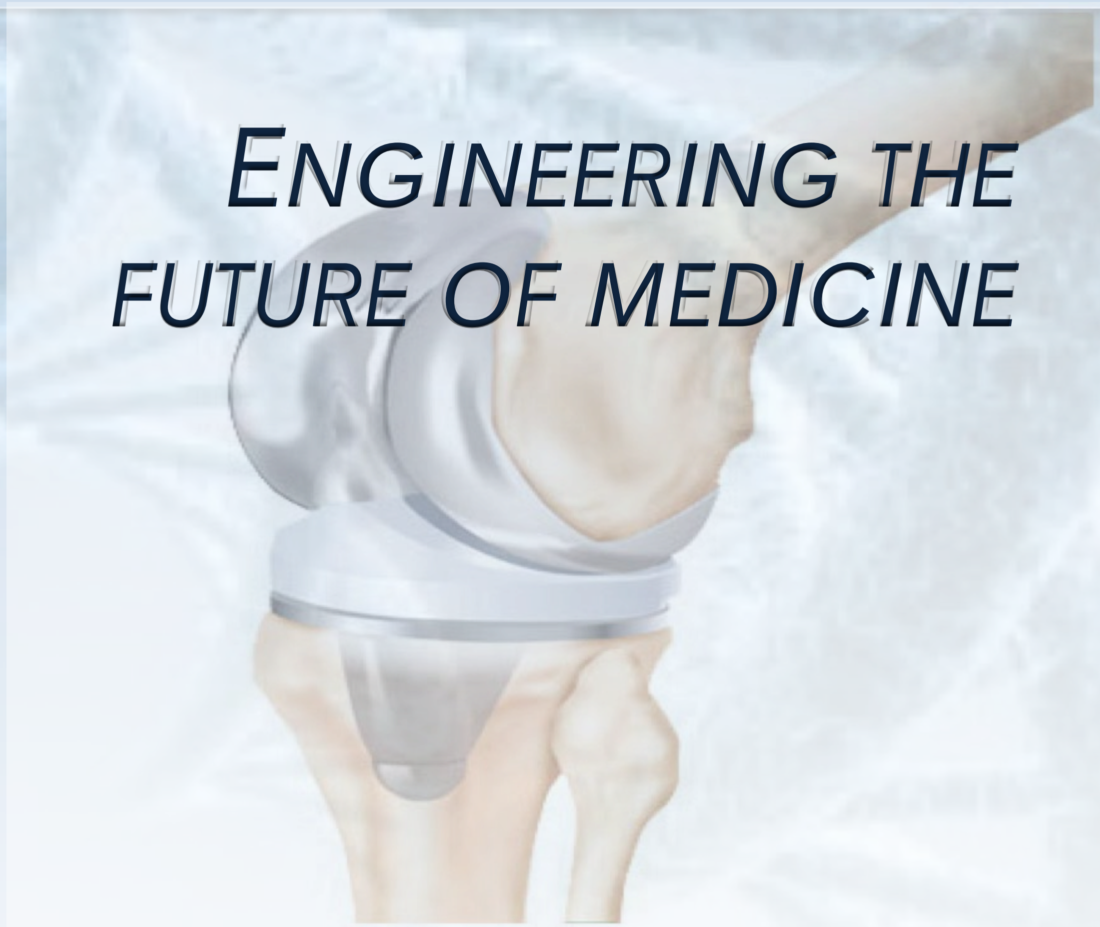
Biomaterials Day 2014

Engineering the future of medicine



Society For Biomaterials

Welcome to the University of Florida's Regional Biomaterials Day 2014!

On behalf of the Biomaterials Day Organizing Committee, we would like to thank you for attending our second annual Biomaterials Day focused on "Engineering the future of medicine." The University of Florida's student chapter of the Society for Biomaterials is very proud to host this one-day symposium and provide an opportunity for students, faculty members, and industry representatives from our region to interact and discuss the newest advances in the field. The National Society for Biomaterials sponsors this event with the goal of promoting interdisciplinary interactions amongst students and professionals.

Again, thank you for attending and we hope you enjoy this dynamic and exciting opportunity to network and learn about biomaterials.

Regards,

Laura Villada
Program Organizing Committee Chair
UF SFB Chapter Vice-President

Evelyn Bracho-Sanchez
Program Organizing Committee Member
UF SFB Chapter President

Cary Kuliasha
Program Organizing Committee Member
UF SFB Chapter Treasurer

Emily Hester
Program Organizing Committee Member
UF SFB Chapter Secretary

Acknowledgments

The Biomaterials Day organizing committee would like to acknowledge and thank the National Society for Biomaterials for the opportunity to host our third annual Biomaterials Day. Without their financial support, this event would not have been possible. We acknowledge support from the University of Florida's Office of Research. We would also like to thank the following sponsors, again without your contributions this event would not have been possible.

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SCHEDULE OF EVENTS

Friday March 28nd, 2014

Time	Event
8:00-9:00 AM	Registration and Continental Breakfast
9:00-9:10 AM	**Welcome Address** **Dr. Winfred Phillips PhD** President of University of Florida Office of Research
9:15-9:55 AM	**Key Note Speech** **Dr. Cato Laurencin MD, PhD** "Regenerative Engineering: The Theory and Practice of a Next Generation Field" University of Connecticut
10:05-10:30 AM	**Dr. Gary Miller PhD** “Translating materials into products: Balancing “Gold Standards” and Innovation” Exactech, Inc.
10:35-11:00 AM	**Dr. Sharan Ramaswamy PhD** "Stem Cell Mechano-Biology Promoting Engineered Heart Valves" Florida International University
11:05-11:30 AM	**Dr. Thomas Estes PhD** "You built a brilliant medical device...what happens next?" Vistakon
11:35-12:00 PM	**Dr. James Hickman PhD** "Human Stem Cell Derived Body-on-a-chip Systems for Drug Discovery and Toxicology" University of Central Florida
12:00 – 1:00 PM	**Complimentary Lunch**
1:10-1:35 PM	**Dr. Stephanie Martin PhD** “The Accidental Biomaterials Engineer” Kimberly Clark
1:40-2:05 PM	**Dr. Tanmay Lele PhD** "Mechanical communication between the nucleus and the extracellular matrix" University of Florida
2:10-2:35 PM	**Dr. Ken Anusavice DMD, PhD** "Dental Biomaterials: The Engineering Side of Dentistry" University of Florida
2:35-3:45 PM	**Student Poster Session/ Corporate Info Session**
3:45-4:00 PM	**Closing Remarks and Awards**

Cato T. Laurencin, M.D., Ph.D.

University Professor
Albert and Wilda Van Dusen Distinguished Professor of Orthopaedic Surgery
Professor of Chemical and Biomolecular Engineering
Professor of Materials Science and Engineering
Director, The Raymond and Beverly Sackler Center for Biomedical, Biological, Physical and Engineering Sciences
Director, The Institute for Regenerative Engineering
Chief Executive Officer, Connecticut Institute for Clinical and Translational Science
The University of Connecticut

"Regenerative Engineering:

The Theory and Practice of a Next Generation Field"

The next ten years will see unprecedented strides in regenerating musculoskeletal tissues. We are moving from an era of advanced prosthetics, to what I term regenerative engineering. In doing so, we have the capability to begin to address grand challenges in musculoskeletal regeneration. Tissues such as bone, ligament, and cartilage can now be understood from the cellular level to the tissue level. We now have the capability to produce these tissues in clinically relevant forms through tissue engineering techniques. Our improved ability to optimize engineered tissues has occurred in part due to an increased appreciation for stem cell technology and nanotechnology, two relatively new tools for the tissue engineer.

Critical parameters impact the design of novel scaffolds for tissue regeneration. Cellular and intact tissue behavior can be modulated by these designs. Design of systems for regeneration must take place with a holistic and comprehensive approach, understanding the contributions of cells, biological factors, scaffolds and morphogenesis.

SESSION SPEAKER ABSTRACTS

Session 1: Gary Miller, PhD

Founder, Executive Vice President
Exactech, Inc.

"Translating materials in to products – balancing "Gold Standards" and Innovation"

With the overarching goal of innovation and differentiation of products that improve patient outcomes, the role of the engineering designer in applying biomaterials to implantable devices can be an exciting endeavor. There are opportunities to innovate at every turn --- the test is in answering the question – "Can we improve patient outcomes"? The ability to understand classical materials, and use them to evolve and improve highly performing implant systems is a key to growth for any company. The challenge is balancing this approach with the introduction of new, innovative, materials that also allow differentiation and improvements in patient outcomes. This presentation will focus on the process improvements and missteps in the use of Ultra High Molecular Weight Polyethylene "the Gold Standard" as a knee articular material and close with the sharing of a recently introduced eBeam printed porous metal for hip component manufacturing.

Session 2: Sharan Ramaswamy, PhD

Professor, Biomedical Engineering
Florida International University

"Stem Cell Mechano-Biology Promoting Engineered Heart Valves"

Congenital heart defects occur in 8 out of 1000 live births in the US (www.aha.org), with several cases presenting with anomalous heart valves. Available valve therapies have major limitations. For example, mechanical valves are commonly used, but require long-term anti-coagulant therapy, which is dangerous for young children. Homografts or bio-prosthetic valves are occasionally used but are prone to calcification, leading to regurgitation. In the pediatric population, repetitive valve replacement surgeries are required, because available prosthetic valves do not accommodate somatic growth. Thus, current prospects in treating valve defects in children are faced with several concerns. In theory, the ability to grow a valve *in vitro* using stem cell progenitors and appropriate scaffolding materials, i.e., a tissue engineered heart valve for subsequent implantation could potentially overcome all the shortcomings of existing treatment strategies. Despite this appeal however, much remains to be understood in terms of the mechanical environments needed to condition growing valves, but which nonetheless have been shown to be essential for the creation of functional valve tissues. In addition, the biological responses to mechanical stimuli are likely to be progenitor cell-specific. Here, we present two adult stem cells, i) the periodontal ligament cell (PLCs) and ii) bone marrow derived mesenchymal stem cells (BMSCs) which we have investigated for heart valve tissue engineering purposes. We reveal their unique responses to valve–relevant mechanical stresses and their suitability in promoting the heart valve phenotype.

Session 3: Thomas Estes, PhD
Marketing Manager
Vistakon

"You built a brilliant medical device... What happens next?"

You built a brilliant medical device... What happens next? You have dredged the deep waters of designing, developing and validating a safe and effective medical device. You were even successful in managing the FDA to allow sale of your device in the US. What about your go to market strategy? Transitioning an engineering success into a marketing success requires deep insight, solid strategy and flawless sales execution to ensure patients have better outcomes, doctors are happy and your product makes you money. The four P's of marketing: Product, Place, Price and Promotion must be mastered. We will discuss each of these crucial elements of your marketing plan and examples of how they have been done well and not so well. Finally we will discuss a few tips to help you manage the business world, turning your idea into a successful medical device.

Session 4: James Hickman, PhD
Chemistry, Biomolecular Science
University of Central Florida

"Human Stem Cell Derived Body-on-a-chip Systems for Drug Discovery and Toxicology"

One of the primary limitations in drug discovery and toxicology research is the lack of good model systems between the single cell level and animal or human systems. This is especially true for neurodegenerative diseases such as ALS, Alzheimer's, spinal cord injury as well as for cardiac disease and cardiac side effect determination during the drug discovery process. In addition, with the banning of animals for toxicology testing in many industries, body-on-a-chip systems to replace animals with human mimics is essential for product development and safety testing. Our research focus is on the establishment of functional in vitro systems to address this deficit where we seek to create organs and subsystems to model motor control, myelination and cognitive function, as well as cardiac subsystems utilizing tissues differentiated from human stem cells. The idea is to integrate microsystems fabrication technology and surface modifications with protein and cellular components, with the aim of initiating and maintaining self-assembly and growth into biologically, mechanically and electronically interactive functional multi-component systems. The ability to control the surface composition of an in vitro system, as well as controlling other variables, such as growth media and cell preparation, all play important roles in creating a defined system for hybrid device fabrication. Our advances in culturing human stem cell derived neurons, cardiomyocytes and liver cells in a defined serum-free medium, suggest outstanding potential for answering questions during the drug discovery process using a functional body-on-a-chip system.

Session 5: Stephanie Martin, PhD
Research and Engineering Technical Leader
Kimberly Clark

"The Accidental Biomaterials Engineer"

Dr. Martin received her Bachelor of Science degree in Materials Science and Engineering from the University of Florida in 1998. She then went on to study biomaterials at the graduate level at the University of Washington under Drs. Buddy Ratner and Cecelia Giachelli, earning a Ph.D. in 2003 as part of the NSF-sponsored UWEB (University of Washington Engineered Biomaterials) Engineering Research Center. Her doctoral research focused on amelioration of the foreign body response to implanted medical devices via attachment of wound healing proteins to model biomaterials. In her current role, Stephanie helps to identify and leverage technical insights for new business opportunities. Dr. Martin previously held positions in the Corporate Research and Engineering department at K-C, where she worked on research projects in areas such as microbial detection, odor control, vaginal health, and biological sensors.

Dr. Martin's talk will focus on her journey to studying biomaterials and the tools and skills that create a strong foundation for biomaterials scientists. In addition, she will provide a broad overview of the importance of biomedical/biomaterials at Kimberly-Clark. Most importantly, Dr. Martin will share how sometimes the things you swore you'd never do end up becoming the things you were made to do.

Session 6: Tanmay Lele, PhD
Chemical Engineering
University of Florida

"Mechanical communication between the nucleus and the extracellular matrix"

Cells can sense and respond to a diverse variety of mechanical cues from their environment including shear forces, matrix strain and matrix rigidity. In particular, the rigidity of the matrix has emerged as a key parameter for controlling cell function for diverse applications in regenerative medicine. Cell motility, adhesion, spreading and differentiation have been shown to vary significantly between soft and rigid substrates. On rigid substrates that can support larger mechanical stresses, intracellular tension is high and cells are able to assemble clear stress fibers and focal adhesions. Cells on very soft substrates are unable to assemble stress fibers and therefore generate much lower levels of tension. Because intracellular tension is balanced in part by the nucleus and can induce nuclear shape changes, this raises the possibility that nuclear shape could be sensitive to substrate rigidity. Here we quantified nuclear shape in NIH 3T3 fibroblasts on polyacrylamide gels with a controlled degree of cross-linking. On soft substrates with a Young's modulus of 0.4 kPa, the nucleus appeared rounded in its vertical cross-section, while on stiff substrates (308 kPa), the nucleus appears more flattened. Over-expression of dominant negative Klarsicht ANC-1 Syne Homology (KASH) domains, which disrupts the LINC complex, eliminated the sensitivity of nuclear shape to substrate rigidity; myosin inhibition had similar effects. GFP-KASH4 over-expression altered the rigidity dependence of cell motility and cell spreading. Taken together, our results suggest that nuclear shape is modulated by substrate rigidity-induced changes in actomyosin tension, and that a mechanically integrated nucleus-cytoskeleton is required for rigidity sensing. These results are significant because they suggest that substrate rigidity can potentially control nuclear function and hence cell function.

Session 7: Ken Anusavice, PhD, DMD

Department of Restorative Dental Sciences
College of Dentistry
University of Florida

Dental Biomaterials: The Engineering Side of Dentistry

The profession of dentistry is the branch of medicine that is focused on the diagnosis, prevention, and treatment of diseases and disorders of the oral cavity, the maxillofacial complex, adjacent structures, and their impact on the human body. When prevention of the diseases of caries and periodontal disease are not successful, restoration of damaged and missing tooth and bone structure requires and engineering approach for the design and material properties that will lead to maximum survivability, while allowing full function of the restored teeth. Restoration of missing tooth structure requires and understanding of the properties and structure of synthetic materials, including metals. polymers, resin-based composites, and ceramics. These materials must retain their properties and structure in an environment that exposes these materials to a pH range between 1 and 10, temperatures ranging from 0 C up to 90 , and bite forces ranging up to 975 pounds-force (4375 N).

In addition, an individual's diet and jaw clenching habits can further lead to degradation of the restorative materials. This presentation will focus primarily on the design on ceramic-based bridges that are supported by dental implants since these represent treatments of patients with severely compromised dental health. The optimum design of these prostheses require a knowledge of engineering concepts including the elastic properties of the materials and their time-dependent survival as a function of biting and clenching forces, force orientation, and thickness ratio of the esthetic veneering ceramic to the supporting core ceramic. The optimum design must also be modified, as necessary, based on clinical performance data, One of the most useful engineering software programs that allows optimization of prosthesis design is NASA's CARES/*Life* software that allows calculations of tensile stress distributions as a function of design and loading conditions. These calculations provide predictions of the time-dependent probability of fracture for prostheses of a wide variety of designs and loading conditions. Such information allows dentists and dental lab technicians to design ceramic-based prostheses for an extensive variety of clinical conditions to ensure the greatest probability of survival.

POSTER PRESENTATIONS

1. **Name:** Maeve Budi
Title: ***"****Multiferroic Janus Fibers for Bioapplications"*
Advisor: Jennifer Andrew
Department: Materials Science and Engineering
Affiliation: University of Florida

2. **Name:** Archana Chidambaram
Title: ***"****Biomimetic" Randall's Plaque to Develop an In-Vitro Model System for Studying the Role of Acidic Proteins in Renal Stone Formation"*
Advisor: Laurie Gower
Department: Materials Science and Engineering
Affiliation: University of Florida

3. **Name:** Joe Decker
Title: *"A Thermodynamic Approach to Engineering Antifouling Surfaces"*
Advisor: Anthony Brennan
Department: Materials Science and Engineering
Affiliation: University of Florida

4. **Name:** Erik Price
Title: "*Synthesis and Characterization of Biorenewable Aromatic Polyacetal Copolymers"*
Advisor: Stephen A. Miller
Department: Chemistry
Affiliation: University of Florida

5. **Name:** Shanna Smith
Title: *"Polymer Therapies for Treating Pediatric Osteosarcoma"*
Advisor: Christopher Batich
Department: Materials Science and Engineering
Affiliation: University of Florida

6. **Name:** Carsten Matthew
Title: *"Drug-eluting microarrays to identify effective drug combinations on patient-derived cancer stem cells"*
Advisor: Benjamin Keselowsky
Department: Biomedical Engineering
Affiliation: University of Florida

7. **Name:** Eden Michael
Title: *"Incorporation of Photo-Carbon Monoxide Releasing Materials into Electrospun Scaffolds for Vascular Graft Applications"*
Advisor: Christopher A. Bashur
Department: Biomedical Engineering
Affiliation: Florida Institute of Technology

8. **Name:** Ismail Ocsoy
Title: ***"****Trypsin based flower-like particle for effective protein digestion"*
Advisor: Weihong Tan
Department: Chemistry
Affiliation: University of Florida

9. **Name:** Manuel Salina
Title: ***"****Implications of Oscillatory Shear Stresses environments for Engineered Heart Valves"*
Advisor: Sharan Ramaswamy
Department: Biomedical Engineering
Affiliation: Florida International University

10. **Name:** Adam Monsalve
Title*:* *"Controlling Single cells and Cell Populations Using Magnetic Materials and Applied Fields"*
Advisor: Jon Dobson
Department: Materials Science and Engineering
Affiliation: University of Florida

11. **Name:** Kelsey Crannell
Title: ***"****Polymer-based Nanocomposite for the Early Detection of Lung Cancer"*
Advisor: Jennifer Andrew
Department: Materials Science and Engineering
Affiliation: University of Florida
Year: Undergraduate

12. **Name:** Cassandra Juran
Title: ***"****Laser Micro-Patterned Xenogenic Fibrocartilage Scaffold for the purpose of Temporomandibular Disc Tissue Engineering"*
Advisor: Peter McFetridge
Department: Biomedical Engineering
Affiliation: University of Florida

13. **Name:** Makenskey Lordeous
Title: *"A Graphene Reinforced Silicone Composite Material for Artificial Heart Valves"*
Advisor: Sharan Ramaswamy
Department: Biomedical Engineering
Affiliation: Florida International University

14. **Name:** Sasmita Rath
Title: ***"****Mechanically-regulated gene expression in heart valve targeted tissue engineering studies"*
Advisor: Sharan Ramaswamy
Department: Biomedical Engineering
Affiliation: University of Florida

15. **Name:** Clayton Argenbright
Title: "*Hierarchical Patterning Using self-assembled block copolymers"*
Advisor: Anthony Brennan
Department: Materials Science and Engineering
Affiliation: University of Florida
Year: Graduate

16. **Name:** Glenda Castellanos
Title: ***"****Bone Marrow stem cells' deformation During Valve-Relevant Loading"*
Advisor: Sharan Ramaswamy
Department: Biomedical Engineering
Affiliation: University of Florida

17. Name: Dua Rupak
Title: *"Interfacial strength properties between stem cell and chondrocyte derived tissue matrices using hydroxyapatite nanoparticles"*
Advisor: Sharan Ramaswamy
Department: Biomedical Engineering
Affiliation: Florida International University

18. Name: Jason Rosen
Title: *"Influencing Neural Progenitor Cell Fates with Hydrogel Scaffolds"*
Advisor: Christine E. Schmidt
Department: Biomedical Engineering
Affiliation: University of Florida

19. Name: Aurore Van de Walle
Title: *"The Human Umbilical Vein for Small Diameter Vascular Bypass: from Acellular Scaffold to Functional Graft"*
Advisor: Peter McFetridge
Department: Biomedical Engineering
Affiliation: University of Florida

20. Name: Xiong Ruitong
Title: *"Jet-based 3D Printing of Biological Constructs"*
Advisor: Yong Huang
Department: Mechanical and Aerospace Engineering
Affiliation: University of Florida

21. Name: Cary Kuliasha
Title: Random Acrylate Copolymer Surface Grafting to Poly(dimethyl siloxane) Elastomer Surfaces for Improved Anti-Biofouling
Advisor: Anthony Brennan
Department: Materials Science and Engineering
Affiliation: University of Florida

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