Summer High School Research Program:
2013 Participating Faculty & Labs

BIOLOGY

Dr. Lee Ligon: ***Website:*** https://www.rpi.edu/dept/bio/faculty/profiles/ligon.html

"In the Ligon lab, we are interested in how the shape and structure of cells affects their function. Some cells, such as those of the nervous system, have elaborate three-dimensional shapes that are essential to their specialized activities. We study the cytoskeleton, a complex network of protein polymers that underlies cell structure. We use a combination of live-cell imaging and other cell biological, biochemical and molecular techniques to examine cytoskeletal organization and dynamics in the context of the living cell."

Dr. Patrick Maxwell: ***Website:*** https://www.rpi.edu/dept/bio/faculty/profiles/maxwell.html

"There are many hypotheses regarding the cause(s) of again. One such hypothesis is that the accumulation of genetic damage limits lifespan. While mutations and genome rearrangements are known to occur with increased frequency during aging, a direct role for genetic damage in causing normal aging has yet to be demonstrated. The Maxwell lab is investigating the mechanisms underlying and the consequences of genome instability during aging. Current projects use *Saccharomyces cerevisia* (budding yeast) as a model organism and focus on the potential contribution of mobile genetic elements known as retrotransposons to aging-associated increases in mutations and genome rearrangements."

BIOMEDICAL ENGINEERING

Dr. James Cooper: ***Website*:** http://faculty.rpi.edu/node/526

"Our mission is the design, development and pre-clinical testing of engineered 3-D tissues with mechanical integrity, engineered surfaces and pore interconnectivity to allow for the regeneration, replacement or repair, of injured or diseased tissues. The aim of the Cooper group is to contribute to the biomaterials, tissue engineering and regenerative medicine sector for the repair of the human body with an integrated, biologically informed strategy. The refinement of methodology will allow for adaptations of bioactive and biomimetic materials, scaffold development and cellular integrations for tissue engineering and regenerative medicine therapies."

Dr. David Corr: ***Website*:** http://faculty.rpi.edu/node/504

"The Corr lab utilizes a scaffold-free approach that harnesses cells' natural abilities to build single fibers and tissue structures in muscle, tendon and ligament. They also use a laser-based direct writing approach to create cellular constructs, cultures, and co-cultures in which th cell type, number and location are precisely controlled in order to study the influence of the local microenvironment on cancer cell activity, collagen production and stem cell differentiation."

Dr. Guohao Dai: ***Website*:** http://faculty.rpi.edu/node/1116

"Currently, the research programs in the laboratory focus on three goals: (1) To understand how biomechanical forces regulate vascular functions, and to identify targets associated with specific cellular phenotype in diseased blood vessels and develop technologies for targeted drug delivery and molecular imagine of those vasculatures; (2) To develop 3-D cell printing technology for vascular tissue engineering applications, such as engineering tissue structures with adequate vascular perfusion and designing optimal conditions for blood vessel regeneration; (3) To develop technology to differentiate stem cells toward vascular lineage in particular arterial and venous endothelial cells, and to apply them in tissue engineering of vascular graft."

Dr. Ryan Gilbert: ***Website*:** http://www.rjgilbertlab.com/

"The Gilbert lab specializes in developing translational biomaterials to aid in spinal cord repair. Our laboratory is developing biomaterials to guide axonal and cellular migration through an injury site, as well as, locally deliver therapeutics."

Dr. Juergen Hahn: ***Website*:** http://homepages.rpi.edu/~hahnj/group.html

"Our research group focuses on two general areas: One is the development of new techniques for systems analysis (e.g., sensitivity analysis, experimental design, parameter estimation, or model reduction) with an emphasis on methods for nonlinear systems and/or significant levels of uncertainty in the model. The second general area is the application of these techniques to specific biochemical systems, such as signal transduction or metabolic pathways, but also to new processes in the chemical process industries, e.g., benzene hydrogenation via reactive distillation."

BIOMEDICAL ENGINEERING

Dr. Mariah Hahn: ***Website*:** http://www.hahntissuelab.com/
"The overarching hypothesis governing my work is that there is a subset of external and internal signals which dominate cellular regeneration of a given tissue and that discovery of these stimuli, and the key intracellular mechanisms through which they actuate cell behavior, will allow us to predict, and there for dictate cell behavior. In essence, my work is attempting to do for tissue engineering what Newton did for the physics- generate a consistent framework of primary effects governing the behavior of cells in specific contexts (in Newton's case, the motion of objects with speeds less than that of light), bringing what now appears unpredictable within our control."

Dr. Xavier Intes: ***Website:*** http://intes-lab.bme.rpi.edu/
"Our laboratory goal is to develop quantitative thick-tissue optical imagine platforms for pre-clinical and clinical applications. We focus on three main areas: (a) design new optical tomographic imaging instrumentation; (b) develop new reconstruction algorithms for quantitative volumetric imaging; and (c) investigate optimal experimental and theoretical parameters for functional, molecular, and dynamical optical imaging."

Dr. Deanna Thompson: ***Website*:** http://faculty.rpi.edu/node/1102
"The Thompson laboratory is interested in neural tissue engineering aimed to aid in the repair of injuries to the peripheral nervous system, spinal cord and brain. Ongoing work in the lab is focused on controlled expansion and differentiation adult neural stem cells as a potential patient-derived cell source for regenerative medicine therapy, electrical stimulation for treatment of nerve injuries, development of tissue-specific biomaterials to support nerve repair and nanomaterials in neural engineering."

Dr. Leo Wan: ***Website*:** http://homepages.rpi.edu/~wanq/
"The mission of this laboratory is to study physical forces in tissue development and regeneration and to develop microassays and technologies for disease diagnosis and drug screening, using integrated theoretical and experimental approaches including tissue and cell biomechanics, novel biomaterials, imaging methods, and micro/ nanotechnologies. The current research projects focus on mechanics and biology at different hierarchical levels, towards understanding of (a) cell chirality (left-right asymmetry), (b) geometry-force control of stem cell function, and (c) biophysical regulation of engineered tissues in bioreactors."

CHEMICAL & BIOLOGICAL ENGINEERING

Dr. Pankaj Karande: ***Website:*** http://cbe.rpi.edu/node/86
"Prof. Karande's research program is focused on engineering peptides as novel drugs, drug carriers and multifunctional biomaterials for medical applications. Peptides play vital roles in various biological functions, including membrane assembly, cell regulation and immunity. Inspired by their roles in physiological processes, the Karande Lab is evaluating the potential of short peptide sequences as therapeutics for cancer, neurodegenerative diseases, immune disorders and as sub-unit vaccines against infectious disease."

Dr. Mattheos Koffas: ***Website:*** http://cbe.rpi.edu/node/107
"The overall research effort is focused on Network, Metabolic and Cellular Engineering that aims at improvement of cellular properties or design new metabolic circuits using molecular biology tools. Efforts in Network Engineering encompass two important components. First, we build biological circuits that allow us to monitor in vivo the intracellular levels of important metabolites that are precursors to numerous high-value chemicals. Second, we build circuits that are based on signaling pathways identified in nature in order to engineer artificial cell-cell communication schemes."

Dr. Cynthia Collins: ***Website:*** http://homepages.rpi.edu/~collic3/index.html
"Our research program focuses on fundamental and applied aspects of microbial consortia. This work combines multiscale modeling of biological networks (from gene to protein to organism to community), metabolic and biochemical engineering, synthetic biology and cell-cell communication with the complexities of coexisting communities of bacteria. Applications range from engineering biosensors, to bioprocessing, bioremediation and bio-energy production, and may also include the development of therapeutics that specifically target the balance between good and bad bacteria in the human body."

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CHEMISTRY

Dr. K.V. Lakshmi: ***Website:*** http://baruch60center.org/group/index.php

"Our research is truly interdisciplinary as it combines molecular genetics, protein biochemistry, synthetic inorganic chemistry, quantum chemistry, pulsed electron paramagnetic resonance (EPR) and solids nuclear magnetic resonance (NMR) spectroscopy to understand the mechanism of light-driven charge transfer reactions in natural and artificial photosynthetic systems."

Dr. Chang Ryu: ***Website:*** http://www.rpi.edu/dept/chem/chem_faculty/profiles/ryu.html

You do not have to see the object to accurately measure the size of the object, and this summer research experience will provide the opportunity for high school students to get hands-on research experience on a characterization tool called dynamic light scattering (DLS). DLS is a commonly used technique to measure the size distribution of light scattering objects, such as surfactants, colloid particles, proteins, carbohydrates, and polymers in water. Although we cannot see those objects even with the help of optical microscopy, we can measure how fast the move around in water and finally relate their diffusivity to the hydrodynamic radius using Stokes-Einstein equation. The high school students will examine how the temperature affects the size of proteins and block copolymer micelles in water. Remember that protein can be denatured at high temperatures (just as you have seen the change of egg white when you fry the egg.)

MECHANICAL, AEROSPACE, AND NUCLEAR ENGINEERING

Dr. Diana-Andra Borca-Tasciuc: ***Website:*** http://faculty.rpi.edu/node/534

"The Thompson laboratory is interested in neural tissue engineering aimed to aid in the repair of injuries to the peripheral nervous system, spinal cord and brain. Ongoing work in the lab is focused on controlled expansion and differentiation adult neural stem cells as a potential patient-derived cell source for regenerative medicine therapy, electrical stimulation for treatment of nerve injuries, development of tissue-specific biomaterials to support nerve repair and nanomaterials in neural engineering."

Dr. Jie Lian ***Website:*** http://www.rpi.edu/dept/ne/public_html/Dr._Jie_Lian.html

"His research mainly focuses on the long term performance evaluation of ceramics as potential matrix for incorporating fission products and actinides, specifically materials behavior under extreme radiation environments encountered under relevant geological repository conditions and reactor environments. Of particular importance, he has performed a systematic study of the behavior of a special type of compounds, pyrochlore, upon extremely ballistic and ionizing irradiations, through which the effects of materials intrinsic parameters (such as ionic size, bond characters, structural deviation) and underlying physics governing materials' radiation response behavior are revealed. This fundamental understanding allows us to design advanced waste forms with enhanced performance for actinide incorporation through bond and structural controls and has a significant impact on the effective management of nuclear waste, critically important for the development of advanced nuclear energy systems."

Dr. Li (Emily) Liu ***Website:*** http://homepages.rpi.edu/~liue/index.html

"Professor Liu's research interests include: use of Neutron, X-ray and Dynamic Light Scattering in nanotechnology and polymer science, such as soft colloidal systems; Molecular Dynamics simulation of Uranium Dioxide; radiation damage; MCNP Simulation in Nuclear Threat Detection; and the measurements and calculations of inelastic neutron cross sections."

Dr. Johnson Samuel ***Website:*** http://www.johnsonsamuel.com

The overarching objective of this research program is "to address the manufacturability issues associated with advanced micro/nano-scale materials, with an eye towards design and realization of products for societal needs." Selected areas of current research include: 1) Health Care: reducing the extent of post-operative complications in total join replacement surgeries; 2) Sustainability: life-cycle enhancement of high-performance micro-parts using nano-scale cutting lubricants; and 3) Defense Applications: materials undergoing micro/nanostructure phase-evolution during manufacturing.

Dr. Zahra Sotoudeh ***Website:*** http://homepages.rpi.edu/~sotouz/index.html

"My research area is modeling of aeroelasticity or fluid structure-interaction phenomena. The applications are mostly aerospace applications such as high altitude long endurance (HALE) aircraft or helicopter. The student should expect to learn some easy programming with MATLAB, and running simulations."