2021 ABI Summer Internship Mentor List

Jonathan M Berman, PhD Assistant Professor of Basic Sciences, NYITCOM-Arkansas, Department of Basic Sciences
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1) SARS-CoV-2 (the virus that causes covid-19) has multiple steps involved in infecting cells. It must recognize a receptor, its S-protein must undergo a proteolytic cleavage event, and it's viral envelope must fuse with the host cell. The proteolytic cleavage domain in the S-protein "RRARSVAS" matches a domain in alpha-ENaC, a subunit of the human Epithelial Sodium Channel, which is cleaved by endogenous proteases. Most likely this allows SARS-CoV-2 to use endogenous proteases such as furin to cleave the S-protein and enter cells. Currently my lab is studying the effects of biological fluid compositions on this proteolytic process. We are also interested in how various conditions that exist in kidney disease effect viral envelope fusion, such as fluid electrolyte compositions, membrane cholesterol content, and body fluid redox state.
2) Interns would be involved in learning various laboratory techniques ranging from pipetting, bacterial culture, cell culture, recombinant DNA techniques, amidolytic assays, as well as general scientific skills such as writing, paper reading for a journal club, note-taking and data analysis and presentation to a scientific team. I expect to show students new techniques in person before expecting them to perform them in the lab.
3) ABI Mission Statement: "to improve the health of Arkansans through new and expanded agricultural and medical research initiatives." This project is in line with the ABI mission statement, with particular regard to 1) improving the health of Arkansans, and 2) being a medical research initiative. This project will help develop a deeper understanding of a disease which has been determined to be a global pandemic by the WHO, and which has infected many Arkansans and killed many others. It has affected the daily life of most to at least some degree.

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Mohammad Abrar Alam – Associate Professor, Department of Chemistry and Physics, College of Sciences and Mathematics
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Synthesis of novel small molecule heterocycles as potent anticancer and antimicrobial agents

In my group, we synthesize small molecules such as pyrazole, thiazole, and steroidal 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. Students will learn a number of techniques for biomedical research such as NMR spectroscopy, Flow cytometry, tissue and bacteria culture, different types of viability assays, and microscopy.

ABI Mission compatibility: Discovery of new anticancer and antibiotics fits in the ABI mission for the improvement of health of millions of people from Arkansas and beyond.

Contributions to the scholarly or creative community: These research projects involve the development of novel compounds as potent anticancer and antimicrobial agents. Due to the multi-disciplinary nature of projects, students will learn and will get hands-on experience in organic synthesis, microbiology, and molecular biology. Students' research experience will be very helpful to pursue graduate studies in Biomedical Sciences and Medicinal Chemistry.

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Dr. Lori Neuman-Lee, Assistant Professor of Physiology
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1) The innate immune system clears the majority of potential pathogens and is required for complete immune system activation, but it is still poorly studied. One way to learn more about the innate immune system is to examine its functioning in reptiles, which rely almost exclusively on this arm of immunity. The Neuman-Lee lab focuses three primary objectives: 1) isolating and identifying reptilian immune cells, 2) examining functional immune responses in reptiles, and 3) testing the influence of different endocrine and environmental factors on the immune response. Students working in the Neuman-Lee lab would expect to gain experience using the flow cytometer and cell sorter, making and processing blood smears, and conducting immunological assays on blood samples.
2) The intern would join an active lab group that emphasizes the benefits of collaboration and teamwork. Any intern would have opportunities to learn skills and techniques outside their direct project, such as handling reptiles, processing blood, sonography, and hormone analyses. The intern would learn about the scientific process, the value of presentation skills, and basic statistical analyses.
3) This work addresses ABI's mission by using innovative methods to study the innate immune system, which can be very difficult in mammalian models. By increasing our understanding of this arm of the immune system, we may be able to better develop therapies and novel approaches to improve health outcomes.

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Troy Camarata, PhD - Assistant Professor, NYITCOM
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Persistence of adult progenitor cells in the reptilian kidney

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 or reverse disease. Developing new treatments, such as cell-based therapies, will be key to reducing the burden of kidney disease. Mammals, including humans, are born with a finite number of functional units in the kidney, called nephrons. If nephrons are damaged, for example from drug induced toxicity or trauma, they can repair and the kidney can compensate for loss of function. However, the damaged tissue does not undergo true regeneration as the human kidney does not possess adult stems cells like those found in other parts of the body such as the intestine. Such acute kidney injury significantly increases the risk for chronic kidney disease and organ failure. Reptiles such as alligators, lizards, and turtles possess a similar type of kidney as humans. Amazingly, the reptilian kidney does possess adult kidney progenitor cells throughout life, suggesting reptiles may be able to truly regenerate damaged tissue. Our lab is currently focused on understanding the embryonic development of the kidney in reptiles using the turtle as a model system. This will allow for a direct comparison of kidney progenitor cells niche between the embryonic and adult turtle kidney. Research within the lab will provide

critical insights into why this progenitor cell population is maintained in reptilian kidneys and not in mammals and may provide a foundation for developing future medical therapies.

Students in the lab will learn fundamental principles of developmental biology, molecular and cell biology, and genetics. Laboratory experiments will include RNA isolation, gene cloning, antibody immune-staining, sectioning, and histology techniques.

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Dr. Richard Segall, Professor of Computer & Information Technology
Department of Computer & Information Technology (CIT)
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COVID-19: Survey of Applications of Neural Network, Machine Learning and other Artificial Intelligence (AI) Techniques for this World-Wide Pandemic

1.) Short paragraph describing the research/work the student will be doing:
Student will participate in providing contents of chapter(s) of book in progress of completing book titled "Biomedical and Business Applications Using Artificial Neural Networks and Machine Learning" contract with IGI Global publishers as described on pre-publication web page with URL: https://www.igi-global.com/book/biomedical-business-applications-using-artificial/270789
Student will primarily conduct web searches for most current world-wide research activities pertaining to Chapters titled "Survey of Applications of Neural Networks and Machine Learning to COVID-19 Predictions" and summarize findings in Tables appropriate for inclusion in final chapter. Additional work could also pertain to "Overview of Multi-Factor Prediction using Deep Neural Networks, Machine Learning and their Open-Source Software."

2.) Some description of what the intern would learn and experience if they chose to work with you this summer.
Student will learn through self-generated searches about the state-of-the-art world-wide techniques and activities for applications of neural networks, machine learning, and artificial intelligence for approaching solutions the COVID-19 pandemic.

3.) Details of how your research/project/creative work adheres to the ABI Mission Statement.
The project aligns with ABI's mission statement in that it "improves the health of Arkansans through new and expanded agricultural and medical research initiatives" by directly pertaining to the COVID-19 pandemic that affects all Arkansans.

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Dr. Jennifer Xie, Assistant Professor, Department of Basic Sciences
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1. Research Project: In light of the national crisis of opioid pandemic, seeking new, non-opioid analgesics as well as non-pharmacological therapies for chronic pain has never been more important. Our *long-*

term goal is to understand the potential mechanisms that lead to pain chronicity and develop new chronic pain treatments. We are striving to work toward this goal to facilitate the discovery of new drug targets that are non-addictive and complementary with minimal side effects to help alleviate patients' sufferings and improve the quality of healthcare. The students joining my lab may choose to take part in one of the ***two main schemes***:

1) Explore the efficacy and mechanism of action of a novel, highly selective antagonist for α9α10 nicotinic acetylcholine receptors (nAChR) in treating migraine.
2) Utilize fetal stem cells and their exosomes to treat nerve injury or spinal cord injury-induced neuropathic pain and functional deficits.

[All projects will be performed in *live* rats or mice.]

2. ABI Mission compatibility: Chronic pain has high prevalence in Arkansans and is the number one reason for patients to see the doctors. The research focus of this internship is on assessing the novel compounds or stem cell-related reagents to tackle neuropathic pain or migraines. This research adheres to the ABI mission to improve the health of Arkansans through new medical research initiatives.
3. Contributions to the scholarly or creative community: We are offering students excellent and unique exposure to *in vivo* biomedical research. Our lab is using comprehensive methods to study the behavior, biochemical, immunohistochemical, and electrophysiological aspects of chronic pain to dissect the mechanisms of migraine and neuropathic pain as well as optimize novel, non-opioid treatment strategies. The students joining our lab will take part in one of these projects and learn any aspects of the relevant techniques. The students are expected to attend weekly lab meetings to discuss the experimental design, review the results, troubleshoot any issues, as well as critique relevant journal articles. Students take active roles intellectually and are offered opportunities to *attend national and international meetings* and present their results (*authorship for abstracts guaranteed*). If sufficient contribution, *authorship for manuscripts will be awarded* as well.

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Viswanathan Rajagopalan, Ph.D. , Assistant Professor,
NYIT College of Osteopathic Medicine at Arkansas State University Faculty, Arkansas State University
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Students in Dr. V. Raj's laboratory get exposure to cutting edge biological/medical technologies in molecular and cell biology, genetics and biotechnology, clinical sciences, biochemistry, physiology, pharmacology, histology, diagnostics, therapeutics, surgery, invasive and non-invasive methods, engineering, etc. Interns learn teamwork, maintaining laboratory notebook and scientific presentation skills. Productive student contributions may also yield opportunities to co-author in presentations beyond the school level. A-State undergraduate students in the lab have won multiple awards including at national and state levels.

The No. 1 cause of death in Arkansas, United States and also worldwide is Cardiovascular diseases. The laboratory investigates mechanisms of cardiovascular disorders and strategies to improve heart health using animal and cellular models. Human-based studies are also emerging. Particularly, a major area of Dr. Raj's laboratory is related to role of novel noncoding ribonucleic acid, ncRNA molecules in cardiovascular disorders associated with hormonal abnormalities using advanced biomedical technologies. Other projects include collaboration with A-State plant products are also ongoing.

In alignment with the ABI's mission, the projects in the laboratory entail improving the health of Arkansas through biological, medical and plant-based research initiatives.

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Kyle Gustafson, Assistant Professor of Parasitology, kgustafson@astate.edu
Tanja McKay, Professor of Entomology, tmckay@astate.edu

The Gustafson and McKay labs invite an undergraduate student to spearhead research on an important parasitic disease transmitted among humans, dogs, cats, and wild mammals. Chagas Disease represents the world's third largest parasitic disease burden after malaria and schistosomiasis, and it is expanding northward into the United States, including through Arkansas. Chagas Disease is caused by the protozoan parasite, *Trypanosoma cruzi*, and is transmitted by assassin bugs in the family Reduviidae. Unfortunately, methods to capture assassin bugs are not well established, limiting our ability to understand the transmission ecology of Chagas Disease. In this project, an undergraduate will test multiple methods to capture assassin bugs. When assassin bugs are captured, microscope slides will be prepared and assessed for various stages (epimastigotes or metacyclic trypomastigotes) of *T. cruzi*. Additionally, DNA from *T. cruzi* will be surveyed from the gut contents of reduviid bugs using PCR methods. This research will spearhead medical research on Chagas Disease in the state of Arkansas, which is currently lacking. Students will learn basics in field epidemiology, parasitological slide preparation, genetic sequencing, and statistics. Additional information about Chagas Disease can be found at https://www.cdc.gov/parasites/chagas/index.html.

This research focuses on an understudied parasitic disease that is expanding into and through Arkansas. By understanding the prevalence of *T. cruzi* in northeastern Arkansas bugs and how to monitor and capture the vector, we will be able to manage this disease in the state. Therefore, this project directly relates to the ABI mission to improve the health of Arkansans through medical research initiatives.

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Dr. Maureen Dolan, 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

Therapeutic Protein Production using Plants as "Biofactories"

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 significantly impacted by the misuse/overuse of antibiotics in livestock production. Our lab team is exploring the utility of plants as biofactories for producing more targeted, safer, protein-based therapeutics as alternatives to antibiotics in controlling disease outbreaks in farmed raised fish (aquaculture) and poultry. Recombinant proteins for therapeutic use in animals often require complex host systems for synthesis. While mammalian cell culture is most commonly used, plants have the capability to synthesize these complex animal proteins similar to an animal cell and thus plants and plant cells have emerged as a viable production platform for therapeutic proteins.

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.

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Asela Wijeratne– Assistant Professor, Bioinformatics
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1) Research Project: 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.

2) ABI Mission compatibility: 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.

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Than Boves, Associate Professor of Ecology
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Nearly all organisms, including humans, are affected by parasites. Parasites, and symbionts more generally (i.e., any organism that interacts closely with another organism), comprise the majority of global biodiversity and are important links in biological systems. Some symbionts can “jump” to new host species and may be a threat to public health. We are exploring how symbionts can “jump” to new host species by studying birds and their feather mites. We are doing so by collecting mites from birds in the field, extracting and sequencing genomic DNA, and using bioinformatics to analyze mite genetic diversity. The student will be given the opportunity to assist in field, lab, and computer work.

Some description of what the intern would learn and experience if they choose to work with you this summer: students will learn to work as part of a team as well as independently to conduct a variety of scientific research – from field work and sample collection, molecular lab work including DNA extraction and quantification of very low amounts of DNA, and bioinformatic analyses to assemble the whole genome, with an emphasis on optimizing data analyses and bioinformatic pipelines. Students will learn to formulate testable hypotheses and present findings in small group settings.

Details of how your research/project/creative work adheres to the ABI Mission Statement: this research explores an important yet underexplored branch of the Tree of Life by investigating how symbionts interact with their hosts. Emerging infectious diseases in wildlife and humans, and other threats to public health, can be mitigated by better understanding the genomic composition of symbiotic organisms. Our novel framework for studying host specificity through molecular work and cutting-edge bioinformatic computational analyses will have the potential to help improve the health and lives of people and wildlife in the state of Arkansas.

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Jason L. Causey, Ph.D., Assistant Professor of Bioinformatics,
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The recent rise in "artificial intelligence" (AI) is already making an impact in healthcare and biological research, especially in areas related to imaging studies. Convolutional Neural Networks (CNNs) in particular have proven human-level or near-human effectiveness in applications such as early diagnosis of cancer in lungs, breast, and skin. CNNs work best when textures and edges in images contain most of the discriminatory information. Contextual cues such as relative position and size of features may be missed by traditional CNNs. The "attention" mechanism is a mathematical technique that allows layers in a deep neural network to incorporate more global contextual information while also keeping the total parameter count of the network relatively small. This relative parameter efficiency could translate into more effective learning with limited datasets.

The goal of this project is to focus on specific aspects of the attention mechanism in the domain of medical imaging. We will seek to determine which imaging modalities respond best to attention models versus CNN or LSTM (Long-Short Term Memory) models. We will also determine which type of model is more robust against adversarial image edits, which provides a framework for understanding ways in which the model could fail in practice.

As part of this internship, a student will gain experience with the broader mathematical foundations of neural networks and more specifically with CNNs, LSTMs, and the attention mechanism in imaging modalities. We will focus on spatial attention in 2D and 3D image analysis. The student will perform experiments to characterize the performance of deep neural network architectures with and without the attention mechanism, and in the presence and absence of adversarial image modifications. The results will be gathered, analyzed, and reported at the conclusion of the project.

This project will help further the ABI's mission by providing insight into the cutting-edge machine learning models utilized to provide assistance to both healthcare providers and researchers. By better understanding not only the underlying mathematical relationships between different deep neural network architectures, and which of these apply best in specific use cases, we will allow future researchers to make smarter decisions about which models to choose for their application. We also hope that by studying the ways in which these models can fail will provide insights that can be used to create more robust models whose failure modes are

more akin to human error so that we can better reason about their mistakes. All of this will help us build trustworthy AI models for analyzing biological systems in the future.

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Andrew Sweet, PhD; Assistant Professor, Department of Biological Sciences
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My lab is interested in understanding the relationships between organisms and their parasites. How have host and parasites interacted over long periods of time? Are certain parasites more likely to switch to a new host? To answer these types of questions, we combine field work, genetics, and computer-based analysis to look at the parasitic lice of birds. As part of this research, an ABI Summer Intern would work on a project documenting the biodiversity of ectoparasites in the Arkansas State Bird Collection. The project will particularly focus on addressing these two questions: 1) do certain species of birds in Arkansas have more lice than others and 2) do birds from certain habitats in Arkansas have more lice than others? The project involves: A) collecting lice from specimens in the Bird Collection, B) documenting and cataloging the lice into a database, C) identifying the different species of lice, and D) analyzing the data to look for patterns related to species of bird, species of louse, and habitat where the bird was collected.

Description of experience: Through this project, the student will gain experience and skills in the following areas: 1) conducting research projects from a hypothesis-driven framework, 2) cataloging and curating specimens for a collection and database, 3) identifying lice using a microscope, 4) preparing microscope slides, 5) learning how to apply appropriate statistical methods to test hypotheses, and 6) learning basic usage of the statistical software R.

Adherence to ABI Mission Statement: This project is consistent with ABI's mission in a number of ways. First, the project will focus on parasites from birds native to and collected in Arkansas. Second, the project will focus on prevalence and transmission of parasites, which can have directly implications for understanding the transmission of zoonotic diseases/parasites to humans. Third, the results from this project could link to understanding how agricultural land use effects parasite diversity.

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Terrance Armstard, Multimedia Journalism Program Instructor, Delta Digital News Service Advisor
A-State SPJ Student Chapter Advisor, School of Media & Journalism
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1) As I mentor, I would help oversee and guide a student to report on health stories within the Arkansas Delta Region. We will be working with Gray Communication—which owns KAIT8 and dozens of TV stations throughout the Midwest, Midsouth and the South—on developing stories related to improving health.

2) The ABI intern would learn various aspects of communication by utilizing multimedia and journalism skills to tell health related stories of the people within the Arkansas Delta. Through practical research and investigation, the intern would discover the effects of sociopolitical constructs upon the lives of the people via law, science and developments of agriculture/agribusiness and medicine.

3) This adheres to the ABI Mission Statement by allowing the intern to discover and developing information, both old and new, and presenting it in a multimedia format accessible to the wider

community by utilizing the Gray Communication partnership. By having the stories broadcast to thousands, and potentially millions of viewers, this will provide the public with potentially new choices when it comes to choosing better healthcare. It is the hope that these 'multimedia broadcast' reports will help improve the health by providing better choices for diet, and modifying behavior such as healthy grocery acquisition within food deserts.

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R. Shea Harris, ABI Outreach Coodinator, AState NASA SPOCS Co-Lead
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1. The selected student would become part of the AState NASA Student Payload Opportunity With Citizen Science (SPOCS) initiative currently working to send an experiment to the International Space Station (ISS) in April 2022. As team member, the student would conduct hands-on, basic research in wax worm degradation of plastic in microgravity environments.

2. The selected student would join a peer-aged team made of AState undergraduate students in biology and engineering programs. Basic learned skills would include laboratory data collection/analysis, critical thinking skills, and science communication. Specifically, the student would learn entomological skills in wax worm (*Galleria mellonella*) cultivation, chemical analysis and bioassays of common household plastic degradation, and solving engineering challenges associated with microgravity environments.

3. NASA's history in developing and advancing medical technologies such as CT imaging, artificial heart valves etc. is well documented and aligns to ABI's mission to improve the health of Arkansans with initiatives in agriculture and medicinal research. Specifically, AState NASA SPOCS project contributes to the understanding of a possible solution to plastic pollution on Earth. This includes micro plastics pollution in Arkansas's watersheds and pristine natural resources. Also as a natural predator to beehives, wax worm lifecycle and control research is invaluable to Arkansas's thriving apiary industry and the agricultural crops they pollinate.

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.