. This disease causes outbreaks annually throughout the world, causing 1,000 cases in a 100,000 population. As the bacterial infection reaches the bloodstream of the host, antibiotic treatments can be administered to disrupt the infection process before organ damage occurs. However, the treatments are dependent on the type of meningitis and the severity of the disease. The micro-fluidic meningitis device proposed will provide a cost effective and preliminary diagnosis that will utilize the science of micro-fluidics and dry reagents to detect bacterial infections. As a mobile device it is a tool that requires a minimum volume of fluid to complete its performance.

# **8.** Three-Dimensional Tomographic Image Analysis of Resolution Using a Hand-Held Optical Imager RAD AKHTER, MANUELA ROMAN, JEAN GONZALES, SARAH ERICKSON

**FACULTY ADVISOR: ANURADHA GODAVARTY** 

**Abstract:** 

Among different modalities, diffuse optical imaging is a promising approach for breast cancer imaging. Hand-held optical imagers have enhanced the translation of the technology to the clinic. However, the hand-held imagers developed to date are capable of performing only two-dimensional (2D) imaging. In our Optical Imaging Lab (OIL), we have developed a Gen-2 hand-held optical imager capable of 2D surface and 3D tomographic imaging. The optical imager is composed of an intensified charge-couple device (ICCD) based detector, six 785nm laser diodes which are connected to probe heads via optical fibers, and two part forked probe. Fluorescence-enhanced resolution imaging studies have been carried out under various experimental conditions using slab phantoms filled with 1% intralipid solution. Reflectance fluorescence images were acquired from phantom contains two 0.95cm diameter targets filled with ICG (Indocynanine Green, a fluorescence contract agent) that were placed at various depths of 0.5 to 2.5cm. The two targets were separated by different distances of 0.5 to 4cm during the studies. Previously, 2D fluorescence images were generated based on the intensity values detected by the ICCD camera using a customized Matlab code. In the current study, the 2D fluorescence data was tomographically reconstructed using appropriate inversion algorithms, and further processed using TecPlot in order to resolve the targets in 3D. Based on the 3Dimages, targets were recovered and resolved up to a distance of 1.5cm between target edges. Currently, extensive 3D tomography studies are carried out to determine the resolution capabilities of the hand-held optical imager.

# **9.** Various Implementations 3-D Printing Techniques for the Development of Biological Tissue and Scaffolds RUDY RODRIGUEZ

FACULTY ADVISOR: YEN-CHIH HUANG

**Abstract:** 

The need for biological tissue has steadily increased, in spite of the lingering availability of tissue from donors and the technical limitations encountered during the processing of various types of specialized tissue. Approximately two thirds of those needing an organ transplants, for example, will not receive it within a given year. In the face of this setback of the medical to provide all patients, emerging technologies such as rapid prototyping in the field of tissue engineering is becoming readily available. A highlighted method involves the computerized numerical control of an extruder deposing biological materials layer by layer, manufacturing a three dimensional piece of biological material. Such 3-D printing techniques can lead to the development of artificial scaffolds used to replace biological structures, with characteristics of said structure. It would be able to be populated by natural or cultured cells, forming an organ that is close to its natural, intended form. Not only are tissue structures from a scaffold possible with 3-D printing, but cells alone can be deposited to form tissue, as well as an implementation of templates for printing of cultures, useful for personalized medicine. Despite the limitations of the technology, it has an opportunity eliminate the waiting lines for available organs, providing an improved, personalized treatment.

## **10.** Computer Simulations to Evaluate the Role of Cytomegalic Neurons in the Genesis of Seizures in FCD

**ERIC BENK** 

**FACULTY ADVISOR: JORGE RIERA** 

Abstract:

Severe focal cortical dysplasia is distinguished by the presence of cytomegalic neurons and balloon cells. These cells are thought to be responsible for epileptogenic activity observed in these brain lesions. According to previous observations (Cepeda et al., 2003, 2005, 2010), cytomegalic neurons are much bigger than normal healthy neurons; hence, their membranes show significantly higher capacitance and lower resistance as determined by whole-cell recording techniques. Additionally, cytomegalic cells have larger type-L calcium channel conductance. Therefore, it has been hypothesized that these cells are essential for the genesis of seizure-like activity. We simulated membrane potentials in cytomegalic neurons using a model developed in our laboratory for cortical pyramidal cells (Wang et al., 2013). We adjusted the size of these cells as well as their capacitance and resistance according to observations by Cepeda and collaborators. We were able to reproduce some aspects, but not all of the neuronal activity in these types of cells as previously reported in voltage and current clamp protocols. Additionally, we evaluated the responsiveness of cytomegalic neurons to sub-threshold spontaneous activity. This study allowed us to shed light on what exactly causes the focal epileptic seizures in cortical dysplasias and eventually will help us develop techniques for treatment.

### 11. Quasi-Static Analyses of Shear Stress Distributions on a Tri-Leaflet Valve Structure

GINA BRIGNOLA, MAKENSLEY LORDEUS FACULTY ADVISOR: SHARAN RAMASWAMY

**Abstract:** 

In the pursuit of improved heart valve implants, elastomer-based valves are an appealing option in terms of similar deformation characteristics to native valves; yet elastomers with their relatively poor tear strength are also susceptible to structural failure. The development of emerging elastomer tri-leaflet valve prosthetic valves requires rigorous analysis of temporal fluid-induced shear stresses that will permit identification of potential spatial locations of leaflet tearing under high stresses. We utilized a computational fluid dynamics, (CFD) approach to predict surface shear stresses from early to late systolic phases. Our overall methodology was as follows: a generic tri-leaflet valve geometry was meshed using unstructured tetrahedral elements and important into a CFD domain (CFx, Ansys Inc, Canonsburg, PA). The opening angles of the leaflets were adjusted to reflect 5 opening angles. For each case, a steady flow simulation was run corresponding to an instantaneous flow rate from a physiologically-relevant human aortic flow waveform. Time-averaged shear stresses were subsequently computed in a temporal fashion. We expect that the interpretation of the final CFD results will be able to contribute towards optimization of a specific elastomer-based valve prosthesis which is being developed by our partners at the University of Florida, Gainesville.

## **12.** Real-Time Impedance Analysis of Epithelial Breast Cancer Cells

## CELISSE ZABALO, FRANK A. ALEXANDER JR. FACULTY ADVISOR: SHEKHAR BHANSALI

### Abstract:

Electrical Impedance Spectroscopy (EIS) is a fast and label-free cell assay technique that can be used to analyze cell activity in real time. EIS calculates the impedance of a sample by applying a small alternating current through a range of frequencies and measuring the resulting voltage. With this label-free technique, interference of labels with the biological processes of cultured cells, which is commonly seen in more traditional label assays, is eliminated, thus producing results that are more reliable and are a more accurate representation of the in vivo environment. In this study, Electrical Impedance Spectroscopy was used in order to analyze the cellular bioimpedance of Hs578T epithelial breast cancer cells (ATCC: HTB-126). Cultured cells were seeded onto microelectrode arrays, which consisted of eight working microelectrodes with a single counter electrode in the center. An Agilent 4294A Impedance Analyzer was then used along with a desktop computer installed with LabVIEW software in order to monitor impedance for 24 hours. The results showed that, with time, there was an increase in impedance and phase shift that corresponded with more cells adhering to the bottom. After 24 hours, when the cells were fully confluent, the phase shifting ceased and impedance reached saturation. The fact that change in impedance is correlated with a change in cellular morphology makes this study significant to cancer biology. Further investigation, along with a comparison of the impedance of these cancer cells with the impedance of healthy cells that exhibit different physiological characteristics, can lead to advancements in cancer diagnostics.

### **13.** Gene Expression of Ion Channels from Salt-Sensitive Dahl Rat Mesenteric Artery by RT-PCR

### NATALIE CORTES, MAHESH S. JOSHI FACULTY ADVISOR: NIKOLAOS TSOUKIAS

### Abstract:

Hypertension has been associated with changes in gene and protein expression in vascular cells. Perturbed gene expression levels of membrane bound proteins (i.e., ion channels, transporters, receptors) can influence cell electrophysiology and function, leading to altered vasoreactivity. Gene expression in terms of mRNA levels from the mesenteric artery of Dahl Salt-Sensitive Rats is investigated using real time PCR to document differences between vessels from hypertensive and normotensive rats.

#### Method:

Two batches of Dahl Rats were put on high (4%) and normal salt (0.49%) diets, monitoring their blood pressure for five weeks. The mesenteric artery was isolated and stabilized to reduce RNA disintegration, then the tissue was homogenized with a probe sonicator. Consequently, mRNA was isolated and purified according to Qiagen's RNeasy Fibrous Mini Kit instructions. The first cDNA strand was synthesized and purified using the SuperScript 3 reagents. This DNA was then amplified using specific primers in the Applied Biosystems' StepOne<sup> $\mathbb{M}$ </sup> Real-Time PCR System. Samples from rats on high-salt diet were run in parallel with samples from rats on a low-salt diet (control) and  $\beta$ -actin was used as the housekeeping gene. The results were analyzed using the delta-delta Ct method.

### **Results and Conclusion:**

A high-salt diet leads to a significant increase in blood pressure (160 mmHg vs 215 mmHg) compared to the control group on normal salt. A number of genes, including TRPC6, Cav1.2 and alpha-2 AR are found to under-express in hypertensive rats. These genes code for nonselective cation channels, L-type voltage operated calcium channels and a2 adrenoreceptor. agtr1-that codes for angiotensin receptors is over-expressed relative to the control. Future work will test the implications of these changes in vasoreactivity. The long term goal is to elucidate basic mechanisms of pathophysiology of hypertension, which can accelerate development of therapeutic treatment for this widely prevalent vascular treatments.



# 14. Selection of Blood Contacting Materials for use in Vascular Access Device Applications DANIQUE STEWART, MANUEL DUGROT FACULTY ADVISORS: NORMAN MUNROE AND SHARAN RAMASWAMY

### Abstract:

Needle-tipped cannulas are commonly used for chronic patients who undergo frequent blood draws in hospitals. However, patients who have long term catheters are at an increased risk for thrombosis, which can lead to lifethreatening complications. Thus, there is an interest in accommodating chronic patients with improved devices that permit safe vascular access. As a first step, we investigated the platelet adhesion characteristics of potential bloodcontacting materials (Stainless Steel, Nitinol, Nitinol-Chromium Nitinol-Tantallum; n = 5 samples/group) by subjecting specimens to a time-averaged steady venous flow rate of 679 ml/min. Anti-coagulated porcine whole blood (0.109 M 3.2% solution of Sodium Citrate) was circulated through a custom-built circulatory loop. All materials were surface polished prior to testing to yield comparable surface roughness properties. Preliminary results suggest that the Nitinol based alloys (with Chromimum or Tantallum) yielded the least amount of platelet adhesion. Scale-up of these materials to a venous access device are currently being evaluated.

### 15. Investigation of Cognition in Motor Skills for Healthy Adult Individuals using Simultaneous Kinematics and Near Infrared Spectroscopy Studies

### BRYANT THOMPSON, UJWAL CHAUDHARY, YOUNG-JIN JUNG, LEONARD ELBAUM FACULTY ADVISOR: ANURADHA GODAVARTY

### **Abstract:**

Near infrared spectroscopy (NIRS) is a non-invasive neuroimaging modality, which can reliably be used to monitor the change in functional activation of the cortex in response to a stimuli. In this study, NIRS is used in conjunction with a motion capture system (Qualysis) to correlate the brain's cognition with the kinematics of a motor task paradigm. An in-house developed NIRS system was used along with a motion capture system to investigate prefrontal region of the brain. The study was performed on 10 healthy adult participants that were asked to perform the given motor task as a block designed paradigm. The block paradigm consisted of five blocks of task and rest periods. During the 30-second task period, participants were asked to touch target markers placed on an A4 paper with their index finger. During the 30-second rest period, participants were asked to relax and close their eyes. Results showed that, on average, right-handed subjects performed a greater number of touches with their right hand than their left hand. Right-handed subjects also showed a greater change in optical density in the left prefrontal channel compared to the right. These studies will eventually have a greater impact in customizing rehabilitation strategies for cerebral palsy populations.

### **DEPARTMENT OF BIOMEDICAL ENGINEERING FACULTY**



# ANTHONY J. MCGORON, PH.D.

Drug delivery and molecular imaging, primarily for cancer, and specifically the development of multimodal drugs that simultaneously image and provide therapy.



### JAMES D. BYRNE, PH.D.

Teaching and mentoring students in undergraduate Medical Instrumentation Laboratory courses. Managing the laboratories and assuring laboratory regulatory compliance.



## MICHAEL C. CHRISTIE, PH.D. Advising underPH.D.

graduates and teaching students as they prepare for advanced study in biomedical engineering. computational modeling of diabetes, sickle cell anemia. hypertension and cardiovascular diseases for improved device designs and clinical intervention

strategies.



### ANURADHA GODAVARTY,

Developing
and applying
near-infrared
optical imaging
technologies for
breast cancer
imaging and
functional brain
mapping (autism
and cerebral palsy
areas).



### JORGE J. RIERA, PH.D.

Developing strategies to integrate different modalities of brain imaging for the understanding of multicellular cortical signaling in pre-clinical rodent models of specific brain disorders.



### NIKOLAOS TSOUKIAS, PH.D.

Combining
experimentation
and mathematical
modeling to
investigate signaling
mechanisms at
the gene, cell and
tissue levels, with
a focus on
cardiovascular
disease



## CHENZHONG LI, PH.D.

Focused research on clinical pointof-care, biodefense and environment related applications of bioelectronic sensing technology.



### MICHAEL BROWN, M.D., PH.D.

Teaching medical physiology and disease pathophysiology to students and mentoring them as they prepare for advanced study in medicine or biomedical

engineering.



### RANU JUNG, PH.D.

Developing and utilizing scientific knowledge and engineering technology to address complex physiological, medical and societal problems presented by neurological disability.



### SHARAN RAMASWAMY, PH.D.

Investigating the mechanical regulation of stem cells in cardiovascular regenerative medicine, heart valve tissue engineering and experimental/computational studies of flow dynamics in vascular/valve implants



### SHULIANG JIAO, PH.D.

Developing high resolution multimodal anatomical and functional imaging technologies for the diagnosis and research of diseased such age-related macular degeneration, diabetic retinopathy and glaucoma.



### YEN-CHIH HUANG, PH.D.

Combining pluripotent stem cells and biomaterials to engineer functional neural, cardiac, and skeletal muscle tissues for basic research and translational application.



### WEI-CHIANG LIN, PH.D.

Developing non-destructive diagnostic devices based on the intrinsic characteristics of diseased and injured tissue and using them to guide surgery.





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