2018 ABI Summer Internship Mentor List

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

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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 summer 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.

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

Bioproduction of medicinal compounds from plants

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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 Summer Internship Program will work specifically with hairy root cultures of peanut to produce a class of biologically active natural products known as stilbenoids. These compounds have potential applications in cancer, obesity and Alzheimer's disease. The interns will be involved in different aspects of the research including production, analysis and purification of stilbenoids in hairy roots, and assessing their bioactivity with breast cancer cells.

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 team and how to present the results of the research in laboratory and scientific meetings. In addition, the interns will learn how to communicate the research to the general public.

The Summer internship research will specifically address the production and bioactivity of novel plant compounds that have potential applications as preventive and therapeutic agents for cancer and obesity. 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.

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Research in the Xu lab aims to effectively produce recombinant proteins of potential pharmaceutical or industrial applications (e.g., vaccines, interleukins and enzymes) with plant cell/tissue culture. The ABI intern will make two or three gene constructs encoding an important growth factor that stimulates the proliferation and differentiation of human stem cells. The intern will stably transform the gene constructs into tobacco cells and characterize the gene expression. The intern will purify the recombinant growth factors from tobacco cell culture media and test their functions.

The intern will learn standard molecular cloning technique; plant cell culture and genetic transformation; recombinant protein detection such as Western blotting and ELISA, mammalian cell culture, etc.

My research exploits plant cell/tissue culture as a safe and cost-effective bioproduction "factory" to produce protein therapeutics, such as antibodies, vaccines, interleukins and enzymes. It supports the ABI Mission Statement to "improve the health of Arkansans through new and expanded agricultural and medical research initiatives". Successful completion of ongoing or upcoming projects will facilitate availability of high-quality low-cost protein therapeutics to the state and to the country. Particularly, ABI at A-State selects "Plant-based production of medicinal molecules" as one of major research growth areas and my research projects dovetails nicely with this effort.

Therapeutic Protein Production using Plants as "Bio-factories"

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Undergraduate research scholars joining our lab will be a part of a dynamic research team that includes undergraduate and graduate researchers focused on using plants as "factories" and recombinant DNA techniques to produce animal therapeutic proteins. An important issue in human and environmental health is development of antibiotic resistance that is contributed through the use of antibiotics in livestock production. Our lab team is exploring the utility of plants for producing more targeted protein-based therapeutics as alternatives to antibiotics in controlling disease outbreaks in farmed raised fish (aquaculture) and poultry. 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, 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 that serves an important the aquaculture industry regarded as an important agriculture sector in Arkansas.

Treatment of an Agricultural Waste and its Use as a Sustainable Construction Material to Improve Health of Arkansas Citizens

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In this research, toward a sustainable use of an agricultural waste and reduce future health hazards of Arkansas citizens, students will be examining and treating very poor quality rich husk ash (RHA) generated by Riceland Foods Inc., headquartered in Stuttgart, Arkansas. Treated RHA is expected to be useful as a construction material of roadway projects throughout Arkansas. Students will consider selected treatment techniques (mechanical, thermal, and chemical approaches) that have been identified by the PI's research team. The quality of the treated RHA will be assessed by evaluating their surface properties through fundamental science approaches by their evaluating physiochemical and mechanistic properties. In this regard, properties such as specific surface area and surface free energy properties will be estimated from laboratory experiments. Fabricated concrete specimens will be examined to find defects and anomalies by overserving them by using microscopy techniques.

Interns will work in the laboratories to treat the bulk RHA by following mechanical, thermal and chemical techniques. They will then test the treated RHA samples for evaluating their surface properties. Testing tools such as (BET Brunauer–Emmett–Teller) analyzer and Optical Contact Angle (OCA) analyzer will be used by the students. Students will also visit Riceland Foods Inc. plant located in Stuttgart, AR to get a first-hand knowledge to understand the problem and know their current production process. Students will use Microsoft Excel tool to plot and visualize the research data and use statistical tools such as MiniTAB to perform statistical analyses of research data. Students will also have opportunity to present their research findings at a local or regional conference or symposium.

The proposed research adheres with the ABI mission "to improve the health of Arkansans through new and expanded agricultural and medical research initiatives." RHA is an agricultural byproduct. It is yielded during the burning process of rice hull. RHA with more than 80% silica content in the form of non-crystalline silica is produced when it is burned below 700^{o}C. This high silica percentage can make RHA a sustainable replacement of ordinary Portland cement. During the husking process of paddy, about 30% rice hull is produced. During the burning process, about 20% of it converts into RHA.

The worldwide annual production of paddy is about 738 million tons, which generates about 40 million tons of RHA. Improper disposal of this huge amount of non-biodegradable RHA may cause environmental havocs. On the other hand, cement industries are responsible for about 7% of the total equivalent CO_2 emissions. Riceland Foods, Inc., a farmer-family owned business, is the largest rice miller in the U.S. It produces about 125 million bushels of paddy/year, which generates a huge amount of RHA. Generally, Riceland considers RHA as a waste product and stores it to nearby custom-designed landfill, which is an economical burden to the company and poses serious health threats to local communities. This RHA contains about 70% amorphous silica that makes it a potential source of pozzolanic material, which can be used as a replacement of cement. But, its application as a pozzolanic material in concrete was not investigated yet other than the PI's recent work, which revealed that RHA produced by Riceland is significantly coarser than the ASTM specifications. Further, Riceland's RHA contains some impurities such as high loss of ignition and high unburned carbon. Use of RHA in substitution of cement can reduce the CO_2 footprint as well as ecological hazards in Arkansas. Once a chemist of Riceland Foods Inc. mentioned, "This project is very important to the farmer-members of Riceland Foods." And, "During this time of severe economic distress for farmers it is important to add value

to their crops.” By the use of this waste product by contractors and transportation agencies, this project is expected to improve the health of citizens and farmers in Arkansas. This project is also expected to help local farmers to be economically sustainable.