RUTGERS

RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY

BIOTECHNOLOGY TRAINING PROGRAM

ANNUAL REPORT
2018

Rutgers, The State University of New Jersey
BIOTECHNOLOGY TRAINING PROGRAM

The PhD Training Program in Biotechnology at Rutgers, The State University of New Jersey was established in 1989. It is one of the select group of such programs throughout the country funded by the National Institute of Health (NIH). The 2017-2018 year marks the 28th year of NIH funding. Biotech Fellows are supported for two years through the funding provided by the NIH and matched by the University. For the 2018-19 year, the NIH is providing 10 fellow positions and the University is providing an additional 5 positions, 2 from RBHS.

The aim of the program is to train a new breed of creative investigators who are able to translate basic science discoveries into technological developments for the needs of society, government, and industry. Students in the program become: (1) well educated within a single biotechnology-related discipline (e.g. biochemistry, chemical engineering, molecular biology), and (2) fluent in the language, approaches and principles of the biological and physical sciences, in general.

The research programs of the training faculty address a broad spectrum of problems in biotechnology. The majority of the individual and collaborative projects fall within two major interdisciplinary research thrusts:

Genomics, Proteomics, and Structural Biology: The past few decades have seen great technical advances in molecular and cell biology that have led to the development of new therapeutics and diagnostics which will have a profound impact on medicine for years to come. With the Human Genome Project complete, a massive effort is being undertaken to build from the molecular level in a step-wise fashion all the way to complex behavior and function. This effort will require further discovery and analysis of biological systems together with integration of high throughput and genetic manipulation technologies in experimental biology, sophisticated data management and statistical analysis techniques from mathematics and computer science, and systems modeling and fabrication tools from engineering. Every major pharmaceutical company is currently invested heavily in “post-genome” technologies, and numerous biotechnology companies have been created in areas such as genomics, proteomics, and systems biology. Genomics-based products and technologies are estimated to exceed $50 billion by 2015.

Tissue Engineering, Regenerative Medicine, and Drug Delivery: Without question, one of the most fertile biotechnological areas for the development of new and innovative medical therapies for the next century lies in the realm of regenerative medicine and tissue engineering. Given the remarkable advances in fundamental understanding of the functions and behaviors of cells and tissues over the past few decades, we are poised in the beginning of the 21st century to translate this basic knowledge into vast improvements in the practice of medicine. By combining basic science, engineering problem-solving and clinical wisdom, age-old handicaps that used to devastate people's lives - blindness, deafness, paraplegia, organ dysfunction and failure, memory loss, and even death - may be circumvented by cell transplants, advanced drug delivery systems, intelligent prostheses, neural implants, artificial organs, and natural organs re-grown after injury or disease. In addition to the latter, we foresee that cell and tissue-based integrated systems will, in the not-too-distant-future, become pharmaceutical industry

standards for early and late stages of drug discovery and drug testing, in the same manner that combinatorial approaches have revolutionized early steps of drug synthesis and discovery. Finally, the NIH estimates that the current world market for replacement organ therapies is in excess of $350 billion, and the projected U.S. market for regenerative medicine is estimated at $100 billion.

Program Faculty

Training faculty, their department affiliation, and their research interests are provided in **Appendix A.** The individuals listed have been selected on the basis of their research expertise, proven ability to engage in collaborative, interdisciplinary work, national and international scientific reputations, proven ability to attract continuing external research support, and established records of didactic and research training in biotechnology. The primary roles of the members of the biotechnology training faculty are to: 1) contribute to the teaching mission of the program, 2) direct the research of individual trainees, 3) serve on thesis committees of individual trainees, and 4) serve as needed on program committees.

Trainee Candidates

Only students of exceptional abilities and motivation are admitted to the Biotechnology Training Program. The program is aimed at producing the very best students in the field. Selection is based on academic performance and potential for future excellence. Students must first gain admission to one of the Ph.D. granting programs with which the training faculty are affiliated. Admission to the Biotechnology Training Program is determined by the Biotechnology Program Admissions Committee. The trainees are expected to meet the same criteria required of graduate students awarded the most competitive awards, such as NSF Graduate or Rutgers Presidential Fellowships. These include an outstanding scholastic record as measured by undergraduate cumulative averages, Graduate Record Examination scores, previous research experience, letters of recommendation, and an indication of leadership potential. Interviews are conducted with all students.

Some students apply to the program after a year or two of study. These students petition their graduate program directors to submit applications to the Biotechnology Training Program on their behalf, and are interviewed if deemed suitable. If accepted, these students are expected to fulfill all requirements of the program, including the coursework and industrial laboratory rotations. No student, regardless of his/her year of admission, is supported longer than two years by the program. Biotech fellows are listed in **Appendix B.**

Student Research, Publications, and Presentations

A listing of current research, publications, and presentations of our trainees is provided in **Appendix C**. For the past year alone, over 40 papers and presentations have been made by Biotechnology Program students. This successful publication and presentation history certainly supports the fact that we continue to train highly skilled and effective scientists and engineers who will contribute to the advancement and success of biotechnology.

Courses – **Appendix D**

Biotechnology Program Specific Courses: The Biotechnology Training Program specific courses and other activities that form a core experience provide the student with a perspective on biotechnology from multiple vantage points: 1) the advanced academic research viewpoint (the Topics in Advanced Biotechnology Course and Academic Lab Rotations), 2) the traditional Biotechnology Industry viewpoint (the Bioengineering in the Biotechnology and Pharmaceutical Industries course and the Industrial Internship), and 3) the start-up and new venture viewpoint (the Innovation and Entrepreneurship for Science and Technology course and the Industrial Internship)

Topics in Advanced Biotechnology I: After the Biotech Program fall orientation which takes place the last week in August, students and faculty meet biweekly during the fall semester for the Topics course. This forum introduces the new students to research opportunities within the program and allows advanced students to sharpen their presentation skills by providing an experienced audience to critique their work. Students who do not have ongoing work to describe may present a recent paper from the literature which is chosen in consultation with the faculty/student group.

Topics in Advanced Biotechnology II: This course is one of the primary unifying threads of the Program. It occurs biweekly during each spring semester (for 2-3 hour sessions), and all students in the training program (those currently supported as well as those who were supported in the past) are required to attend. The course serves as a forum to: 1) highlight and unify ongoing biotechnology research on campus, 2) introduce emerging new areas of biotechnology to students and faculty, and 3) provide trainees with insight into the technological development of basic discoveries. Faculty guide students in the choice of literature articles that they will present. Critical analysis of data, its interpretation and implications are highlighted, and special attention is paid to applied research, technology-oriented issues, ethical considerations, and policy-oriented issues in the subject area. In this regard, invited investigators from industry play a key role. By having students enroll in the course during their entire graduate career (every spring semester), it is possible to involve advanced students in the selection of topics and seminar speakers (including the responsibility for organizing speakers) and to encourage their interaction with scientists from outside institutions.

Bioengineering in the Biotechnology and Pharmaceutical Industries: The goal of this course is to offer students insight into the practical aspects of industrial bioprocessing. Industrial practitioners from various fields of expertise provide lectures and facilitate discussions highlighting problems and issues that engineers and scientists encounter. Topics vary from year to year but always include: drug discovery, drug metabolism, microbial fermentation and mammalian cell culture optimization and scale-up, monoclonal antibody, vaccine and gene therapy production, downstream purification, drug delivery, formulation, regenerative medicine, stem cell culture, tissue engineering, cellular therapies, regulatory considerations, manufacturing challenges, and clinical research. This course provides students with exposure to topics which are beyond the scope of a purely theoretically-structured course. After taking this course, students have a much better understanding of the challenges that engineers and scientists face in industrial bioprocessing.

Innovation and Entrepreneurship for Science and Technology: This course introduces and outlines the fundamentals of “technology entrepreneurship” and introduces a framework for identification of high-potential, technology-intensive, commercial opportunities, gathering required resources (human and financial), and maturing the innovation to a commercializable product. The course places a specific focus on commercialization derived from scientific and technological research with special emphasis on

biotechnology and the life science industry. The course is led by Susan Engelhardt and Martin Yarmush with guest lecturers from industry and academia. The course objective is to have students complete the class with: 1) an understanding of the major components of the life cycle from research to innovation to commercialization, 2) knowledge of the many ways that innovation manifests itself, in the context of start-up, corporate, social and public sector concerns, 3) practical methods to intelligently and objectively evaluate potential commercialization opportunities, and 4) a framework within which to consider the ethical issues that are intertwined with entrepreneurial activities. Through the collection of lectures and projects, students build upon the following critical skills for entrepreneurial success: 1) opportunity evaluation, 2) strategic thinking, 3) teamwork, 4) art of selling, persuasion and motivation, oral and written communication, basics of start-up legal concepts, basics of startup finance and accounting. This course was developed in response to student demand.

Professional Preparedness in Biotechnology: Although current courses in the typical graduate curriculum appropriately deliver strategic discipline-based learning for life science and engineering graduate students, the broader biotech and health science industry further demands that scientists be prepared to serve a variety of distinct functions within the life and biomedical sciences ecosystem, and to understand broader developmental aspects of the business of science and engineering in a professional environment. Many scientific professionals, while experts in their respective fields, have little academic/professional background in business management; skills that ensure that scientific projects and research are implementable, feasible and sustainable. In addition, these skills work to expand scientists' and researchers' professional reach and help them to realize their true career potential. This course entitled, "Professional Preparedness in Biotechnology" will enhance students' competitive skills and introduce additional layers of specialized competence enabling immediate contribution within diverse organizations in the life and biomedical sciences commercial sector. Students will develop business, communication, management, (and other), and skills.

Interdisciplinary Biostatistics Research Training For Molecular And Cellular Sciences: Enhancing Rigor And Reproducibility: This course will provide students with a strong foundation in statistical approaches to data analysis and will be specifically tailored to the molecular, cellular, and tissue biotechnology and bioengineering data relevant to their thesis projects. Two particularly important components of the course involve the training of students on how to: 1) critically assess and interpret published scientific data, and 2) enhance and optimize experimental rigor and reproducibility. An active learning strategy combining didactic instruction and experiential training will reinforce understanding and appreciation for the importance of data analysis in designing rigorous and reproducible data suitable for publication in top-tier scientific journals. This course will be taught by bench scientists with a solid grasp of statistical methodology, using easy to understand terminology, and who are very effective teachers of statistics to wide audiences.

Applications In Medical Device Development: This course will provide students insight into the application of a variety of medical devices, and introduce business concepts as they relate to medical devices from a realistic industrial perspective. Representative fields including but not limited to cardiovascular, orthopedics, diagnostics, imaging, rehabilitation, and dental will be covered. Industrial practitioners provide lectures and facilitate discussions highlighting problems such as manufacturing issues or project management challenges that engineers and scientists may encounter when dealing with the medical device industry.

Summer Industrial Internship Program - Appendix E

The purpose of this program is to provide an opportunity for the students to gain access to industrial facilities and become more aware of the "gestalt" and practice of industrial research and development. At a minimum, students spend eight weeks full time at an industrial site under the guidance of a particular industrial investigator. These experiences may, on occasion, lead to the involvement of an industrial mentor on the student's dissertation committee. Students who have prior extensive industrial experience may elect to opt out of this requirement; but many of these students still wish to do rotations in different fields. We are extremely fortunate to have a tremendous variety of experiences available.

Symposium and Orientation – Appendix F

The Biotechnology Program's Annual Minisymposium of faculty, trainees, and industrial investigators serves as a forum for presentation and review. The meeting is a one-day offsite retreat and colloquium, during late summer, where the trainees, faculty, and industrial members present research papers and posters. The meeting also helps to introduce new students to the research programs at Rutgers and to other topics of interest to the biotechnology industry. Speakers from industry have discussed health care reform and entrepreneurship, for example, at past retreats. Student awards are presented to the top research posters.

Alumni- Appendix G

Since its inception, the Biotechnology Training Program has trained over 150 PhD candidates. These graduate students have gone on to achieve successful careers in both industry and academia. Many of our alumni currently support our program by hosting our trainees as interns for the summer and by participating in Biotechnology Training Program courses.

APPENDIX A: BIOTECHNOLOGY TRAINING PROGRAM FACULTY

Faculty	Role in Program	Research Interest
Androulakis, Ioannis, PhD Associate Professor Biomedical Engineering	Mentor	Systems biology, transcription, inflammation
Arnold, Edward, PhD Professor Chemistry and Chemical Biology	Mentor	HIV, AIDS, drugs, vaccines, structural biology
Berman, Helen, PhD Board of Governors Prof Chemistry and Chemical Biology	Mentor	Structural biology, structural bioinformatics
Berthiaume, Francois, PhD Associate Professor Biomedical Engineering	**Executive Committee**	Regenerative med, metabolic eng, stem cells for skin wounds
Bertino, Joseph, MD, PhD Professor Pharmacology	Mentor	Tumor suppressor genes and drug resistance
Bunting, Sam, PhD Assistant Professor Molecular Biology and Biochemistry	Mentor	Cell survival and DNA repair in mammals
Burley, Stephen, MD, PhD Distinguished Professor Chemistry and Chemical Biology	Mentor	Structural biology and proteomics
Cai, Li, PhD Associate Professor Biomedical Engineering	Mentor	Tissue engineering, stem cells, retinal cells
Copeland, Paul, PhD Associate Professor Biochemistry & Molecular Biology	Mentor	Regulation of gene expression at the translational level
Drake, Justin, PhD Assistant Professor Medical Oncology	Mentor	Cancer metastasis, Kinase signaling, Targeted therapies Targeted therapies
Dunn, Michael, PhD Associate Professor Orthopaedic Surgery	Mentor	Musculoskeletal Tissue engineering
Ebright, Richard, PhD Board of Governors Prof Chemistry and Chemical Biology	Mentor	Transcription; Antibacterial Drug Discovery
Firestein, Bonnie, PhD Professor Cell Biology and Neuroscience	Mentor	Dendrite branching in forebrain and spinal cord neurons
Freeman, Joseph, PhD Associate Professor Biomedical Engineering	Mentor	Repair of musculoskeletal tissues; tissue engineering
Gormley, Adam, PhD Assistant Professor Biomedical Engineering	Mentor	Bioinspired nanobiomaterials
Grumet, Martin, PhD Professor Cell Biology and Neuroscience	**Executive Committee**	Control of Inflammation after spinal cord injury

Faculty	Role in Program	Research Interest
Ierapetritou, Marianthi, PhD Professor Chemical and Biochemical Engineering	Mentor	Systems engineering, metabolic engineering
Khare, Sagar, PhD Assistant Professor Chemistry and Chemical Biology	Mentor	Design principles of molecular recognition
Kramer, Sunita, PhD Associate Professor Pathology & Laboratory Medicine	Mentor	Cell migration, signaling, heart and blood vessel development
Lee, Ki Bum, PhD Associate Professor Chemistry and Chemical Biology	Mentor	Nanomedicine and Controlling stem cell/cancer fate o
Lobel, Peter, PhD Professor Pharmacology	**Executive Committee**	Hereditary neurodegenerative diseases, functional genomics
Madura, Kiran, PhD Professor Pharmacology	Mentor	Ubiquitin-mediated protein degradation
Messing, Joachim, PhD University Professor Genetics	Mentor	Molecular biology of plant development
Millonig, James, PhD Associate Professor Neuroscience & Cell Biology	Mentor	Neurodevelopmental disorder
Moghe, Prabhas, PhD Professor Biomedical Engineering	Mentor	Stem cells, nanobiomaterials, tissue engineering
Montelione, Gaetano, PhD Distinguished Professor Molecular Biology and Biochemistry	Mentor	Bioinformatics / hybrid structure determination methods
Muzzio, Fernando, PhD Professor Chemical and Biochemical Engineering	Mentor	Pharmaceutical engineering; chaos & mixing
Nanda, Vikas, PhD Associate Professor Biochemistry & Molecular Biology	Mentor	Protein evolution and folding, de novo design of proteins
Olabisi, Ronke, PhD Assistant Professor Biomedical Engineering	Mentor	Tissue eng, regenerative medicine for injury and disease
Parekkadan, Biju Associate Professor Biomedical Engineering	Mentor	Develops platform technologies for cell and gene therapy
Pedersen, Henrik, PhD Professor Chemical and Biochemical Engineering	**Executive Committee**	Plant cell culture, chemical and biochemical fiber optic sensors
Roth, Charles, PhD Professor Biomedical Engineering	Mentor	Nucleic acid delivery, nanobiotechnology, cancer
Shreiber, David, PhD Associate Professor Biomedical Engineering	Mentor	Nervous system repair, biomechanics, tissue eng

Faculty	Role in Program	Research Interest
Sinko, Patrick, PhD Distinguished Professor Pharmaceutical Sciences	Mentor	Biopharmaceutics; intestinal absorption; peptide drugs
Stock, Ann, PhD Professor Biochemistry & Molecular Biology	**Co-Director**	Structure/function analysis of signal transduction proteins
Sy, Jay Assistant Professor Biomedical Engineering	Mentor	Applying biomaterials chemistry to prototype medical devices.
Welsh, William, PhD Professor Pharmacology	Mentor	Drug discovery, computer- aided modeling and design
White, Eileen, PhD Professor Molecular Biology and Biochemistry	Mentor	Oncogenes, tumor suppressor genes, apoptosis, autophagy
Williams, Lawrence, PhD Professor Chemistry and Chemical Biology	**Executive Committee**	Molecular structure and reactivity.
Yarmush, Martin, MD, PhD Monroe Chair Professor Biomedical Engineering	**Director**	Tissue engineering, stem cells, applied immunology
Zahn, Jeffrey, PhD Associate Professor Biomedical Engineering	Mentor	BioMEMS, microfluidics, medical devices
Zaratiegui, Mikel, PhD Assistant Professor Molecular Biology & Biochemistry	Mentor	Chromatin dynamics, , transposons, silencing
Zloza, Andrew, PhD Assistant Professor Medical Oncology	Mentor	Tumor immunology, combination cancer immunotherapy, viral infections

APPENDIX B: BIOTECHNOLOGY TRAINING PROGRAM FELLOWS

FELLOWS	THESIS TITLE/CURRENT RESEARCH
Acevedo, Alison BME Androulakis	Pathway-based Analysis of the liver response to Intravenous Methylprednisolone (MPL) Administration in rats: Acute versus Chronic Dosing
Anderson, Jeremy BME Cai	Endogenous Neural Stem Cell Activation after Traumatic Brain Injury
Browe, Daniel BME Freeman	Optimization and Characterization of Actuating PEG/Acrylic Acid Hydrogels as Artificial Muscles
Bae, Seul-A CBE Roth	Modeling Convergence of Circadian Clocks and Metabolism
Cheng, Larry Pharm Drake	Investigating the Phosphoproteome of Prostate Cancer in Response to Treatment with a PI3K Pathway Inhibitor (LY3023414) and Enzalutamide
Davis, Mollie BME Berthiaume	Alginate Encapsulation for Bupivacaine Delivery and MSC Co-therapy
DiMartini, Emily BME Shreiber	Targeted Delivery of Therapeutic Factors via Free Radical Mediated Immobilization
Fritz, Zachary BME Williams	Improving Cancer Screening Using a Novel Protein Energetics Model and Microfluidics
Godesky, Madison BME Shreiber	Hyaluronic Acid-Based Bioinks for Cell-Friendly 3D Printing
Guasp, Ryan CDB Driscoll	Gonad-induced Proteostatic Remodeling at the Onset of Adulthood Influences Exopher Production in Caenorhabditis elegans
Krzyszczyk, Paulina BME Berthiaume	Secretome Analysis of Macrophages Treated with Hemoglobin-Haptoglobin Complexes
Leipheimer, Josh BME Yarmush	Design and Evaluation of a Hand-held, Automated Venipuncture Device Employing a Force Sensing/Puncture Detection System
Locke, Trevan CBE Sofou	Membrane Activity of Phase-Separating Liposome-Anchored GALA
Luo, Jeffrey Chemistry Lee	Hybrid Magnetic Nanoparticle-Nanofiber Substrate for Stem Cell Behavior Contro
Lowe, Christopher BME Shreiber	BDNF Fragment Peptides to Combat Secondary Injury Following TBI
Marrero, Ileana BME Yarmush	Encapsulated Mesenchymal Stromal Cells for Osteoarthritis Treatment

FELLOWS	THESIS TITLE/CURRENT RESEARCH
Melentijevic, Ilija MBS Driscoll	Neuronal Exophers: A Novel Mechanism for the Removal of Neurotoxic Cytoplasm Components
Miranda-Alarcon, Yoliem BME Berthiaume	A Thermoreversible and Photoactive Collagen-Based Scaffold for Tissue Engineering Applications.
Nelson, Antoinette BME Sinko	Engineering Nano-Based Delivery Systems for a Rectal Pre-Exposure Prophylaxis of HIV
Newman, Jenna MBS Zloza	Intratumoral administration of the 2017-2018 seasonal influenza vaccine halts tumor growth and provides protection from subsequent influenza challenge
Okeke, Evelyn CBE Yarmush	Evidence That The Nucleocytoplasmic Trafficking Of Rad23 Promotes The Turnover Of Nuclear Substrates Of The Proteasome
Omelchenko, Anton Neuroscience Firestein	Brain-on-a-chip for Traumatic Brain Injury Drug Discovery
Perez, Xiomara BME Yarmush	Alginate-Liposomal Bupivacaine Formulation Preserves Mesenchymal Stromal Cells Anti-Inflammatory Function
Pfaff, William BME Dunn	Optimization of Collagen-Hyaluronate and Collagen-Alginate Substrate Mechanics and Permeability in Biomimetic Articular Cartilage Scaffolds
Rathnam, Chris Chemistry Lee	NanoScript: A Synthetic Transcription Factor for Regenerative Medicine
Reilly, Eve MBS Zaratiegui	Identifying Factors Involved in Coordination of Heterochromatin Inheritance and DNA Replication
Swiatkowski, Peter CBN Firestein	The role of mTOR/Akt pathway in recovery of neural electrophysiology in an *in vitro* model of traumatic brain injury
Tan, Victor Pharmacy Drake	Phosphoproteomic contributions towards resistance of advanced prostate cancer against androgen deprivation therapies
Turk, Liam Biochemistry Comeletti	Structural Characterization of Reelin Using Cryo-Electron Tomography
White, Corina BME Olabisi	The Effects of Scaffold Rigidity on Retinal Pigment Epithelial Inflammation and Dedifferentiation
Yevick, Sonia BME Sy	Toxicity Study: Cerebrospinal Fluid Modulators and Chemotherapies in In Vitro Rat Glioma

ALISON ACEVEDO
Advisor: Ioannis Androulakis

Synthetic corticosteroids, such as the corticosteroid methylprednisolone (MPL), are widely used antiflammatory and immunosuppressive agents for the treatment of a variety of inflammatory and autoimmune conditions including organ transplantation, rheumatoid arthritis, lupus erythematosus, asthma, and allergic rhinitis. Our understanding of the critical endocrine, immune, and pharmacologic functioning of the body's response to MPL continuously improves as our ability to probe experimental models at diverse levels of functional organization (genomic, transcriptomic, proteomic and eventually metabolomic) also improves. In order to properly organize this wealth of -omics data and upgrade its information content, integrated computational analyses are required to unravel direct and indirect regulatory mechanisms of MPL. Our investigation, focusing on MPL response in the liver, kidney, and skeletal muscle tissue, aims to demonstrate a top-down, generalizable and expandable framework for augmenting dynamic pharmacokinetic and pharmacodynamic (PK/PD) models incorporating genomic, transcriptomic and proteomic information. We seek to extend our ability to describe steroid responses in ways of mechanistic, pharmacologic, and clinical relevance by developing complex models in the context of quantitative systems pharmacology (QSP). This investigation will help evolve quantitative pharmacologic models towards system-level integration providing insights into, and prediction of, the tissue- and dosage-dependent response to MPL.

PRESENTATIONS

Acevedo A, DuBois D, Almon R, Jusko W, Androulakis I. Allostatic Global, Dynamic, Liver-Specific Transcriptomic and Proteomic Pathway-Based Analysis of In Vivo Responses Following Intravenous Methylprednisolone (MPL) in Rats 2017 AAPS Annual Meeting and Exposition Nov 15, 2017

JEREMY ANDERSON
Advisor: Li Cai

Traumatic brain injury (TBI), defined as a mild to severe shock to the head that disrupts normal brain function, can result from sport injuries, vehicular accidents, and falls. TBI, which can lead to temporary or permanent loss of memory and motor function, was responsible for 2.2 million emergency department visits and 50,000 deaths in 2014 (CDC, 2015). The primary injury is irreversible, with treatments focusing on decreasing the secondary injury to minimize cell death and nervous tissue damage, which are often insufficient in patients with significant injury. However, TBI induces endogenous neural stem cell (NSC) activation, where the activated NSCs can integrate into neuronal circuitry and play a role in learning, memory, and motor functions. Unfortunately, the extent of NSC activation (e.g., proliferation, migration, differentiation) and the genes driving this NSC activation upon TBI are not well characterized. Understanding this NSC activation after injury will aid in the development of novel therapeutics promoting neurogenesis and functional recovery. Our overall objective is to investigate what cellular and transcriptome changes are induced in NSCs after TBI with hopes that the neurogenic response can be promoted to aid injury repair post-TBI. We believe that the endogenous NSCs respond to TBI and have the potential to recover TBI-induced cell damage. Understanding this response can identify genes associated with neurogenesis post-TBI and provide a basis for the development of new therapies. Our goal is to characterize the activation of endogenous NSCs after TBI to determine their potential in injury repair and neural regeneration by: 1) using a clinically relevant closed head injury (CHI) model with Notch1CR2-GFP transgenic mice, to identify GFP+ NSC response to injury, 2) identifying molecular changes driving injury-induced NSC response on a single-cell level using

single-cell RNA-seq to identify unique gene expression in a heterogeneous cell population, and 3) validating identified genes in vitro/in vivo.
Page 9RPPR

PRESENTATIONS

Anderson J, Endogenous Neural Stem Cell Activation after Traumatic Brain Injury, BMES National Conference (Oral); October 201 Anderson J, Activating Endogenous Neural Stem Cells for Traumatic Brain Injury Treatment, NEBEC Regional Conference (Poster); April 2017

Anderson J, Endogenous Neural Stem Cell Activation for Traumatic Brain Injury Treatment, JMBGSA Symposium (Poster); March 2017

SEUL-A-BAE
Advisor: Ioannis Androulakis

Food availability and intake is a strong environmental signal that can entrain the biological rhythms of the periphery along with the light/dark cycle. Recent studies revealed that nutrient availability has close ties to circadian rhythms, exhibiting bi-directional influence and complex signaling cascades. In mammals, metabolic activities are under the regulation of daily feeding rhythms as well as the peripheral clock machinery. In turn, the feeding rhythms influence the circadian rhythms of key clock components via enzymatic reactions and transcriptional regulation. As a result, circadian disruption is linked to clinically significant metabolic abnormalities such as diabetes mellitus, obesity, and high level of tri-glycerides. On the other hand, time restricted feeding (TRF) has been shown to be effective in restoring the circadian rhythmicity, also deterring disease progression. Therefore, it is imperative to understand the mechanism behind how meal timing in relation to the light/dark cycle affects the host's disease.

In humans, the light/dark cycle synchronizes the rhythms of the peripheral tissues by entraining the release of cortisol from the hypothalamic-pituitary-adrenal (HPA) axis. In the periphery, cortisol interacts with the glucocorticoid response element (GRE) to regulate the transcription of clock genes such as Per and Cry, whose robust rhythms are necessary for healthy metabolic functions. The objective of my project is to understand the role of feeding cycle in the neuroendocrine system and its phase relations to the light/dark cycle entrainment via a mathematical model. Last year, I hypothesized that a feeding-induced increase in the NAD+ level inhibits SIRT1, which regulates some of the components in the core clock machinery such the PER/CRY and CLOCK/BMAL1 protein complexes via deacetylation. Mathematical modeling of this network showed that the feeding cycle can independently entrain the clock genes in the periphery, and revealed that there exists an optimal phase relationship between the light/dark cycle and feeding cycle for robust expression of circadian rhythmicity. This year, I selected hepatic gluconeogenesis as a representative metabolic reaction that is entrained by both of light/dark and feeding cycles, and am currently investigating the entrainment dynamics via the previously modeled neuroendocrine components and SIRT1. My hypothesis is that the dynamics of gluconeogenic genes such as Pck1 and G6pc are regulated by the convoluting effects of cortisol and SIRT1 through the key elements like PGC-1α and FOXO1. I expect to observe deterioration in rhythmicity of gluconeogenic gene expression under abolition of oscillation in light or feeding. Upon completion, this work will provide insight into the mechanism of how circadian disruption results in abnormal metabolism as well as the functions of peripheral clock genes in metabolic diseases.

PRESENTATIONS

Bae SA, Effect of Circadian Disruption on Hepatic Gluconeogenesis. AIChE Annual Meeting, Minneapolis, MN 31 Oct 2017.

PATENTS

Medoff M, Bae S, Valdez R, Masterman T. Xyleco Inc. (Wakefield). Processing Biomass. US Patent Application No: 2016/0222,475, filed April 14, 2016.

DANIEL BROWE
Advisor: Joseph Freeman

There are about 1.6 million individuals in the United States that have had a limb amputation due to a traumatic injury, and there are roughly 80,000 new amputations each year. Tissue engineering strategies to regenerate large voids in skeletal muscle may be able to prevent limb amputation for certain patients. Current tissue engineering strategies typically involve seeding muscle progenitor cells on some sort of biomaterial scaffold; however, this approach fails to generate mature skeletal muscle tissue with adequate contractile strength. Artificial muscles have the capability to restore normal force production and motion to damaged limbs by augmenting force production. A group of "soft" actuators known as ionic polymer-metal composites have the ability to produce comparable contractile stresses to native muscle tissue while remaining relatively lightweight. These artificial muscles typically require some sort of power source and don't allow for restoration of muscle tissue when used externally. The objective of this project is to develop a biocompatible artificial muscle for skeletal muscle regeneration that will provide electrical and mechanical stimulation to developing myoblasts. This contractile, composite scaffold seeks to closely mimic the in vivo environment of developing skeletal muscle, producing highly organized and differentiated muscle tissue. The central hypothesis of this project is that the resulting electrical and mechanical stimulation from a biocompatible artificial muscle will provide an environment for muscle cells that encourages growth and differentiation into organized muscle fibers. We plan to test this hypothesis through the pursuit of the following specific aims: 1) to develop, characterize, and evaluate the ability of a conductive, nanofibrous scaffold made of polycaprolactone (PCL) and polypyrrole (PPy) to promote the organization and differentiation or myoblasts into myotubes; 2) to develop and characterize a biocompatible, electroactive hydrogel made of poly(ethylene glycol) (PEG) and poly (acrylic acid) (PAA) which actuates in an electric field; and 3) to characterize the in vitro response and evaluate the effect on myoblast differentiation of combined electrical and mechanical stimulation provided by the contractile, composite scaffold.

Myoblasts respond to both topographical cues, in the form of aligned fibers, and passive electrical cues, in the form of a conductive material, by fusing into myotubes in the same direction as the alignment of scaffold fibers. Aim 1 of this project involved synthesizing a copolymer of PPy and PCL to design a conductive fibrous scaffold for myoblast growth and development. Once synthesized, the PPy-PCL copolymer was fabricated into a fibrous mesh using a technique called electrospinning. When comparing the conductive PPy-PCL scaffold with a nonconductive PCL scaffold, we have found that the PPy-PCL scaffold promotes higher myoblast proliferation, fusion, and differentiation than scaffolds with PCL alone. For aim 2 of this project, we developed a biocompatible, electroactive hydrogel made of PEG and PAA. When optimizing hydrogel movement, we identified three key factors which impact the speed and extent of movement. These factors are the geometry of the hydrogel (thickness to length ratio), the

ratio of PAA to PEG, and the overall polymer concentration of the hydrogel. When seeding myoblasts on these hydrogels, we discovered that cell attachment greatly depended on the ratio of PEG to PAA. We found that a ratio of about 1:4 of PEG:PAA was ideal for cell attachment, which created the right balance of low acidity and high concentration of functional groups amenable to attachment.

Ongoing work in this project will combine the materials developed in aims 1 and 2 in order to produce a composite scaffold that will support myoblast attachment, growth, and differentiation, while also allowing us to test our central hypothesis about applying simultaneous electrical and mechanical stimulation to developing myoblasts. These tests will utilize a range of stimulation patterns with different amplitudes and frequencies of applied voltage to discover the optimal pattern of stimulation.

PRESENTATIONS

Browe DP, Freeman JW. Development Of A Composite Scaffold To Provide Electrical, Mechanical, And Topographical Cues For Myoblast Maturation. Oral Presentation. Biomedical Engineering Society Annual Meeting. October 11-14, 2017

LARRY CHENG
Advisor: Justin Drake

Prostate cancer is the most common and the third leading cause of death related to cancer of men in the United States. While localized disease is treatable, late stage prostate cancer, called metastatic castration-resistant prostate cancer (mCRPC), is lethal with an expected survival of only a couple of years. Current treatment options are limited to second-generation antiandrogens and taxane-based chemotherapy. Therefore, discovering targets for novel therapies is an important clinical need. Our lab takes a phosphoproteomic approach to generate hypotheses on potential new targets and signaling pathways. In my first year, I worked to build our lab's shotgun phosphoproteomic pipeline. The purpose of the computational pipeline is to streamline our data processing and information gathering. We use the MaxQuant software to predict phosphopeptide sequences and calculate their intensity values from the mass spectrometry raw data. The pipeline applies filters to remove poorly predicted hosphopeptides as well as phosphopeptides that are statistically insignificant between samples. The remaining phosphopeptides are mapped to protein sequences in the UniProt database, searched against hosphoSite for functional annotations of their phosphoresidues, and mapped to upstream kinase motifs from databases including PhosphoSite, NetworKIN, Phosida, and the Human Protein Reference Database. The pipeline generates a tidy file that is allowable for manual inspection as well as usable to perform downstream analyses. The analysis tools that I have streamlined for our lab up to this point include unsupervised and supervised hierarchical clustering, kinase-substrate enrichment analysis, the DAVID functional annotation tool, and gene-set enrichment analysis. While establishing this infrastructure, I have already utilized the pipeline and downstream tools to analyze the phosphoproteomic data for several collaborators.

Using our phosphoproteomic pipeline on mass spectrometry data collected from clinical prostate cancer specimens, we found mitogen- and stress-activated kinase 2 (MSK2) to be hyperphosphorylated in mCRPC clinical tissue compared to treatment-naïve tissue. This phosphoresidue is an enzymatically active residue, suggesting that MSK2 is hyperactive in late stage prostate cancer. MSK2 is a member of the RSK family kinases and is a downstream effector in the mitogen-activated protein kinase (MAPK) cascade, where it is a substrate of p38 (MAPK14) and extracellular signal-regulated kinase 1 and 2 (ERK1/2). While some literature implicates the metastatic role of RSK family members, the role of MSK2

in metastases is unknown. Furthermore, MSK2 is important in the production of IL-10 in macrophages, but no research has been conducted on its relevance in prostate cancer. I am currently generating the tools to investigate this kinase, including working out western blot and IHC conditions of commercially available phospho-antibodies, producing microRNA knockdown and rescue lentivectors, as well as characterizing THP1-derived macrophages for coculture experiments. Using these tools, the goals of this project are to identify the cellular source of MSK2 signaling in tissue microarrays, to determine whether MSK2 affects proliferation and migration of prostate cancer cells, and to examine how MSK2 affects the interaction between macrophages and prostate cancer cells. If MSK2 is found to help mediate mCRPC, it offers a new signaling pathway for novel therapies to target.

AWARDS

The Martin L Yarmush Award for Outstanding Poster Presentation 2017

MOLLIE DAVIS
Advisor: Martin Yarmush

The ultimate goal of my work is to develop a nanoparticle–based (NP) cancer vaccine. The project is an extension of the nanoparticle drug delivery construct development studies that I have already completed (summarized below) and based on some of the work conducted in the Zloza lab, which focuses on targeting and boosting the immune cell pockets within tumors to eradicate the tumors. Due to the dynamic vasculature of tumors and its continually changing organization, effective treatments that target cancer cells have been difficult to develop. To combat these setbacks, many groups have focused on altering immunoregulatory pathways within the patient's immune system to recognize and eliminate cancer cells. However, immunotherapies lack widespread success due to the immune systems inability to recognize all cancer cells as foreign. Therefore, researchers have turned towards NP, which have been shown to successfully penetrate into tumors, and can target the immune pockets within them. What makes Dr. Zloza's work different from other groups using NP for immunotherapy is that instead of focusing on individual peptides or antigens that have been shown to boost the immune response, Dr. Zloza's group is interested in using the entire tumor lysate to identify tumor associated antigens that promote an increased immune response. Dr. Zloza postulates that the entire tumor lysate will be more successful at improving immune response because it contains all the peptides found within the tumor, which will allow the immune system to recognize more cells as foreign. Dr. Zloza's group has conducted some preliminary work using polystyrene NP coated with the entire tumor lysate and has had positive results in boosting immune cell activity. Therefore, my first goal is to mimic his work using PLGA NP coated with tumor lysate. To take the project further, I will be using these NP to mimic APC (antigen presenting cells). These artificial APC (aAPC) will be coated with the tumor lysate and MHC signaling antibodies to help improve T-cell interactions. The NP will also encapsulate cytokines or other immunoregulatory molecules, such as IL-2 and IFN, which have been shown to target T-cells and help stimulate their responses. Once these initial studies have been completed, I hope to use these aAPC NP as a cancer vaccine to help target early cancer markers. To date, I have been working on creating PLGA NP and studying dye diffusion from within. In addition, computational modeling is being used to determine optimal size and loading of the NP. I will then start researching how to complex the different components of the tumor lysate to the PLGA NP.

Other drug delivery systems that I have worked on at Rutgers include the creation of a co-treatment of local anesthetics and mesenchymal stromal cells (MSC). This secondary project has allowed me to

explore the connection between cells and non-cell materials, both experimentally and computationally, which I will be using in the NP project. Local anesthetics (LA) act by inhibiting sodium channels, which block sensory pain receptors from relaying information to the brain. LAs are commonly used to mitigate surgical and post-surgical pain and are often co-administered with MSC therapies, which have been shown to promote regeneration and inflammation reduction. However, LAs can affect MSC viability and function. The Yarmush lab previously has shown that in the presence of LAs, MSC secretions and anti-inflammatory capabilities are altered. Therefore, an improved method of coadministration of LA and MSCs is necessary.

We have developed a sustained release LA delivery model that could enable the co-administration of LA and MSC. Liposomes containing bupivacaine were encapsulated in an alginate matrix, which enables the sustained release of bupivacaine as compared to bupivacaine-containing liposomes alone. Computational modeling indicated that our engineered construct improved cell viability compared to bolus LA administration, and maintained drug release for 4 days. In vitro analysis supports the model, with significantly increased MSC viability when the construct is applied compared to a bolus dose or to bupivacaine- containing liposomes alone. Cell secretion analysis of three MSC regulatory molecules, interleukin 6 (IL-6), an overall MSC marker of functionality, prostaglandin E2 (PGE2), an anti-inflammatory cytokine, and transforming growth factor- beta 1 (TGF-β1), a marker for chondrogenesis, have been used to determine the overall functionality of MSCs treated with various bupivacaine formulations in both normal and inflammatory environments. Our results indicated that the engineered construct promoted IL-6 and PGE-2 secretion but did not increase TGF-β1 secretion when compared to bolus and liposomal bupivacaine, which indicates better anti-inflammatory properties and overall functionality but no additional cartilage regeneration. Therefore, this engineered construct would be beneficial in post-surgical setting where inflammation reduction and pain mitigation are important components for healing. Current studies include secretion analysis of alginate encapsulated MSCs in the presence of various LA modalities as well as modeling of drug from construct to cells within the system. In addition, in vivo studies are being planned to study this co-therapy in a pain mouse model. Understanding the formation of micro-sized liposomes and how to determine bupivacaine diffusion, loading, and release profile, has helped me transition towards my overall goal of micro- and nano-sized particles for cancer therapies. While the applications are different, the processes of creating micro- and nanoparticles, computational modeling, and general experimental design are the same, which has enabled me to progress easily to my new goals.

PRESENTATIONS

Davis M, Maguire T, Marrero-Berrios I, Zhu C. Gaughan C, Schloss R, Yarmush ML. “Control Release Anesthetics to Enable and Integrated Anesthetic-mesenchymal Stromal Cell Therapeutic.” BMES Conference. Minneapolis, MN, October 2016.

EMILY DIMARTINI
Advisor: David Shreiber

As a first year graduate student, I am completing rotations to find the lab where I will pursue my thesis project. I am completing my first rotation in the Shreiber Laboratory, where I previously worked as an undergraduate researcher. My rotation project is to develop an in vitro model to quantify the ability of acrylated PEG polymers to crosslink and become immobilized in an injured tissue where free radical

species persist. PEG acrylates have the potential to act as a drug delivery platform to deliver a therapeutic to an injury site. The first year of graduate school is dedicated primarily to coursework, so I have focused mainly on my classes thus far. At the end of my first semester I have the opportunity to rotate through other labs, but I plan on remaining in the Shreiber Laboratoy to pursue my PhD.

ZACHARY FRITZ
Advisor: Lawrence Williams

Cancer is the second leading cause of death in the US, but early detection through screening methods can lead to lower mortality rates and more effective treatments. While imaging modalities are commonly used to screen for cancer, these can be expensive, potentially expose a patient to ionizing radiation, and may not be able to distinguish between benign and malignant tumors. It has been found that many malignancies can induce the production of autoantibodies via mutation and/or over-expression of tumor associated antigens. These autoantibodies, such as those specific to the tumor suppressor protein p53, can be detected in at-risk patients years before formal cancer diagnosis, making them potentially powerful pre-disease biomarkers. However, current immunoassays used for their detection suffer from low sensitivities; for example, even in cancers with the highest frequency of p53 mutation, autoantibodies are only detected in at most ~30% of patients. While it is undoubtedly true that not all cancer patients will exhibit these autoantibodies, we believe that the choice of capture antigens used in an immunoassay is critical to its efficacy, and that current assays are using antigens (whether whole proteins or truncated peptides) that might not be suitable targets of a patient's polyclonal autoantibody response.

In view of this need for better antigen targets, we have developed a novel, coarse grained bioinformatics model that can translate sequence data from a protein or peptide into information about that protein's energy profile. We hypothesize that this model could be used to increase the sensitivity of autoantibody immunoassays by aiding in the selection and design of antigenic peptides with a higher affinity for polyclonal autoantibodies. This includes the identification of novel antigens not previously considered for use in assays. Our long term goals are to develop and apply this bioinformatics model for use in biomarker discovery and multipanel assay optimization for the detection of diseases like cancer. Our short term goals focus on proof of concept studies targeting a single analyte and demonstrating the model's potential for integration into an assay platform.

PRESENTATIONS

Fritz Z, Yarmush ML, Williams L. Using a Novel Protein Energetics Model to Improve Cancer Diagnostics. SAPA Oncology Symposium. Rutgers University, Piscataway, NJ, April 8th, 2017

Fritz Z, Yarmush ML, Williams L. Using a Novel Protein Energetics Model to Improve Cancer Diagnostics. BMES Annual Meeting, Phoenix, AZ, October 11-13, 2017

MADISON GODESKY
Advisor: David Shreiber

The global population of older persons is growing at an unprecedented rate. Driven by recent medical achievements and remarkable increases in life expectancy, the number of people aged 60 years or older is expected to grow from 900 million in 2015 to more than 2 billion by 2050. Now more than ever, the ability to bioengineer replacement tissues for damaged body parts could revolutionize the concept of aging and enhance the qualities of life for billions of people. 3D bioprinting is a promising technique to produce living tissues from autologous cell sources. Despite recent progress, advances in bioprinting remain limited by the availability of biomaterial "inks" that can properly replace the native extracellular matrix (ECM) and its important functions. For instance, it is well known that the ECM directs cell fate through specific presentations of mechanical properties and adhesive ligands. Far from static, adhesive interactions generate cell-matrix traction forces that not only regulate cellular behaviors including migration, proliferation, and differentiation, but also provide dynamic feedback through ECM remodeling. From a regenerative medicine perspective, the technical ability to print live tissues will require bioinks that recapitulate the complex functional role of native ECM. As such, a critical need exists to develop nextgeneration biomaterials that can patterned to regulate diverse cellular functions mimetic of native tissues.

The long-term goal within this continuum of research is to develop a high-throughput approach to generate functionally complex biomaterials that provide precise spatiotemporal control over cell and tissue fate. The objective of this project is to establish a straightforward and versatile bioink system to guide cell-matrix interactions, which are known to direct a variety of cellular behaviors. We hypothesize that a non-cytotoxic bioink based on thiol-modified hyaluronic acid (HA-S) and polyethylene glycol diacrylate (PEGDA) can be established using modular templates to independently tune matrix stiffness and adhesive ligand presentations. Prior work has demonstrated that the mechanical properties of HASPEGDA hydrogels are dictated by two cytocompatible crosslinking reactions that occur at discrete time points. Previously, we have demonstrated that immobilizing adhesive ligands to HA-S interrupts latent disulfide crosslinking and enables control over an otherwise spontaneous process that dramatically stiffens the hydrogel over a period of days to weeks. The rationale is that dual crosslinking mechanisms offer discrete opportunities to tune the material's functional characteristics; we believe this system can be leveraged as a convenient approach to produce functionally complex bioinks for 3D printing.

PRESENTATIONS

Godesky MD, Shreiber DI. Hyaluronic Acid-Based Hydrogels with Independently Tunable Mechanical and Bioactive Properties. Biotechnology Training Program Annual Symposium, Piscataway, NJ, June 8, 2017.

Warren R, Kemraj A, Godesky MD, Shreiber DI, Baum J. The Impact of Vascular Ehlers-Danlos Syndrome Mutations on Integrin-to-Collagen III Binding. 2017 Biomedical Engineering Society Annual Meeting, Phoenix, AZ. October 12, 2017.

Godesky MD, Shreiber DI. Hyaluronic Acid-Based Hydrogels with Independently Tunable Mechanical and Bioactive Properties. 2017 Biomedical Engineering Society Annual Meeting, Phoenix, AZ. October 12, 2017.

RYAN GUASP
Advisor: Monica Driscoll

Advanced age is a major risk factor for neurodegenerative diseases, such as Alzheimer's, Parkinson's, and Huntington's disease. These diseases are increasing in prevalence as the population of older Americans continues to expand. One pathological hallmark shared by these three diseases is the formation of protein aggregates in the brain. Using the nematode Caenorhabditis elegans as a model organism, the Driscoll lab has recapitulated the aggregating protein phenotype by expressing human huntingtin protein, or multiple copies of mCherry fluorescent protein in its mechanosensory neurons. A surprising discovery was made of a heretofore unreported ability of the neurons to jettison these protein aggregates, alongside damaged mitochondria and large quantities of cytoplasm in a single, massive (average 3.8-µm diameter) extracellular vesicle, which we term the exopher. Although producing an exopher is a rare neuronal event (approximately 7% chance in strains expressing aggregating proteins), we have shown that releasing one correlates to improved cellular function later in life.

My first specific aim is to elucidate the exopher mechanism by genetically characterizing the cellular machinery responsible for selecting, transporting, and ejecting exopher cargo. I have previously performed genetic screens using RNA interference (RNAi) to knock down expression of genes which I hypothesized might be relevant to exopher-genesis. I identified several genes that can inhibit exopher formation including genes that encode molecular motors, cytoskeletal proteins, and polarity proteins, as well as two potent inhibitors with no previously known adult functions. Additionally, I found that genes required for the production and release of well-characterized extracellular vesicles seem to play no role in exopher-genesis. Extending on this work, I have used gene network analysis software (Cytoscape 3) to map previous hits and all known interacting genes as recorded on WormBase, the C. elegans genomics database. I am using RNAi to investigate each gene in the network linking at least two other nodes in an iterative process. The neurons that we study are embedded in the C. elegans hypodermis, which may play a role in exopher-genesis. The question of whether genes identified in previous screens are functioning in a cell-autonomous or non-cell-autonomous manner is being addressed using four strains that express RNAi-uptake channel proteins in a tissue-specific manner.

My second specific aim is to characterize the ultrastructure of the exopher and its cargo at the suborganellar level. Using high-pressure freeze fixation and transmission electron microscopy the lab has produced the first EM images containing exophers. An exopher produced by an ALMR mechanosensory neuron is completely surrounded by the multinucleate hypodermal syncytium, hyp 7. It is multi-membrane bound with at least 4, and as many as 20, membrane layers surrounding various sub-compartments. Whether the membranes originate from the neuron, or from the surrounding hypodermis remains to be elucidated. The exopher displays a globular morphology and is divided into compartments that contain distinct cargo; membrane whorls and vacuoles are discernible, along with dense inclusions that may be the mCherry aggregates we observe with fluorescence microscopy. We are working on processing additional samples to try to capture the distinctive filament that attaches some exophers to the originating neuronal soma. An EM image of an exopher definitively containing a mitochondrion is a priority because evidence in the literature shows that mitochondria can be ejected from murine retinal ganglion neurons and superficial cortical layers and degraded in neighboring astrocytes.1 If exophers are evolutionarily conserved in mammals, this research may offer insights into mechanisms of neurodegenerative pathology, as well as targets for novel therapeutic agents in several diseases.

My third aim is to develop a system that allows exophers to be studied in a more physiologically normal context. Anecdotally in the lab, we have noticed exophers forming and moving away from the soma more quickly when viewed in Petri dishes under low magnification fluorescence dissecting microscopes, than when mounted between a slide and coverslip. When grown on an agarose plate, C. elegans is perpetually initiating sinusoidal movements and pharyngeal pumping to continuously eat bacteria. Worms undergo a metabolic shift to a starvation state after minutes without food, and under our current time lapse microscopy protocol, an exopher can take up to an hour to form. To screen for exophers under a higherpower fluorescence microscope, C. elegans is mounted on a slide and paralyzed using the anthelmintic drug, tetramisole, in a buffer without bacteria. I aim to create a microfluidic device that will allow exophergenesis to be studied at high magnification, while the worms are able to freely move in individual chambers that are continuously perfused with bacteria. To investigate a potential mechanical component to exopher-genesis or whether it is metabolically-influenced, we need conditions where C. elegans move and feed freely.

PRESENTATIONS

Smart J, Melentijevic I, Harinath G, Toth M, Guasp R, Meghan Arnold, Monica Driscoll. Touch neurons can toss out mitochondria. 21st International C. elegans Conference. University of California, Los Angeles, June 21 - June 25, 2017

Guasp R, Arnold M, Melentijevic I, Harinath G, Toth M, Nyguen K, Taub D, Gabel C, Xue J, Hall D, Driscoll M. Structural Components and Genetic Requirements of Exophers and their Formation. 21st International C. elegans Conference. University of California, Los Angeles, June 21 - June 25, 2017

Abbott A, Melentijevic I, Guasp R, Driscoll M. A novel high-throughput whole-genome RNAi screening technology utilized to investigate the molecular pathways of exopher production. 21st International C. elegans Conference. University of California, Los Angeles, June 21 - June 25, 2017

AWARDS

Poster in Neurobiology Honorable Mention, 21st International C. elegans Conference June 2017

PAULINA KRZYSZCZYK
Advisor: Francois Berthiaume

Chronic wounds affect millions of Americans. These wounds are non-healing, reach deep into the skin, and are commonly infected. Due to these complications, they are a major cause of non-traumatic limb amputations. On the tissue level, chronic wounds are characterized by a persistent inflammatory state and hypoxia. A main reason as to why these wounds are stalled in inflammation is due to the presence of pro-inflammatory, M1 macrophages, which produce high levels of pro-inflammatory cytokines and damaging reactive oxygen species (ROS). Under normal wound healing processes, M1 macrophages transition to anti-inflammatory M2 macrophages as tissue regenerates, but this does not occur in chronic wounds. We are investigating the use of hemoglobin (Hb) as a chronic wound therapy mainly due to its potential to promote the M2 macrophage phenotype via the heme-oxygenase 1 (HO-1) pathway. Hb can also be used as an oxygen delivery vehicle to hypoxic wounds. We take two approaches to utilizing Hb to elicit beneficial wound healing effects: 1) by polymerizing hemoglobin (forming PolyHb)

and 2) in combination with haptoglobin (Hp). The effect of these approaches is investigated both on macrophages in vitro and overall wound healing response in vivo.

PolyHb: The rationale behind the use of PolyHb is that oxygen delivery can be tuned by polymerizing hemoglobin under fully oxygenated or deoxygenated conditions (relaxed/R-state and tensed/T-state, respectively). Resulting PolyHb molecules have different sizes, properties and oxygen affinities, which may elicit varying responses in macrophages. Additionally, polymerizing hemoglobin reduces protein unfolding and disassembly, thereby protecting against the release of the toxic free heme group. PolyHb is acquired in collaboration with Dr. Andre Palmer's lab at The Ohio State University.

Progress: In in vitro studies with isolated human M1 macrophages from three different donors, we investigated the effects of Hb/PolyHb on reactive oxygen species (ROS) generation, cell shape and cell attachment. We found that T-state PolyHb consistently reduces ROS generation whereas Hb elongates cells and promotes attachment. Current studies are investigating the expression of M1/M2 macrophage markers (CD68/CD206/CD163) and the effect of hypoxia. An in vivo wound healing study on diabetic mice was also completed, comparing the effect of the topical application of different PolyHbs, Hb and buffer controls. Histological analysis revealed significantly higher CD31 expression (endothelial cell marker), and thicker epidermal and dermal layers in T-state PolyHb groups. Additional histological analysis of M1/M2 macrophage markers is underway.

Hb and Hp: The rationale behind the use of Hp in conjunction with Hb is that these proteins bind tightly to each other and to CD163 receptors on macrophages. The Hp-Hp complex is endocytosed, thereby activating the anti-inflammatory heme-oxygenase 1 (HO-1) pathway, which has shown benefits in promoting wound healing.

Progress: Levels of secreted M1 and M2 macrophage markers, tumor necrosis factor-α (TNF-α) and interleukin 10 (IL-10), respectively, have been measured in macrophages exposed to various forms of PolyHb with or without haptoglobin (Hp), an acute phase protein that increases Hb-CD163 binding. Addition of Hp was shown to dramatically increase secretion of both factors, resulting in a macrophage "wound healing" pheonotype that lies within the M1/M2 spectrum. Addition of dexamethasone, an antiinflammatory glucocorticoid, resulted in intermediate levels of both factors. Current studies are investigating resulting secretion of a panel of cytokines and growth factors (e.g. VEGF, IL-6, PDGF) from Hb-Hp treatment. An in vivo study will also be completed with Hb-Hp treatment on diabetic mouse wounds. Analysis will include histological staining for M1/M2 markers.

This work focuses mainly on targeting inflammation in chronic wounds, which is a key barrier to healing. By promoting the M2 anti-inflammatory phenotype in resident macrophages, the wound will be primed for repair. This work will also provide knowledge on the effects of various forms of Hb on macrophage response within a chronic wound healing setting.

PRESENTATIONS

Krzyszczyk P, Patel K., Richardson K., Schloss R., Yarmush M., Palmer A., Berthiaume F., In Vitro Macrophage Response to Hemoglobin-Based Treatments for Chronic Wounds, 2017 Innovations in Dermatological Sciences Conference, Iselin, NJ, October 2-3, 2017.

Krzyszczyk P, Patel K., Richardson K., Schloss R., Yarmush M., Palmer A., Berthiaume F., Effects of Polymerized Hemoglobin on Macrophage Response, 2017 BMES Annual Meeting, Phoenix, AZ, October 12, 2017.

AWARDS

Department of Education GAANN Fellow 2015-2018 Executive Women of New Jersey Graduate Merit Award 2017

JEFFREY LUO
Advisor: Ki-Bum Lee

Since starting my PhD, I have been involved in several projects seeking to exploit nanotechnology to modify and regulate cell behavior. One project is the use of gelatin nanoparticles modified with simple ligands (e.g., ethylenediamine, transferrin and insulin) to penetrate the blood-brain barrier (BBB) via receptor-mediated transcytosis. These particles will be used to deliver other nanoparticles. Particles have been reduced to approximately 100 nm with narrow size distribution (polydispersity index < 0.020) to facilitate endocytosis. These particles are fluorescently labeled as a means to both visualize localization within cells and quantify transcytosis. Without ligands, these particles show minimal uptake, whereas cationized particles with conjugated insulin and transferrin show near universal uptake by human cerebral microcapillary endothelial cells (hCMEC). While not currently explored, small molecule dyes have been loaded into these particles and successfully released to stain hCMEC without uptake of the particle itself. Next steps include generation of BBB models using semi-permeable supports and multiple cell types to test transcytosis. Another project I have been working on is using manganese dioxide (MnO_2) and graphene oxide (GO) as 2D solid growth factor carriers. Both substances are capable of binding various proteins, which allow for the delivery of small protein growth factors on the surface of scaffolds with mitigated “burst” release. Adipose-derived stem cells were cultured on top of substrates coated with myogenic factors complexed to MnO_2 or GO and monitored for myogenesis. Preliminary results showed greater expression of myogenic genes compared to growth factors added to media, potentially due to the increased local concentration of myogenic factors as opposed to freely diffusing in the cell media. Further characterization of myogenesis for longer experimental durations are forthcoming. A minor project I have initiated is the generation of gelatin-based scaffolds with growth factor gradients. Future plans for the project are to culture cells that respond to neurotrophic factors. Recently, I have been asked to take over a microfluidic-based neuroinflammation project. Refinement of the experimental technique is underway to expand applications of the microfluidic channel to further strengthen the BBB transcytosis project described above.

ILEANA MARRERO-BERRIOS
Advisor: Martin Yarmush

Osteoarthritis (OA), the principal source of physical disability and impaired quality of life in the US, is a chronic age-related disease characterized by the progressive destruction of articular cartilage, leading to total joint deterioration. OA severely burdens the US healthcare system with overall costs of ~ $190 billion/year. Recent evidence suggests that inflammatory cytokine and chemokine release signals and cellular infiltration ultimately lead to matrix degradation and cartilage destruction. There is currently no

cure for OA. Existing treatments, such as non-steroidal anti-inflammatory drugs (NSAIDs) and intraarticular steroid injections, alleviate symptoms initially; however, they are not able to alter disease progression and disease development eventually proceeds. Therefore, there is a need to develop effective therapies that could alter OA progression and promote healing in osteoarthritic joints.
One approach to alter the progression of OA has been intra-articular administration of mesenchymal stromal cells (MSC) which secrete anti-inflammatory and regenerative factors that could alter the underlying pathophysiology of OA. However, these cells are required in large numbers and are not longlasting when freely administered. We have previously demonstrated that encapsulation of MSC lengthens their survival and promotes their secretory function, a characteristic that could serve as long term treatment for OA. On the other hand, to develop effective therapies, comprehensive in vitro systems that recapitulate the joint environment are needed. However, most OA-based in vitro systems consist of chondrocytes, the sole cell component of cartilage, in different culture configurations while ignoring other cell components, such as synoviocytes, and the effects of cell-cell interactions. Therefore, and in vitro culture system that allows for the co-culture of multiple cell types and the study of cell-cell interactions would significantly benefit the field.

We aim to ascertain whether intra-articular injection of encapsulated MSC can provide sustained reduction of OA mediated joint inflammation and destruction, and promote re-growth and healing by: (1) developing an optimized eMSC therapy that is both anti-inflammatory and chondrogeneic and testing its efficacy in (2) an in vitro relevant model of OA. Such experiments could provide a powerful new therapy in an otherwise irreversible progressive disease.

In a preliminary in vitro model of OA, we tested the effect of interleukin (IL)-1 stimulation on primary bovine chondrocytes and conducted a RT-PCR gene analysis of pro-inflammatory cytokine and receptor expression. As expected, IL-1 stimulation upregulated the expression of pro-inflammatory cytokines associated with the pathology of OA such as IL-1β, IL-8, RANTES, MCP-1, and GM-CSF. To further assess the chondrocyte responses in the presence of MSCs, chondrocytes were co-cultured with free or eMSCs and gene expression changes were quantified. Downregulation of pro-inflammatory gene expression was observed in all conditions co-cultured with free on eMSC even in the presence of an inflammatory stimulus. This indicates that the use of eMSC as a cell therapy to immunomodulate OA inflammation is a viable option. Future studies will focus on the eMSC pro-chondrogenic effects on chondrocytes by performing an extracellular matrix (ECM) RT-PCR gene panel and testing for collagen II and GAGs deposition in the co-culture experiments.

Interestingly, even though eMSC secrete significantly higher levels of prostaglandin E2 (PGE2) than free MSC, we did not observe significant downregulation of pro-inflammatory genes in chondrocytes compared to free MSCs. This observation differs from previous studies in spinal cord injury and macrophage immunomodulation. As well, we observed that macrophages stimulated with IL-1 and TNF-α, key mediators of OA inflammation, secrete more IL-8 in the presence of low levels of PGE2 and have no significant change in secretion at high levels of PGE2 (similar to eMSC PGE2 secretion). Therefore, future studies will consider the effects of other MSC secreted molecules on target cells. These results will be critical to understand cell-cell interactions in our system and move forward with a more comprehensive in vitro OA system which includes chondrocytes, synoviocytes, and MSCs.

To develop a multiple-cell culture system, we are working in collaboration with Dr. Anil Shrirao to design and fabricate a novel culture device. This device will have the capacity for the culture of multiple cell types on individual layers while allowing for diffusion of molecules between them. A prototype has

been prepared and studies to test scalability of the manufacturing process and biocompatibility of the materials are scheduled for the next month.

PRESENTATIONS

Marrero I, Schloss R, Yarmush M. Encapsulated Mesenchymal Stromal Cells for Osteoarthritis Treatment, Biomedical Engineering Society Annual Meeting. October 12, 2017.

Marrero I, Schloss R, Yarmush M. Encapsulated Mesenchymal Stromal Cells for Osteoarthritis Treatment, Biotechnology Training Program Symposium. June, 2017.

AWARDS

GAANN Fellowship for Personalized Medicine 2017-Present

CHRIS LOWE
Advisor: David Shreiber

Elevated concentrations of free radicals are characteristic of a wide variety of tissue injuries and disease states, such as inflammatory diseases, neurological disorders, ischemic diseases, burn wounds, and traumatic brain injuries. Free radicals are extremely reactive and can cause significant damage to proteins, lipid membranes, and nucleic acids. Left unchecked, these free radicals can perpetuate inflammatory states, induce the continued generation of further free radicals, and overall serve as an obstacle to healing. Delivery of exogenous compounds, such as antioxidants, to scavenge or otherwise detoxify these free radicals has been frequently investigated, but typically antioxidants alone are insufficient in remediating complex injury environments. Delivery of drugs or growth factors may promote healing through other mechanisms in these conditions and have similarly shown promising results in preliminary studies, but are often cleared too rapidly from the injury site to have a prolonged effect. Although the heightened reactivity of free radicals is deleterious in vivo, it is of great benefit in polymer chemistry, propagating polymerization reactions, and initiating crosslinking reactions between specific functional groups. Our hypothesis is that free-radicals generated through injury and disease can inducing acrylate-acrylate crosslinking. The advantages of this reaction will be two-fold: 1) sufficient crosslinking of acrylated polymers will reduce their diffusivity, thereby localizing them to the target tissue and providing a vehicle for delivery of therapeutic factors and 2) the crosslinking reaction may reduce or sequester radicals, reducing their ability to damage the tissue.

Investigations with acrylated PEGs in standard radical scavenging assays (DPPH) as well as with reactive xygen species (ROS) and reactive nitrogen species (RNS) commonly found in vivo have indicated that acrylated polymers can react with and detoxify free radicals. Additional characterization with NMR spectroscopy and gel permeation chromatography has confirmed that the result of reaction with ROS is the covalent coupling of acrylated PEGs to one another, increasing their effective molecular weight. Further, we have demonstrated that acrylated PEGs can become immobilized within a collagen hydrogel acting as a tissue mimic when ROS are introduced to the system. To evaluate protection, the presence of acrylated PEGs in cellular assays has been enough to protect cultures from hydrogen peroxide injury.

Together these results strongly support our proposed use of acrylated PEGs as a means of targeting injured or diseased tissues, immobilizing therapeutic factors within those tissues, and protecting them

from further free-radical damage. Improving our tissue mimicking models and continued characterization of the diffusivity of these acrylated carrier polymers will help us to better understand which sizes and configurations of acrylated PEGs will be most effective in immobilizing desired therapeutics. Ongoing work is also evaluating the potential of other free radical sensitive functional groups whose reactivity may meet or exceed that of acrylate groups. Ultimately, this proposed free radical immobilization system represents a versatile drug delivery platform that specifically targets regions of injured or diseased tissue and can be amended to carry nearly endless therapeutic payloads.

PRESENTATIONS

Lowe CJ, Mirmajlesi KR, Shreiber DI. "Targeting, delivery, and immobilization of therapeutic factors with native free radicals". 2017 Annual Meeting. October 29-November 3, 2017. Minneapolis, MN

Lowe CJ, Reucroft I, Grota M, Shreiber DI. "Freeze-drying of self-assembled, fibrillar collagen gels produces highly aligned collagen scaffolds for tissue engineering". 2015 Johnson & Johnson Engineering Showcase. March 10, 2015. New Brunswick, NJ.

Lowe CJ, Mirmajlesi KR, Shreiber DI. "Targeting and Immobilization of Therapeutic Factors via Native Free Radicals" 2017 BMES Annual Meeting. October 11-14, 2017. Phoenix, AZ

Mirmajlesi KR, Lowe CJ, Shreiber DI. "Free-radical scavenging potential of acrylated polyethylene glycol polymers for TBI treatment" 2017 BMES Annual Meeting. October 11-14, 2017. Phoenix, AZ. Suarez VM,

Mirmajlesi KR, Lowe CJ, Shreiber DI. "Native Free Radical Mediated Crosslinking of Functionalized PEGs as a Targeted Delivery Mechanism" 2017 BMES Annual Meeting. October 11-14, 2017. Phoenix, AZ.

AWARDS

DoEd GAANN Fellowship 2017-18 New Jersey Commission on Brain Injury Research Graduate Fellowship 2014-17

ILIJA MELENTIJEVIC
Advisor: Monica Driscoll

Toxicity of misfolded proteins and mitochondrial dysfunction are pivotal factors that promote ageassociated functional neuronal decline and neurodegenerative disease. Accordingly, neurons invest considerable cellular resources in chaperones, protein degradation, autophagy, and mitophagy to maintain proteostasis and energy/redox balance while avoiding neurotoxicity. Although these neurotoxic challenges have long been considered to be cell-intrinsic, evidence now supports that both misfolded human disease proteins and mitochondria originating in one neuron can appear in neighboring cells, a phenomenon proposed to promote pathology spread. I have been documenting a previously unknown capacity of C. elegans adult neurons to extrude large (~5 μM) vesicles that include substantial amounts of cytoplasmic contents via a dynamic process requiring specific cytoskeletal proteins and motors. These exopher vesicles can include fluorescent GFP or mCherry, DiI loaded from the outside environment, aggregated human proteins such as an expanded Q128 polyglutamine protein,

lysosomes, and/or mitochondria. Aggregation-prone proteins and oxidized mitochondria can appear preferentially segregated into exophers, and neurons that extrude exophers generally function better than those that do not. Inhibiting chaperone expression, autophagy or the proteasome, as well as compromising mitochondrial quality, enhances exopher prevalence, and some extruded exopher contents can be found in remote cells. Together our observations suggest exopher-genesis as a potential "garbage-removal" response to stresses in proteostasis and organelle maintenance. Our working model is that exophers are components of a conserved mechanism that constitutes a fundamental, but formerly unrecognized, branch of neuronal proteostasis and mitochondrial quality control.

As a previously undescribed phenomenon, I want to continue characterizing the exopher and investigate its function on several fronts. We were recently successful in visualizing exophers using electron microscopy. This revealed the presence of endoplasmic reticulum and lysosomes in exophers. There appears to be two classes of extruded lysosomes: ones that appear to occupy the entire area of the exopher, and smaller lysosomes occupying a small portion of the exopher. This begs the question of how the exopher pathway interacts with the autophagy-lysosome system. It is possible that lysosomes initially make up a large portion of the exopher and shrink in size, or that these are two separate categories of lysosomes. It is possible that the extruded lysosomes are likewise dysfunctional ones being removed, or that the lysosomes being removed are functional and continue degradation in the exopher. I am utilizing time-course microscopy to study the extrusion of lysosomes in a time-dependent manner to see if theextruded lysosomes shrink over time. This will also allow me to also study if exopher loaded contents are normally loaded through lysosomes. I will utilize bafilomycin A1, which should inhibit aggregate loading into lysosomes, and see if lysosomes and aggregates still localize to exophers. I will also utilize NH4Cl to disrupt lysosomal pH, to see if dysfunctioning lysosmes are preferentially loaded into exophers.

Considerable excitement in the field of neurodegenerative disease has focused on the findings that mammalian neurons can extrude conformational disease proteins as well as mitochondria. Recently I identified ced-1, ced-6, and ced-7 to act in a phosphatidylserine-independent mechanism through which exophers are engulfed by the surrounding tissue. These genes have recently been shown to be involved in the transfer of polyq protein aggregates from neurons to glia in Drosophila through an unidentified manner. Finding the protein that mediates ced-1 recognition of exophers is of great interest and may potentially have therapeutic value. Looking through known binding partners of the mammalian ced-1 ortholog CD91, I found the promising candidate GRP94/GP9630, an Hsp90 family chaperone with C. elegans ortholog enpl-1. Investigations of enpl-1 RNAi knockdown show the same phenotype of increased numbers of cells with multiple exophers as ced-1/ced-6. I have obtained a CED-1::GFP reporter and have seen that CED-1 can localize around exophers. I have also obtained a native promoter ENPL-1::GFP reporter and can find ENPL-1 localization in our neurons of interest, which has not been reported previously. I cannot observe any membrane localization of ENPL-1::GFP, but this may be due to high expression levels of the transgene. I am working on making low copy number reporters that should be closer to native protein expression levels to see more accurate localization patterns. The enpl-1 mutant proved to be developmentally lethal, so I am working on constructing a cell specific enpl-1 mutant to investigate the role of a knockout and confirm its cell-specific role.

Lastly, the mechanisms involved in regulating and executing exopher formation are of great interest to understanding this phenomenon. Through targeted RNAi screening, I discovered aip-1 to act as a genetic suppressor of exopher production, and I am now looking in more detail at its role in exopher formation. In the last year, I have been validating a methodology for performing automated rapid whole genome screens that will allow for the unbiased identification of more suppressors and enhancers, as well as for whole genome epistasis experiments. We are now able to grow a high-density RNAi feeding library in a

96-well format, replace the media so that animals can develop fertilely, and induce RNAi suppression in the animals. We have worked out an image analysis pipeline that will allow us to automatically count animals and phenotypes in each well. We have refined our machine vision process and are now able to detect general fluorescence intensity changes and detect RNAi treated and control wells, and have performed a quarter genome screen as an initial validation. We can also detect through machine vision digested exopher fragments, and can quantify what fraction of animals in a well had an exopher on earlier days. We are now also able to detect exophers themselves by taking advantage of the cargo specificity of exophers, which gives us a direct readout of exopher occurrence and will let us screen for cargo segregation defects as well. We hope to launch a whole genome screen by the end of the year, and then subsequently perform high-throughput epistasis analysis between our top hits to help us further elucidate the exopher formation and clearance mechanisms.

PRESENTATIONS

Melentijevic I, Neuronal Exophers: A Novel Mechanism for Removal of Neurotoxic Cytoplasmic Components, Plenary Talk at the C.elegans International Meeting, Los Angeles, CA. June 4, 2017

Melentijevic I, A Novel High-throughput Whole-genome RNAi Screening Technology Utilized to Investigate the Molecular Pathways of Exopher Production, Poster, C.elegans International Meeting, Los Angeles, CA. June 3, 2017

Melentijevic I, Touch Neurons Can Toss Out Mitochondria, Poster, C.elegans International Meeting, Los Angeles, CA. June 3, 2017

Melentijevic I, Structural Components and Genetic Requirements of Exophers and Their Formation, Poster, 2017 C.elegans International Meeting, Los Angeles, CA. June 3, 2017

AWARDS

Aaron Shatkin Scholarship 2017 F31 Understanding the Exopher: A Novel Mechanism for Extrusion of Neurotoxic Contents 2017 Teaching Assistant and Graduate Assistant Professional Development Fund

---

JOSH LEIPHEIMER
Advisor: Martin Yarmush

Venipuncture is pivotal to a wide range of clinical interventions and is consequently the leading cause of medical injury to both patients and staff in U.S. healthcare facilities. This is because venipuncture success rates rely heavily on clinician expertise and patient physiology. Our lab has developed and validated a device that improves upon the accuracy and safety of venipuncture by autonomously performing the needle-stick procedure using phantom arms. The robotic device combines a near-infrared (NIR) imaging system, computer vision software, ultrasound technology, and a 9-DOF (degree of freddom) robotics system to autonomously perform the venipuncture procedure without human intervention. An integrated, point-of-care, diagnostic device has also been created in junction with the venipuncture robot that receives, centrifuges, and analyzes whole blood autonomously that is drawn via the venipuncture device. The diagnostic device is a point-of-care blood analyzing unit that has the potential of extrapolating clinical information from the patient's blood by using centrifugation, fluid sample pump loading, and microscopic fluorescence imaging, all done autonomously and without

human intervention. This device has been validated by performing a 3-part differential leukocyte counting on porcine blood controls and generating standard curves with known, measured cell counts. My recent efforts have been directed towards miniaturizing the autonomous venipuncture device into a hand-held, portable, version that is capable of performing blood draws as well as inserting IV catheters with equal first time success rate. With the device made portable, clinicians can easily perform venipuncture procedures without being encumbered by the previous devices size and complexity. Additionally, with a less complex, less expensive, and easier to use device for various scenarios, I believe the hand-held automated venipuncture device will become more easily implemented into standard clinical practice.

The current venipuncture device consists of a 9 DOF robotic system in order to insert the needle into the vein center completely autonomously. The miniaturized device will be designed to be hand-held, in which the clinician brings the ultrasound probe and attached device to the intended venipuncture area. Because of its semi-autonomous design, this version will only require 2 DOF for needle insertion, greatly reducing the size and complexity of the previous device. Additionally, the previous device required a NIR imaging system in order to image and identify a target vein for insertion. In this setup, once the vein is identified, the device would then position the ultrasound and needle insertion manipulator above the target vein. Because the hand-held device is being manually positioned by the user, the device will no longer require a NIR imaging system to identify target veins for ultrasound placement. However, an ultrasound probe is still used to identify veins and their distances between lumen centers and forearm surface. This information is used to determine how far the needle insertion motor must travel to reach its target location (lumen center). The current hand-held device design is comprised of three main components: the needle insertion device, the ultrasound probe which the needle insertion device attaches to, and the control software, sensors, and display interface. These three components will work in junction to achieve a successful first-stick venipuncture for patients with and without difficult venous access.

The needle insertion device will consist of 2 DOF robotic system: one DOF is used for needle insertion along a fixed axis, the other DOF will be for minute adjustments in a lateral fashion in order to align the needle with the vein trajectory. I will be investigating alternative robotic mechanisms for achieving needle positioning control, such as worm gear rotary-translatory motor conversion instead of the device's previous spindle drive fashion. These components will be compactly fit into a chassis that will then be attached to a standard ultrasound transducer probe to create a lightweight, hand-held version of the autonomous venipuncture device.

The ultrasound probe will be used to find and identify viable veins in the patient. An accompanying image processing program will be used to segment vein walls and identify the lumen centers and their respective distances between the lumen center and forearm surface. Doppler ultrasound will be used to verify that the segmented vein is in fact a vein and not an artery. However, because veins are located more superficially than arteries, and with the ultrasound configured to a higher frequency, arteries would not appear on the resultant ultrasound images anyway. Additionally, I will investigate if it is possible to perform the autonomous venipuncture procedure without the use of a standard ultrasound transducer probe. One of the most limiting factors in implementing medical device research work into the clinical realworld is cost. Hospitals and medical insurers will not purchase products or adapt new methods that cannot prove to have an economical advantage over the current, standard method. As it is, the ultrasound transducer probe is the most expensive component on both the hand-held and Gen3 venipuncture device. I will investigate the possibility of using simplified ultrasound technology to identify, at most, vein depths in patient's arms. In conjunction with a force-feedback-to-distance-

mapping algorithm and this simplified ultrasound, I believe it will still be possible to perform the same autonomous venipuncture procedure accurately and safely.

The hand-held device will also incorporate a uniaxial force sensor along the needle insertion axis. In the previous venipuncture designs, a force sensor was implemented to extract the feedback forces along the needle axis during the insertion into the vein center. From phantom arm trials, a characteristic force peak is seen when the needle punctures the initial vein wall. However, this information was not implemented into the final motor positioning control software, but used as more of a fail-safe. After interviews and shadowing phlebotomists at RWJH, they agree that they can identify this rise in resistance; feeling a slight force resistance just before the needle punctures the vein, and use this as a "rule-of-thumb" that the needle has reached the vein center. With the hand-held venipuncture, I will implement this characteristic force peak into the positioning control software to halt the motor to stop inserting once this characteristic peak is identified. Since all patients are different, and many patients will have different vein and forearm structures, I will investigate implementing a machine learning algorithm to find characteristics of vein wall force peaks between many demographics of patients. The ultimate goal of this will be to have a force feedback to distance mapping algorithm that is capable of accurately determining when the needle has punctured the initial vein wall.

In terms of work done, I have completed the CAD design and prototype of the first version of the handheld device. This prototype is just a proof of concept design to demonstrate that the design is working as attended. When the final working prototype is complete, I will begin performing positioning control experiments. In this, I will test the accuracy and precision of the robotic controls in positioning the needle tip to a desired location. Phantom trials will involve testing the accuracy and reliability of the hand-held device in identifying a vein and positioning the needle tip directly into the center of the vein. Force feedback motor control will involve performing insertions on phantom forearms and veins and retrieving a force vs distance plot of the insertion. Doing this multiple times with differing phantom forearms will retrieve enough information to identify a characteristic force peak across varying phantom arms that will be used in the positioning controls. In this, I will identify a characteristic force peak for all phantoms and use this characteristic as a control to relay to the system that the target vein has been reached. I will again test to see how accurate the device is on positioning the needle tip in the center of the vein based on force sensor information alone.

PRESENTATIONS

Leipheimer J, Balter M, Chen A, Maguire T, Yarmush ML. "Investigating the Use of Structured Light Imaging for 3-D Reconstruction of the Human Forearm for Automated Venipuncture." Northeast Bioengineering Conference (NEBEC), Newark, NJ, March 31st, 2017.

Leipheimer J, Balter M, Chen A, Maguire T, Yarmush ML. "A Robotic Device for Automated Venipuncture." NJ Tech Council – What's Next in Medical Devices, Princeton, NJ. June 13th, 2017.

YOLANDA S. MIRANDA ALARCON
Advisor: David Shreiber

As my transition from masters to PhD took place this last year, I have been assigned to two projects. Both projects are rooted in the field of tissue engineering (TE), with the idea of following the one with the most promise. A common modality in TE is to take naturally occurring molecules and proteins like

collagen and supplement them with other moieties to exhibit additional properties. With this in mind, we have been developing collagen materials following this approach: primary amine combined with a carboxylic acid in ideal conditions (pH and pKa, solubility, temperature, reaction chemistry and stoichiometry). Following this rationale, I have been working on two different projects. The commonality among them is my primary amine source: collagen type-I. To supplement the collagen backbone with additional properties, we graft carboxylic acid sources such as methacrylic acid for properties of thermoreversibility and photoactivity, as well as ciprofloxacin for antibacterial protection.

Project 1: We have modified type-I collagen by adding methacrylate groups to lysine residues to develop collagen methacrylamide (CMA), which is a unique material for 3D printing scaffolds. Like collagen, CMA self-assembles into D-banded, fibrillar hydrogels, degraded by metalloproteinases, and maintains natural bioactivity, but CMA is also thermoreversible and photoactive. CMA can reversibly form a fibrillar hydrogel at 4oC. As a photoactive material, CMA can be photocrosslinked when exposed to UV radiation in the presence of a photoinitiator to afford a gel with increased stiffness. Photocrosslinking eliminates thermoreversibility, maintaining the stiffness of the gel without having to rely on temperature. Combined, these two properties enable a number of exciting applications, such a 3D printing and cell encapsulation. We have focused on validating CMA's thermoreversibility and photocrosslinkability through rheological testing. After validation, we further tested the potential for cell encapsulation of CMA using mesenchymal stem cells (MSCs). MSCs are an attractive cell for regenerative medicine because of their relative ease of isolation and their potential to differentiate into a variety of cells, including chondrocytes, adipocytes, and osteocytes. The crosslinking process includes exposure to UV light and to free radicals, which can both damage cells. We introduce the use of antioxidants to protect cells while still allowing crosslinking. Once cells are encapsulated, we examine cell viability and hydrogel degradation. Preliminary data indicates good cell viability of MSCs encapsulated in CMA hydrogels. Furthermore, we observed that as the grafting efficiency of our CMA increased, cell viability decreased. The next steps will involve differentiating cells into chondrocytes and osteocytes with a stiffness range of CMA to evaluate the effect of matrix stiffness in MSCs differentiation. Project 2: As the largest organ of our body, skin plays a role in many physiological processes. Due to skin's continuous environmental exposure and likelihood of injury, many products have been developed focused on one stage of wound healing, the stages being: hemostasis, inflammatory stage, proliferative stage, and maturation. Our aim is to develop a scaffold that both enhances epithelization and provides infection prevention to reduce the overall healing time of the wound. To this end, we have chosen ciprofloxacin, an antibiotic with activity against both Gram-positive and Gram-negative bacteria, most effective in treating skin infections. To react ciprofloxacin with collagen type-I, we utilize carbodiimide crosslinkers to activate the carboxylic acids of ciprofloxacin. Once synthesized we purify and evaluate its grafting efficiency. Further analysis involves assessing its antibacterial properties of the synthesized composite by measuring growth rates of exposed E. coli to different concentrations of ciprofloxacin grafted to collagen (CiproCollagen) and collagen. The data obtained showed that CiproCollagen inhibits the growth of E. coli as the CiproCollagen concentration increases in a mixture of CiproCollagen/collagen. To perform a proof-of-concept of this grafting material, we have grafted to collagen type-I other carboxylcontaining antibiotics such as ampicillin and amoxicillin. Both materials have demonstrated bacterial inhibition. Our next aim is to understand the mechanism of action of CiproCollagen for bacterial inhibition. To this end, we will treat CiproCollagen with Collagenase, followed by exposing E. coli to the afforded fragments to confirm if the released ciprofloxacin from collagen is what provide antibacterial properties.

PRESENTATIONS

Miranda Alarcón YS, Shreiber DI. Development of Bioactive, Thermoreversible, and Photoactive Collagen Based Scaffolds for Tissue Engineering Applications SACNAS The National Diversity in STEM Conference (Oral Presentation, Salt Lake City, Utah). October 19-21, 2017.

AWARDS

National Science Foundation-Graduate Research Fellowship Program 2017-2022

ANTOINETTE NELSON
Advisor: Patrick Sinko

Both men and women who engage in unprotected receptive anal intercourse (RAI) are at a significantly higher risk of contracting HIV from an infected partner than those who participate in unprotected vaginal intercourse. It is estimated that unprotected RAI results in 10-100 times more incidences per exposure than unprotected vaginal intercourse, exposing a critical need for interventions to prevent viral transmission through this route. Currently, the only FDA approved approach for HIV prevention is the systemic pre-exposure prophylaxis (PrEP) treatment, Truvada. With Truvada, there are toxicity concerns since the entire body is being exposed to antiretrovirals. Patient compliance is also a limitation due to a strict once-a-day oral dosing regimen. A mucosal PrEP would address these concerns by lowering the necessary dosage and frequency while avoiding systemic exposure to drugs. However, a major obstacle to drug delivery in the colon is penetration of the protective epithelial cell barrier and the mucus lining. Through the conjugation of selected cell penetrating peptides to nano-sized delivery systems we have been able to increase and sustain carrier penetration into intestinal tissue. The objective of this study is to develop a foam-based mucosal PrEP capable of delivering therapeutic agents to the gut mucosal region with limited leakage, good colorectal coverage and sustained drug release within the colorectal tissue. The central hypothesis is that our mucosal PrEP will maximize surface coverage within the colon, sustain local drug concentrations to minimize administration frequency, provide limited systemic exposure to prevent toxicity, and have very low, if any, anal leakage. Our rationale is that by ensuring minimal leakage of our foam formulation along with sustained drug release, we will increase patient adherence and produce a more effective PrEP therapy for the prevention of HIV transmission. Our study will be guided by the following aims: 1) to engineer and evaluate a number of drug-loaded nanocarriers capable of translocating across the colorectal mucus to locally deliver anti-HIV therapies in a sustained manner; 2) to establish target mucosal tissue drug concentrations and correlate drug elimination and release properties from nanocarriers; and 3) to formulate and assess pharmaceutical foams that cover the mucosal surface, leave minimal residual volume upon breaking, and homogeneously distribute nanocarriers throughout the distal colon and rectum. Currently, we are testing a number of foam formulations in vitro and in vivo to investigate foam expansion, breakability and toxicity. We are also enhancing the delivery of nanocarriers to colorectal cells through the conjugation of cell-penetrating peptide bac-7. In vitro and in vivo work for bac-7 optimization is being completed and a manuscript has already been submitted for this work using model PEG conjugates. Another manuscript is currently being prepared for our work using larger bac7labeled nanoparticles. We are also exploring novel peptides that our lab has identified to increase intestinal uptake. A manuscript for this work in enhancing oral drug delivery is being prepared. In addition, preliminary pharmacokinetic studies are currently being performed to test key anti-HIV drugs.

While completing my graduate research I was a 2014-2016 fellow in the Rutgers Predoctoral Leadership Development Institute. I previously served as Vice President of the Rutgers Council of Black Graduates and Co-President of the Rutgers Science Policy Group. I have also been involved with numerous STEM outreach programs where I serve as a mentor. These programs include Research in Science and Engineering (RiSE), NAACP ACT-SO Program, Leadership Alliance and The Academy at Rutgers for Girls in Engineering and Technology (TARGET). In addition to the papers mentioned above, I have also edited the Solubility and Distribution Phenomena chapter in the Martin's Physical Pharmacy and Pharmaceutical Sciences, and published three abstracts regarding the described work In the FASEB Journal. I am a former fellow with the American Foundation for Pharmaceutical Education and currently a fellow with the National Science Foundation.

AWARDS

National Science Foundation EAPSI Fellowship Summer 2017 Martin L. Yarmush Best Presentation Award (2nd Place) Summer 2017

JENNA NEWMAN
Advisor: Andrew Zloza

Recent advances in the field of immunotherapy have resulted in prolonged survival of patients with various types of cancer. Such clinical successes have elucidated the fact that cancer development is not solely dependent on the accumulation of mutations in cells but is likewise mediated by the ability of the cancer to evade detection and elimination by the immune system. The inability of host immunity to stop cancer development and growth may be due to concomitant challenges faced by the immune system. Epidemiological studies have reported that cancer patients infected with non-oncogenic viruses exhibit an elevated rate of cancer-related death as compared to patients without concomitant viral infections. My lab has developed a model to study this phenomenon. In our model, mice with cancer (melanoma, breast cancer) exhibit faster tumor growth when concomitantly challenged with influenza (or other pathogens) than when such mice are uninfected (Kohlhapp, et al. 2016, Cell Reports, in press). We have discovered that in influenza-infected mice, anti-tumor killer (CD8+) T cells (important for the immune response against cancer) are decreased in the tumor microenvironment (where they are needed to control and eliminate the tumor) and found at increased levels in the lung (the site of influenza infection). These data suggest that infection leads to the shunting of anti-tumor killer T cells from the tumor site to the site of infection. Recent work that I have conducted has indicated that the scenario in which concomitant challenge of viral infection and cancer yields accelerated tumor growth may not be as universally observed. Experiments have consistently shown that, if mice harboring palpable (~3 x 3 mm) flank tumors are challenged intranasally with influenza, concomitantly challenged mice exhibit significantly slower tumor growth, and in some cases, regression, as compared to that of uninfected controls (Newman et al., 2017, unpublished). This is in stark contrast to what was reported by Kohlhapp et al., 2016, in which administration of influenza prior to tumor challenge, or during the subclinical phase of tumor development, yields accelerated tumor growth in concomitantly challenged mice. To investigate whether both results could be observed, an experiment in which one half of all mice were administered influenza prior to melanoma challenge, and the other half were infected following the development of a palpable tumor was conducted. Challenge with B16 melanoma was performed on the same day for all mice. In accordance with aforementioned data, it was observed that concomitantly challenged mice exhibited accelerated tumor growth when the peak of influenza infection coincided with the subclinical phase of tumor development, and slower tumor growth when mice were infected

with influenza upon emergence of a palpable tumor, relative to mice bearing melanoma alone (Newman et al., 2017, unpublished). The dual role of infection in promoting or curbing tumor growth has been described above for scenarios in which infection is occurring at a location in the body (lung) that is distant from the tumor site (flank); the relationship between infection and cancer is further complicated when both challenges afflict the same anatomical location. In experiments in which influenza was intranasally administered and B16 F10 melanoma was intravenously injected (for colonization of melanoma in the lung), concomitantly challenged mice had significantly fewer melanoma foci in the lungs when compared to influenza-naïve mice, irrespective of the timing of influenza infection vs. melanoma challenge (Newman et al., 2017, unpublished). Hence, influenza infection harbors differential impact on tumor growth depending on both timing (relative to the onset of tumor challenge) and location of the tumor. Mechanistic interrogation of the described phenomena is underway, utilizing tools such as flow cytometry, LEGENDPlex multiplex cytokine assays, qPCR and histology.

PRESENTATIONS

Newman JH, Huelsmann E, Broucek J, Kaufman H, and Zloza A. Local but not distant viral infection improves cancer outcomes: implications for cancer immunotherapy. Society for the Immunotherapy of Cancer (SITC) 2016, National Harbor, MD. November 12, 2016

Newman JH, Li S, Chesson CB, Schenkel JM Silk A, and Zloza A. "Growth of Established Tumors is Reduced in Hosts Concomitantly Challenged with Non-oncogenic Acute Viral Infection." Sino-American Pharmaceutical Association (SAPA) Symposium: Revolution in Cancer Treatment-Immunotherapy and Beyond. Rutgers University, Piscataway, NJ. April 8, 2017.

Newman JH, Li S, Chesson CB, Schenkel JM, Silk A. and Zloza A. "Non-oncogenic Acute Viral Infection Reduces Tumor Growth in Hosts with Established Cancer." Immunology 2017, Washington, D.C. May 15, 2017

Newman JH, Li S, Chesson CB, Schenkel JM, Silk A. and Zloza A. "Concomitant Non-oncogenic Viral Infection Harbors Dual Roles in Tumor Progression." The 2017 Annual Retreat on Cancer Research in New Jersey, Rutgers University, New Brunswick, NJ. May 25, 2017

Newman JH, Chesson CB, Zloza A. “Non-oncogenic Acute Viral Infection Modulates the Innate Immune Response and Reduces Tumor Growth in Hosts with Established Cancer”. Society for the Immunotherapy of Cancer (SITC) 2017, National Harbor, MD. November 10, 2017

AWARDS

Rutgers University Graduate School Conference Travel Award for the American Association of Immunologists (AAI) Immunology 2017 conference March 2017

Excellent Poster Award (Sino-American Pharmaceutical Association (SAPA) Symposium: Revolution in Cancer Treatment-Immunotherapy and Beyond) April 2017

Gallo Award for Scientific Excellence (The 2017 Annual Retreat on Cancer Research in New Jersey, Rutgers University) May 2017

EVELYN OKEKE
Advisor: Kiran Madura

The ubiquitin proteasome pathway (UPP) is the primary mechanism for removal of cellular proteins and is conserved from yeast to humans [1]. The main focus of attention of the Madura lab is to determine how proteolytic substrates are targeted to the proteasome. In 2002, the laboratory reported evidence that there are proteins that can bind and deliver polyubiquitinylated substrates to the proteasome, and characterized these as shuttle-factors [2]. Interestingly, recent studies from our lab show that most proteasomal substrates are nuclear, whereas the proteasome is located in cytosol [3]. Consequently, Rad23 must function as a shuttle factor that transports nuclear substrates out of the nucleus to the cytosolic proteasome. Despite extensive studies by us and others, it is still unclear if shuttle factors promote this function.

The focus of my efforts is to characterize this transport mechanism. I am using unique yeast mutants with which I have been able to control Rad23 subcellular localization. Using these mutants has allowed me to test specific predictions. First, nuclear-localized Rad23 should be bound to polyubiquitinylated substrates of the proteasome, whereas cytosolic-localized Rad23 should bind the proteasome. Second, the nuclear export pathway must be a key component responsible for the translocation of substrates from the nucleus to the cytosol.

The availability of genetic mutants has facilitated studies to test these questions, and we are beginning to improve our understanding of the function of shuttle factors. One of these mutants is sts1-2 that exhibits a proteasome localization defect at non-permissive temperature. As a result, nuclear substrates become stabilized and Rad23 is trapped in the nucleus. The other mutant is the temperature sensitive mutant called rna1-1. Rna1p is a RanGAP protein of the family of GTPases that facilitates the conversion from GTP to GDP, which is essential for the nuclear import and export cycle to occur. In rna1-1 at nonpermissive temperature, nuclear substrates are also stabilized, but Rad23 is trapped in the cytosol. Subsequently, we determined that Rad23 formed a strong interaction with polyubiquitinylated substrates only when it was trapped in the nucleus. In contrast, Rad23 interaction with polyubiquitinylated proteins was strongly reduced in the cytosol.

To support the genetic studies, I have generated recombinant proteins that can be selectively targeted for degradation using the Auxin-inducible degradation (AID) system. Specifically, AID-tagged Sts1 can be degraded in the presence of plant based protein Tir1 and the addition of auxin to the growth medium. This construct will allow me to replicate my findings in the sts1-2 mutant. A similar construct is generated for Rna1. In addition, I can reevaluate Rad23 localization and interactions with polyubiquitinylated substrates, as well as the proteasome. An extension of this study using the AID-tagged Sts1 expressed in an rna1-1 sts1Δ strain should allow me to demonstrate the nucleo-cytoplasmic trafficking of Rad23 for the first time. However, yeast has multiple shuttle-factors, including Ddi1 and Dsk2, and I will investigate if they function in a similar way.

PRESENTATIONS

Okeke EI, Madura K. Characterization of the nucleocytoplasmic trafficking of Rad23, a shuttle factor that functions in protein degradation. The Ubiquitin Family CSHL, Cold Spring Harbor, NY. April 18-22, 2017. Poster.

Okeke EI, Madura K. Characterization of the nucleocytoplasmic trafficking of Rad23, a shuttle factor that functions in protein degradation. SACNAS, Salt lake City, UT. October 19-21, 2017. Talk.

AWARDS

NSF GRFP Fellowship 2015-2017

ANTON OMELCHENKO
Advisor: Bonnie Firestein

Traumatic Brain Injury (TBI) is one of the leading causes of death and disability in the United States, and there is currently no successful pharmacological treatment for TBI. TBI is primarily characterized by two mechanisms of injury, primary and secondary injury. Primary injury refers to the mechanical insult to the brain, and this insult directly damages cellular structures and connectivity and occurs immediately postinjury. Secondary injury occurs as a consequence of the cellular processes and biological events initiated after the primary insult and takes place over the hours and days following injury. Mitochondrial dysfunction has been previously implicated in the excitotoxicity and cellular damage that occurs during secondary injury. Excessive glutamate release by neurons and glia, mechanosensitive channel activation, and the disruption of the axonal plasma membrane as a result of injury can lead to an increase in calcium influx into neurons. Mitochondrial buffering of the excess calcium present in the intracellular space leads to increased production of reactive oxygen species, an excess in mitochondrial fission, decreased ATP production and the release of pro-apoptotic factors. These processes ultimately lead to cell death and contribute to the symptoms of secondary injury in TBI.

During my second year as a student in the Firestein laboratory, my work has primarily focused on the development of a microfabricated device that can be used to model TBI in vitro and to screen pharmacological treatments for injury in a high-throughput manner. The device is constructed using polydimethylsiloxane (PDMS), a silicon-based polymer, and consists of two compartments connected by microfluidic channels. Two separate hippocampal organotypic rat brain slices are cultured within the two compartments, and the two slices create axonal connections through the microfluidic channels. In order to model TBI, uniaxial strain is applied beneath the axons spanning through the microchannels, and mitochondrial function is examined in the axons of neurons with fluorescence microscopy and label-free optical scatter imaging.

After optimizing the organotypic culture technique during my first year, I began testing different fluorescence methods to visualize mitochondrial morphology changes in response to stretch injury. I generated two lentivirus constructs encoding mito-DsRed2 and mito-GFP and microinjected the viruses into regions of the organotypic hippocampal slices. However, transduction efficiency was low due to the glial barrier present in organotypic slices, which made it difficult to examine mitochondrial morphology inside the microchannels. I began to test different mitochondrial dyes, including MitoTracker Green FM, Tetramethylrhodamine methyl ester (TMRM), and JC-1, to examine both mitochondrial morphology and function in response to injury and found that all three dyes are visible inside axons within the microchannels. After optimizing injury parameters, I applied different pressures with varied peak deflection times and observed axonal and mitochondrial response to injury. I found that a pressure of

4psi applied for 50ms leads to axonal beading in the hours following injury and eventual degradation of the axons by the 24-hour time point. In contrast, pressure of 14.5psi applied for 260ms leads to immediate degradation following injury. Additionally, the application of 2.5psi for 50ms leads to a significant reduction in mitochondrial area and mitochondrial major axis, a significant increase in mitochondrial roundness, and does not affect mitochondrial minor axis. This suggests that these injury parameters lead to increased mitochondrial fission within axons following injury. My next goals include repeating the same injury parameters in neurons labeled with MitoTracker dye to examine mitochondrial morphology and with CellROX dye for oxidative stress detection. I will also use slices from transgenic animals expressing GFP in axons to investigate axonal beading in response to injury. Moreover, I will test whether pharmacological agents that target mitochondrial dysfunction and reversal of sodium-proton and sodium-calcium exchangers ameliorate cellular and molecular responses to injury.

PRESENTATIONS

Omelchenko A, Shrirao A, Zahn J, Schloss R, Boustany N, Yarmush M, Firestein B. Brain-on-a-chip for Traumatic Brain Injury Drug Discovery, 2017 Biomedical Engineering Society Annual Meeting, Phoenix, Arizona, October 11th-October 14th, 2017.

Omelchenko A, Shrirao A, Zahn J, Schloss R, Boustany N, Yarmush M, Firestein B. Brain-on-a-chip for Traumatic Brain Injury Drug Discovery, Third Annual BRAIN Initiative Meeting Poster Session, Bethesda, Maryland, December 12th-December 14th, 2016.

Omelchenko A, Sanchez S, Cabral M, Alliger A. Environmental Enrichment and its Effect on Depressivelike Behavior in Rats, 42nd Hunter College Psychology Conference Poster Session, New York, New York, March 30, 2014

XIOMARA PEREZ Advisor:
Martin Yarmush

I am currently working on a project, the aim of which is to develop alginate-encapsulated PLGA nanoparticles (NPs) as a drug delivery system that can be used to transport different biomolecules and drugs. I am utilizing PLGA and alginate because they are both FDA-approved, biocompatible, and biodegradable materials. This alginate-PLGA NP drug delivery system can be used to target complex diseases or tissue trauma, such as, spinal cord injury or traumatic brain injury. The significance of encapsulating PLGA NPs in alginate is that it provides superior positional control as well as an improved controlled release profile compared to other systems. For example, liposomes are commonly used as drug delivery systems; however, they are expensive to manufacture and release most of the drug within the first 24hrs. As a way to address these limitations, our group has encapsulated liposomes loaded with bupivacaine (BVC) in alginate to better control the drug release profile1. Both in vitro and computational data have shown that incorporation of alginate provided a sustained release profile of BVC for at least 4 days. I have been characterizing and optimizing PLGA NPs in order to evaluate the effects of NP size on encapsulation efficiency and diffusivity rate. This information will allow us to adjust NP size based on the substance to be encapsulated. I will then encapsulate conditioned media or purified biomolecular factors in alginate-PLGA NPs to compare against results using encapsulated mesenchymal stromal cells (eMSC). As a proof of concept, I will begin with encapsulating Prostaglandin E2 (PGE2), a key antiinflammatory mediator, and study the effects on M1, pro-inflammatory, macrophages.

Additionally, I am currently applying for the NSF-GRFP fellowship, based on what I intend to do for my thesis work. I am also presenting at BMES and SACNAS conferences this fall semester. Finally, a majority of my coursework will be completed this year as my focus shifts towards my thesis research.

PRESENTATIONS

Perez XI, Davis M, Marrero-Berrios I, Maguire T, Schloss RS, Yarmush J, Yarmush ML. AlginateLiposomal Bupivacaine Formulation Preserves Mesenchymal Stromal Cells Anti-Inflammatory Function. Biomedical Engineering Society (BMES), Phoenix, Arizona, October 2017

Perez XI, Davis M, Marrero-Berrios I, Maguire T, Schloss RS, Yarmush J, Yarmush ML. AlginateLiposomal Bupivacaine Formulation Preserves Mesenchymal Stromal Cells Anti-Inflammatory Function. Society for the Advancement of Chicanos/Latinos and Native Americans in Science (SACNAS), Salt Lake City, Utah, October 2017

WILLIAM PFAFF
Advisor: Michael Dunn

Osteoarthritis is one of the major causes of joint pain and disability in middle-aged and older adults. Wear and sports-related injuries cause the degeneration of articular cartilage, and may necessitate surgical intervention due to the tissue's natural inability for self-repair. Current surgical interventions include the practice of microfracture and autologous chrondrocyte transplantation. The practice of microfracture involves the debridement of damaged cartilage and piercing the bone surface to release bone marrow stem cells and blood that initiates wound healing. While the resulting scar tissue can alleviate joint pain, it is mechanically inferior to native cartilage tissue and merely delays the progression of osteoarthritis. Autologous chondrocyte transplantation is an experimental technique where chondrocytes are harvested from non-load-bearing cartilage and implanted into the defective site. While these chondrocytes are capable of proliferating and producing collagen type II, there is no organization of the fibrous extracellular matrix (ECM) and the resulting scar tissue is mechanically inferior to native cartilage. The field of articular cartilage tissue regeneration is currently examining the development of implantable scaffolds seeded with autologous chondrocytes that can develop a strong and durable ECM that is identical to native cartilage. Current models have attempted mechanically preconditioning a scaffold seeded with autologous chondrocytes in vitro prior to implantation, while other studies have tested how scaffolds with a gradient of porosity/growth factors/proteoglycan distribution can direct ECM development of chondrocytes. Our lab's focus is to determine how a scaffold's gradient mechanical properties that can condition chondrocytes to produce the desired ECM while in vivo, obviating the time and expense of preconditioning in vitro as well as the risks of using growth factors. The objective of this study is to develop a polymer fiber-reinforced composite scaffold that can be seeded with autologous chondrocytes and immediately implanted into the defect site to assist in cartilage regeneration. The central hypothesis is that since chondrocytes produce collagen type II orthogonal to the direction of compressive stress, a scaffold that undergoes increasing lateral compressive stress with depth will cause chondrocytes to produce fibers in an orientation similar to native cartilage tissue. Our rationale is that if we can prove that autologous chondrocytes can be mechanically conditioned to produce the desired ECM in vivo, then we can create a clinically viable scaffold that is superior to current surgical interventions while avoiding the risk and cost of experimental scaffolds that require growth factors or preconditioning in vitro. The specific aims are to (1) develop a

composite scaffold with the same day-zero biomechanical properties as native cartilage and is capable of internal lateral expansion when undergoing compression and shear distortion, (2) determine how this scaffold supports chondrocyte proliferation and collagen type II production and orientation in vivo, and (3) test how an expandable scaffolds can integrate into the surrounding native cartilage tissue when laterally compressed prior to insertion. Our lab has developed a prototype scaffold consisting of woven and sintered polycaprolactone fibers with an alginate-collagen substrate. We have optimized the biomechanical properties of the scaffold by testing prototypes with fibers of varying sizes and weaving patterns, as well as substrates with varying compositions of collagen and alginate. We are currently developing a substrate with proteoglycan components such as hyaluronic acid to improve the viscoelasticity as well as promote chondrocyte expression. Once the scaffold has the desired mechanical properties, we are going to test its ability to support an autologous chondrocyte population in vivo in a rabbit model, and test its functional capabilities in a larger animal model. By examining the response of the chondrocyte population to the mechanical stimulus in vivo, we can provide insight on how collagen type II fibers can be produced and aligned to recreate the ECM found in native cartilage.

PRESENTATIONS

Pfaff WH, Dunn MG, Gatt C. Composite Collagen-Alginate Substrates in Biomimetic Articular Cartilage Scaffoldds. New Jersey Center for Biomaterials Symposium. New Brunswick, NJ October 2016.

CHRISTOPHER RATHNAM
Advisor: Ki-Bum Lee

Regenerative medicine is a continually growing field that has attempted to revolutionize the healthcare industry. My research focuses on two main areas for advancing the field of regenerative medicine. I hope to 1) develop technologies to control gene activation and repression to control stem cell behavior and 2) develop inorganic nanoscaffolds to deliver stem cells to injury sites to treat CNS injuries.
Ever since Yamanaka and colleagues' pioneering work on cellular reprogramming, the use of transcription factors to modulate cell fate and behavior has exploded. However due to the safety concerns with the use of viral vectors and integrating plasmids, the potential for translation of many of these studies has been severely limited. To this end our lab has developed a novel nanoparticle based platform, termed NanoScript, that has been designed to mimic the structures and functions of natural transcription factors. Using NanoScript we have demonstrated that adipose derived mesenchymal stem cells can be induced towards different cell lineages including myocytes and chondrocytes. In addition, NanoScript can be easily designed to target various genes and either upregulate or repress them. I have recently been working on methods to 1) increase activation of NanoScript by modifying activation and epigenetic domains and 2) increase specificity of NanoScript by utilizing triplex forming oligonucleotides (TFO) as a DNA-binding domain.

To achieve the higher levels of activation I have designed plasmids and expressed the VPR activation domain. This is a fusion of the VP64, P65 and RTA activation domains. The VPR protein has been shown to have over 100 times the expression level of VP64 in literature. I therefore will test the VPR domain on our NanoScript platform to see if we can achieve similar levels of activation. To do this I inserted a snaptag sequence into the plasmid of the VPR protein in order to facilitate the conjugation onto the NanoScript platform. I have currently expressed the protein in E. coli systems and showed that it has the correct molecular weight. I am currently in the process of attaching it to NanoScript and testing its activation levels.

To achieve the increased specificity of NanoScript I am testing the use of TFOs as the DNA binding domain. TFOs are oligonucleotides that bind to the major groove of DNA. Compared to the previous DNA-binding domain that can only recognize 6-8 base pairs, TFOs can recognize 20-22 bp making them much more specific. I have designed TFOs to target the promoter of the genes MyoD1 and ASCL1 and have tested the gene activation using NanoScript and have showed a similar or increased activation for the two genes using the TFO. In addition, I am testing the binding affinity of the TFO with various numbers of base pair mismatches using SPR to elucidate how base pair mismatches will affect the binding of the TFO. I am also looking to test the binding of the TFO's in the entire genome to find how many sites these TFOs bind to compared to hairpin polyamides.

At the culmination of my research I hope to improve both the specificity as well as the level of activation of NanoScript to raise it to the next level where it can be used for stem cell differentiation and transplantation for the treatment of various disorders.

EVE REILLY
Advisor: Andrew Zloza

Replication and transcription conflicts are potent sources of genomic instability, and the transcription machinery has been recognized as a naturally occurring impediment to the replication fork. Strategies to minimize the potentially deleterious effects of these conflicts, therefore, are present in numerous iterations from bacteria all the way up to humans. In prokaryotes, these conflicts are minimized by orienting essential genes so that they are codirectional with replication (Bermejo, Lai, & Foiani, 2012). In higher eukaryotes, replication and transcription are often spatially and temporally separated (Bermejo et al., 2012). In humans, a number of difficult-to-replicate loci referred to as common fragile sites (CFS) have been described. A significant number of these CFS are the product of replication-transcription collisions (Khurana & Oberdoerffer, 2015). Collisions between the replication and transcription machinery are also highly mutagenic; further, this interference can lead to formation of RNA-DNA hybrids known as R loops which then present an additional impediment to the replication fork (Brambati, Colosio, Zardoni, Galanti, & Liberi, 2015) (Santos-Pereira & Aguilera, 2015). R loops are associated with recombinogenic doublestrand breaks, making recognition and clearance of aberrant R loops imperative for maintaining genome stability (Santos-Pereira & Aguilera, 2015). Replicative stress arising as the product of collisions between the replication and transcription machinery, therefore, poses a serious threat to genomic integrity. Understanding the ways in which the negative consequences of these events are minimized and/or prevented will lead to a better understanding of the principles governing genome stability and maintenance. Our work demonstrates that replication and transcription conflicts occur at the sites of long terminal repeat (LTR) retrotransposons in Schizosaccharomyces pombe, or fission yeast. Using LTRs as a model for this phenomenon will provide insight into the consequences of replicative conflict occurring as a result of encounters with the transcriptional machinery and the impact on the local chromatin environment.

It has been suggested previously that encounters between the replication and transcriptional apparatus may induce heterochromatin formation (Nikolov, 2015). Conserved naturally occurring fork barriers which are the product of replication and transcription collisions include tRNA genes (tDNAs) and 5S rRNA genes (5S rDNAs) (Gadaleta & Noguchi, 2017) (Sánchez & Russell, 2015). Like LTRs, both elements are occupied by an H3K9methylated nucleosome; further, they are all highly abundant repetitive elements. We hypothesized that H3K9 methylation may be a response to replication and transcription conflicts at these loci, given the importance of this modification in maintaining genomic stability at repetitive loci. Preliminary experiments suggest that encounters between the replication and

transcription machinery at LTRs may induce H3K9 methylation. This raises the possibility that chromatin may be epigenetically 'marked' at sites of replicative stress, and these markings may persist in subsequent cell cycles. Currently, I am in the process of purifying mononucleosomes found within the body of LTRs in the presence and absence of transcription-replication collisions to ascertain whether there is any relationship between these events and epigenetic markings at these loci. It has been suggested that replication fork stalling can promote changes in the local chromatin environment which influence fork management and restart in subsequent cell cycles. The goal of this work is to achieve a more comprehensive understanding of the ways in which chromatin environment is altered in response to stalled forks, in addition to identification of the cellular factors coordinating replication and chromatin formation. We also seek to explore the potential for these local epigenetic changes to impact higher-order chromatin organization.

PRESENTATIONS

Hardy E, Steward R.53rd Annual Drosophila Research Conference (2012), poster presentation Dlg5, a MAGUK family protein, functions in Drosophila oogenesis.

Hardy E, Changela N, Tan W, Steward R. 2011 Annual Retreat on Cancer Research in NJ, poster presentation Zfrp8, a conserved stem cell factor, interacts with the MAGUK family protein Dlg5.

VICTOR TAN
Advisor: Justin Drake

Prostate cancer tumors are reliant upon androgens for survival and growth. As a result, androgen deprivation therapies have been widely effective for prostate cancer patients. Unfortunately, a subset of patients invariably goes on to develop resistance to these therapies. The disease eventually advances to a castration-resistant state, where it no longer responds to the available treatments. We have previously identified elevated levels of tyrosine kinase activity in CRPC patients independent of DNA amplification or mutations of the kinases themselves. This finding raises the question of whether or not the kinase signaling contributes to resistance mechanisms of CRPC against systemic therapies.

I am currently investigating the benefit of targeting certain kinases in conjunction with standard of care therapies. My central hypothesis is that aberrant kinase signaling in prostate cancer contributes to resistance against standard of care therapies. As such, I have outlined my current plan to identify and investigate these contributions.

Identify and validate potential kinases as therapeutic targets in CRPC. Our recent quantitative phosphoproteomic analysis of CPRC patients have revealed potential kinase targets owing to their aberrant activation. We hypothesize that targeting these kinases in combination with standard of care antiandrogen enzalutamide will enhance antitumor response. The specifics of this aim is to use FDA approved pharmacologic inhibitors of identified kinase targets in combination with standard of care enzalutamide and assess antitumor responses such as cell proliferation, migration, invasion, and tumorigenicity. Based on our predictions, the SRC kinase and DNA-protein kinase are intriguing targets in our prostate cancer cell line model. Investigate the importance of SRC kinase in contributing to CRPC resistance via interactions with androgen receptor splice variant ARv7. Our preliminary results from the first aim have identified the potential of SRC kinase inhibitors when used in combination with enzalutamide. This particular combination is intriguing due to its efficacy on the cell line model 22Rv1.

While it was previously known that androgen receptor (AR) splice variants contributed to resistance against antiandrogen enzalutamide, we were surprised that SRC inhibitors were able to re-sensitize prostate cancer cell line 22Rv1 containing the aforementioned AR splice variants. We hypothesize that SRC activates AR and AR splice variants via phosphorylation in a ligand-independent fashion. In this aim, we plan to assess the interaction of SRC with clinically relevant AR splice variant ARv7. We will first validate the effectiveness of targeting SRC in other cell lines that possess the AR splice variant. If increased sensitivity is also observed, we plan to clone the wild type and splice variants of AR to construct a controlled model system to test our drug combinations on. Following up on this, we plan to investigate the mechanism of synergy. We are currently testing the hypothesis that SRC kinase phosphorylates and activates AR and AR splice variants. In the future, we plan to look at differential signaling cascades for possible overlap between the two downstream signaling pathways: AR and SRC. Identify additional resistance mechanisms in enzalutamide and saracatinib resistant prostate cancer cell lines. We acknowledge that the combination of enzalutamide and saracatinib is not an end-all cure and will still induce eventual resistance in CRPC. SRC kinase most likely does not work alone but instead in concert with additional unidentified factors. We hypothesize that additional kinase signaling networks contribute to the second level of drug resistance against enzalutamide and saracatinib. Ideally then, we will find additional signaling network changes that testify to the use of additional kinase inhibitors. We plan to generate prostate cancer cell lines that are resistant to the initial combination and assess further actions to alleviate it. The inclusion of the newly minted triple drug therapy could then elicit a greater antitumor response.

PRESENTATIONS

Tan V, Justin M. Drake J. Synergistic Combination of Kinase Inhibitors with Enzalutamide against Advanced Prostate Cancer. 2017 Annual Retreat on Cancer Research, New Jersey, May 25th, 2017. Selected for podium presentation.

Tan V, Drake J. Enhancing Standard of Care Anti-androgen Therapies with Synergistic Addition of Tyrosine Kinase Inhibitors in Advanced Prostate Cancer. 2017 Biotechnology Training Program Annual Symposium, New Jersey, June 8th, 2017.

AWARDS

2017 Gallo Award for Scientific Excellence: Podium Presentation/Abstract Selection 2017 Martin L. Yarmush Award: 1st place Outstanding Poster Presentation

---

LIAM TURK
Advisor: Davide Comoletti

After completing rotations in the Schindler, Marcotrigiano, and Comoletti Labs last year, I joined the Comoletti Lab in the Child Health Institute of New Jersey as my thesis lab for my graduate career. The Comoletti Lab studies the mechanisms by which neurons connect to each other and form synapses through the analysis of various cell surface and secreted proteins that are implicated in brain development.

Particularly we focus on how proteins in the pre and post synapses interact with each other using structural and biophysical methods. At the moment, I have been working on three projects: 1) using

protein crystallography to try to understand the novel interaction between amyloid precursor protein and the class B GABA receptor; 2) solving the structure of NTRI, a member of the IgLON protein family; 3) analyzing the 3D architecture of the Reelin protein by cryo-electron microscopy, in collaboration with the Dai Lab (see below).

During this time, I have had the opportunity to learn protein purification techniques such as affinity chromatography and size exclusion chromatography, biophysical techniques of measuring binding affinity like bio-layer interferometry and isothermal calorimetry, and methods used in structural biology such as xray crystallography and data collection at a synchrotron facility (CHESS, Cornell). Through our collaboration with Dr. Wei Dai in the Rutgers Center for Integrative Proteomics Research, I have also been introduced to cryo-electron microscopy as a method to ascertain the structure of large and multidomain proteins. Thus far, I have focused my efforts on learning important techniques in protein chemistry that will prove valuable in the development and completion of my own thesis project.

AWARDS

Rutgers Graduate School of Biomedical Sciences Excellence Award 2016-2017 Rutgers Institute for Quantitative Biomedicine Joint PhD Excellence Award 2016-2017

SONIA YEVICK
Advisor: Jay Sy

There are several indications for injecting a treatment directly into the brain, physically bypassing the blood brain barrier and avoiding the issue of off-target systemic effects. However, slow diffusion into the brain tissue and rapid cerebrospinal fluid (CSF) clearance remain barriers to achieving reasonable drug penetration. The tortuous geometry in the brain, coupled with proteoglycan obstruction and cell-receptor binding in the interstitial fluid all lead to slow diffusion into brain tissue. Furthermore, the CSF is completely replaced about 4 times per day, removing foreign chemicals from the brain.

Our lab is investigating a combination therapy, simultaneously modulating the rate of CSF production and administering a chemotherapy drug to treat brain cancer (glioblastoma). If the larger hurdle to drug penetration is lack of diffusion, then increasing the rate of CSF production with verapamil may enable a chemotherapy drug to penetrate further. If the larger hurdle is rapid CSF clearance, then decreasing the rate of CSF production with acetazolamide may allow the chemotherapy to penetrate further before being cleared away. We are testing these hypotheses in a rodent model, and a slow-release mechanism is necessary to properly administer the drugs to the brain. Currently available such devices for the brain are expensive and highly invasive, therefore we are working to develop a low-cost, refillable, minimally invasive slow-release drug delivery device for the rat brain.

Our device is modeled after the Ommaya device used in humans, consisting of an elastic reservoir anchored to the skull and an attached catheter penetrating into the brain. We are redesigning and miniaturizing this device for use in rats, starting by determining the appropriate dimensions and design for each component and applying a mathematical model to compare pressure and flow rates to catheter length membrane elasticity. Those prototypes and experiments are ongoing.

I have also been evaluating the CSF-modulating drugs for toxicity in four rat glioma cell lines and in primary rat brain cells, both alone and for synergistic toxicity with chemotherapy drugs temozolomide and doxorubicin. The data obtained has indicated that acetazolamide is non-toxic at tested concentrations, verapamil is only toxic at high concentrations in both primary and cancerous brain cells, and there does not seem to be a synergistic effect.

PRESENTATIONS

Yevick S, Sy JC. Comparative cerebrospinal fluid modulator toxicity study – in vitro rat glioma model. NEBEC 2017, Newark, NJ. Electronic poster.

PAPERS PUBLISHED

Tan VM, Cheng LC, Drake JM. Complementing genomics and transcriptomics: Phosphoproteomics illuminates systems biology in prostate cancer. Molecular & Cellular Oncology. 2016 October 14;3(6):e1246075. PMCID: PMC5160408.

Kamisoglu K, **Acevedo A**, Almon RR, Coyle S, Corbett S, Dubois DC, Nguyen TT, Jusko WJ, Androulakis IP. Understanding Physiology in the Continuum: Integration of Information from Multiple -Omics Levels. Frontiers in pharmacology. 2017 February 27;8:91. PMCID: PMC5327699.

Xi Y, Kim T, Brumwell AN, Driver IH, Wei Y, **Tan V**, Jackson JR, Xu J, Lee DK, Gotts JE, Matthay MA, Shannon JM, Chapman HA, Vaughan AE. Local lung hypoxia determines epithelial fate decisions during alveolar regeneration. Nature cell biology. 2017 August;19(8):904-914. PubMed PMID: 28737769; PMCID: PMC5600325.

Miao C, Schiffhauer ES, **Okeke EI**, Robinson DN, Luo T. Parallel Compression Is a Fast Low-Cost Assay for the High-Throughput Screening of Mechanosensory Cytoskeletal Proteins in Cells. ACS applied materials & interfaces. 2017 August 30;9(34):28168- 28179. PubMed Central PMCID: PMC5891216.

Newman JH, Zloza A. Infection: a Cause of and Cure for Cancer. Current pharmacology reports. 2017 October 5;3(6):315-320. PMCID: PMC5686242.

Lue HW, Podolak J, Kolahi K, Cheng L, Rao S, Garg D, Xue CH, Rantala JK, Tyner JW, Thornburg KL, **Martinez-Acevedo A**, Liu JJ, Amling CL, Truillet C, Louie SM, Anderson KE, Evans MJ, O'Donnell VB, Nomura DK, Drake JM, Ritz A, Thomas GV. Metabolic reprogramming ensures cancer cell survival despite oncogenic signaling blockade. Genes & development. 2017 November 14;31(20):2067-2084. PMCID: PMC5733498.

Drzewiecki KE, Malavade JN, Ahmed I, Lowe CJ, Shreiber DI. A thermoreversible, photocrosslinkable collagen bio-ink for free-form fabrication of scaffolds for regenerative medicine. Technology. 2017 December;5(4):185-195. PMCID: PMC5845803.

Fromholtz A, **Balter ML, Chen AI, Leipheimer JM**, Shrirao A, Maguire TJ, Yarmush ML. Design and Evaluation of a Robotic Device for Automated Tail Vein Cannulations in Rodent Models. Journal of medical devices. 2017 December;11(4):0410081-410087. PMCID: PMC5676643.

Davis MS, Marrero-Berrios I, Perez XI, Maguire T, Radhakrishnan P, Manchikalapati D, SchianodiCola J, Kamath H, Schloss RS, Yarmush J. Alginate-liposomal construct for bupivacaine delivery and MSC function regulation. Drug delivery and translational research. 2018 February;8(1):226-238. PMCID: PMC6218803.

Rodríguez AR, O'Neill KM, Swiatkowski P, Patel MV, Firestein BL. Overexpression of cypin alters dendrite morphology, single neuron activity, and network properties via distinct mechanisms. Journal of neural engineering. 2018 February;15(1):016020. PMCID: PMC5797707.

Omelchenko A, Firestein BL. Lipids and phosphates at odds in synaptic depression. The Journal of biological chemistry. 2018 February 2;293(5):1568-1569. PMCID: PMC5798288.

PAPERS PUBLISHED

O'Neill KM, Donohue KE, **Omelchenko A,** Firestein BL. The 3' UTRs of Brain-Derived Neurotrophic Factor Transcripts Differentially Regulate the Dendritic Arbor. Frontiers in cellular neuroscience. 2018 March 7;12:60. PMCID: PMC5845904.

Shrirao AB, **Fritz Z**, Novik EM, **Yarmush GM, Schloss** RS, Zahn JD, Yarmush ML. Microfluidic flow Cytometry: The role of microfabrication methodologies, performance and functional specification. Technology. 2018 March 16;6(1):1-23. PMCID: PMC5907470.

Shrirao AB, Kung FH, **Omelchenko A**, Schloss RS, Boustany NN, Zahn JD, Yarmush ML, Firestein BL. Microfluidic platforms for the study of neuronal injury in vitro. Biotechnology and bioengineering. 2018 April;115(4):815-830. PMCID: PMC5831486.

Krzyszczyk P, Schloss R, Palmer A, Berthiaume F. The Role of Macrophages in Acute and Chronic Wound Healing and Interventions to Promote Pro-wound Healing Phenotypes. Frontiers in physiology. 2018 May 1;9:419. PMCID: PMC5938667.

Balter ML, Leipheimer JM, Chen AI, Shrirao A, Maguire TJ, Yarmush ML. Automated end-to-end blood testing at the point-of-care: Integration of robotic phlebotomy with downstream sample processing. Technology. 2018 June;6(2):59-66 PMCID: PMC6058193.

Svane KC, Asis EK, **Omelchenko A**, Kunnath AJ, Brzustowicz LM, Silverstein SM, Firestein BL. d-Serine administration affects nitric oxide synthase 1 adaptor protein and DISC1 expression in sex-specific manner. Molecular and cellular neurosciences. 2018 June; 89:20-32. PMCID: PMC5970076.

Wagner J, Kline CL, Zhou L, Campbell KS, MacFarlane AW, Olszanski AJ, Cai KQ, Hensley HH, Ross EA, Ralff MD, Zloza A, Chesson CB, **Newman JH**, Kaufman H, Bertino J, Stein M, El-Deiry WS. Dose intensification of TRAIL-inducing ONC201 inhibits metastasis and promotes intratumoral NK cell recruitment. The Journal of clinical investigation. 2018 June 1;128(6):2325-2338. PMCID: PMC5983321.

Patel MV, **Swiatkowski P**, Kwon M, Rodriguez AR, Campagno K, Firestein BL. A Novel Short Isoform of Cytosolic PSD-95 Interactor (Cypin) Regulates Neuronal Development. Molecular neurobiology. 2018 August;55(8):6269-6281. PMCID: PMC6028325.

Cheng LC, Li Z, Graeber TG, Graham NA, Drake JM. Phosphopeptide Enrichment Coupled with Label-free Quantitative Mass Spectrometry to Investigate the Phosphoproteome in Prostate Cancer. Journal of visualized experiments : JoVE. 2018 August 2;138 PMCID: PMC6126612.

Yang L, Chueng SD, Li Y, Patel M, **Rathnam C**, Dey G, Wang L, Cai L, Lee KB. A biodegradable hybrid inorganic nanoscaffold for advanced stem cell therapy. Nature communications. 2018 August 8;9(1):3147. PMCID: PMC6082841.

de Leeuw R, McNair C, Schiewer MJ, Neupane NP, Brand LJ, Augello MA, Li Z, **Cheng LC**, Yoshida A, Courtney SM, Hazard ES, Hardiman G, Hussain MH, Diehl JA, Drake JM, Kelly WK, Knudsen KE. MAPK Reliance via Acquired CDK4/6 Inhibitor Resistance in Cancer. Clinical cancer research : an official journal of the American Association for Cancer Research. 2018 September 1;24(17):4201-4214. PMCID: PMC6125187.

PAPERS PUBLISHED

Ghodbane SA, Brzezinski A, Patel JM**, Pfaff WH**, Marzano KN, Gatt CJ, Dunn MG Ph.D. Partial Meniscus Replacement with a Collagen-Hyaluronan Infused 3D Printed Polymeric Scaffold. Tissue engineering. Part A. 2018 October 23. PMCID in process

White CE, Kwok B, Olabisi RM. Activin A improves retinal pigment epithelial cell survival on stiff but not soft substrates. Journal of biomedical materials research. Part A. 2018 October 26. PubMed PMID: 30367547. PMCID in process

Swiatkowski P, Sewell E, Sweet ES, Dickson S, Swanson RA, McEwan SA, Cuccolo N, McDonnell ME, Patel MV, Varghese N, Morrison B, Reitz AB, Meaney DF, Firestein BL. Cypin: A novel target for traumatic brain injury. Neurobiology of disease. 2018 November; 119:13-25. PMCID: PMC6214165.

APPENDIX D: RUTGERS UNIVERSITY BIOTECHNOLOGY TRAINING PROGRAM
INDUSTRIAL ROTATIONS
SUMMER 2018

STUDENT	DEPT/ADVISOR	COMPANY	PROJECT
Josh Leipheimer	Martin Yarmush	MDI	Assembly design and build of a single-wire pattern braided aortic stent made from nitinol metal.
Jenna Newman	Andrew Zloza	Cellularity	Utilizing CRISPR/Cas9 to delete genes implicated in immune evasion in Chimeric Antigen Receptor (CAR) T cells
Larry Cheng	Bin Tian	Defined Health	- Indication Prioritization of Product X - Opportunity Assessment of Product Y - Competitive Landscape Assessment of Product Z
Victor Tan	Shengkan Jin	Celgene	Regulatory in Chemistry, Manufacturing, and Controls Department, emphasis on Biologics.
Liam Turk	Davide Comoletti	Aleon Pharma	Regulatory Affairs - Investigational New Drug Application (IND) for an Anti-Pd1 Monoclonal Antibody (mAb)
Jeffrey Luo	Ki-Bum Lee	Merck	Characterization of different luciferase species in functional cell-based assay”

RUTGERS
THE STATE UNIVERSITY OF NEW JERSEY

Biotechnology Training Program
Biomedical Engineering Building
Rutgers, The State University of New Jersey
599 Taylor Road
Piscataway, NJ 08854

Biomedical.rutgers.edu/biotech
Phone: 848-445-6530
Fax: 732-445-3155
Email: empresa@soe.rutgers.edu

STUDENT INTERNSHIP REPORT

Student Name: Josh Leipheimer

Department and Advisor: Biomedical Eng, Martin Yarmush

Corporation: Medical Device Imagineering (MDI)

Mentor: Jin Park and Dan Olsen

Project Title:
Assembly design and build of a single-wire pattern braided aortic stent made from nitinol metal.

General Objective of the Project:
My project was involved in the build-design and assembly of a custom-made aortic stent made exclusively from nitinol metal. Nitinol is a biocompatible, superelastic and shape memory alloy, making it ideal for medical stent applications requiring high elastic yield. My work consisted of creating the assembly instructions for manufacturing a single-wire braided aortic stent made from nitinol metal, rather than traditional stain-less steel. The final result of my project was a successfully assembled aortic nitinol stent for veterinary applications.

Student's Contribution to the Project:
My contribution to the project was involved with creating the initial assembly design instructions to successfully create a single-wire nitinol braided aortic stent. My other duties involved: Instron radial and tensile strength testing of medical stent implants, device calibrations, and quality control related tasks involved with maintaining equipment.

Techniques Learned:
- Mechanical testing of various aortic stents using Instron machine to meet FDA regulations and standards. (Radial and tensile testing in a temperature-controlled environment).
- Electropolishing techniques.
- Laser cutting equipment usage for stent manufacturing.
- CAD designing for 3D printing.
- Stent characterization using imaging techniques and mechanical testing.

Student Comments on the Company and Mentor:
The industrial experience I gained at MDI gave me a fresh perspective on how the medical device industry in stents operates and functions. I not only learned new technical skills such as Instron mechanical testing to meet FDA standards, but also professional skills involved with the management and business side of medical device development. Jin Park and Dan Olsen were fantastic mentors dedicated to exposing me to both the technical and business aspects of stent development.

Biotechnology Training Program
Biomedical Engineering Building
Rutgers, The State University of New Jersey
599 Taylor Road
Piscataway, NJ 08854

Biomedical.rutgers.edu/biotech
Phone: 848-445-6530
Fax: 732-445-3155
Email: empresa@soe.rutgers.edu

STUDENT INTERNSHIP REPORT

Student Name: Jenna Newman

Department and Advisor: Biochemistry and Molecular Biology, Andrew Zloza

Corporation: Celularity, Inc.

Mentor: Dr. James Li

Project Title:
Utilizing CRISPR/Cas9 to delete genes implicated in immune evasion in Chimeric Antigen Receptor (CAR) T cells

General Objective of the Project:
The Genetically Modified T Cell Group at Celularity, Inc. seeks to employ the latest cutting-edge gene-editing techniques to modify T cells to become enhanced mediators of tumor cell death.

Student's Contribution to the Project:
My objective this summer was to use CRISPR/Cas9 to delete genes in CAR-T cells that could be hindering anti-tumor directed cytoxicity mediated by CAR-T cells. I developed processes for successful knockdown of genes of interest in primary T cell lines, and tested functionality of these tumor-killing T cells by cytokine assays and co-culture cytotoxicity assays.

Techniques Learned:
CRISPR/Cas9, cytokine assays, cytotoxicity assay

Student Comments on the Company and Mentor:
Celularity is a great environment to work in; everyone is very collaborative and friendly, and its small size lends itself to these attributes very well. I learned a lot in group lab meetings—and company-wide gatherings—on a variety of different research topics, which was very enlightening. My mentor, Dr. James Li, provided me with a great set of tools to acclimate to the CAR-T cell field, and gave me advice and support through this process. He was also flexible with respect to the projects that I wished to work on—which was beneficial for my learning experience at Celularity. I had a great summer internship at Celularity and am very thankful for this experience!

Biotechnology Training Program
Biomedical Engineering Building
Rutgers, The State University of New Jersey
599 Taylor Road
Piscataway, NJ 08854

Biomedical.rutgers.edu/biotech
Phone: 848-445-6530
Fax: 732-445-3155
Email: empresa@soe.rutgers.edu

STUDENT INTERNSHIP REPORT

Student Name: Larry Cheng

Department and Advisor: Quantitative Biomedicine, Bin Tian

Corporation: Defined Health

Mentor: Serom Lee

Project Title:

1. Indication Prioritization of Product X
2. Opportunity Assessment of Product Y
3. Competitive Landscape Assessment of Product Z

General Objective of the Project:

1. Recommend to the client an indication for Product X to proceed into clinical development
2. Evaluate the opportunity of Product Y in an indication for the client
3. Survey the strengths and weaknesses of current and potential competition of Product Z for the client

Student's Contribution to the Project:

- Evaluating and extracting information from publicly available sources including scientific literature, company press releases, analyst reports, and patents
- Participated in interviews with key opinion leaders
- Coalescing information into PowerPoint slides that will be presented to the client

Techniques Learned:

- Crafting effective PowerPoint presentation slides
- Searching and interpreting patent documents
- Exposure to conducting interviews with KOLs
- Construct a target product profile for a biopharmaceutical

Student Comments on the Company and Mentor:

- The mentor and the entire company fostered an excellent environment to learn about the consulting world, especially with a life science PhD background.
- Would recommend to future fellows to complete the Innovation & Entrepreneurship class as well as the Bioengineering in the Biotechnology and Pharmaceutical Industries course before participating in this internship.

Biotechnology Training Program
Biomedical Engineering Building
Rutgers, The State University of New Jersey
599 Taylor Road
Piscataway, NJ 08854

Biomedical.rutgers.edu/biotech
Phone: 848-445-6530
Fax: 732-445-3155
Email: empresa@soe.rutgers.edu

STUDENT INTERNSHIP REPORT

Student Name: Victor Tan

Department and Advisor: Pharmacology, Shengkan Jin

Corporation: Celgene

Mentor: Agnes Yeboah, Renea Faulknor

Project Title:
Regulatory in Chemistry, Manufacturing, and Controls Department, emphasis on Biologics.

General Objective of the Project:
Celgene has several products in the pipeline which require regulatory approval from government agencies before commercialization can happen. The project involves learning about the necessary regulation on biologics specifically and how to author the specific documents with regards to the quality of the product. Proper filing of regulatory paperwork results in approval of drug use in patients.

Student's Contribution to the Project:
Supported authoring of necessary dossiers for regulatory filing for commercialization of biologic products.

Techniques Learned:
Authoring BLA, IND, IMPD, NDA dossiers for regulatory filing.

Student Comments on the Company and Mentor:
While the company is considered large by regular standards, there are still many areas that need improvement. There will be growing pains when learning certain things in the pharmaceutical industry, especially so given the advent of biologics as drugs. I've certainly learned a great deal from my mentor on how to approach each problem in a flexible manner. It is important to remember that ultimately, the product is meant for the patients

Biotechnology Training Program
Biomedical Engineering Building
Rutgers, The State University of New Jersey
599 Taylor Road
Piscataway, NJ 08854

Biomedical.rutgers.edu/biotech
Phone: 848-445-6530
Fax: 732-445-3155
Email: empresa@soe.rutgers.edu

STUDENT INTERNSHIP REPORT

Student Name: Liam Turk

Department and Advisor: –Biochemistry/Neuroscience & Cell Biology, Davide Comoletti

Corporation: Aleon Pharma International Inc.

Mentor: Jiajun Mei, PhD and Shirley Ruan

Project Title:
Regulatory Affairs - Investigational New Drug Application (IND) for an Anti-Pd1 Monoclonal Antibody (mAb)

General Objective of the Project:
To compile, produce and submit and IND to aid a client in the FDA approval process for an anti-PD1 mAb for use in specific cancers.

Student's Contribution to the Project:
Reviewing documents (such as experimental procedures and data regarding the mAb), creating reports, and delivering presentations on the scientific theory with respect to protein/mAb purification and production.

Techniques Learned:
-Preparing an IND
-Reviewing preclinical data and applying it in the proper context of an IND
-Developing a familiarity with the various modules within new drug applications
-Scientific writing skills to clearly convey the results in experimental data
-Analytical skills in identifying important experimental data points to include in experimental summary sections of an IND.

Student Comments on the Company and Mentor:
The mentors and the company both provided a comfortable and amiable environment to work efficiently. Both Jiajun and Shirley were knowledgeable and approachable when help was needed, as I was completely inexperienced within the field of regulatory affairs prior to the internship. I think it would have been more helpful if there was a more structured training period during which the intern could become more familiar with the work and process of FDA drug approval, however I don't know if it is possible given the small size of the company. The small size did provide a "family feel" to the work environment and everyone got along well with each other. The CEO, Andrew Jiang, too was very approachable and mindful when it comes to the experiences of the interns. Interns, of which there were three during my time there, were expected to give biweekly presentations as a means of staying on track with work and also provided important practice and feedback in regard to work-related presentations.

Biotechnology Training Program
Biomedical Engineering Building
Rutgers, The State University of New Jersey
599 Taylor Road
Piscataway, NJ 08854

Biomedical.rutgers.edu/biotech
Phone: 848-445-6530
Fax: 732-445-3155
Email: empresa@soe.rutges.edu

STUDENT INTERNSHIP REPORT

Student Name: Jeffrey Luo

Department and Advisor: Chemistry and Chemical Biology, Ki-Bum Lee

Corporation: Merck

Mentor: Dr. Junming Yie

Project Title:
"Characterization of different luciferase species in functional cell-based assay"

General Objective of the Project:
The objective is to characterize the response of various luciferase variants for cell-based biological potency assays.

Student's Contribution to the Project:
Important contributions include execution of transfection and cell assays, analysis of dose-response curves for model biological drugs, optimization of assay conditions, and issuing recommendations for future assay development efforts.

Techniques Learned:
Notable techniques learned include non-viral transfection, general luciferase expression assays, and data acquisition and documentation in-line with Good Laboratory Practices

Student Comments on the Company and Mentor:
The inclusion of an internship mentor (specializing in navigating industrial workplace) in addition to a project mentor (expert in the particular research field) is a very good idea. Aforementioned mentor is a project mentor who was quite understanding of the limitations of the internship and pleasant to work with.

RUTGERS

Fall 2017

16:125:603 Topics in Advanced Biotechnology I

Fridays, 9:00-11:00, BME Room 122

DATE	TOPIC	SPEAKER*	Trainee Presenter**	Trainee Presenter**
September 8	**Introduction**	Martin Yarmush	Chris Rathnam	Madison Godesky
September 15	**Fellowships/Proposal**	Francois Berthiaume Pauline Krzyszczyk	Anton Omelchenko	Yoliem S. Miranda Alarcon
September 29	**Science Policy**	Ann Stock	Larry Cheng	_____
October 20	**Industry Perspective** **Celgene**	Agnes Yeboah	Zachary Fritz	Sonia Yevick
November 3	**Industry Perspective** **Troy Corporation**	Jake Jacobs	Victor Tan	Josh Leipheimer
November 17	**Ethics**	Eric Singer	Liam Turk	Jeff Luo
December 1	**Government Agency Prospective** **FDA**	Andrea Gray	Isabel Perez	Mollie Davis

* Faculty presentations are limited to 30 minutes

**Trainee Presentations are limited to 10 slides and no more than 15 minutes to allow for discussion

RUTGERS

16:125:604 Topics in Advanced Biotechnology
Spring 2018
Fridays, 9:00-11:00, BME Room 122

TOPIC	DATE	FACULTY MEMBER	STUDENT COORDINATOR	PRESENTERS	DISCUSSANTS
Dieting and the Microbiome	Jan 19	Martin Yarmush	Ileana Marrero Berrios	Madison Godesky Josh Leipheimer	Jeremy Anderson
Auto Antibodies in Cancer	Feb 2	Lawrence Williams	Antoinette Nelson	Zachary Fritz Mollie Davis	Sal Ghodbane
Reactive Oxygen Species in Chronic Wounds	Feb 16	Francois Berthiaume	Paulina Krzyszczyk	Isabelle Perez Yoliem Miranda Alaracon	William Pfaff
Phosphoproteomics	Mar 2	Justin Drake	Ilijia Melentijevic	Larry Cheng Victor Tan	Jenna Newman
Strategies for Identification of Novel Extracellular Protein Interactions	Mar 30	Davide Comoletti	Ryan Guasp	Liam Turk Jeffrey Luo	Eve Reilly
Nano Material Self Assembly	April 13	Adam Gormley	Daniel Browe	Emily DiMartini Misaal Patel	Chris Lowe
Traumatic Brain Injury	April 27	Bonnie Firestein	Alison Acevedo	Anton Omelchenko Chris Rathnam	Evelyn Okeke

- Faculty members prepare **a 30-minute presentation** to introduce both the overall topic and the papers to be discussed.
- Student coordinators should contact the assigned faculty advisor in order to identify two papers, **at least 3 weeks** prior to the session.
- Papers are sent to the presenters, first meeting is called to thoroughly review the papers (with the coordinator and presenters).
- The group then meets with the faculty member to review draft slides and to answer any remaining questions.
- Each student prepares a 15 minute ppt presentation of their respective paper, and then meets with the coordinator to review the presentation. Attention should be given to both content and delivery.
- A final “dress rehearsal” is conducted with the entire group present (with the faculty member).
- The discussants read the papers, attend the dress rehearsal, and outline discussion points on each paper for the session according to prescribed guidelines.

RUTGERS
THE STATE UNIVERSITY OF NEW JERSEY

Center for Innovative Ventures of Emerging Technologies
School of Engineering
599 Taylor Road
Piscataway, NJ 08854
www.rutgers.edu
engels@rci.rutgers.edu
848-445-6572

Innovations and Entrepreneurship

Date	Week	Session Objective
1/25/2017	1	**Introduction:** Familiarize the student with course logistics, technology entrepreneurship and the nature of innovation. • Course overview • Entrepreneurship defined • Emerging technologies • Profile of an entrepreneur • Entrepreneurial types/teams • Entrepreneurial risks • Staged entrepreneurial process
1/25/2017	2	**Analyze the Opportunity:** Innovate and Create the Vision • Observation, problem and need identification • Needs filtering • Ideation and brainstorming • Concept screening • Importance of documentation • Review of venture project technologies and team assignments
2/1/2017	3	**Analyze the Market:** Analyze the Market and Build a Plan, Prepare Industrial Analysis • Innovation types and frameworks • Initial innovation assessment • Market analysis and planning • Market segmentation
2/8/2017	4	**Analyze Competitive Position, Market Forces** • Competitive analysis • Porter's 5 market forces
2/15/2017	5	**Profile the Product/Service** • Profile essentials: product, pricing, place, promotion • Create a brand
2/22/2017	6	**Communicate the Opportunity:** Build "The Pitch" • Communication guidelines • Pitch elements • Pitch delivery
3/1/2017	7	**Implement, Scale & Harvest the Venture:** Setting Up the Company, Team Management, Venture Exit • Business model development • Business planning outline • Setting up a company • Managing the team • Operational agreements • Exiting the venture
3/8/2017	8	**Protect the Innovation:** Determine best protection method, File necessary documentation • IP protection overview • Patents defined • Trade secrets defined • Copyrights defined • Trademarks defined

RUTGERS
THE STATE UNIVERSITY OF NEW JERSEY

Center for Innovative Ventures of Emerging Technologies
School of Engineering
599 Taylor Road
Piscataway, NJ 08854
www.rutgers.edu
engels@rci.rutgers.edu
848-445-6572

Date	Week	Session Objective
		• Strategic alliances and licensing agreements G: Kettle, UG: Zimmerman
3/15/2017	SPRING BREAK	
3/22/2017	9	**Acquire Financial Resources:** Secure Early Stage and Growth Funding • Valuation overview • Funding sources: equity and non-equity sources • Angel, Venture Capital funding • Funding series **Guest Lecturer: Larry Horowitz, Doremus Advisory Services**
3/29/2017	10	**Material Review**
4/5/2017	11	**Draft Pitch Presentations**
4/12/2017	12	**Guest Speakers: The Entrepreneurial Experience.** Tim Maguire: VascuLogic; the commercialization journey
4/19/2017	13	**Final Pitch Presentations**
4/26/2017	14	**Course Review**

BIOENGINEERING IN THE BIOTECHNOLOGY AND PHARMACEUTICAL INDUSTRIES: FUNDAMENTAL AND REAL WORLD PERSPECTIVES

Course Number: 16:155:532 (CBE) **Index Number: 73148 (CBE)**
16:125:575 (BME) **70267 (BME)**

Course Time: Wednesday, 5 – 8 PM

Description and Objectives:
The goal of this course is to offer students insight into the practical aspects of industrial bioprocessing. Industrial practitioners from various fields of expertise provide lectures and facilitate discussions highlighting problems and issues that engineers and scientists encounter. Topics will vary from year to year but will typically include: drug discovery, drug metabolism, microbial fermentation and mammalian cell culture (optimization and scale-up), monoclonal antibody and vaccine production, gene therapy, downstream purification, formulation, regenerative medicine, stem cell culture, tissue engineering, cellular therapies, regulatory considerations, manufacturing challenges, and clinical research. This course provides students with exposure to topics which are beyond the scope of a purely theoretically-structured course. After taking this course, students should have a better understanding of the challenges that engineers and scientists face in industrial bioprocessing.

Course Directors: Kristen Labazzo, PhD, Tim Maguire, PhD, and Martin Yarmush MD, PhD

Grading: **25%** Class Participation
30% Homework Assignments
35% Research Paper
10% Short Presentation

Class Preparation: Reading material for each session can be found on the course website:

- Course NOT recommended if you expect to miss > 1 class
- You must notify Dr. Labazzo in advance if you will miss a session, and you must submit answers to questions on that session's reading assignment

Topics and Speakers, Spring 2016:

20-Jan: (A) Introduction to Course Objectives
(B) Science-Driven Business: Examples in the Pharma Industry
Tim Maguire and Kristen Labazzo, Rutgers University

27-Jan: Discovery and Careers in Biotechnology: A Case Study- *Kambiz Shekdar*, Rockefeller University

03-Feb: Extracting the Full Potential of Single Use for Biologics and Vaccines - *David Pollard*, Merck

10-Feb: Preparative Chromatography for the Purification of Therapeutic Proteins - *Antonio Ubiera*, GlaxoSmithKline

17-Feb:	Working the Science: Overcoming Issues in Biopharmaceutical Drug Product Development – *Charlene Brisbane, George Crotts*, GlaxoSmithKline
24-Feb:	The Future of Medical Innovation: A History-*Bob Goldberg,*Center for Medicine in the Public Interest (CMPI)
02-Mar:	Intellectual Property: Lifeblood of the Industry-*Rick Girards*, Registered Patent Attorney
09-Mar:	Mammalian Cell Culture Scale-Up for Monoclonal Antibody Production - *Gregory Russotti*, Celgene Cellular Therapeutics
16-Mar:	SPRING BREAK
23-Mar:	Live Virus Vaccine Production - *Gregory Russotti*, Celgene Cellular Therapeutics
30-Mar:	DNA Vaccines Product Development and New Approaches to Cancer Immunotherapy - *Niranjan Sardesai*, Inovio
06-Apr:	The Hurdles and Benefits of In vivo Relevance in Regenerative and Drug Screening Platforms - *Carlos Caicedo*, Orthobond
13-Apr:	"That Can't be Right!" - Real Data in Cell Therapy Development-*Brian Murphy*, Celgene Cellular Therapeutics
20-Apr:	Development of Cell Based Therapies - *Michael Daley*, Cognate Consultants
27-Apr:	OPEN

Homework:

- Questions will be posed by the speakers related to articles selected as an intro to the class topic.
- Answers should be submitted in essay format (1-2 double spaced pages).
- Due at the beginning of class in hard copy form or submitted to the Sakai website

Presentation:

Each student will have the opportunity to more thoroughly understand a particular course topic through the review of contemporary literature and presentation of a particular article of interest. The individual presentation is intended to expose students to a greater quantity of literature and gain a better understanding how areas of focus are evolving. We encourage you to show preference to topics of interest but recognize that presentations will need to be equally distributed across the class.

Term Paper:

Due date: **Wednesday, 27-Apr** (Please submit electronic copies by 5pm on that date)

Students are required to submit an abstract and outline on **Wednesday, 9-Mar**. The abstract and outline will be worth 5 points of the total term paper grade. Comments will be returned so both can be updated for the final paper.

Interdisciplinary Biostatistics Research Training

Week	Topic	Reading
1	**Overview and Descriptive Statistics.** Type of data, graphic presentation, central tendency and dispersion, introduction to R, introduction to GraphPad Prism.	1 Ch. 1,2
2	**The Peanut Lab I.** Students will generate data of peanut length and weight to demonstrate variability within and between groups. They will use GraphPad Prism to present their data.	
3	**Probability and Distributions.** Probability, conditional probability, binomial and normal distribution.	1 Ch. 3,4
4	**Estimation.** Sampling distribution, confidence interval (population means and proportions), sample size estimation based on proportions.	1 Ch. 5,6
5	**Hypothesis Testing**. Type I and type II error, steps of performing hypothesis testing (hypothesis testing on population means, hypothesis testing on population proportions, *z* and *t*-statistics), power and sample size estimation.	1 Ch. 7
6	**The Shell Lab.** Students will be asked to measure the length and width of cold and warm water seashells and determine if there is statistical difference between the two groups.	
7	**Analysis of Variance.** Comparisons between and among means, multiple comparisons.	1 Ch. 8
8	**Correlation and Regression.** Correlation and simple linear regression.	1 Ch. 9
9	**Multiple Linear Regression and Logistic Regression.** Multiple linear regression, model building and diagnosis, logistic regression.	1 Ch. 10,11
10	**Analyze my Data Lab.** Students will analyze data that they have generated using R and GraphPad Prism to analyze and graphically display the results.	
11	**Nonparametric Statistics.** Sign test, Wilcoxon sign rank test, Wilcoxon rank sum test, Kruskal-Wallis test.	1 Ch. 13
12	**Survival Analysis**. Kaplan-Meier procedure, Log-rank test, Cox proportional hazard model.	1 Ch. 12
13	**Biostatistics in the Genomic Age.** Microarray data analysis.	
14	**Reading the Scientific Literature.** Use of statistical analysis in the scientific literature, misuse of statistical analysis in the scientific literature.	Handouts
15	**Student Presentations.** Students will present preliminary statistical design and data analysis plan for their thesis projects.	

RUTGERS
Center for Innovative Ventures of Emerging Technologies

Center for Innovative Ventures of Emerging Technologies
Rutgers NIH Biotechnology Training Program
School of Engineering
599 Taylor Road
Piscataway, NJ 08854
www.rutgers.edu
engels@soe.rutgers.edu
848-445-6572

Professional Preparedness in Biotechnology

16:125:579:01
(3 credit)

Course Background/Overview

Although current courses in the typical graduate curriculum appropriately deliver strategic discipline-based learning for life science and engineering graduate students, the broader biotech and health science industry further demands that scientists be prepared to serve a variety of distinct functions within the life and biomedical sciences ecosystem, and to understand broader developmental aspects of the business of science and engineering in a professional environment. Many scientific professionals, while experts in their respective fields, have little academic/professional background in business management; skills that ensure that scientific projects and research are implementable, feasible and sustainable. In addition, these skills work to expand scientists' and researchers' professional reach and help them to realize their true career potential. This course entitled, "Professional Preparedness in Biotechnology" will enhance students' competitive skills and introduce additional layers of specialized competence enabling immediate contribution within diverse organizations in the life and biomedical sciences commercial sector. Students will develop business, communication, management, (and other), skills.

This course will be offered during the first 2019 Summer Session (May 28, 2019 through July 5, 2019), over a 6-week period, on Tuesdays and Thursdays for sessions of 4 hours each with direct student contact. Each session will be comprised of lecture, followed by lab in which students will have hands-on experience with the concepts introduced, as they review and analyze case studies specific to various professional environments and challenges. They will then present recommendations to the class to seed group discussions and further role-play.

Textbooks: *Various, (licensed) copies of relevant sections scanned for student use.*

Instructional Methods: This course will utilize various learning modes to ensure that students are engaged and successfully integrate the concepts learned with their professional area(s) of focus. Course concepts will be emphasized in (at least) three different ways:

1. The lecture portion of the course introduces appropriate concepts in an interactive, engaging format. Basic tenets are presented and students are asked to apply the concepts to their personal experiences and to highlight the differences in application in academic and corporate environments.
2. During the lab portion, students are introduced to a case study profiling genuine situations in which the key concepts learned are prominently cast. The case studies, gleaned from current business situations and made anonymous to minimize bias, describe business situations that require decisions and/or action plans relative to topics such as accounting, marketing, finance, quality control, operations research, research and development (in an industry setting), project management and others. Students are grouped into teams and each is assigned one of the "characters" introduced in the case study. Through group discussion and role-play, allowing team members to consider multiple solutions, the team crafts a strategic action plan. During this lab portion, the instructor facilitates, rather than directs, student interaction and mastery of the concepts highlighted and students are required to present their results during the remaining 30 minutes of the class.
3. A final project will require that students work individually to present a case study focused within their area of professional interest and analyze the actions and inactions relative to the concepts taught in class.
4. In addition to work within formal class time, online forums/blogs, will be available as a venue for students to participate in discussions with class instructors, share their opinions and experiences, and debate with professors and fellow students. The forums will be open for 7 days, with (one of the) professors opening the

discussion with a topic or question about which participants will share their thoughts and answers, providing the students opportunity for reflection, personal connection with the material and understanding of how the concepts learned can be applied to other, varied circumstances. Available 24 hours a day, the format will allow each student to make his/her discussion contributions at a time of his/her convenience.

Using this multi-pronged approach, students will learn to think outside the "researcher's box" and understand how business functions; an indispensable skill for all scientists that wish to navigate the boundaries between research and industry.

Course Assignments and Grading: Student performance will be evaluated through participation class discussions, in group projects, presentations of their case study analyses and participation in forums/blogs.

Instructors: As the course is comprised of sessions focused upon unique individual aspects of professional preparedness, several instructors will be involved in its delivery. To address certain business or legal-intensive topics, senior faculty member instructors will be recruited from the Rutgers Business School, Rutgers Law School, and others to ensure that the required expertise is represented. Where no expertise is resident within the Rutgers schools, outside instructors (with affiliation/history with the Rutgers), will be recruited to teach specific sessions.

Course Objectives

1. Promote an understanding of key technology professional skills and effectiveness of delivery for same
2. Equip students with skills and knowledge for post-graduation professional placements
3. Improve qualifications of students in preparation for employment within the field of biotechnology

Course Outline

The course provides the students with the following knowledge and perspective:

- **Course Overview:** curriculum review, case-based analyses to identify professional success factors
- **Life and Biomedical Sciences Ecosystem:** overview of the life and biomedical sciences marketplace, review of industry strategies, analysis of the economic environment
- **Managing Communications:** individual skills assessment, team dynamics, decision-making, responsibility, interpersonal skills, presentation/pitching, communication vehicles
- **Project Planning and Management:** phased development process, quality gates, project management
- **Customer Focus:** customer requirements, profiles of economic stakeholders, decision-makers, payers, marketing, sales
- **Financial Management:** cash flow, investment evaluation, risk & return, financial statements
- **Operations Management:** business logistics, demand planning, global sourcing
- **Risk Management, Quality and Safety:** risk analysis**,** good manufacturing practices (GMP), good lab practices (GLB), quality control, quality assurance
- **Regulatory Processes:** market clearance pathways for drugs, biologics, medical devices and combination products (laws, regulations, and regulatory agencies)
- **Organizations and Partnerships:** internal and external partnerships, negotiating corporate silos
- **Ethics in Biotechnology:** TBD
- **Student Presentations.** Students will submit, and present, case study analyses relevant to their current area of professional interest and highlighting lessons learned throughout the course.

Center for Innovative Ventures of Emerging Technologies
Rutgers NIH Biotechnology Training Program
School of Engineering
599 Taylor Road
Piscataway, NJ 08854
www.rutgers.edu
engels@soe.rutgers.edu
848-445-6572

Note that these topics are not assigned to specific classes as some may require more than one session to complete; therefore, the exact sequence remains fluid. Within coverage of these topics areas, we build upon the following critical skills for professional success:

- Strategic thinking
- Art of selling, persuasion and motivation
- Oral and written communications

The course consists of lecture with extensive participation between students and the instructor. Concepts are inter-mingled with practical applications whereby students are challenged to apply an academic concept to real-world professional context.

Assignments
Students will be assigned to teams to work on case analyses provided by the instructor, with review of articles and role-play scattered throughout the individual classes. Throughout the course, readings are assigned and relevant discussions held during subsequent classes. For some of these reading assignments, written responses to questions will be required.

Prerequisites
Graduate student populations who seek to learn skills recommended for success within the biotechnology professional organizations.

Textbook(s)
There are no textbooks required for this course. Readings are provided throughout the sessions.

Grading Criteria

• Overall Class Attendance, Contribution and Discussion	25%
• Session-Focused Case Study/Participation	20%
• Contribution to Blog	15%
• Final Case Study/Presentation	25%
• Final Essay	15%

Note that class attendance is mandatory. Each student is allowed one unexcused absence and, in the event that he/she is absent two or more times, he/she will forfeit 10% of the grade allocated for class contribution/participation (equal to one letter grade). Students are expected to come to class having read the assigned material, completed the assignment, and well prepared to engage in dialogue regarding the assigned material. All reading and other preparatory assignments must be completed by their due date(s).

RUTGERS
Center for Innovative Ventures of Emerging Technologies

Center for Innovative Ventures of Emerging Technologies
Rutgers NIH Biotechnology Training Program
School of Engineering
599 Taylor Road
Piscataway, NJ 08854
www.rutgers.edu
engels@soe.rutgers.edu
848-445-6572

Proposed Syllabus:

Session	Session Title	Session Objectives	Session Contents	Case Focus	Lecturer
1	Course Overview Life and Biomedical Sciences Ecosystem	Communicate a general understanding of the landscape for the life science industry and how it has evolved, with a focus on Biotechnology and BioPharma companies.	Relevant to the Life and Biomedical Sciences Industry: • Overview of evolving trends that shape the landscape • US Structure and the Economic environment (basics of reimbursement) • Government intervention and Policy • Highlights of global differences • Strategic Role of the Biomedical Organization	TBD	Gary Branning
2	Managing Oneself: Communications and Accountability	Work with students to hone their communication skills by learning how to read organizational culture(s), direct people to the same goals, build confidence and communication skills and accept responsibility for their actions. The session will address emotional Intelligence, decision-making (critical thinking), presentation skills, accountability and performance coaching.	Communication Styles: • Strengths/weakness of each style • When to use/not to use each style • How analytics can work with the driver style Presentation Skills: • How to start off your presentation with a story • Structuring your presentation • Effective delivery: eyes, voice, stance, gestures	TBD, but to include: • Styles assessment • Demonstration/skills practice	Stan Elison/CPE
3	Biotechnology: Customer Perspectives: The Commercialization Process	Innovations from the laboratory go through several stages before, during, and after commercialization. For each phase of product commercialization, understand stakeholder and target customer values and	• Stages of development and commercialization • Customer-focused requirements at each stage • Role of economic stakeholders and decision makers	• Selling Ideas	Josh Simon

Session	Session Title	Session Objectives	Session Contents	Case Focus	Lecturer
		requirements. Students will understand the relevance and application of ascertaining and integrating the customer's perspective and influencing decision-makers and economic stakeholders at each stage of development and commercialization. For each stage, students will be introduced to basic marketing and sales concepts with examples that draw from situations in the life sciences industry. These are used as a basis for developing, pricing, promoting and distributing products and services that satisfy customer needs.	• Marketing and sales through development and commercialization stages • Tailoring approach to customer and stakeholder at each stage: • Selling ideas, projects, and products to personalities, not automatons.		
4	Successful Projects: Planning and Management	Provide a solid framework for managing projects addressing the project life cycle and associated communication requirements, ensuring accountability for assigned tasks, setting expectations in a team environment and managing project kick-off and close-out. *If time allows, provide students with an overview of the key analyses, processes and decisions companies use to optimize their*	• Project Management Concepts • Project definition (scope management) planning and cost / resource estimation • Project Kick-off • Phased Development Process (Project & Quality Management System) • Quality Gates • Project management methodologies in a regulated environment • Project Teams • Stakeholders & Requirements • Budgeting and financial analyses • Project Close-out	• Draft project plan for fictitious product: • Timeline • Budget considerations • Resource considerations • Project & Quality phase gate /milestones such as concept, feasibility, design, V&V/regulatory submissions, market	Claudia Campbell

Session	Session Title	Session Objectives	Session Contents	Case Focus	Lecturer
		portfolio of product development projects.	• Communications • Drafting a project plan • Handling poor performance (during a project) • Project life cycle vs. product life cycle • Risk management - projects and their products	release; possible tie to funding milestones, etc.	
5	Economic Value: Financial Accounting	Promotes an understanding of the financial markets and the tools and techniques needed to properly analyze biotechnology and healthcare stocks. The objective of the course is for students to gain fundamental knowledge of the financial markets and to learn the skills necessary to conduct a thorough analysis of healthcare projects and stocks. Upon completion of this session, students will learn how to value projects and securities, analyze financial statements, and learn how to rigorously create portfolios of projects or investments. As a capstone exercise, students with work in a group on a case study designed to demonstrate their financial and strategic management skills.	• Overview of Financial Markets • Project Evaluation • Financial Statement Analysis • Strategic Analysis • Portfolio Management • Asset Pricing (Risk / Return Analysis) • Risk Management	Case study related to healthcare stocks with both financial and strategic decision-making required.	John Longo
6	Efficient Operations: Process Management	Demonstrate how the careful design and implementation of operational processes ensures the	• Introduction, history and evolution of Quality Management (Pre-Read)	Process redesign and analysis	Gurpreet Singh

School of Engineering
599 Taylor Road
Piscataway, NJ 08854
www.rutgers.edu
engels@soe.rutgers.edu
848-445-6572

Session	Session Title	Session Objectives	Session Contents	Case Focus	Lecturer
		optimal use of inputs and the effective production of goods and services. Foster an understanding of the link between efficient business operations and process (improvement) and briefly review applicable process improvement methodologies (such as Six Sigma, Lean Management, Total Quality Management).	• Introduction to Lean and Six Sigma process improvement standards • Strategic value of quality and cost of poor quality • Introduction to process management and process mapping with various as - Is and to-be process mapping examples various shapes. • *Process mapping* • *Process redesign methodolog(ies)* • *Discussion of process focus/design in business logistics, demand planning and global sourcing* • *Customer report cards, benchmarks, and best practices*		
7	Risk Analysis: Risk Management, Quality and Safety	Following an analysis of biotechnology product/service development risk, students will be introduced to quality analysis and assurance/control practices, inclusive of Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP).	• Risk analysis • Quality analysis and control • Good manufacturing practices (gmp) • Good lab practices (glb)	• Risk analysis of biotechnology product development project and/or • Risk analysis of biotechnology product manufacturing project	Rosemarie Logan
8	Teamwork: Organizations and Partnerships	Students to understand the landscape and associated value of internal and external partnerships and how to successfully negotiate corporate silos.	Accountability: • Why accountability? • Using feedback and coaching to achieve accountability. Teambuilding: • Why teamwork?	TBD, but to include: • Organizational conflict and/or • Organizational politics	Stan Elison/CPE

School of Engineering
599 Taylor Road
Piscataway, NJ 08854
www.rutgers.edu
engels@soe.rutgers.edu
848-445-6572

Session	Session Title	Session Objectives	Session Contents	Case Focus	Lecturer
			• Team dynamics • Working collaboratively. Managing Conflict: • What's your primary style? • Strengths and weaknesses • Techniques for managing conflict		
9	Regulatory Approval: FDA Process and Pathways	Students will be introduced to the regulations that guide the manufacture of FDA-approved biopharmaceutical and biotechnology products, addressing classification and pathways for various product types.	• Market clearance • Pathways for drugs biologics, medical devices and combination products	• Design of regulatory pathway for biotechnology product	Rosemarie Logan
10	Ethics and Discussion about movie "12 Angry Men"	Understand team dynamics under circumstances that involve ethics and decision making thereof.	View movie entitled, "12 Angry Men"	N/A. Essay required reviewing dynamics highlighted in the movie and relationship to class learnings.	Engelhardt
11	Student Presentations	Students to submit and present case study analyses relevant to their current area(s) of professional interest, highlighting lessons learned throughout the course.			Engelhardt and Panel

Center for Innovative Ventures of Emerging Technologies
Rutgers NIH Biotechnology Training Program
School of Engineering
599 Taylor Road
Piscataway, NJ 08854
www.rutgers.edu
engels@soe.rutgers.edu
848-445-6572

Guest Lecturer Profiles:

- **Gary Branning:** Mr. Gary Branning is President of Managed Market Resources (MMR), a healthcare consulting and medical communications company, offering the pharmaceutical and biotechnology industry innovative solutions for the complex healthcare market, responsible for strategic consulting, new product development, business development, and executing Managed Market Resources strategic plan. Previously, Mr. Branning was Executive Director of Managed Marks Marketing for Pharmacia Corporation. Before working with Pharmacia, he worked with Quintiles Informatics as senior vice president of the Pharmaceutical Strategic Business Unit. Most of his experiences come from 17 years' working in several areas within Parke-Davis: managed care, marketing, sales, business development, and finance. Mr. Branning is recognized throughout the pharmaceutical industry for his innovative approaches to creating leading-edge programs and services with a primary focus on customer impact and corporate profitability. Mr. Branning is an adjunct professor at Rutgers Graduate School of Business and Guest Lecturer at Blench and Irwin Learner Center for Pharmaceutical Management Studies. Mr. Branning received his Bachelor of Science degree in business administration from Wagner Collect, and an MBA in finance from Fairleigh Dickinson University. Expertise**:** Pricing, Healthcare Strategy, Pharmacoeconomics, Institutional Dynamics, Healthcare Policy. Teaches Rutgers' Mini-MBA™: Strategic Healthcare Management for Practices, Online Mini-MBA™, BioPharma Innovation

- **Claudia Campbell:** Claudia Campbell-Matland's 30-plus year career in the *in vitro* diagnostics (IVD) industry has included senior positions in Research & Development and Business Development, and certifications as a Project Management Professional (PMP®) and Quality System internal auditor. Skill sets demonstrated in these roles have included teaching and training content areas including: project management; technical/scientific (diagnostics, hemostasis, infectious disease, among others); quality management systems aspects; and sales and customer IVD product use and technical support. Her project management experience has included managing a variety of business-critical programs such as new product development programs from conception to commercialization, product acquisitions, functional department integrations and remediation of Quality System/Regulatory audit deficiencies. Now working as an independent consultant, she is leveraging her expertise to assist start-up and small medical device/IVD companies with project management, training and compliance services for new product development and other programs, and also assist universities with their technology commercialization efforts. Campbell received her M.S. in Microbiology at Rutgers University Graduate School / University of Medicine & Dentistry Graduate School of Biomedical Sciences, where she was a teaching assistant in Physiology.

- **Stan Elison:** For more than 25 years, Stan has designed and delivered a wide variety of management, soft skills, customer service, sales, and technical training programs in a number of different industries such as healthcare, pharmaceuticals, manufacturing, and financial services. He prides himself on designing and delivering extremely creative and interactive training programs which are focused on producing business results. Working as an Adjunct Instructor for Rutgers University Office of Continuing Professional Education, Stan designed and delivered a communications program for a major health insurance company comprised of Presenting with Pizazz, Communicating with Clarity, and Leadership Presence. In addition, he has developed and conducted a wide repertoire of workshops such as Feedback and Coaching, Communication Teambuilding, Managing Conflict, Time Management, Business Development and Cross-Selling. In his role as an independent training consultant, Stan designed and delivers training for New York Presbyterian Hospital where programs were focused on improving patient satisfaction and patient safety. He is certified in: Performance Consulting, Langevin Learning, Executive Presentation Skills, Communispond and Facilitation Skills, Development Dimensions International (DDI) and holds a Master's Degree in Vocational Counseling from New York University with extensive short-term

behavioral counseling experience. He has a B.A. in Economics from Brooklyn College and has taken graduate courses in Economics as well.

- **Rosemarie Logan:** Rosemarie is currently a Regulatory Science Consultant. She recently taught lectures for both the Rutgers School of Engineering and the Rutgers Medical School. The School of Engineering lecture was on Design Control as it relates to medical device development. The lecture for UMDNJ provided an overview of the regulatory pathways that a drug, device or biologic might take on its path to FDA approval. Rosemarie has worked with a variety of Pharmaceutical and Medical Device companies to help them with Technical Writing for Regulatory Submissions, raw material qualifications, Quality Systems compliance audits, remediation assistance, and providing support for regulatory submissions. Prior to being a consultant, Rosemarie spent 15 Years at Celgene Cellular Therapeutics in a variety of roles such as Director of Validation, Director of Developmental Quality (R&D Quality), and Director of Quality Operations. She contributed and reviewed the Chemistry, Manufacturing and Controls (CMC) section of the cell therapy regulatory submissions, the medical device submissions (510k, IDE) and the Human Cell and Tissue Product regulatory submissions. She had oversight of all Shelf-Life Studies, Validations (Process, Analytical, Equipment, and Facilities), Package Inserts, Safety Data Sheets, Standard Operating Procedures, & Raw Material Monographs. She would design and maintain the cell therapy products adventitious agents programs and would coordinate and perform any training activities needed for the QA and QC teams. She also trained laboratory staff in Manufacturing Operations and Technical Development. Prior to joining Celgene Rosemarie spent 3 years as a Scientist at Instrumentation Laboratory, an In-Vitro Medical Device company, in charge of the design and execution of all Validations, Shelf-life studies and the qualification of Critical Raw Materials. Prior to her time at Instrumentation Laboratory, she spent 5 years at Ortho Clinical Diagnostics, a Johnson & Johnson Company. While at Ortho she worked in both R&D and in Quality performing the laboratory work supporting product 510k's, Validations, Shelf-life studies, Operator Manuals, and Package Inserts. While pursuing her Bachelor's degree at Douglas College, Rutgers, she worked as a Phlebotomist for 5 Years at St. Vincent's Medical Center in New York City.

- **John Longo:** Dr. Longo is Professor of Finance at Rutgers Business School and a Visiting Professor of Finance at Global EMBA - the joint Executive MBA Program of Columbia University, London Business School, and The University of Hong Kong. He is also Chief Investment Officer and Portfolio Manager for Beacon Trust, a registered investment advisor with roughly $2.5 billion under management. Beacon is a subsidiary of Provident Financial Services (NYSE: PFS), founded in 1839. Dr. Longo is part of a team that manages a mutual fund and series of partnerships/hedge funds. Dr. Longo has appeared on CNBC, Bloomberg TV, Bloomberg Radio, Fox Business, BBC World, wsj.com (video), The (Ron) Insana Quotient, and several other programs. He has been quoted in The Wall Street Journal, Barron's, Thomson Reuters, Dow Jones MarketWatch, U.S. News & World Report, CNBC.com, and dozens of other periodicals. He is the author of The Art of Investing: Lessons from History's Greatest Traders. He has served as a consultant to many firms on a global basis and led students to a personal visit with Warren Buffett on 4 separate occasions. Previously, he was a Vice President at Merrill Lynch & Co., Inc. and served on the Advisory Board of Bloomberg's educational subsidiary, The Bloomberg Institute. Professor of Practice, Finance and Economics Dept, Rutgers Business School, July 1, 2013 – present, Clinical Associate Professor of Finance, Finance and Economics Dept, Rutgers Business School, July 1, 2010 - June 30, 2013, Visiting Professor of Finance, Global EMBA the joint EMBA program of Columbia University, London Business School, and The University of Hong Kong, Fall 2016 – present

- **Josh Simon:** Josh Simon, PhD is an Adjunct Professor of Biomedical Engineering at the New Jersey Institute of Technology, with 13 years of experience in medical device development and nine years of experience teaching at the graduate level. Over the course of his career, he has touched every aspect of device development from conception through sales and marketing for small and large-sized companies. Through involvement on upwards

School of Engineering
599 Taylor Road
Piscataway, NJ 08854
www.rutgers.edu
engels@soe.rutgers.edu
848-445-6572

of over a hundred device projects, he gained broad understanding of the processes for pre-clinical research, regulatory, quality, marketing, sales, clinical studies, and surgeon education. Josh holds a PhD and Master's in Biomedical Engineering from the joint program between the former University of Medicine and Dentistry of New Jersey and Rutgers University, now both combined into Rutgers University. He also holds an MBA in General Business, and a Bachelor's degree in Biochemical Engineering. A martial arts teacher in his spare time, (for the past 20 years), Josh has developed professionals through mentorship and coaching. Currently, Josh operates medicaldevicecourses.com, a website offering short courses in medical device development for new professionals and those that need a refresher. He is also doing consultant work for small and medium-sized medical device companies that have new products in the pipeline.

- **Gurpreet Singh,** ASQ-MBB, CPSM, CPSD, C.P.M., is an international, award winning, thought leader, consultant, entrepreneur, coach and educator. Gurpreet serves as a subject matter expert on various functions within Supply Chain Management, Lean Six Sigma and Operational Excellence. He has an MBA from Rutgers Business School, NJ with a dual concentration in Supply Chain Management and Strategic Management and an undergraduate degree in Industrial/ Production engineering from India. Gurpreet has been teaching at Rutgers Business School in the Department of Supply Chain Management since 2011 as a PTL. He has taught courses on Lean Six Sigma, Operations Management, Procurement and future or Procurement. While he teaches mostly to MBA students, he had the opportunity to share knowledge with undergraduate students as well as students of Masters in Supply Chain Management. Further, he is also on Faculty of Rutgers Executive MBA program as well as the lead faculty for a recently launched Mini-MBA program. An ASQ Certified Master Black Belt designated by American Society for Quality (ASQ), a distinction held by less than 100 people around the globe, Gurpreet is also a designated Certified Purchasing Manager (C.P.M.), Certified Professional in Supply Management (CPSM), and a Certified Professional in Supplier Diversity (CPSD), having achieved all of these designations from the Institute for Supply Management (ISM). Gurpreet is also pursuing a doctorate in Supply Chain Management from Rutgers Business School in New Jersey. His research areas include application of Lean Six Sigma in service sector and in particular in Procurement. Gurpreet's professional affiliations include ISM and ASQ. He recently completed his term as the President of the board of ISM's New Jersey chapter (one of the largest affiliates with almost 800 members). He has also served on the ISM National Leadership Training Committee for several years. Gurpreet has led countless break-through projects in various sectors and has a proven record of achieving considerable savings while streamlining processes with a focus on change management and people development. He has developed a multifaceted focus on cost savings and process improvement by eliminating waste and has saved millions of dollars for his clients.

TOPICS IN BME: APPLICATIONS IN MEDICAL DEVICE DEVELOPMENT

Course Number: 16:125:575 (BME) **Index Number: 15933**

Course Time: Thursday, 5 – 8 PM **Room**: BME-128

Description and Objectives:

This course will provide students insight into the practical aspects of medical device applications, and introduce business concepts as they relate to medical devices from a realistic industrial perspective. Representative fields including but not limited to cardiovascular, orthopedics, diagnostics, imaging, rehabilitation, and dental will be covered. Within each field, topics such as market and design considerations, FDA pathway, clinical trial requirements, manufacturing/QA/QC, and post-market considerations will be touched on. Industrial practitioners provide lectures and facilitate discussions highlighting problems such as manufacturing issues or project management challenges that engineers and scientists may encounter when dealing with the medical device industry.
After taking this course, students should have a better understanding of the challenges that engineers and scientists face in the medical device industry and gain an appreciation for the practical applications of their academic studies.

Course Directors:

Kristen Labazzo, Ph.D., MBA
Executive Director
Medical Device Development Center
Rutgers University
848-445-6578
kristen.labazzo@rutgers.edu

Natalie Macon, PhD
Founder
Macon Consulting
908-432-3454
ndmacon@gmail.com

Martin Yarmush, M.D., Ph.D.
Professor, Department of Biomedical Engineering
Rutgers University
Director, Center for Engineering in Medicine
Massachusetts General Hospital
732-445-4346
yarmush@rci.rutgers.edu

Major Textbooks and Other Reference Materials:

Relevant reading material will be provided by each lecturer.

Criteria for student grading:

Component	Percent
Class Participation	25%
Homework	30%
New Device Executive Summary	35%
Presentation	10%
Total	**100%**

Homework:

- Questions will be posed to by the speakers related to materials selected as an intro to the class topic.
- Answers should be submitted in essay format (1-2 double spaced pages).
- Due at the beginning of class to ensure preparedness for the lecture and active participation.

Class Preparation: Reading material for each session can be found on the course website:

http://sakai.rutgers.edu
Course: 16125:575 (2017)→ Assignments

- Course NOT recommended if you expect to miss > 1 class
- **You must notify** Dr. Labazzo or Dr. Macon in advance if you will miss a session, and you must submit answers to questions on that session's reading assignment

Topics and Speakers, Spring 2017:

19-Jan	A) Introduction to Course Objectives B) Job Prospects in Medical Devices	*Kristen Labazzo/ Natalie Macon*	Rutgers/Macon Consulting
26-Jan	Historical FDA Perspective for Medical Device Development	*Jordan Katz*	Orthobond
2-Feb	Medical Devices: An Overview of Generally Used Standards & Guidances	*Rosemarie Logan*	Rlogan Consulting (Regulatory Science)
9-Feb	Cardiovascular Devices	*Natalie Macon*	Macon Consulting
16-Feb	Dental Applications for Medical Devices	*Josh Simon*	Spiral Medical Development
23-Feb	Orthopedic Reconstruction Devices and Bone Void Fillers	*Paul Viola*	Quantum Concepts
2-Mar	Product Management Across Life of a Medical Device from Innovation to Life Cycle Management	*Nasir Uddin*	BD
9-Mar	Drug/Device Combination Products	*Jordan Katz*	Orthobond
16-Mar	SPRING BREAK-NO CLASS		
23-Mar	The Integration of Design and Manufacturing for Medical Devices	*Meg Smith*	Stryker
30-Mar	Process for Scouting and Evaluating New Technologies for Medical Diagnostics	*Lance Ladic*	Siemens
6-Apr	Wheelchairs and seating: Promoting abilities through understanding and innovation	*John Reck*	Matheny Medical and Educational Center
13-Apr	Wound Closure Products	*Carlos Caicedo*	Orthobond
20-Apr	Panel Discussion (physician, patient, clinical, researcher, engineer, etc all at one table!)	variety TBD	variety
27-Apr	Medical Device Presentations		

Medical Device Proposal:

Each student will have the opportunity to propose a novel medical device. The idea does not have to be realistic, so long as it can be appropriately justified and a convincing argument can be made. Students are to prepare an executive summary their medical device which should include the following elements:

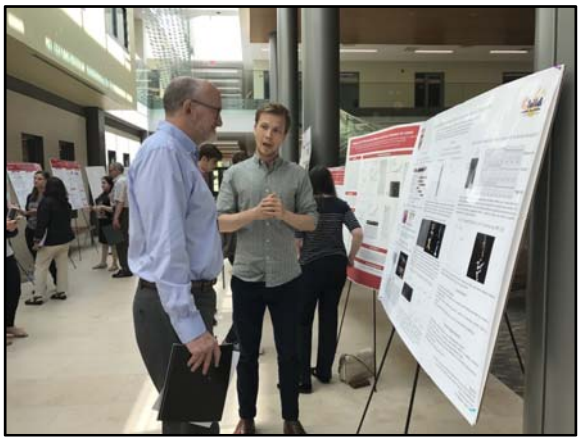
- Opportunity: what is the unmet need that your device fulfills?
- Value Proposition: how will your device be better? What value does it bring to the community you are serving?
- Market Size: who are your customers and how large is the population? If there are comparable products, how many are sold a year?
- Development: What are your big design hurdles? User Needs, Design Inputs, Performance Requirements??
- Investment Opportunity: how much money are you looking to generate? Can the product be reimbursed through health insurance to make it more attractable to physicians?
- Competition and Barriers to Entry: what are some competitive products? Are there other barriers such as FDA issues or clinical trial difficulties?
- Exit Strategy:
- Freedom to Operate: are there patents which may prevent you from making this product?
- Regulatory: what FDA classification will your device have? What will your clinical trials look like? Enrollment size?

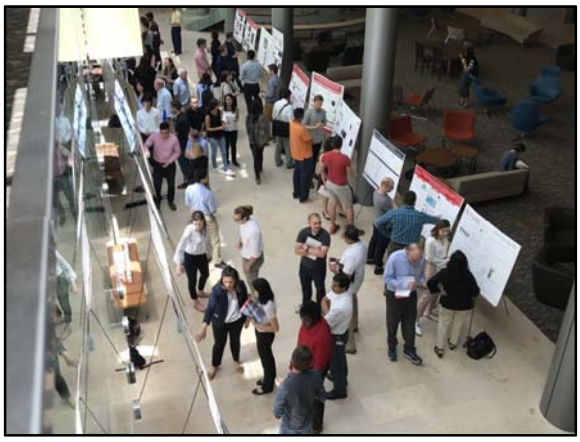
The executive summary should be no more than 2 pages.

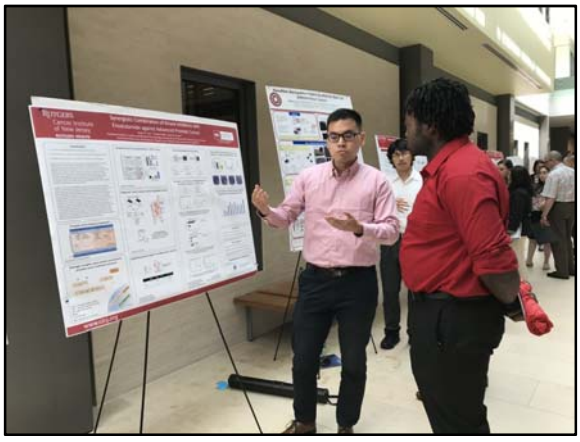
Presentation:
Each student will have the opportunity to present their medical device concept to the class. Each presentation should contain 7-10 powerpoint slides. Presentations will be graded on relevance, novelty, justification of idea, attention to detail, and how well the presentation is organized and delivered.

Academic Integrity:
Students are expected to familiarize themselves with and adhere to the University policy on academic integrity at: http://academicintegrity.rutgers.edu/academic-integrity-policy/

BIOTECHNOLOGY TRAINING PROGRAM
ANNUAL SYMPOISUM







RUTGERS UNIVERSITY
BIOTECHNOLOGY TRAINING PROGRAM
ANNUAL MINI-SYMPOSIUM
JUNE 25TH, 2018

AGENDA

Continental Breakfast…….. 9:30 am

Introduction……10:00 am

Dr. Martin Yarmush

Keynote Address……10:30 pm

Dr. Jordan Katz Ph. D

Poster Session…….. 11:30 am

Lunch…….. 12:30 pm

Poster Awards and Closing Remarks…….. 1:30 pm

KEYNOTE ADDRESS

Dr. Jordan Katz, PhD

Vice President of Research and Development &
CSO of Orthobond

Dr. Jordan Katz is the Vice President of Research and Development and CSO of Orthobond, a company focused on developing antimicrobial nanosurfaces for medical devices. With the growing realization that contamination is a major contributor to medical device failure, Orthobond has developed a suite of proprietary antimicrobial nanosurfaces for applications in orthopedics, trauma, cardiovascular, plastics, dental, and oncology.

Prior to joining Orthobond, Dr. Katz worked as a Senior Scientist at RTI Biologics in Gainesville, FL and at Orthocon in Irvington, NY. At both companies, he participated in the development of new technologies from the research phase through product launch. Dr. Katz is very passionate about addressing the unmet need for antimicrobial medical devices and looks forward to commercializing such devices in the near future.

Dr. Katz earned his PhD in Biomedical Engineering from Rutgers University in 2004 and has focused his career on the research and development of improved biomaterials and implant surfaces

RUTGERS UNIVERSITY
BIOTECHNOLOGY TRAINING PROGRAM
ANNUAL MINI-SYMPOSIUM
JUNE 25TH, 2018

STUDENT POSTERS

Alison Acevedo
Biomedical Engineering
Dr. Ioannis Androulakis

Jeremy Anderson
Biomedical Engineering
Dr. Li Cai

Larry Cheng
Cellular and Molecular Pharmacology
Dr. Justin M. Drake

Mollie Davis
Biomedical Engineering
Dr. Martin Yarmush

Emily DiMartini
Biomedical Engineering
Dr. David Shreiber

Zachary Fritz
Biomedical Engineering
Dr. Martin Yarmush

Madison Godesky
Biomedical Engineering
Dr. David Shreiber

Ryan Guasp
Cell and Developmental Biology
Dr. Monica Driscoll

Paulina Krzyszczyk
Biomedical Engineering
Dr. François Berthiaume
Dr. Martin Yarmush

Josh Leipheimer
Biomedical Engineering
Dr. Martin Yarmush

Jeffrey Luo
Chemistry and Chemical Biology
Dr. KiBum Lee

Ileana Marrero-Berríos
Biomedical Engineering
Dr. Martin Yarmush

Ilija Melentijevic
Molecular Biology and Biochemistry
Dr. Monica Driscoll

Yoliem Miranda Alarcón
Biomedical Engineering
Dr. David Shreiber

Jenna Newman
Biochemistry and Molecular Biology
Dr. Andrew Zloza

EveLyn Okeke
Biochemistry and Molecular Biology
Dr. Kiran Madura

Anton Omelchenko
Cell Biology & Neuroscience
Dr. Bonnie L. Firestein

Misaal Patel
Biomedical Engineering
Dr. Li Cai

Xiomara I. Perez
Biomedical Engineering
Dr. Martin Yarmush

William Pfaff
Biomedical Engineering
Dr. Charles J. Gatt
Dr. Michael G. Dunn

Christopher Rathnam
Chemistry and Chemical Biology
Dr. Ki-Bum Lee

Eve Reilly
Molecular Biology and Biochemistry
Dr. Mikel Zaratiegui

Victor M. Tan
Pharmacy
Dr. Justin M. Drake

Liam Turk
Neuroscience and Cell Biology
Dr. Davide Comoletti

BIOTECHNOLGY TRAINING PROGRAM ALUMNI

Name/Department	Current or Last Known Position
Patricia Darcy, Biochemical Engineering	Associate Professor, Chemical Engineering, Lafayette College
Frank Goveia, Microbiology	Director Client Services, IntrinsiQ, LLC
Michael Sacco, Pharmaceutical Sciences	Executive Director, Product Safety, Global Information and Analysis, Novo Nordisk
Jean Boyer, Biochemical Engineering	Senior Director Analytical Sciences, Inovio Pharmaceuticals Inc.
Vaughn Cleghon, Microbiology	Associate Professor, Department of Pediatrics, University of Cincinnati
Ramona Lloyd, Microbiology	President and Principal Consultant, CymReg Consulting, LLC
Maria Lee, Pharmaceutical Sciences	Research Scientist, Advanced Care Products, Ortho Pharma
Diane Zimmerman, Computer Science	Technical Writer and Editor, Self-employed, CO
Carlos Aparicio, Biochemical Engineering	CEO and President, ImmunoSite Technologies, FL
Nathan Busch, Biochemical Engineering	Attorney-at-Law, Anovus LLC, MN
Amlan Dutta, Biochemical Engineering	Executive Director, Merck & Co, PA
Susan Harlocker, Molecular Biology & Biophysics	Patent Agent, McDermott Will & Emery, LLP
Deena Oren, Chemistry	Manager, Structural Biology Resource Center, The Rockefeller University
Maura Collins Pavao, Microbiology	Professor, Biology, Worcester State University
Mark Riley, Biochemical Engineering	Professor & Department Head, Biological Systems Engineering, University of Nebraska
Connie Schall, Biochemical Engineering	Professor & Graduate Director, Chemical & Environmental Engineering, University of Toledo
Nancy Sladicka (Iler), Molecular Genetics	Vice President, Client Services Scientific Pathways, Nucleus Global , NY
Srikanth Sundaram, Biochemical Engineering	President and Chief Scientific Officer, MAIA Pharmaceuticals , NJ
William Thorpe, Biochemical Engineering	Area Director, Club Z! In-Home Tutoring Services, Winchester, MA

BIOTECHNOLGY TRAINING PROGRAM ALUMNI

Ashish Upadhyay, Biochemical Engineering	Senior Research Biochemical Engineer, Merck & Co, PA
Kenneth Valenzano, Pharmacology	Senior Vice President, Amicus Therapeutics, NJ
Madhaven Vasudevan, Biochemical Engineering	Vice President, Analytics Solutions, GENPACT, CA
David Odde, Biochemical Engineering	Professor, Biomedical Engineering, University of Minnesota
Paul Olson, Molecular Genetics	President and Co-founder, Kypha Pharma, Inc.
David Powers, Biochemistry	Senior Principal Research Scientist, Abbott BioTherapeutics, CA
Maria Ortiz Rivera, Microbiology	Scientific Support Call Center Leader, GE Healthcare, MA
Amit Roy, Biochemical Engineering	Group Director, Clinical Pharmacology & Pharmacometrics, Bristol-Myers Squibb, NJ
Myrna Uytingco, Biochemical Engineering	Physician (Medicine), Lakeside Community Healthcare, Providence Holy Cross Med Ctr, CA
Clelia Biamonti, Biochemistry	Senior Principal, Blue Fin Healthcare Group, NJ
David Lamberto, Biochemical Engineering	Associate Director, Engineering, Merck & Co, NJ
Elizabeth Powell, Biochemical Engineering	Associate Professor, Anatomy and Neurobiology, University of Maryland School of Medicine
Greg Russotti, Biochemical Engineering	Vice President, Technical Operations, Celgene Cellular Therapeutics, NJ
Bruce Weaver, Biochemical Engineering	Director, Process Development, VaxInnate Corporation, NJ
Shiun-Kwei Chiou, Molecular Biology	Adjunct Professor, National University, Principal Scientist, Department of Veteran Affairs, CA
Joseph Le Doux, Biochemical Engineering	Associate Professor & Associate Chair, Biomedical Engineering, Georgia Tech
Colette Ranucci, Biochemical Engineering	Executive Director, Merck & Co, PA
Hsin Chien Tai, Biochemical Engineering	Senior Material Designer, Monlnlycke Health Care, NJ
Charlie Chang, Biochemical Engineering	Senior Investment Officer, Missouri State Employees' Retirement System
Hany Michail, Biomedical Engineering	Physician (Ophthalmology), The University of Texas Southwestern Medical Center
Matthew Pellegrini, Biochemistry	Manager, Drug Discovery, PTC Therapeutics, NJ (Deceased 2006)

BIOTECHNOLGY TRAINING PROGRAM ALUMNI

Seshu Pedapudi Tyagarajan, Biochemical Engineering	Director, Cell and Gene Therapies, Novartis Pharmaceuticals, NY
Petra Archibald, Biochemical Engineering	Facilitator & Mediator, Soliya/Institute for Mediation & Conflict Resolution, NY
Lori Herz, Biochemical Engineering	Professor and Associate Director, Bioengineering, Lehigh University
Todd Muccilli, Biochemical Engineering	Director of Operations, Integrated Process, Merck & Co, PA
Jane Tjia (Atkins), Biochemical Engineering	Director, Early Stage Pipeline Leadership, Biogen Idec, MA
Albert Alexander, Biochemical Engineering	Senior Scientist, AstraZeneca, PA
Aquanette Burt, Biochemical Engineering	Lead Scientist, g-Force Biosystems, CA
Elizabeth Shen, Biochemical Engineering	Technical Marketing Manager, Colorcon, PA
Deanna Thompson, Biochemical Engineering	Associate Professor, Biomedical Engineering, Rensselaer Polytechnic Institute
C. Alves, Molecular Genetics & Microbiology	Medical Student, Univ of Texas
Leonard Edelstein, Molecular Genetics & Microbiology	Research Assistant Professor, Cardeza Foundation for Hematologic Research, Thomas Jefferson University
Joseph Freeman, Biomedical Engineering	Associate Professor, Biomedical Engineering, Rutgers University
Scott Banta, Biochemical Engineering	Professor, Chemical Engineering, Columbia University
Eric Hacherl, Biochemical Engineering	Network Strategy and Execution Director, Merck, PA
James McCarthy, Molecular Genetics & Microbiology	Staff Scientist, J. Craig Venter Institute, Scripps Institute of Oceanography, CA
Mary Lynn Mercado, Pharmacology	Senior Medical Writer, Novartis Pharmaceuticals Corporation, NY
Annmarie Pacchia, Microbiology	Vice President, Research and Project Administration, Memorial Sloan Kettering Cancer Center, New York, NY
Thomas Brieva, Biochemical Engineering	Director, New Product Platform Process Development, Celgene Cellular Therapeutics, NJ
Paul Gong, Chemistry	Senior Professional Staff, John Hopkins University Applied Physics Laboratory
Sean Hanlon, Molecular Genetics & Microbiology	Senior Program Manager, Office of Physical Science-Oncology, National Cancer Institute

BIOTECHNOLGY TRAINING PROGRAM ALUMNI

Elizabeth Manheim, Genetics	Adjunct Professor, Biology, Kean University
Susan Maskery, Biochemical Engineering	Biotechnology Professional, MN
Kristine Schmalenberg, Chemistry	Associate Manager, Johnson & Johnson, NJ
Jintae Lee, Biochemical Engineering	Assistant Professor, Chemical Engineering, Yeungnam University, Korea
E.J. Amato-Pavlik, Biochemistry	Senior Project Manager, Amgen, Inc, CA
Michael Baran, Biochemistry	Senior Director, Business Operations & Scientific Affairs, Pfizer, NY
Michele Burley, Molecular Genetics & Microbiology	Research Scientist, Germ Guard Lighting, NJ
Brian Geldziler, Molecular Genetics & Microbiology	Director, Medical Writing, Otsuka Pharmaceutical Companies, NY
Paloma Pimenta, Biochemical Engineering	Senior Technical Associate, R&D Personal Care Product Development, Colgate Palmolive, NJ
Andrew Roberts, Molecular Genetics & Microbiology	Director, CERA and CSAFF, ILSI Research Foundation, VA
H. Chen, Chemistry	Postdoctoral Fellow, Massachusetts Institute of Technology
Justin Lacombe, Biochemical Engineering	Manager, Process Development, Teva Pharmaceuticals, NJ
Eric Semler, Biochemical Engineering	Associate Director, Product Development, Musculoskeletal Transplant Foundation, NJ
Ram Sharma, Biochemical Engineering	Assistant Professor, Biomedical Engineering, University of Bath, UK
David Snyder, Biochemistry	Associate Professor, Chemistry, William Paterson University, NJ
Joseph Vitolo, Biochemical Engineering	Deceased 2006
Carlos Caicedo, Biomedical Engineering	Senior Scientist, Orthobond, NJ
Tim Maguire, Biomedical Engineering	Assistant Research Professor, Biomedical Engineering, Rutgers University
Jason Maikos, Biomedical Engineering	Director, Gait and Motion Analysis Laboratory Manhattan VA Medical Center
Erik Novik, Biomedical Engineering	Chief Technical Officer, Hurel Corp, NJ
Sam Phillips, Biomedical Engineering	Adjunct Professor, Mechanical Engineering, University of South Florida

BIOTECHNOLGY TRAINING PROGRAM ALUMNI

James Voordeckers, Molecular Genetics & Microbiology	Research Associate, University of Oklahoma
Eddie Davis, Biochemical Engineering	Technical Services Engineer, Epic Systems Corp, WI
Chris Gaughan, Biochemical Engineering	Staff Scientist, Zymera, CA
Frances Gratacos, Molecular Genetics & Microbiology	Educational Adviser, Centro Boliviano Americano, NY
Keirnan Lamarche, Biochemical Engineering	Senior Researcher, Bristol Myers Squibb, NJ
Natesh Parashurama, Biochemical Engineering	Assistant Professor, Chemical and Biological Engineering, SUNY Buffalo
Nina Rodriguez-Pinto, Biochemical Engineering	Technical Services Engineer, Epic Systems Corp, WI
Alan Sasso, Biochemical Engineering	Statistician, US Environmental Protection Agency, VA
Harini Sundararaghavan, Biomedical Engineering	Assistant Professor, Biomedical Engineering, Wayne State University
Eric Yang, Biomedical Engineering	Associate Director of Data Science, Covance, NJ
Leilani Del Rosario, Chemistry	Senior Research Chemist, Church and Dwight, NJ
Maria Della-Valle, Biochemistry	Senior Research Investigator II, Amicus Therapeutics, NJ
Stephen Guzikowski, Biochemical Engineering	Senior Investigator, Bristol-Myers Squibb, NJ
Nicole Iverson, Biomedical Engineering	Assistant Professor, Biological Systems Engineering, University of Nebraska
Dominick Naczynski, Biomedical Engineering	Research Analyst, Tavistock Life Sciences, CA
Ronald Perez, Pharmacology	Associate Consultant, Prescient Healthcare Group, NY
Eric Wallenstein, Biomedical Engineering	Associate Principal Scientist, Merck & Co., NJ
Chris Langhammer, Biomedical Engineering	Resident Physician, Orthopaedic Surgery, UCSF
Norman Lapin, Biomedical Engineering	Postdoctoral Associate, Surgery, Baylor College of Medicine, TX
Joseph Moloughney, Pharmacology	Postdoctoral Fellow, Pharmacology, Robert Wood Johnson Medical School
Jean-Pierre Dolle, Biomedical Engineering	Postdoctoral Fellow, Neuroscience, University of Pennsylvania

BIOTECHNOLGY TRAINING PROGRAM ALUMNI

Melinda Kutzing, Biomedical Engineering	Consultant, Bionest Partners, New York
Eric Sweet, Neuroscience	Postdoctoral Fellow, Neurology, Mount Sinai Medical Center
Jeff Barminko, Biomedical Engineering	Postdoctoral Fellow, Hematology, Mount Sinai Medical Center
Jonathan Gonzalez-Flores, Molecular Genetics	Postdoctoral Fellow, Molecular Oncology, Ponce School of Medicine, Puerto Rico
Shirley Masand, Biomedical Engineering	Management Consulting, Accenture, NY
Lawrence Sasso, Biomedical Engineering	Lead Engineer and Chief Technical Officer, Genesis Technologies, TX
Jillian Whidby, Chemistry	Medical Writer, Integrium, PA
Serom Lee, Biomedical Engineering	Associate Consultant, Defined Health, Florham Park, NJ
Daniel Lewis, Biomedical Engineering	Postdoctoral Fellow, Biomedical Engineering Rutgers University
Frank Macabenta, Pathology	Postdoctoral Fellow, Biology, California Institute of Technology
Adriana Martin, Pharmacology	Medical Student, Robert Wood Johnson Medical School
Nir Nativ, Biomedical Engineering	R&D Scientist, Ethicon Biosurgery, NJ
Melissa Przyborowski, Biomedical Engineering	Postdoctoral Fellow, National Research Council, Army Institute of Surgical Research, TX
Renea Faulknor, Biomedical Engineering	Postdoctoral Fellow, Tissue Engineering, Harvard University
Mehdi Ghodbane, Biomedical Engineering	Bioprocess Engineer, GlaxoSmithKline, PA
Andrea Gray, Biomedical Engineering	Biomedical Engineering Staff Fellow, Food and Drug Administration, MD
Kristina Hernandez, Neuroscience	Medical Writer, Meditech Media, NY
Oleg Milberg, Biochemical Engineering	Postdoctoral Fellow, Biomedical Engineering, Johns Hopkins University
Jillian Nguyen, Neuroscience	Research Associate, Technical Analysis, Cornerstone Macro New York, NY
Phil Tedeschi, Pharmacology	Senior Scientist, Oncobiologics, NJ
Gabriel Yarmush, Biomedical Engineering	Senior Research Scientist, Salvona, Dayton, NJ
Perry Yin, Biomedical Engineering	Consultant Analyst, PA Consulting Group, New York, NY

BIOTECHNOLGY TRAINING PROGRAM ALUMNI

Elizabeth Stucky, Chemical and Biochemical Eng	Postdoctoral Research Associate, Manchester Institute of Biotechnology
Brittany Taylor, Biomedical Engineering	Postdoctoral Fellow, University of Pennsylvania
Agnes Yeboah, Chemical and Biochemical Eng	Senior Director, Celgene, New Jersey
Jake Jacobs, Molecular Biology and Biochemistry	Microbiologist, Troy Corporation, Florham Park, NY
Alvin Chen, Biomedical Eng	Research Scientist, Phillips Healthcare, Cambridge, MA
Ana Rodriguez, Biomedical Eng	Medical Writer BIONYC, New York, NY
Kathryn Drzewiecki, Biomedical Eng	Consultant, Early Charm Ventures, Baltimore, MD
Trevan Locke, Chemical and Biochemical Eng	Scientific Program Administrator, Regulatory Science and Policy, American Association for Cancer Research, Washington DC
Sal Ghodbane, Biomedical Eng	R&D Formulating Scientist, Ethicon, NJ
Chris Lowe, Biomedical Eng	Senior Upstream Development Engineer at Shire, Boston, MA
Corina White, Biomedical Eng	Process Engineer at Amicus Therapeutics, NJ
Seul-A Bae, Biomedical Eng	Post Doctoral Fellow at Merck, NJ