“Polymers in Tissue Engineering”

October 29, 2009
1:00 pm to 6:30 pm

Cook Campus Center
Rutgers University
New Brunswick, New Jersey

Organized by NJ ACS Polymer Topical Group

Sponsors:
Polymers in Tissue Engineering

POLYMERS IN TISSUE ENGINEERING

October 29, 2009 (Thursday), 1:00 to 6:30 pm
Rutgers University, Cook College Campus Center
59 Biel Rd., New Brunswick, NJ 08901-8508

Organized by the NJACS Polymer Topical Group
Prof. Treena Livingston Arinzeh and Prof. Michael Jaffe (Organizers, NJIT - Newark)
Dr. Tamal Ghosh (Poster Chair) and Dr. Nicole Harris (Exhibits Chair, Sun Chemical)

12:00 Registration & Setting up of Posters
1:00 Welcome and Opening Remarks
1:10 Keynote Lecture: Joachim Kohn (Rutgers University, New Brunswick)
“Challenges for the Biomaterials Scientist in Tissue Engineering”

2:00 Helen Lu (Columbia U.)
“Biomimetic Scaffold Design for Integrative Soft Tissue Repair”

2:40 Treena Livingston Arinzeh (New Jersey Institute of Technology).
“Polymeric Scaffolds for Stem Cell Tissue Engineering”

3:20 Coffee; Poster Session and Networking

3:50 Patrick Snowhill (Integra LifeSciences Corp.)
“Regenerative Duraplasty”

4:30 Jack Donners (J & J Inc.)
“Biodegradable Polymer Scaffolds for Regenerative Medicine Applications.”

5:10 Wrap up
5:15 Reception; Poster Session and Networking
5:45 Drawing for Door Prize

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Abstract:
The restoration of form and function of patients who have suffered massive traumatic tissue loss continues to be a major health care challenge. Current treatment options range from prosthetic devices to transplantation of human tissue, but do not yet include tissue engineered solutions. The biomaterials scientist faces several difficulties in bringing polymer-based tissue scaffolds to the clinic. These scientific barriers and strategies for possible solutions will be discussed with a focus on polymeric biomaterials and the unique contributions materials science can make to advancing the field of tissue engineering.

Bio:
Professor Joachim Kohn is the Board of Governors Professor of Chemistry and Chemical Biology at Rutgers University, and an Adjunct Associate Professor of Orthopedics at the New Jersey Medical School. He has served as Director of the New Jersey Center for Biomaterials since its establishment in 1997. He is a Fellow of the American Institute for Medical and Biological Engineering (AIMBE) and of the International Union of Societies for Biomaterials Science and Engineering (IUSBSE). He is the principal investigator of several leading federally-funded R&D programs: NIH-funded postdoctoral training program in Tissue Engineering, NSF-funded Partnership for Innovation designed to explore new plant-synthetic hybrid biomaterials, NIH funded National Resource for Polymeric Biomaterials (RESBIO), and the DoD-funded Center for Military Biomaterials Research (CeMBR).

Professor Kohn's research interests focus on the development of new biomaterials. He pioneered the use of combinatorial and computational methods for the optimization of biomaterials for specific medical applications. He is mostly known for his seminal work on "pseudo-poly(amino acid)s" - a new class of polymers that combine the non-toxicity of individual amino acids with the strength and process ability of high-quality engineering plastics. The most prominent member of this class of polymers is poly(DTE carbonate), a tyrosine-derived polycarbonate for which a Materials Master file has been submitted to the US Food and Drug Administration (FDA) in anticipation of the routine clinical use of this material in several medical implants. He has published over 200 scientific manuscripts and reviews and holds 40 patents.
Polymers in Tissue Engineering

In 2007, Professor Kohn was inducted into the New Jersey High-Tech Hall of Fame. He is the recipient of numerous awards and honors, including the prestigious Thomas Alva Edison Patent Award for best patent in New Jersey in the category of medical research, once in 1999 for his invention of tyrosine-derived polycarbonates, and once in 2006 for his invention of the first combinatorially designed library of polyarylates.
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Biomimetic scaffold design for integrative soft tissue repair
Helen H. Lu, Ph.D. (Columbia University)

Abstract: Musculoskeletal motion is facilitated by synchronized interactions between multiple tissue types and the seamless integration of bone with soft tissues such as tendons, ligaments or cartilage. In general, soft tissues transit into bone through a multi-region fibrocartilaginous interface, which serves to minimize the formation of stress concentrations while enabling load transfer between soft and hard tissues. Given its functional significance, re-establishment of the soft tissue-to-bone interface is critical for promoting the integrative repair of both biological and synthetic soft tissue grafts. To address the challenge of biological fixation, our approach centers on interface tissue engineering, guided by the working hypothesis that this multi-tissue transition may be regenerated by controlled culture of interface-relevant cell populations on a stratified scaffold pre-designed with a biomimetic gradient of structural and functional properties. Focusing on the anterior cruciate ligament-to-bone insertion site, in vitro co-culture/tri-culture models evaluating the role of heterotypic cellular interactions in interface regeneration will be discussed. Moreover, elucidation of interface structure-function relationship has yielded biomimetic scaffold design parameters for interface tissue engineering. In vitro and in vivo testing of stratified scaffolds for interface regeneration will be presented. It is anticipated that interface tissue engineering will promote the development of a new generation of integrative soft tissue fixation devices. Moreover, by bridging soft tissue and bone, interface tissue engineering will be instrumental for the ex vivo development and in vivo translation of integrated musculoskeletal tissue systems with biomimetic complexity and functionality.

Short Biography: Dr. Helen H. Lu received her undergraduate and doctoral degrees in Bioengineering from the University of Pennsylvania. After completing postdoctoral training in Orthopedic Tissue Engineering at Drexel University and later at Tufts University, she joined the faculty at Columbia University in the summer of 2001. Dr. Lu is currently the Associate Professor of Biomedical Engineering and the Director of the Biomaterials and Interface Tissue Engineering Laboratory at Columbia. She also holds a joint appointment as Associate Professor of Dental and Craniofacial Bioengineering at the Columbia College of Dental Medicine. Dr. Lu’s research focuses on Orthopaedic Interface Tissue Engineering and the formation of complex tissue systems, with the goal of achieving integrative and functional repair of soft tissue injuries. Additionally, her research group is active in the design of composite biomaterials for orthopedic and dental repair. Her research has been recognized with Early Faculty Career Award in Translational Research from the Wallace H. Coulter Foundation, and the International Y’ROBOTS award for Young Researchers in Orthopedic Biomechanics and Sports Medicine. Dr. Lu was recently honored with a Y oung Investigator A ward from the Society for Biomaterials as well as the Presidential Early Career A ward for Scientists and Engineers (PECASE). Her group has published over fifty original research articles, invited reviews and book chapters in biomaterials and tissue engineering, and Dr. Lu’s research is supported by the Whitaker Foundation, the Wallace H. Coulter Foundation, the Musculoskeletal Transplant Foundation, the New York State Stem Cell Initiative, the National Football League (NFL) Charities and the National Institutes of Health.
Polymeric Scaffolds for Stem Cell Tissue Engineering
Treena Livingston Arinzeh, PhD
Associate Professor and Chair (Interim)
Biomedical Engineering
New Jersey Institute of Technology

Abstract
Stem cells have become a promising cell source in the tissue engineering field. Major advances have occurred in the isolation and characterization of stem cells derived from embryos, nonembryonic/adult sources, and more recently, adult somatic cells that can be genetically reprogrammed to become pluripotent stem cells. Intense studies have been focused at the cell and molecular biology levels on understanding the relationship between stem cell growth and terminal differentiation in an effort to control these processes. Recent discoveries have shown that the microenvironment can influence stem cell self-renewal and differentiation, which has had a tremendous impact on identifying potential strategies for using these cells effectively in the body. This presentation will describe studies examining the influence of polymeric biomaterials on stem cell behavior with an emphasis on polymer surface properties, chemistries and designs that impart appropriate cues to stem cells to affect their behavior and ultimately, tissue formation in vivo.

Biography
Dr. Arinzeh received her B.S. from Rutgers University, New Brunswick, NJ in Mechanical Engineering in 1992, her M.S.E. in Biomedical Engineering from Johns Hopkins University in 1994, and her Ph.D. in Bioengineering from the University of Pennsylvania in 1999. After completing her Ph.D., she worked for several years as a project manager at a stem cell technology company, Osiris Therapeutics, Inc., based in Baltimore, MD, where she developed stem cell based therapies for orthopaedic applications. Dr. Arinzeh joined the faculty of NJIT in the fall of 2001 as one of the founding faculty members of the department of Biomedical Engineering. Dr. Arinzeh has been recognized with numerous awards, including the National Science Foundation CAREER Award in 2003, Presidential Early Career Award for Scientists and Engineers (PECASE) in the fall of 2004, Outstanding Scientist Award from the NJ Association for Biomedical Research in 2004, People to Watch in 2005 in The Star Ledger and 40 Under 40 to Watch in 2008 in Black Enterprise. She also serves on review panels for NIH, NSF as well as state and private agencies. Dr. Arinzeh is also a member of Connecticut’s Stem Cell Research Advisory Committee. She has over 70 peer-reviewed journal and conference proceeding papers, five book chapters and five patents pending. Her research support is from the National Science Foundation, Musculoskeletal Transplant Foundation, New Jersey Commission on Science and Technology – Stem Cell Grant, New Jersey Commission on Spinal Cord Repair and industry.
Regenerative Duraplasty
Patrick Snowhill (Integra LifeSciences Corp.)

Abstract:
While not the most glamorous of the “regenerative” technologies (specifically in the neurosciences),
duraplasty is one of the most important (and only existing marketed technology for the CNS). After access of the
CNS, the dura must be closed to prevent or minimize CSF leakage, invading or excessive inflammatory
responses, and infection. Often, dural edge approximation is not possible due to loss of tissue during
surgical access and/or retraction of the dura due to local swelling or stress relaxation of the tissue. Repair often
requires the use of autologous or allogenic materials (fascia lata, pericranium, etc) or a synthetic graft. Due to donor sight morbidity, scarcity
of tissue at the harvest site, and risk of infective agents (in allogenic materials), the use of synthetic grafts have gained in popularity over the last decade. The ability to repair
and/or regenerate the dura mater is dependent on device structure and physical properties. This talk will review some of the design experiences of Integra LifeSciences and its
position as the leader in dural regeneration matrices.

Bio: Graduated from Rutgers University and the University of Medicine and Dentistry of New Jersey with a Ph.D in Biomedical Engineering in 2003. Ran a freelance consulting
business for two years assisting the Department of Radiology at UMDNJ to run a clinical trial for a contrast agent. Additionally, received an adjunct instructor position and
continued to write grants, assisted with a textbook project, and taught a variety of courses and lectures. In 2005 joined Integra LifeSciences as a Scientist in the Product
Development Group for Regenerative Medicine. In 2008, after divisionalization, was promoted to Senior Scientist within the NeuroSciences Division. Responsibilities include preclinical animal studies, biocompatibility studies, technical resource for Product Development, Regulatory, Quality, and Manufacturing, Lead for the Exploratory Group, and operation of the laboratory facilities. Was a student member and has been an active member of BMES since 2004. Currently on the Industrial Review Board at NJIT.
Abstract
The field of regenerative medicine is an exciting area of therapeutic treatments that is seeing its first commercial applications. The regeneration of native tissue to repair local damage requires a careful balance between bioactives (proteins, drugs, cells) and biomaterial support. The various aspects of development of a regenerative cartilage product will be discussed with an emphasis on the selection of the scaffold material and its impact on the function of the device.

Bio
Jack Donners

The author received his M.Sc degree from the Radboud University Nijmegen in the Netherlands in 1998 in the field of physical organic chemistry with a minor in homogeneous catalysis. Subsequently he received his Ph.D. in polymer science in 2002 from the Eindhoven University of Technology (The Netherlands) under supervision of prof. Bert Meijer and prof. Roeland Nolte. From 2002-2005 the author was a postdoctoral fellow at Northwestern University in the group of prof. Sam Stupp working on regenerative applications of self-assembling peptide gels. In 2006, the author joined Johnson & Johnson and is currently part of Advanced Technologies & Regenerative Medicine, LLC where he provides scaffold and materials support for projects focused on tissue engineering, regenerative medicine and drug delivery. The author has 16 papers in peer-reviewed journals and 5 patent applications with 1 issued patent.

Poster Titles
1. “Polymers for Nucleic Acid Binding, Recognition, and Delivery” Mohammed R. Elshaer, Cosimo Antonacci Ph.D, James E. Hanson Ph.D*, Seton Hall University

2. “An Electroactive Conduit for Spinal Cord Injury” Yee-Shuan Lee, George Collins, Treena Livingston Arinzech, Department of Biomedical Engineering, New Jersey Institute of Technology
Polymers in Tissue Engineering

3. Comparative Percutaneous Absorption Studies of N,N-Diethyl-meta-toluamide (DEET) across Polymer-based Human Skin Equivalents (HSE)
Vishwas Rai1, Priya Batheja1, Prafulla Chandra2 and Bozena Michniak-Kohn1,2
Ernest Mario School of Pharmacy, Dept. of Pharmaceutics, Rutgers – The State University of New Jersey, Piscataway, NJ, USA1
New Jersey Center for Biomaterials, Piscataway, NJ, USA2

4. “Investigation of the molecular weight change of PEG-6000 in various formulations / storage conditions through analysis by SEC with RI and MS detection” Peter Tattersall, Brian Yan, Scott Miller and John Grosso
Analytical R & D, Bristol-Myers Squibb Company, New Brunswick, NJ

5. “Neuronal plasticity with a Piezoelectric Polymer” Núria Royo-Gascón1, Damien Carrel2, Bonnie L. Firestein Ph.D2, Jerry Scheinbeim,PhD3, William Craelius PhD1
1Department of Biomedical Engineering, Rutgers, The State University of New Jersey
2Department of Cell Biology and Neuroscience, Rutgers, The State University of New Jersey
3Department of Chemical and Biochemical Engineering, Rutgers, The State University of New Jersey

6. “Fabrication and Evaluation of Bioactive-based Polyanhydride Nerve Guidance Conduits” Jeremy Griffin1, Roberto Delgado-Rivera2, Ashley Carbone2, Sally Meiners3, Kathryn Uhrich1,2
1Department of Biomedical Engineering, Rutgers University, 599 Taylor Road, Piscataway, NJ 08854
2Department of Chemistry & Chemical Biology, Rutgers University, 610 Taylor Road, Piscataway, NJ 08854
3Department of Pharmacology, Robert Wood Johnson Medical School, Piscataway, NJ 08854

7. Microscale Plasma-Initiated Patterning of Polymer Scaffolds
Roberto Delgado-Rivera1,4, Jeremy Griffin2, Christopher Ricupero3, Martin Grumet3, Sally Meiners4, and Kathryn E. Uhrich1,2
1Department of Chemistry and Chemical Biology, Rutgers University, Piscataway, NJ 08854
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3W.M. Keck Center for Collaborative Neuroscience, Rutgers University, Piscataway, NJ 08854
4Department of Pharmacology, Robert Wood Johnson Medical School, Piscataway, NJ 08854

8. “NANOGELS IN TISSUE ENGINEERING OF CARTILAGES” Sathish Ponnurangam, Columbia University

9. 3D Precision Microfabrication Technology: From Tissue Engineered Scaffolds to Cardiovascular Stents
Qing Liu, Marika Bergenstock, Nick Wang, and Wing Lau 3D Biotek, LLC, 675 US Highway 1, Technology Center of New Jersey, North Brunswick, NJ 08902

10. “Improved Reproducibility of MW Measurements of Polypeptoids using an EcoSEC GPC System” Howard Barth, Consultant and Joe Machamer*, GPC Marketing Manager, Tosoh Bioscience LLC
Polymers in Tissue Engineering

1. “Polymers for Nucleic Acid Binding, Recognition, and Delivery”
Mohammed R. Elshaer, Cosimo Antonacci Ph.D, James E. Hanson Ph.D*
, Seton Hall University

Abstract:
Molecular recognition is vital to many biochemical processes and is at the heart of promising bio-medically related technologies. Molecular imprinting has a long history as a successful method for generating molecular recognition. However, its utility has been limited since traditional molecularly imprinted polymers are insoluble. Our focus is directed towards developing a method for generating soluble, non-charged (or weakly charged), biodegradable, imprinted polymer nanoparticles possessing affinities for specific nucleic acid sequences. We have begun by screening a large number of synthetic polymers, some commercially available and some prepared in our lab, in an effort to identify viable polymer candidates with nucleic acid recognition capabilities. The affinity of these polymers for quadruplexed G-tetrad (T4G4)4 oligonucleotides have been evaluated by polyacrylamide gel electrophoresis. Quasi elastic light scattering will be used to further characterize the prepared polyplexes in solution. The best candidate polymers identified have the potential to be modified accordingly and developed into nucleic acid molecularly imprinted polymers.

Yee-Shuan Lee, George Collins, Treena Livingston Arinzeh
Department of Biomedical Engineering, New Jersey Institute of Technology

Abstract:
Spinal cord injury is a serious clinical problem where therapeutic strategies leading to efficient functional recovery are urgently needed. After the injury, the unidirectional aligned structure of the axons is disrupted. Thus, restoring its original structure is necessary for functional recovery. A tissue-engineered bridging device providing axonal growth guidance holds great potential. We investigated neurite extension on a novel, piezoelectric scaffold consisting of aligned fibers where the piezoelectric characteristic of the fiber should provide local electrical stimulation coupled with contact guidance cues of the fiber for neurite extension. Scaffolds consisted of piezoelectric, polyvinylidene fluoride-trifluoroethylene (PVDF-TrFE) fabricated into random or aligned fibers using the electrospinning technique. Since fiber size affects the surface to volume ratio, which may in turn influence the piezoelectric effect due to changes in surface area exposure to the surrounding milieu, we also investigated changes in fiber size on neurite extension.

Dorsal root ganglion (DRG) explants were cultured on random and aligned PVDF-TrFE scaffolds having either nano- or micron-sized fibers. DRGs neurite extension was observed on both random and aligned scaffolds where neurites extended along the fibers on the aligned scaffolds. The result suggested the piezoelectric behavior of PVDF-TrFE may enhance neurite extension.

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3. Comparative Percutaneous Absorption Studies of N,N-Diethyl-meta-toluamide (DEET) across Polymer-based Human Skin Equivalents (HSE)

Vishwas Rai¹, Priya Batheja¹, Prafulla Chandra² and Bozena Michniak-Kohn¹,²
Ernest Mario School of Pharmacy, Dept. of Pharmaceutics, Rutgers – The State University of New Jersey, Piscataway, NJ, USA¹
New Jersey Center for Biomaterials, Piscataway, NJ, USA²

**Purpose:** HSEs are in vitro bioengineered skin models containing combinations of cells (human dermal fibroblasts & epidermal keratinocytes) and extracellular matrix components that serve to mimic native human skin. HSEs can serve as important and reproducible in vitro alternatives to human and animal skin for assessment of permeability of a variety of molecules for pharmaceutical, personal care and cosmetic applications. HSEs prepared using a collagen-fibroblast dermis lack good mechanical properties and ease of handling. Polymer-based HSEs have been developed and tested in our lab for improved handling properties. N,N-Diethyl-meta-toluamide (DEET) is a mosquito repellent and in this study, DEET was used as a model compound to observe comparative in-vitro permeation studies across HSE models (collagen and polymer-based) and human skin.

**Methods:** HSEs are prepared in vitro using a combination of neonatal fibroblasts, primary keratinocytes, bovine type I collagen and special culture conditions that aim to mimic native human skin. In polymer-HSE, an electrospun fibroporous mat made using a biocompatible polymer is used as a dermal scaffold. Fibroblast proliferation in scaffolds was quantified using the MTS tetrazolium-based assay. Permeation studies were carried out using different concentration of DEET [100%, 25% in acetone, and 25% in Ethanol-commercial preparation ‘OFF’] on Franz diffusion cells and for 24 hr. HPLC was performed on samples and results were evaluated using Minitab® software. Controls used were human cadaver skin samples (for all formulations); and human skin and Epiderm FT (MatTek Corp., Ashland MA) (for 100% DEET).

**Results:** The polymer scaffold generated by electrospinning had a fibro-porous structure and resulted in penetration and proliferation of dermal fibroblasts. A full-thickness HSE was successfully cultured using the electrospun scaffold. Steady state flux of 100% DEET across collagen & polymer-based HSE, Epiderm FT and human skin was found to be 743.2±56.0, 846.0±10.0, 942.6±54.3 and 120.3±54.7 ug/cm²/hr respectively. Steady state flux of 25% DEET in acetone across collagen & polymer-based HSE and human skin were 779.3±225.2, 628.8±88.6 and 170.6±30.1 ug/cm²/hr respectively; and for 25% DEET in Ethanol, the values were 664.4±229.3, 523.3±89.2 and 144.5±73.3 ug/cm²/hr respectively. The formulations showed significant different flux values across different skin models/human skin (P≤0.05).

**Conclusions:** Polymer HSE with improved mechanical handling properties was successfully developed in our lab. Collagen- and polymer-based HSE model performed similarly during permeation analysis and showed similar or better flux compared to EpidermFT.
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4. Investigation of the molecular weight change of PEG-6000 in various formulations / storage conditions through analysis by SEC with RI and MS detection

Peter Tattersall, Brian Yan, Scott Miller and John Grosso
Analytical R&D, Bristol-Myers Squibb Company, New Brunswick, NJ

Abstract: PEGs are known to easily oxidize and degrade at elevated temperatures. Tablet formulations of an Active Pharmaceutical Ingredient (API) - benzene sulfonate salt (besylate), where PEG-6000 was being utilized as a binder in a hot melt granulation process, were evaluated. PEG besylate esters with molecular weights less than approximately 1500 daltons are positive in the Ames test which is indicative of mutagenic activity. This triggered a number of studies to probe the potential for the formation of smaller molecular weight PEG species and besylate esters in the PEG-6000 formulation. PEG was subjected to heat stress conditions mimicking the hot melt granulation process and analyzed at different time points. Another study looked at the degradation of PEG besylate ester, PEG API- besylate mixture and tablet formulations after periods of exposures to various thermal stability stress conditions. Size Exclusion Chromatography (SEC) coupled with Reflective Index (RI) and Mass Spectrometry (MS) detection were utilized. The changes of the molecular weight distributions demonstrated the generation of smaller molecular weight PEG species and thus the risk of generating potentially genotoxic impurities.

5. Neuronal plasticity with a Piezoelectric Polymer

Núria Royo-Gascón¹, Damien Carrel², Bonnie L. Firestein PhD², Jerry Scheinbeim,PhD³, William Craelius PhD¹

¹ Department of Biomedical Engineering, Rutgers, The State University of New Jersey
² Department of Cell Biology and Neuroscience, Rutgers, The State University of New Jersey
³ Department of Chemical and Biochemical Engineering, Rutgers, The State University of New Jersey

Mechanical vibration of piezoelectric (PZ) polymers produces a variation in the charge density in their surfaces. This mechanical vibration provides an electromagnetic field to which neurons can respond. We used the PZ polymer PVDF (Poly-vinylidene fluoride) to provide a substrate for electrical stimulation of spinal cord neurons. The effects of these electrical fields in the neurons can be quantified in terms of: branching (Branch Points, Terminal Points, Order), number of processes and average length of processes. Results show the effects of electrical and vibrational stimuli in neurons, demonstrating a potential for combinational approaches in neuronal differentiation using piezoelectric scaffolds. Specifically, PZ stimulation caused a significant increase in dendritic branching.
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6. Fabrication and Evaluation of Bioactive-based Polyanhydride Nerve Guidance Conduits

Jeremy Griffin¹, Roberto Delgado-Rivera², Ashley Carbone², Sally Meiners³, Kathryn Uhrich¹,² ¹Department of Biomedical Engineering, Rutgers University, 599 Taylor Road, Piscataway, NJ 08854
²Department of Chemistry & Chemical Biology, Rutgers University, 610 Taylor Road, Piscataway, NJ 08854
³Department of Pharmacology, Robert Wood Johnson Medical School, Piscataway, NJ 08854

Abstract: Implantable biodegradable nerve guidance conduits are promising alternatives to autograft nerve transplants for tissue regeneration in the peripheral nervous system and have the potential to align and support regenerating cells and prevent scar formation. A synthetic nerve graft material must be able to: interact favorably with the cellular components of nerve tissue, be strong and pliable, and ideally biodegrade when regeneration is complete, leaving the biological structure intact. In this study in vitro assays and preliminary in vivo evaluation is performed using a novel bioactive-based polyanhydride nerve guidance conduit material. Using a dip-coating technique, an admixture of polylactide anhydride (PLAA) and a poly(anhydride-ester) comprised of salicylic acid is fabricated into a conduit of the appropriate size for an in vivo model with the sciatic nerve in Sprague-Dawley rats. Additionally, triethyl citrate plasticizer and glucose molecules were included in the polymer admixture to alleviate brittle mechanical properties and to introduce porosity into the biomaterial. Under physiological conditions, the polymer conduit undergoes surface erosion and pH-dependent non-enzymatic hydrolytic bond cleavage. The degradation rate of the polymer conduits were analyzed in vitro by measuring the mass loss and release of the non-steroidal anti-inflammatory active therapeutics via UV/vis spectrophotometry.

7. Microscale Plasma-Initiated Patterning of Polymer Scaffolds

Roberto Delgado-Rivera¹,⁴, Jeremy Griffin², Christopher Ricupero³, Martin Grumet³, Sally Meiners⁴, and Kathryn E. Uhrich¹,²

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Microscale plasma-initiated patterning is a novel technique used to create biomolecular micropatterns for cellular guidance. The patterning method uses a poly(dimethylsiloxane) (PDMS) stamp to selectively protect regions of the polymer substrate from oxygen plasma treatment. In this research, following plasma treatment, fibroblast growth factor (FGF-2) or laminin is applied to the surface and selectively adhered to its preferential region. In vitro studies involved isolating and culturing primary cells from the nervous system from postnatal Sprague Dawley rat pups (dorsal root ganglia, cerebellar granule neurons,
Schwann cells, and astrocytes) and radial glial clones (neuronal precursors) on the nanofibrillar surfaces. Previous research has shown that electrospun polyamide nanofibers closely mimic the three-dimensional (3D) architecture of the assembled extracellular matrix that regulates neuronal growth in vivo. The ultimate goal of such research is to chemically modify the surface of polymer scaffolds to provide external chemical cues for cellular organization without compromising the physical properties of the scaffold itself.

8. 3D Precision Microfabrication Technology: From Tissue Engineered Scaffolds to Cardiovascular Stents
Qing Liu, Marika Bergenstock, Nick Wang, and Wing Lau
3D Biotek, LLC
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The loss or failure of an organ or tissue is one of the most devastating and costly problems in healthcare today. There is an increasing demand to find solutions for repairing injured and/or diseased tissues and organs. In an effort to meet this considerable challenge, 3D Biotek has developed 3D Precision Microfabrication Technology to fabricate porous structures of intricate shape and/or patterns with precisely controlled size and porosity. The application of this novel technology in biomedical fields is endless. Both degradable and non-degradable polymers, such as polycaprolactone (PCL), poly(lactide-co-glycolide) (PLGA), poly(DL-lactide) (PDLLA), polyglycolide (PGA) and polystyrene (PS), have been used to develop scaffolds for orthopedic and tissue engineering research, as well as for creating normal and diseased in vitro tissue models. Based on the 3D Precision Microfabrication Technology platform, 3D Biotek has recently developed a Rapid Stent Fabrication (RSF) System which can be used to fabricate bioabsorbable porous tubular structures for blood vessel regeneration and cardiovascular stent applications. Porous tubes and stents for cardiovascular applications have been successfully fabricated using biodegradable polymers such as PCL, PLGA and PGA. The world’s first CAD-based RSF System has the capability to quickly and reproducibly fabricate bioabsorbable polymer stents directly from polymer pellets/powders. Moreover, this fabrication system makes very efficient and cost-effective use of expensive polymers, and can therefore accelerate the product development process and reduce the overall R&D cost. Ultimately, this RSF System introduces a new method for the fabrication of drug loaded bioabsorbable stents.

Acknowledgements: This research was supported by NJ CST’s Incubator Seed Fund and Technology Fellowship Program.
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9. Improved Reproducibility of MW Measurements of Polypeptoids using an EcoSEC GPC System

Howard Barth, Consultant and Joe Machamer*, GPC Marketing Manager, Tosoh Bioscience LLC

There is considerable attention placed on the synthesis and characterization of polypeptoids, a new class of synthetic polypeptide analogues. Peptoids are peptide isomers that differ in the connectivity of the side chain. The resulting structure imparts proteolytic stability, may mimic polypeptide behavior and could have novel polymer properties for commercial use, as they are close in structure to nylon-type polyamides. The EcoSEC GPC System and a set of TSK-GEL mixed-bed columns, both available from Tosoh Bioscience, were used successfully for obtaining high quality MWD data of a series of block poly-β-alkylalanoids with HFIP as the mobile phase in under 15 minutes. The apparent MW averages based on PMMA calibration ranged from 27,000 to 49,000 for M_n and from 30,000 to 61,000 for M_w with an average polydispersity of 1.20. Because of excellent flow rate and temperature control, and baseline stability of the EcoSEC GPC System, average MW values ranged from 0.2 to 0.3% relative standard deviation, a ten-fold reproducibility improvement as compared to SEC literature data of polyamides using a similar mobile phase system.

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