# Keynote Address Abstracts

## Keynote Address 1: " Entrepreneurship in Biomaterials"

Speaker: Jamie Grooms, Chairman and Director of AxoGen Inc.

Abstract

The terms entrepreneurship and engineer seamlessly fit together. However, as engineers, we have a responsibility to create and design products that will help progress our society. This talk will focus on the challenges engineers face when taking an idea and successfully implementing it into usable product. Specifically, this talk will focus on the integrity needed to be successful as an engineer and a businessperson.

## Keynote Address 2: "Biomaterial and Medical Device Innovation Challenges in the New Economy"

Speaker: John W. Sheets, PhD, Senior Vice President of Research at Boston Scientific

Abstract

The challenges of translational medicine and medical device product development continue to increase with higher demands for evidence generation for safety, clinical efficacy and cost effectiveness. The priority of "time to market" has been supplanted by "time to reimbursement."

The key to success begins during the research phase of product development and a highly collaborative and synergistic innovation environment. The presentation will discuss some of the key roles for rigorous science, disciplined process and the inspired innovation. The mandate for innovation in not only products and technology, but also business models will be discussed.

## Keynote Address 3: "The Beginnings of Biomaterials: The Good, The Bad, and The Funny!"

Speakers: Larry Hench, PhD, Inventor of Bioglass®, Professor of Materials Science and Engineering, University of Florida, and David Greenspan, PhD, President of Spinode Consulting

Abstract

The MSE Department was one of the few sites in the world that pioneered biomaterials as an academic, professional and commercial field. Anecdotes from these early days will be shared for the first time publically. Stories will include the construction of the Surge Building and well witchery; finding a furnace in the basement of the Seagel building; a bus trip that led to the discovery of Bioglass; the fire alarm that shocked the biomaterials class and woke up a draped "cadaver" on the conference table; the mini-poof-off bio-mechanics tests of Bioglass mouse incus prostheses on New Years Eve at Shands; the escaped monkey and flagrant indelecti baboons that shocked the Board of Regents; Gordon Research Conference blunders and Bioglass licensing disasters with grand theft and stock fraud endings. For a serious ending, we present from a lifetime perspective an overview of the transition of biomaterials from an observational field of trial and error dominated by *"Just put it into a few animals and see if it works"* into a truly scientific discipline with world-wide impact on healthcare for millions of people.

## Keynote Address 4: "Translation of University-Industry Research into New Biomedical Technologies"

Speaker: Eugene Goldberg, PhD,Professor of Materials Science and Engineering

Abstract

How do we develop important new directions in Biomedical Research? Some are developed in Industry, some in Academia, and some by Individuals in clinical practice. One significant approach is to define a clinical problem of major importance and work your way back to research strategies that are aimed at solving the problem. The evolution of this approach is seen historically in such developments as (1) balloon catheters i.e. endotracheal tubes for providing open airways during surgery and Foley catheters for draining the bladder, (2) angioplasty catheters for opening and stenting (with wire mesh tubes) clogged coronary arteries, (3) use of aqueous polymer solutions to coat and protect fragile tissues during surgery and biodegradable polymer patches to cover injured internal tissues during healing; solutions and patches usually made of a natural compound found in the body, i.e. hyaluronic acid, (4) biopolymer-nerve cell compositions for spinal cord and CNS repair, and (5) flexible acrylic copolymers for foldable intraocular lenses to be used for small incision cataract eye surgery to repair visual acuity. Consideration of industry-university interactions in the context of translating research into clinically useful technology is the subject of this lecture.

# Session Speaker Abstracts

## Session 1: Successful Implementation of Commercial Biomaterials

Speakers: James F. Schumacher,PhD, James Talton, PhD, Antonio Webb, PhD

**James F. Schumacher, PhD**
Project Leader – Medical Devices
Global Research and Engineering
Kimberly-Clark Health Care, Roswell, GA

Presentation Title: **Material Selection in Medical Device Product Development**

Abstract: Proper and timely material selection in medical device product development is vitally important for the performance, usability, and safety of new medical devices. This success is primarily driven by the engagement and involvement of a biomaterials engineer (scientist) during the product development process. Traditionally, the materials scientist is not engaged until the final device designs are chosen and material selection is required for each component. Earlier participation by a materials specialist in the product development process, such as concept development or early physician interviews, has resulted in significant improvements in product innovation, functionality, and physician endorsement. Case studies will be presented that demonstrate the impact and role the biomaterials engineer or materials scientist plays in the medical device field.

**James Talton, PhD**
Chief Executive Officer and President
Nanotherapeutics, Alachua, FL

Presentation Title: **NanoFUSE® DBM as a viable bone graft substitute**

Abstract: Nanotherapeutics, Inc. is a specialty biopharmaceutical company with one FDA-approved implant product (NanoFUSE® DBM) and in-house cGMP manufacturing. NanoFUSE® DBM is a combination of allogeneic human bone and bioactive glass bone void filler. NanoFUSE® DBM is shown to be biocompatible in a number of different assays and has been approved by the FDA for use in bone filling indications. NanoFUSE® DBM shows the ability of the material to support cell attachment and proliferation on the material thereby demonstrating the osteoconductive nature of the material. NanoFUSE® DBM was also shown to be osteoinductive in the mouse thigh muscle model. NanoFUSE® DBM manufacturing, regulatory submission, and performance as an effective bone graft substitute will be discussed.

**Antonio Webb, PhD**
Assistant Professor of Biological and Agricultural Engineering
University of Georgia, Athens, GA

Presentation Title: **A novel drug eluting perivascular wrap for the prevention of neointimal hyperplasia**

Abstract: In the United States, it is estimated that 8 million people suffer from peripheral artery disease (PAD). PAD is characterized by a gradual reduction in blood flow to the muscular arteries of the lower extremities caused by atherosclerosis. For those with severe PAD, lower extremity bypass grafting remains the predominant option for limb salvage. Although native vessels remain the gold standard conduit for bypass grafting, they are not available in approximately one-third of

patients due to intrinsic venous disease or prior vein harvesting. In these cases, expanded polytetrafluoroethylene (ePTFE) grafts are the most commonly used alternative despite dismal patency rates due to the formation of neointimal hyperplasia at the distal anastomosis. To address this problem, VesselTek Biomedical has developed a novel drug eluting perivascular wrap for the prevention of neointimal hyperplasia. The perivascular wrap utilizes a biodegradable citric-acid based polymer, poly(1,8-octanediol-co-citrate) (POC). This presentation will detail the development and characterization of POC perivascular wraps. Furthermore, data showing efficacy in both rat and pig animal models will be presented.

## Session 2: Pioneering Advancements in Biomaterials Research

Speakers: Anthony Brennan, PhD, Thomas Angelini, PhD, Christopher Batich, PhD

**Anthony Brennan, PhD**
Margaret A. Ross Professor of Materials Science and Engineering
Professor of J. Crayton Pruitt Family Department of Biomedical Engineering
University of Florida, Gainesville, FL

---

Presentation Title: **Cell response to bioinspired microtopographies**

Abstract: This study examines hierarchical combinations polymers that have used to produce engineered surfaces, which elicit micro-topographical and chemical cues in biological systems. Nature provides complex chemical forms of polymers that are manipulated through both conformational and configurational forms to yield specific functions. Our recent studies have been focused on the design of polymeric surfaces that can be used as models in the study of biological adhesion mechanisms. The recent expansion of bioengineered tissue has increased our need for better models for cellular adhesion, migration and chemical manipulation of surfaces.

A process commonly referred to as contact guidance has been known to modulate cell shape and function in a variety of cell types by physical attributes of a surface. Cell adhesion and motility are both highly dependent upon patterned surfaces as well as their chemical functionality. Our group has focused on developing a rational model for cell attachment that uses the physical and chemical structure of surfaces in a thermodynamic function to predict and modulate cell attachment to surfaces. More recently, we have demonstrated the ability to induce specific cell differentiation using our topographically modified surfaces. This presentation will focus on the influence of the thermodynamic state of patterned surfaces on cell attachment density and function.

**Thomas E. Angelini, PhD**
Assistant Professor of Mechanical and Aerospace Engineering
University of Florida, Gainesville, FL

---

Presentation Title: **The biomaterial solution commensurate with the biological problem**

Abstract: Engineers have a great diversity of tools at their disposal, but the right tool is hard to choose in cases where the problem is poorly understood. In biomaterials design, the complexity of living systems generates major challenges; our understanding of the physical and chemical dynamics within tissues and microbial systems is limited, but expanding. In this talk I will describe several examples of biological systems that have totally unexpected physical properties. I will show that surface tension gradients, osmotic pressure gradients, glassy-dynamics, and even mere symmetry can govern the motion of bacterial biofilms and tissue cell monolayers. I will discuss how a basic understanding of these multi-cellular systems can guide the design.

**Christopher Batich, Ph.D.**
Grodsky Professor of Materials Science and Engineering
University of Florida, Gainesville, FL

Presentation Title: **Pioneering Advancements in Biomaterials Research: "Bioguard": a Novel Intrinsically Biocidal Utility Substrate (NIMBUS)**

Abstract: A very different type of wound dressing was invented by a group at UF, with help from others, and was developed into a commercial product by creation of a start-up company in Gainesville called "QuickMed". A simple idea took a great deal of technical improvement efforts, team work, money and luck to reach the market, and these aspects will be described. The UF OTL office was very helpful in moving it forward, and offered advice that would have made the path easier to follow. However, having a broad-based research base with good collaborative support allowed this company, with UF help, the eventually move through FDA clearance via the arduous "de novo" process (for very novel devices with no predicate on the market already).

Gainesville, and the UF environment, offer great opportunities for inventing and moving technology into the health care area. The recent changes at the NIH (formation of NCATS, and the new director), and the awarding of a CTSA to UF greatly increase the likelihood of success for small business ventures involving students and faculty members. There are huge needs in the health care field, since the US system is the least cost effective among all developed countries, and that is driving a market for better, cheaper and faster technology.

## Session 3: Pioneering Advancements in Biomedical Engineering

Speakers: Benjamin Keselowsky, PhD, Jon Dobson, PhD, Peter McFetridge, PhD

**Benjamin Keselowsky, PhD.**
Associate Professor of J. Crayton Pruitt Family Department of Biomedical Engineering
University of Florida, Gainesville, FL

Presentation Title: **Nanoparticles for the study and enhancement immune response**

Abstract: Biomaterials of synthetic or biological origin undergo complex interactions with cells of the immune system upon implantation. These interactions are incompletely understood and poorly controlled. This complicates the ability to achieve desirable outcomes in clinical applications. Our efforts focus on both a basic understanding of interactions of immune cells with biomaterials as well as the engineering of biomaterials capable of directing immunological processes. These have wide-ranging implications in diverse fields such as implanted devices, tissue engineering, combination products, and therapeutic vaccines. In particular, we are interested in the phagocytic antigen present cell types of macrophages and dendritic cells. Our macrophage interests focus on identifying receptors involved in the phagocytosis and inflammatory responses to ultra-high molecular weight polyethylene particles such as those generated as wear debris from total joint replacement implants. Furthermore, we engineer multi-functional microparticle formulations targeting dendritic cells (a key director of immune responses) as a vaccine delivery device to provide antigen-specific immunosuppression as therapy for type 1 diabetes. Additionally, we have developed high-throughput strategies to both formulate particle-based vaccines as well as screen them for specific dendritic cell responses.

**Jon Dobson, PhD.**
Professor of J. Crayton Pruitt Family Department of Biomedical Engineering
Professor of Materials Science and Engineering
University of Florida, Gainesville, FL

Presentation Title: **Magnetic nanoparticles for research and therapeutic applications**

Abstract: The use of magnetic micro- and nanoparticles for biomedical applications was first proposed in the 1920s as a way to measure the rehological properties of the cytoplasm. Since that time, particle synthesis techniques and functionality have advanced significantly. Magnetic micro- and nanoparticles are now used in a variety of biomedical techniques such as targeted drug delivery, MRI contrast enhancement, gene transfection, immnoassay and cell sorting. More recently, magnetic micro- and nanoparticles have been used to investigate and manipulate cellular processes both in vitro and in vivo.

This talk will focus on some of the research our group is doing on (i) magnetic nanoparticle-mediated activation of cellular processes for tissue engineering, stem cell research and drug screening applications and (ii) novel methods of magnetic nanoparticle-based gene transfection and hyperthermia.

**Peter S. McFetridge, PhD.**
Assistant Professor of J. Crayton Pruitt Family Department of Biomedical Engineering
University of Florida, Gainesville, FL

Presentation Title: **Optimizing cell culture techniques for whole organ tissue engineering**

Abstract: Our research encompasses the three main phases of the tissue engineering approach: 1) biomaterial/scaffold development and characterization, 2) cells and their phenotype, and 3) Bioreactor design and implementation to culture re-seeded scaffolds under replicated physiological conditions.

Using a variety of biomaterials designed for specific organ replacement therapies our approach is to use ex vivo-derived biomaterials to further our understanding of the bodies natural healing processes. Our aim is to produce tissue constructs that are not only cell dense, but also fully functional. Using this approach our laboratories investigate a variety scaffolds for different clinical applications.

In this presentation our laboratories progress in a number of different research areas will be discussed, including design parameters for engineering vascular grafts, where mass transport conditions are modulated to speed cell migration and fluid shear stress to control endothelial cell phenotype. Recent investigations assessing the effect of different culture conditions and scaffold mechanics will be discussed, with details of scaffold structural properties, biomechanics, cellular function and gene expression. Details of an ovine implantation model will be presented to provide an overview of these materials capacity to regenerate within an in vivo environment.

# Student Poster Presentation Abstracts

**Name:** Adwoa Baah-Dwomoh
**Title:** "Engineered Microtopographies Regulate Vascular Smooth Muscle Cell Phenotype"
**Advisor:** Anthony Brennan
**Department:** Materials Science and Engineering
**Year:** Graduate
**Abstract:** Coronary heart disease, the number one cause of the death in the United States, kills approximately 500,000 individuals each year [1]. Common methods of attempting to correct the affects of atherosclerosis include angioplasty, stenting, and grafting. However, the risk of in-stent restenosis, the renarrowing of the blood vessel, is highly probably when using this procedure, especially for a small diameter vessel such as the coronary artery [2]. In addiction to in-stent restenosis, intimal hyperplasia, the excessive proliferation of smooth muscle cells, provides another failure mechanism of small diameter vascular graft
Several cues, both physical and chemical cues have been studied to induce a particular phenotype of smooth muscle cells. This study uses a topographical approach, the N- Series of the Sharklet topographies to study phenotypic switching of smooth muscle cells to the contractile phenotype.

**Name:** Jordan Ball
**Title:** "Elastomeric Nanocomposites for Orthopedic Tissue Engineering"
**Advisor:** Dr. Josephine Allen
**Department:** Materials Science and Engineering
**Year:** Graduate
**Abstract:** With the mean age of the population rising, it increasingly important to identify more successful treatment options in regenerative medicine. Interest in utilizing synthetic biomaterials has increased in past decades to circumvent limitations in the availability of autografts. While allografts can also alleviate problems with autograft usage, the risk of immunological rejection and pathological concerns are still present. Orthopedic tissue regeneration is a major topic of interest as the annual occurrence of bone grafting procedures performed in the United States is estimated to be near 500,000. One method for the regeneration of bone tissue defects is the introduction of either an osteoinductive scaffold material or a growth factor to achieve a similar result. Here, an ongoing investigatio! n to characterize a material system for orthopedic tissue engineering is presented. Poly(octane-1,8-diol co citrate) combined with tricalcium phosphate, containing immobilized bone morphogenetic protein-2 (BMP-2), has been designed to accomplish the goal of having an osteoconductive scaffold as well as an osteoinductive growth factor for improved bone tissue growth. Results were obtained through measuring osteogenic gene expression in human mesenchymal stem cells (hMSCs) as they differentiate via real-time quantitative polymerase chain reaction (RT-qPCR).

**Name:** Matthew Carstens
**Title:** "Development and Characterization of Drug Delivering Cellular Microarrays"
**Advisor:** Dr. Benjamin Keselowsky
**Department:** Biomedical Engineering
**Year:** Graduate
**Abstract:** Introduction: While small molecule microarrays have demonstrated their capacity to screen a large variety of drugs on a small cell population, a microarray consisting of discreet islands of cells, thereby mitigating potential cross talk and diffusion concerns, has yet to be shown. An application for such technology would be to screen drug efficacy on rare cell populations. Colon cancer stem cells are one such population, having only recently been recognized as a potential

cause of colon cancer. As such, this cell population has been targeted for future therapeutics. One approach to therapy lies in manipulating signaling pathways, which govern self-renewal. Here we report a method for performing such analyses using a limited number of cells. Methods: Glass coverslips were cleaned in an oxygen plasma etcher. Coverslips were then printed with arrays of NH2-terminated silane and coated with titanium and gold. Following coating, gold-coated arrays were sonicated to remove gold from the amine spots, exposing NH2-terminated silane islands. The coverslips were then incubated with methyl-terminated alkanethiol and 10% Pluronic F-127 to create a non-fouling surface around the amine islands.Ethylene vinyl acetate was dissolved in cyclohexanol and printed over the amine islands. HCT116 cells were then seeded over the array in 3 ml serum-free media. The arrays were then gently washed in PBS, placed in a 35 mm petri dish with complete media and placed in an incubator for 72 hrs. Arrays were then fixed, mounted, and imaged.Results: Cellular arrays can be manufactured in a robust fashion. The tightly controlled specificity of cell attachment allows for co-localization of cells with drug releasing polymer while eliminating cross-talk between islands. Small molecules have been shown to exhibit release profiles consisting of a burst release for 18-24 hrs. Ongoing studies are being directed toward efficacy of drug release and cellular uptake.

**Name:** Joe Decker
**Title:** "Rational Design of Antifouling Surfaces Through Thermodynamics"
**Advisor:** Dr. Anthony Brennan
**Department:** Materials Science and Engineering
**Year:** Graduate
**Abstract:** The preparation and implementation of materials to deter biofouling in the marine and medical environments has gained considerable interest over recent years. Our group has focused primarily on the use of microtopographies to deter attachment. These topographies have been shown to be effective against a variety of organisms, but their antifouling mechanism remains unknown. We have developed a model based in first principle thermodynamics to explain the antifouling effect of microtopographies and help aid in the development of future technologies. The model uses an appropriately defined energy function to describe the relative probability of organism settlement between a smooth surface and a topographically modified surface of the same chemistry. We have demonstrated the model's effectiveness for the green algae Ulva linza, gram negative bacteria Cobetia marina, gram positive bacteria Staphylococcus aureus, diatoms Navicula permintua and Seminavis navicula, and cyprids of Balanus amphitrite. All organisms fit the linear model with an R2 value of .93 or higher.

**Name:** Can Duan
**Title:** “Acute Rat Brain Tissue Refractive Index Measurement Using Optical Coherence Tomography"
**Advisor:** Dr. Huikai Xie
**Department:** Electrical and Computer Engineering
**Year:** Graduate
**Abstract:** In the Biophotonics & Microsystems Laboratory (BML), we employed a time domain Optical Coherence Tomography (OCT) system for refractive index (RI) measurement of acute rat brain tissue slices under compression free states and compressed states. A Microelectromechanical systems (MEMS) mirror was used for lateral scan of tissue samples. And an indentation technique was employed to locate the precise location of measurement, and cause tissue deformation. RI in white-matter and grey-matter regions, including the cerebral cortex, putamen, hippocampus, thalamus and corpus callosum were measured. RI in corpus callosum was found to be 4% higher than RIs in other regions. Changes in RI under uniform compression of 20% to 80% deformation were measured for corpus callosum and cerebral cortex regions. Nonlinear increase in RIs of up to

90% and 70% were found in corpus callosum and cerebral cortex regions separately at 80% deformation. This result can help to correct OCT images of brain tissues caused by heterogeneousness of the material itself and tissue co! mpressions caused by certain diseases or surgical loads. In addition, mechanical testing based on OCT-elastography can also benefit from this result.

**Name:** Kuan-Hui Hsu
**Title:** "Vitamin E Loaded Contact Lens for Extended Ophthalmic Drug Delivery"
**Advisor:** Dr. Anuj Chauhan
**Department:** Chemical Engineering
**Year:** Graduate
**Abstract:** Ophthalmic drug delivery via eye drops is inefficient as only 1-5% of the applied drug enters the cornea and the rest is absorbed into the bloodstream causing undesired side effect. To eliminate the problem, our approach is to incorporate Vitamin E into commercial silicone hydrogel lenses as diffusion barrier and thus increasing release duration of drugs. Results show significant increase of release durations for both hydrophilic and hydrophobic drugs. An in vivo animal study also showed the feasibility and effectiveness of this technique. Several properties including geometry, ion permeability, oxygen permeability and UV transmittance are characterized to determine the pros and cons of loading Vitamin E into the lenses. The results indicate the properties change caused by Vitamin E loading does not disqualify these silicone hydrogels as extended-wear contact lens. Therefore, Silicone hydrogel contact lenses with Vitamin E are promising candidates for extended ophthalmic drug delivery.

**Name:** Hyun-Jung Jung
**Title:** "Thermally Triggered Release of Ophthalmic Drugs from Stimuli-Responsive Contact Lenses"
**Advisor:** Dr. Anuj Chauhan
**Department:** Chemical Engineering
**Year:** Graduate
**Abstract:** Several approaches are currently being explored for extended delivery of ophthalmic drugs to overcome the limitations of eye drops. Most prior research in this area focuses on systems that release a fraction of the loaded drug during packaging. The focus of our research is to develop contact lenses retain the loaded drug during packaging and begin releasing the drug after insertion into the eye.The basic approach is to prepare thermally responsive nanoparticles that release the drug at the physiological temperature but have negligible release under refrigerated condition of 5 0C. A novel approach has been developed for designing the thermally responsive particles by preparing highly crosslinked nanoparticles whose pore size depends on temperature leading to temperature dependent release. The nanoparticles are prepared by polymerization of an emulsion of a monomer with multi-vinyl functionalities of PGT (propoxylated glyceryl triacylate) in presence of oily diluents. Hydrophobic oily drugs such as the base form of the glaucoma drug timolol can be loaded into the particles by addition into the polymerization mixture. The pore size of the particles is smaller than the drug size leading to trapping of the drug, and long release lasting about a month. The drug-loaded particles were then dispersed in various polymers suitable for contact lenses including hydroxy methyl me! thacrylate (HEMA) and silicone hydrogels, which are common contact lens materials. Both HEMA and Silicone-hydrogel lenses containing timolol loaded particles are transparent and can provide extended therapeutic release of timolol for a period of more than a month at physiological temperature. The release rate is highly temperature sensitive. The particles can be designed to absorb UV light leading to the beneficial effects of UV blocking in the contact lenses.

**Name:** Jamal Lewis
**Title:** "Targeted, Immunosuppressive Microparticles Modify Immune Dendritic Cell Behavior for the Prevention of Autoimmune Diabetes in Mice"
**Advisor:** Dr. Benjamin Keselowsky
**Department:** Biomedical Engineering
**Year:** Graduate
**Abstract:** Antigen-specific immunomodulation remains an important goal in the treatment of type 1 diabetes (T1D). We hypothesize that in vivo targeting of biodegradable microparticles (MPs) to DCs delivering immunomodulatory agents can promote a tolerogenic DC phenotype and induce Tregs in vivo, in order to ameliorate type 1 diabetes in NOD mice. In order to test this hypothesis, poly(lactide-co-glycolide) MPs were loaded with antigen – insulin B:9-23, and immunomodulatory factors – vitamin D3 (D3), TGF-B1 and GM-CSF. These MP formulations were injected subcutaneously into 4 week old female NOD mice followed by a booster at 5 weeks of age. Formulations (n = 10) consisted of a.) blank MPs, b.) MPs loaded with insulin peptide only, c.) MPs loaded with GM-CSF + insulin peptide, d.) MPs loaded with D3+TGF-B! 1+insulin peptide, e.) MPs loaded with GM-CSF+D3+TGF-B1 + insulin peptide. Blood glucose was measured once a week until 32 weeks of age (currently at 22 weeks). Kaplan-Meier analysis at this point reveals an overall p-value of 0.094 for survival proportions among groups, with the highest proportion of non-diabetic mice attributed to the formulation of MPs loaded with GM-CSF+D3+TGF-B1+insulin peptide (60% non-diabetic), compared to the blank MPs with the lowest proportion (20% non-diabetic), suggesting delayed onset of T1D. In vitro mechanistic assessments demonstrate MP formulations are capable of promoting tolerogenic DC phenotype and inducing syngeneic CD4+CD25+foxp3+ regulatory Tcells.

**Name:** David Lovett
**Title:** "Modulation of Nuclear Forces by Substrate Rigidity"
**Advisor:** Dr. Tanmay Lele
**Department:** Chemical Engineering
**Year:** Graduate
**Abstract:** The nucleus is mechanically coupled to the three cytoskeletal elements in the cell via linkages maintained by the LINC complex (for Linker of Nucleoskeleton to Cytoskeleton). It has been shown that mechanical forces from the extracellular matrix (ECM) can be transmitted through the cytoskeleton to the nuclear surface. We asked if substrate rigidity can control nuclear forces. We found that the nucleus in NIH 3T3 fibroblasts undergoes significant changes in shape as the substrate rigidity is varied. On soft substrates (1 kPa), the nucleus appears rounded in its vertical cross-section, while on stiff substrates (396 kPa), the nucleus becomes flattened. Over-expression of dominant negative Klarsicht ANC-1 Syne Homology (KASH) domains, which disrupt the LINC complex, caused cell rounding and eli! minated the sensitivity of nuclear shape to substrate rigidity; myosin inhibition had similar effects. KASH over-expression altered the rigidity dependence of cell motility and cell spreading. Taken together, our results suggest that nuclear forces are modulated by substrate rigidity, and that a mechanically integrated nucleus-cytoskeleton is required for rigidity sensing. These results are significant because they suggest that substrate rigidity can potentially direct nuclear function and hence cell function.

**Name:** Michael Springer
**Title:** "Development of a Vascular Graft to Induce Stem Cell Differentiation"
**Advisor:** Dr. Josephine Allen
**Department:** Materials Science and Engineering
**Year:** Graduate
**Abstract:** The need for a suitable vascular graft for small diameter arteries has been sought after for many decades. The 2 main challenges are the identification of a vascular cell source and a suitable biomaterial. This research is aimed at developing a vascular graft that would allow for the tissue engineering of a fully functional small diameter artery. A biphasic vascular graft has been fabricated with a solid Poly(1,8-Octanediol Citrate) (POC) elastomeric lumen encased in an electrospun network of collagen and elastin nanofibers. We have also examined the potential of Mesenchymal Stem Cells (MSCs) and Circulating Progenitor cells (CPCs) to create an autologous construct. Our burst pressure results indicate that the solid POC lumen is capable of withstanding pressures as high as 260mmHg, much highe! r than physiological relevant pressures. We have also shown through gene expression that MSCs can differentiate into both smooth muscle and endothelial cell types. While optimization of the graft is still underway, our results indicate that our vascular graft is a promising method for tissue engineering small diameter vessels.

**Name:** Justin Starr
**Title:** "Enhanced Multiferroic Properties of Multiferroic Nanocomposite Materials"
**Advisor:** Dr. Jennifer Andrew
**Department:** Materials Science and Engineering
**Year:** Graduate
**Abstract:** By combining ferroelectric and ferromagnetic phases in a single material, it is possible to synthesize composite multiferroic materials that display strain-induced magnetoelectric coupling. Traditionally, these composite multiferroics have been synthesized in the form of multilayer thin films, due to the ease of controlling an epitaxial relationship in these structures. However, substrate based constraints limit the magnetoelectric response of these materials. Nanofibers offer additional degrees of freedom when compared to thin films, and therefore the potential for increased magnetoelectric effects. While other groups have synthesized randomly dispersed and core-shell biphasic composite fibers, these configurations make it difficult to access and utilize both phases. To remedy this, we have synthesized novel, Janus-type, multiferroic fibers that arrange ferroelectric ($BaTiO_3$) and ferromagnetic ($CoFe_2O_4$) phases along the length of a nanofiber. These fibers maintain a large contact area between phases and are structured such that each phase is externally accessible.

**Name:** Elena Ten
**Title:** "Template-Mediated Synthesis and Bio-Functionalization of Flexible Lignin-Based Nanotubes and Nanowires"
**Advisor:** Dr. Wilfred Vermerris
**Department:** Agronomy
**Year:** Graduate
**Abstract:** Large-scale implementation of biofuels is only feasible if biofuels are priced competitively with fossil fuels. In addition to reducing the cost of biofuel production itself,

production of high-value co-products can off-set the operating costs of the biorefinery, especially if these co-products are derived from the waste stream. We have developed lignin-based nanotubes synthesized in an alumina membrane template. We covalently linked lignin to the inner walls of activated alumina membranes, then added layers of dehydrogenation polymer onto this base layer via a peroxidase-catalyzed reaction, and dissolved the membrane in dilute acid. By using phenolic monomers displaying different reactivities, we were able to change the thickness of the polymer layer deposited within the pores, resulting in the synthesis of nanotubes with a wall thickness of approximately 15 nm or nanowires with a nominal diameter of 200 nm. In contrast to carbon nanotubes, these novel nanotubes/nanowires are flexible and can be specifically bio-functionalized, as evidenced by in vitro assays with biotin and Concanavilin A. Together with their intrinsic optical properties due to the natural fluorescence of the lignin, which can also be varied as a function of their chemical composition, these lignin-based nanotubes are expected to enable a variety of new applications including as delivery systems that can be easily localized and imaged after uptake by living cells. The ongoing study focuses on effects of different biomass species and chemical pretreatments on morphology and properties of the nanotubes. Funding from the USDA-Biomass Research & Development Initiative project 2011-10006-303508 is gratefully acknowledged.

**Name:** Joseph Uzarski
**Title:** "Development of a Novel Flow Chamber for Real-Time (Direct) Analysis of Blood and Biomaterials Interactions"
**Advisor:** Dr. Peter McFetridge
**Department:** Biomedical Engineering
**Year:** Graduate
**Abstract:** Endothelialization of vascular grafts has been used as a strategy to minimize platelet adhesion, leukocyte infiltration, and other unfavorable host responses that lead to graft failure. Assessment of vascular grafts' intimal reactivity is commonly performed by flowing whole blood across the lumenal (blood-contacting) surface. However, performing such experiments at physiological shear rates requires large blood volumes, and only end-point assessment is possible due to the closed vascular geometry. Here we describe the development of an acrylic flow chamber designed for seeding and conditioning of an endothelium under defined shear conditions on a flexible (opaque) biological scaffold using a parallel plate geometry. The chamber was designed to allow direct imaging of labelled cells as the! y attach to the biomaterial surface in real time using fluorescence microscopy. HUV scaffolds decellularized using sodium dodecyl sulphate (SDS) were sliced open axially and compressed between two acrylic plates, creating a flow channel of uniform height. Primary human umbilical vein endothelial cells (HUVEC) were seeded on the lumenal HUV surface and maintained with high viability (>95%) under perfusion for 7 days. DAPI/rhodamine phalloidin co-staining revealed a confluent endothelial monolayer with uniform cytoskeletal alignment in the flow direction. Time lapse fluorescence imaging successfully captured promyelocytic GFP+ HL-60 cell adhesion to activated endothelia in real time. These results demonstrate that the device can be used effectively for comprehensive assessment of engineered vascular surfaces. The chamber not only provides an environment more reminiscient of the vascular intima, but also permits live visualization of endothelial cells cultured under flow,! and is also useful for studies in

leukocyte rolling and plate! let adhe sion and aggregation. This chamber has been successfully tested with the human umbilical vein and human amniotic membrane, and can be adapted for a wide range of other conduit biomaterials.

**Name:** Lokendrakumar Bengani
**Title:** "Extended Ocular Drug Delivery via surfactant laden P-HEMA gels"
**Advisor:** Dr. Anuj Chauhan
**Department:** Chemical Engineering
**Year:** Freshman
**Abstract:** Protein binding in hydrogels adversely affects their performance and usage in several biomedical applications including contact lenses. Here, we focus on understanding and modeling transport of lysozyme, the most abundant tear fluid protein, in hydrogels of poly-hydroxylethyl methacrylate (p-HEMA), a common contact lens material. Protein uptake experiments with gels of different thicknesses showed a time scale increase as the square of the thickness suggesting diffusion control transport. A Fickian model was fitted to the uptake data to obtain a lysozyme diffusivity of 1.92 x 10-16 ± 6.3 x 10-17 m2/s. A large fraction of protein is adsorbed in the gel and a subsequent Langmuir binding isotherm was obtained. Uptake of lysozyme was found to be reversible and release profiles were accurately pre! dicted without any additional parameters, thus validating the model. This model could assist in lens development of lens cleaning protocols and applications related to protein binding in several biomaterials.

**Name:** Evelyn Bracho-Sanchez
**Title:** "Synthesis and Surface Functionalization of Gold Nanorods for Photothermal Therapy of Cancer"
**Advisor:** Dr. Brian Sorg
**Department:** Biomedical Engineering
**Year:** Senior
**Abstract:** Photothermal therapy (PTT) using gold nanoparticles has gained increasing attention in the past decade, especially for an alternative treatment to cancer with minimal invasion and damage to the surrounding healthy tissue. PTT uses electromagnetic radiation, to reach the gold nanoparticles and transform the absorbed light into heat in order to destroy the carcinogenic cells. The objective of this project is to synthesize gold nanorods with an aspect ratio of 4.1 then functionalize their surface in order to target murine cell line RAW 264.7 macrophages. These macrophages will act as carriers for the nanoparticles to reach the affected area where a laser will be used to irradiate them. The gold nanorods will be synthesized using a seed mediated method by Babak Nikoobakht and Mostafa A. El-Saye! d. Then they will be attached to CD11b antibodies, specific to the cell line mentioned above, using a water soluble carbodiimide cross-linker and N-Hydroxysuccinimide.

**Name:** Scott Brown
**Title:** "Functionalizing Silica Nanoparticles for Non-toxic Anti-fouling Purposes"
**Advisor:** Dr. Anthony Brennan
**Department:** Materials Science and Engineering
**Year:** Senior

**Abstract:** Fouling in the marine and medical industries poses health risks as well as financial burdens. Effective methods of preventing fouling are through chemical and topographical changes in surfaces. This project will investigate the property of amphiphilicity, which is when a material has both hydrophobic and hydrophilic properties. This will be imparted on hydrogels of silica nanoparticles functionalized with poly(ethylene glycol)methacrylate for hydrophilicity and nonafluoroexyltriethoxysilane for hydrophobicity. Characterization through FTIR, swell tests, and dynamic light scattering on the hydrogels will be done to understand the properties and determine effectiveness of functionalization.

**Name:** Natalie Ganio
**Title:** "Biphasic MnO-Fe3O4 nanoparticles for use as magnetic resonance imaging (MRI) contrast agents"
**Advisor:** Dr. Jennifer Andrew
**Department:** Materials Science and Engineering
**Year:** Senior
**Abstract:** Often delivered through the blood stream, contrast agents are used to help clarify images that result from magnetic resonance imaging (MRI). By increasing the sensitivity of the scan, and thereby the visibility of the tissue, doctors can more easily identify problem areas within the patient. The most commonly used compounds for these contrast agents contain gadolinium. However, when used in patients with acute renal failure or end-stage renal disease, these gadolinium-based agents may lead to a rare disease called Nephrogenic Systemic Fibrosis (NSF). NSF results in hyperpigmentation and hardening of the skin, localized to the extremities. The percentage of those diagnosed after exposure to gadolinium-based agents is roughly 4%, with mortality approaching 31%. Since there is currently no prove! n long-term treatment for NSF, there is a need for an alternative to gadolinium-based agents. By creating a Janus-type nanoparticle using MnO and Fe3O4, the manganese helps to enhance the T₁ signal while the iron oxide reduces the T₂ signals of absorbing tissues. These characteristics lead to an effective biphasic nanoparticle that is useful as a contrast agent, specifically one that is a successful alternative to those that are gadolinium-based. These Janus-type biphasic nanoparticles can be created via electrospinning, a process that uses an electric charges to draw out nano scale fibers from a liquid. To achieve nanoparticles rather than nanofibers, the voltage can be increased to yield small, highly charged droplets.

**Name:** Jose Garcia
**Title:** "Chitosan nanoparticles for the advanced delivery of Photodynamic therapy drugs"
**Advisor:** Dr. Brian Sorg
**Department:** Biomedical Engineering
**Year:** Senior
**Abstract:** Over the past decade, photodynamic therapy (PDT) has been an increasingly used method for treating cancer in human patients. PDT however, has its drawbacks in that the drugs injected into the body exhibit factors such as poor solubility, poor circulation half-time in the body and minimal selective uptake by tumor sites. With this in mind, the purpose of this project was to create nanoparticles which selectively deliver PDT drugs to target tumor sites (via the EPR effect) while avoiding clearance from the blood stream.

Current synthesized nanoparticles were found to have a mean diameter of 154 nm along with a singlet oxygen creating efficacy of 51% as compared to that of free-floating PDT drug. Further studies will show effective use of these nanoparticles in shrinking tumors in animal models.

**Name:** Stefany Holguin
**Title:** "Modulating collagen and elastin geometry through electrospinning as a platform for vascular grafts"
**Advisor:** Dr. Josephine Allen
**Department:** Materials Science and Engineering
**Year:** Senior
**Abstract:** "According the American Heart Association, approximately every 25 seconds, cardiovascular disease will change the life of an American. Every minute, an American will die from a coronary event [1]. Thus, there is an obvious, urgent need for therapies to remedy the effects of cardiovascular disease. The fundamental principle of materials science upholds even within the areas of cardiovascular tissue engineering research—how does processing affect structure that thereby affects performance? Cell molecular biology is subsequently triggered by substrate morphology. The question remains, can electrospun nanofibers of collagen and elastin be spun at different densities and orientation, thereby affecting hMSC behaviors such as cell proliferation, focal adhesion distribution and ultimately differe ntiation.
The Allen research group at the University of Florida aims to provide such a tissue engineered treatment, with the ultimate goal being an engineering blood vessel for replacement of diseased segments of the vasculature. Being that blood vessels are divided into three major layers—adventitia, media, and intima, it is critical to study extracellular proteins that play a critical role in maintaining the framework of a blood vessel. In particular, collagen and elastin respectively provide tensile strength and elasticity, contributing to support of the vessel. Previous research has suggested that such a vessel can be engineered from electrospun proteins (like collagen and elastin), producing a scaffold mimicking the texture of natural tissue materials [2]. However, there is yet an understanding of the effects of electrospun fiber morphology on cell behavior. Such a study will provide engineers with a fundamental understanding of the effect of structure/morphology! of a fiber on cell proliferation and adhesion."

**Name:** Kristi Lim
**Title:** "Poly(ethylene glycol) Diacrylate Hydrogels for Diagnostic Purposes"
**Advisor:** Dr. Jennifer Andrew
**Department:** Materials Science and Engineering
**Year:** Senior
**Abstract:** This project is aimed at designing an enzymatically cleavable hydrogel to diagnose lung cancer. To achieve this, a peptide sequence will be incorporated into a poly(ethylene glycol) diacrylate (PEGDA) polymer backbone. The resulting PEGDA-peptide polymer will be polymerized with varying molecular weights of PEGDA to tailor the degradation profile of the gel. It is expected that the hydrogels will degrade enzymatically only in the presence of the appropriate enzyme and that it will also slowly degrade hydrolytically in the event that the target enzyme is not present to cleave the gel.

Luminescent quantum dot nanoparticles will also be incorporated into the hydrogel matrix in order to signal that the matrix has degraded and will be used as a urinary reporter

**Name:** John Parilla
**Title:** “Embossing Low-Density Polyethlyene for Anti-Fouling"
**Advisor:** Dr. Anthony Brennan
**Department:** Materials Science and Engineering
**Year:** Senior
**Abstract:** The Sharklet™ topographical design is a viable no-kill, non-toxic solution to bacterial growth on surfaces [1]. Silicon based polymers are the original base surface that the technology works with. However, the silicon based polymers, like poly(dimethyl siloxane) elastomer (PDMSe), have properties, such as modulus, that lack compared to other polymers. For this reason, alternative materials were investigated by Jackson [2]. It’s been shown that these specific topographies can be transferred via PDMSe or silicon wafer mold species through a thermal embossing process. Low-density polyethylene (LDPE) is a viable candidate for investigation because it has a considerably higher modulus which would prevent features from collapsing and toppling. A thermal embossing process will be used to replicate the Sharklet™ topography onto LDPE films; sessile drop water contact angle, scanning electron microscopy, and optical microscopy will be conducted to ensure replication.

**Name:** Philip Schlenoff
**Title:**"Antibody-coated Magnetic Nanoparticles: Targeting and Treating Cancer in a Dynamic Environment"
**Advisor:** Dr. Joseph Schlenoff
**Department:** Chemistry (Florida State University)
**Year:** Sophomore
**Abstract:** Nanoparticles are rapidly gaining popularity for their use in the fight against cancer. Attached to antibodies, they have the powerful ability to slip through capillary walls and target tumors. Once inside, iron oxide nanoparticles can be targeted using RF killing tumor cells with localized heat. These particles, however, face a hazardous environment in the body and must be modified with ligands to help them reach their target. This project achieves the synthesis and modification of magnetic nanoparticles, coating them with antibodies and the unique stabilizing zwitterion SBS. Once developed, the particles were tested in an animal-simulating environment to evaluate targeting and thermal ablation of tumor cells. The treatment succeeded in targeting and ablating a high number of the tumor cells! , while death count of the control cells was negligible.

**Name:** Laura Villada
**Title:** “Surface Properties of Amphiphilic Hydrogels"
**Advisor:** Dr. Anthony Brennan
**Department:** Materials Science and Engineering
**Year:** Senior
**Abstract:** Surface chemistry of a material influences its biofouling behavior. A series of amphiphilic cross-linked networks/hydrogels will be created to systematically vary their surface energies. The hysteresis and the surface energy will be calculated. The gels will be

examined by measuring the static and dynamic contact angles. The surface will also be examined with FTIR for further understanding of the chemical structures. The different compositions will also be studied using swelling and compression testing to examine the correlation, as far as fouling properties, with surface energy if any and to the amount of protein adsorption. Protein adsorption can be use to screen the materials for antifouling properties. Protein adsorption will be studied in order to determine the antifouling properties of the different compositions. Further work includes the addition of protein to the hydrogel network in order to study cell growth/attachment, based on the same concept. A trend in the contact angle is expected for increasing amount of hydrophobic monomer; a decrease in contact angle measured with the sessile drop method and an increase in contact angle with the captive air bubble method. Surfaces that are more hydrophilic are expected to exhibit less protein adsorption.