2020 ABI Summer Internship Mentor List

Dr. Fabricio Medina-Bolivar, Professor of Plant Metabolic Engineering
Department of Biological Sciences
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1. Research Project:

   Discovery and bioproduction of medicinal compounds from plants. The Medina-Bolivar research team is involved in the discovery and bioproduction of bioactive plant compounds with medicinal applications. Our studies utilize "immortalized" root cultures (known as "hairy roots") as factories for a large diversity of plant natural products. Using a combination of molecular, cellular and biochemical approaches, our research team has developed strategies to increase the levels of selected natural products in hairy roots by more than 1,000 times when compared to the parental plant. Students that participate in the ABI Internship Program will work specifically with hairy root cultures to produce a class of biologically active natural products known as stilbenoids. These compounds have potential applications as preventive and therapeutics agents for cancer and cardiovascular diseases. The interns will be involved in different aspects of the research including production, analysis and purification of stilbenoids in hairy root cultures, and assessing their activity in chemical and cellular assays.

2. ABI Mission compatibility:
   The research focus of this internship is on production and bioactivity of novel plant compounds that have potential applications as preventive and therapeutic agents for cancer and cardiovascular diseases. These are major health concerns in Arkansas. To this end, this research adheres to the ABI mission to improve the health of Arkansans through new and expanded agricultural and medical research initiatives.

3. Contributions to the scholarly or creative community:
   Interns will learn the technical skills associated with a plant tissue culture/analytical/molecular and cellular laboratory. These include aseptic techniques, plant tissue culture, analysis of natural products by high performance liquid chromatography (HPLC) and mammalian cell culture. In addition, the interns will learn how to maintain a research laboratory notebook, how to do research as part of a team and how to present the results of their research in laboratory and scientific meetings. The interns will also learn how to communicate their research to the general public.

Dr. Maureen Dolan, Therapeutic Protein Production using Plants as "Bio-factories"
Please check out this weblink for more information about research in our lab: http://www.plantpoweredproduction.com/faculty/maureen-dolan/or contact me at:
Email: [mdolan@astate.edu;](mailto:mdolan@astate.edu) **Phone:** 870-680-4359

The fasting growing sector of the human/animal pharmaceutical market is protein-based drugs (protein biologics). Undergraduate research scholars joining our lab will be a part of a dynamic research team that includes undergraduate, graduate and senior researchers focused on using plants as "factories" and recombinant DNA techniques to produce animal and human protein biologics. An important issue in human and environmental health is development of antibiotic resistance that is contributed through the misuse/overuse of antibiotics in livestock production. Our lab team is exploring the utility of plants for producing more targeted, safer, protein-based therapeutics as alternatives to antibiotics in controlling disease outbreaks in farmed raised fish (aquaculture) and poultry. A related project aims to express the human homolog of this candidate protein biologic for enhancing its delivery to stimulate tissue repair as a therapeutic countermeasure in treating diseases such as inflammatory bowel disease (IBD). Student researchers will have opportunity for hands-on experience using some of the skills and techniques seen/learned in your lab courses including buffer preparation, pipetting, molecular cloning, PCR, DNA and protein extraction/chromatography, electrophoresis and animal cell culture. Student scholars are paired with senior researchers in the lab to train in the techniques they will use to carry out their research project.

This project aims to contribute innovations to the fastest growing sector of the pharmaceutical market, protein biologics, and thus aligns with several ABI Research Mandate Areas addressing agricultural bioengineering for improved animal health implications and enabling technology serving the aquaculture and poultry industries; important agriculture sectors in Arkansas.

Please check out this weblink for more information about research in our lab: http://www.plantpoweredproduction.com/faculty/maureen-dolan/or contact me at:
Email: mdolan@astate.edu; **Phone:** 870-680-4359

Anahita Izadyar , Associate Professor of Chemistry
Department of Chemistry and Physics
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Research Project: Development of a biosensor using Recombinant Manganese Peroxidase Enzyme from Corn Grain to Detect Glucose for Diabetics.

Diabetes mellitus is a major public health problem and a leading cause of death and disability in the world. The diagnosis and management of this disease requires everyday monitoring of blood glucose levels. Thus, development of a fast, sensitive and reliable biosensor to detect glucose is imperative. As biological devices, electrochemical biosensors will become ever more prevalent and integral to medical as well as industrial and environmental applications. The enzymes most commonly used in biosensors are glucose oxidase (GOx) and horseradish peroxidase (HRP). However, HRP has several disadvantages because of the high cost of the enzyme, its limited reaction conditions and its low catalytic effect to reduce hydrogen peroxide (H_2O_2). Manganese peroxidase (MP) is known as a strong oxidizing enzyme with promising potential in a variety of applications. We introduced a novel enzymatic biosensor using recombinant plant produced MP (PPMP). Our recent study shows that this recombinant manganese peroxidase (PPMP) has promising activity in detecting H_2O_2 as low as 1.3 µM (Izadyar et al., 2019). In this proposal, we outline how we will use this PPMP to develop a biosensor to detect glucose. Even with this new highly active PPMP, challenges in the use of these biosensors remain because of the low efficiency of enzyme immobilization on a solid electrode to keep the sensor active in direct monitoring. At the successful completion of this project, expected outcomes include the following: understanding better the selective, sensing and recognition mechanisms of glucose biosensors, which are classified as emerging biotechnology for micro-level sensing. The applicability of the proposed modified electrode will be tested using hydrophilic polymers to monitor real samples such as blood glucose; having a positive impact for diabetes sufferers.
ABI Mission compatibility: This type of a project fits into ABI's mission of providing meaningful research and projects in medical/health related areas. It is expected that this modified biosensor has potential for applications in bioassays, environmental chemistry, food chemistry and biological applications.
Contributions to the scholarly or creative community: We will integrate research and teaching programs by introducing electrochemical biosensors as a shared educational tool in the undergraduate instrumentation laboratory at Arkansas State University (A-State), Department of Chemistry and Physics, to address emerging real-life problems such as Diabetes mellitus as one of the greatest public health crises. By working on this project, students will modify and apply the proposed electrode to detect glucose. Besides taking advantage of the interdisciplinary research, current students in our group will serve as mentors and role models to

encourage students from underrepresented groups to participate in our programs. This project will also be helpful if a student has plans to pursue graduate studies in areas such a Biomedical Engineering or Biochemistry and related areas.

Troy Camarata, PhD, Assistant Professor, NYITCOM at A-State, tcamarat@nyit.edu, 870-680-8823

1.) a short paragraph describing the research/work the student would be doing
The Camarata laboratory focuses on the genetic and differentiation pathways that create the metanephric kidney, the definitive organ found in mammals, birds, and reptiles. It is poorly understood how the 30 to 40 different cell types that make up the kidney are specified. Understanding how cells are instructed to differentiate during embryonic development will provide key insights into developing novel therapies for kidney repair in acute or chronic kidney disease. The Camarata laboratory uses the zebrafish embryonic kidney system, which is highly conserved to mammals and humans, to study kidney development. The student intern will characterize novel CRISPR/Cas9 induced genetic mutations in genes that are hypothesized to play a role in kidney cell differentiation. Experiments will also be conducted to integrate the genes of interest with specific signaling pathways to determine the mechanism of how specific portions of the kidney are specified.

2.) some description of what the intern would learn and experience if they choose to work with you this summer
The student intern will be able to directly apply concepts in genetics and developmental biology/embryology in the laboratory. The research project includes learning zebrafish husbandry, how to create genetic mutations, and molecular biology techniques such as polymerase chain reaction, gel electrophoresis, and gene cloning. Basic cell biological principles will also be addressed to connect the studied genes with signal transduction pathways to understand how these genes are regulated. To do this work, the student will learn how to manipulate gene expression in zebrafish embryos using microinjection techniques or incubating embryos with specific pathway agonists or antagonists.

3.) details of how your research/project/creative work adheres to the ABI Mission Statement
Kidney disease is the 8th leading cause of death in the State of Arkansas and the state ranks 3rd in the United States in deaths caused by kidney disease. Currently, we have a poor understanding of how the kidney responds to acute kidney injury and how it can lead to chronic kidney disease. Additionally, the only major therapies that exist are dialysis or transplantation, neither of which are long term solutions and they do not reverse disease. Understanding how the kidney develops will provide key insights into new therapies such as progenitor cell transplantations. This research is needed to provide a fundamental understanding so that future therapies have the intended positive outcomes without inducing unintended disease such as cancers.

Synthesis of novel small molecule heterocycles as potent anticancer and antimicrobial agents

Mohammad Abrar Alam, Ph.D., Associate Professor of Chemistry
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In my group, we synthesize small molecules such as pyrazole, thiazole, and androstane derivatives by using readily available starting material and mild reaction conditions. We have generated a library of small molecules to test their potential to treat different diseases. We have found several lead molecules as potent antibacterial and antimelanoma agents.

Students doing their research in my group will get the opportunity to learn to synthesize new molecules by using commercially available substrates and reagents under mild reaction conditions. Based on their interest, students will also get the opportunity to test the compounds against different bacterial strains and several cancer cell lines.

Finding new antibiotics and anticancer agents is extremely important to save lives and alleviate the sufferings of millions of people.

My group's research is in consistent with the ABI mission to improve the health of Arkansans through medical research initiatives.

Lori Neuman-Lee, Assistant Professor, lneumanlee@astate.edu

1.) a short paragraph describing the research/work the student would be doing;
The student will work with the research team to examine the immune and hormonal system of reptiles. Reptiles are some of the most understudied species when examining physiology. We will be collecting blood samples from turtles and snakes from a nearby field station and bringing blood samples back to ABI, where we will use a variety of techniques to measure the health of these animals.

2.) some description of what the intern would learn and experience if they choose to work with you this summer;
Students will learn how to work as a part of a team to answer important questions about animal health. Techniques that students will likely use include making, prepping, and counting blood using smears, running antibody assays, conducting experiments on the cell counter, using microscopy to identify cells, and more. Students will learn how to formulate testable hypotheses and present their findings to small groups.

3.) details of how your research/project/creative work adheres to the ABI Mission Statement.
This research explores an important evolutionary branch of vertebrates. Emerging diseases and public health threats, such as antibiotic resistant bacteria, can be helped by a better understanding of the innate immune system and the effects of hormones have on immunity. Because reptiles represent an ancient branch, further research about the complexity of their immune system can provide novel treatments. These novel treatments would have the potential to help improve the health and lives of Arkansans.

Asela Wijeratne– Assistant Professor, Bioinformatics
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<u>1) Research Project:</u>
Similar to animals, plants get sick by a variety of microorganism, including fungi, bacteria, virus, and oomycetes (fungi-like organisms). Plants fight against these infections using immune responses that trigger a resistance against an invading pathogen. The current research project focuses on studying how soybean plants fight against an oomycete, *Phytophthora sojae*, that causes a Phytophthora stem and root rot (PSR) in soybean. When soybeans are resistant to the pathogen, plants utilize a single gene mediated detection mechanism that can detect the invading pathogen. However, *P. sojae* can evolve to overcome the detection mechanism by modifying its genes. This avoidance leads to the death of soybean plants, causing an annual crop loss of $200 million in the US alone. The focus of this research is to find novel soybean genes that can be used to fight against *P. sojae*. We will use a combination of cutting-edge bioinformatics, and molecular biology tools for our research.

<u>2) ABI Mission compatibility:</u>

Our research aims to address the ABI Mandated Research Areas 2: Bioengineering research that expands genetic knowledge & creates new applications in agriculture/medicine. Our long-term goal is to utilize cutting-edge computational and molecular biological techniques to strategically decipher the components of signal transduction pathways during biotic stress in soybean. This research will help us to learn the fundamentals of the gene regulations and use this information to create new transgenic plants to maximize yield potential while managing diseases caused by plant pests and pathogens.

3) Contributions to the scholarly or creative community:

Interns will have the opportunity to get exposed to a wide variety of techniques in computational biology, construct development, gene editing, plant transformation techniques, plant pathology, and plant phenotyping. These techniques are high in demand by academia and industry and will prepare interns well for their next career move. In addition, interns will learn how to maintain a laboratory notebook, communicate with other researchers and work collaboratively, and present their research work in various meetings.

Philip L. Tew, PhD / JD, Associate Professor of Finance
Office: Room 332B
Direct Line – 870-972-3742; Email – Ptew@astate.edu

1.) a short paragraph describing the research/work the student would be doing: The students will be gathering data on geographic locations (at the census tract area) in Arkansas and southeastern Missouri of the following types of businesses: (a) sellers of fresh fruits and vegetables (grocery stores, farmers' markets, etc), (b) fast food businesses, and (c) convenience stores. From this information, they will determine the following information – density of each of these census tracts as it relates to the above type of businesses, wealth inequality, income levels, percentage on SNAP, health insurance coverage, and vehicle access.

2.) some description of what the intern would learn and experience if they choose to work with you this summer: the students will learn how to gather geographic economic and health-related data, use of geo-graphing, and basic econometric techniques.

3.) details of how your research/project/creative work adheres to the ABI Mission Statement: The long-term research project is to see how proximity to fresh foods (or in the alternative, the proximity to fast food and convenience stores) results in college students making smarter (poorer) financial decisions, by looking at incoming first year students at A-State meal plan purchases and actual usage.

4.) name, title, and contact information: Dr. Philip Tew, Associate Professor of Finance and Director for the Center of Economic Education, 870-972-3742 (office) and email (ptew@astate.edu)

Applications of neural networks to predict disease-gene associations

Dr. Richard Segall, Professor, Department of Computer & Information Technology
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1) Overview:

The gene interactive networks play an important role in understanding the disease causative genes. This project helps students to collect data and apply data mining tools to analyze the ORCS datasets established by BioGRID (Biological General Repository for Interaction Datasets).

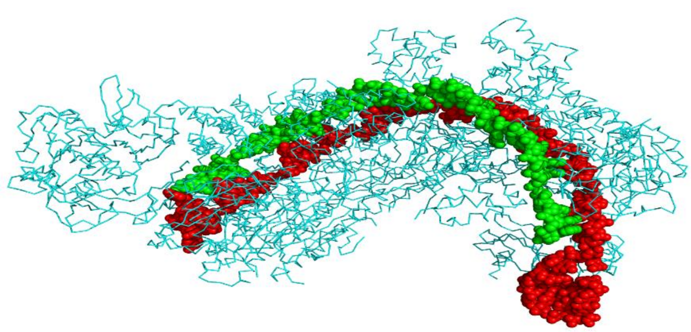
By joining the project, students have the chance to be exposed with an open repository of CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) screens, a technique used to discover important genes from a vast amount of genetic sequence, compiled through comprehensive curation efforts and listing genes linked with diseases such as leukemia or cancer based on different categories. From the biological information aggregated from the analysis, the project aims at predicting disease-gene associations implementing neural networks technique and further assisting with suggesting disease treatments.

The dataset and explanations of the dataset are provided from:

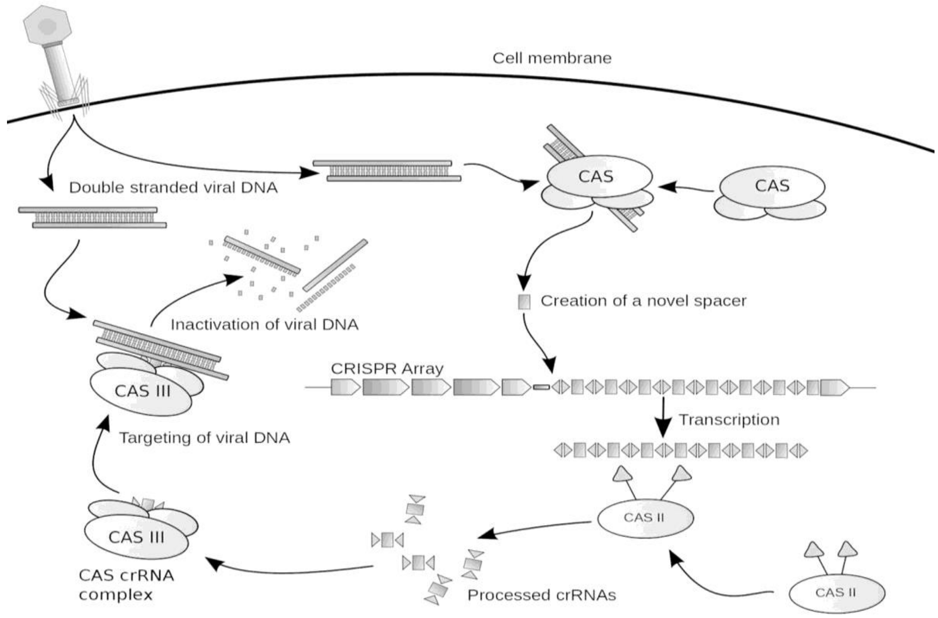
1.) Dataset from https://orcs.thebiogrid.org/
2.) Explanations of the dataset: https://blog.addgene.org/the-open-repository-of-crispr-screens?utm_campaign=crispr&utm_content=113298465&utm_medium=social&utm_source=twitter&hss_channel=tw-82411462

According to Wikipedia (2020) and Barrangou (2015), CRISPR is a family of DNA sequences found in the genomes of prokaryotic organisms such as bacteria and archaea. These sequences are derived from DNA fragments of bacteriophages that had previously infected the prokaryote. They are used to detect and destroy DNA from similar bacteriophages during subsequent infections. Hence these sequences play a key role in the antiviral (i.e. anti-phage) defense system of prokaryotes.

Images of CRISPR are below from



Source: Mulepati S, Héroux A, Bailey S (2014). "Crystal structure of a CRISPR RNA–guided surveillance complex bound to a ssDNA target". *Science*. 345 (6203): 1479–1484. Bibcode:2014Sci...345.1479M. doi:10.1126/science.1256996. PMC 4427192. PMID 25123481



Source: Horvath P, Barrangou R (January 2010). "CRISPR/Cas, the immune system of bacteria and archaea". *Science*. 327 (5962): 167–170. Bibcode:2010Sci...327..167H. doi:10.1126/science.1179555. PMID 20056882.

References:

1.) Barrangou R (2015). "The roles of CRISPR-Cas systems in adaptive immunity and beyond". *Current Opinion in Immunology*. 32: 36–41. doi:10.1016/j.coi.2014.12.008. PMID 25574773.
2.) BioGRID ORCS Database Statistics, Retrieved March 16, 2020 from https://wiki.thebiogrid.org/doku.php/orcs:statistics#crispr_screen_statistics
3.) Wikipedia (2020). CRISPR. Retrieved March 16 2020 from https://en.wikipedia.org/wiki/CRISPR

2) What the student will learn:
Participating in the project, the students have the opportunity to explore and apply data mining and data analysis techniques to discover new information of gene networks. These skills are in high demand in academia and industry and this can prepare students in their career plans. Furthermore, the students will gain knowledge of how genes interact with one another, which can be utilized to provide key information to treat the diseases.

3) ABI mission compatibility:
The project follows one of ABI research areas which is about bioengineering research that expands genetic knowledge & creates new applications in agriculture/medicine. It has aligned with ABI's mission in that the project increases the health of Arkansas through collaboration between faculty and students.