2020-21 ABI Undergraduate Research Scholar Mentor List

Mohammad Abrar Alam – Associate Professor, Department of Chemistry and Physics, College of Sciences and Mathematics
Contact Info: malam@astate.edu; 870-972-3319, Office: LSW 339C

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

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. 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.

= = = = = = = = = = =

Emily Bellis – Assistant Professor, Bioinformatics, ABI & Department of Computer Science
Contact Info: ebellis@astate.edu; 870-972-3979, Office: ABI 202

Research Project: Understanding antimicrobial resistance in soil microbiome communities

Antibiotic resistance is a major threat to human health, with more than 2.8 million antibiotic-resistant infections per year in the U.S. alone. Antibiotics are an important part of the ecology of microbes, used for competition, defense, and subduing prey or hosts. Exchange of antibiotic resistance genes (ARGs) between clinical pathogens and soil bacteria suggests the environment can be a reservoir for novel ARGs of clinical importance. The goal of this project is to understand the potential role of interactions among soil microbes in shaping the diversity and distribution of ARGs in Arkansas soils. Soil microbiome diversity will be characterized in a unique model system for investigating microbial interactions: tallgrass prairie restorations. In Arkansas, tallgrass prairie once covered over 700,000 acres, but less than 0.5 percent remain today. Older restorations are generally characterized by fungal-dominated communities but bacteria are more abundant in less mature restorations. Higher fungal:bacterial ratios are associated with increased carbon storage and soil health. The student will gain experience comparing communities of bacteria and fungi from soil samples collected at different sites. These differences can then be linked to presence/absence of diverse ARGs. While this is a primarily bioinformatics-focused project based on already sequenced samples, there is additional opportunity for the student to contribute to soil collections and DNA extractions planned by collaborator Dr. Jeff Shaver at University of Arkansas Fort Smith in early 2021, depending on interest. This sampling effort will contribute to a

long-term temporal dataset of soil microbiome communities over several years of the tallgrass prairie restoration project in Ben Geren Park (Fort Smith, AR) and virgin remnants of Massard Prairie.

ABI Mission compatibility: The project is compatible with the ABI mission and its outcomes are relevant to both agricultural and medical fields. Better understanding soil microbial interactions has important implications for managing ecological interactions, such as mitigating spread of antibiotic resistance or managing other traits of soil microbiomes. For example, if ARGs are less abundant in mature restorations, results from this study could suggest that increasing diversity and abundance of soil fungi, such as through no-tillage or reduced tillage practices, could also help limit spread of ARGs in agricultural environments.

Contributions to the scholarly or creative community: Improved understanding of species interactions is critical to informing potential management of these interactions for desired outcomes in biomedical, agricultural, and other fields. The proposed project will be an excellent chance for the student to learn about many different facets of microbiome communities in a diversity of environments. The student will gain experience with independent research and data analysis skills that would translate well to a broad variety of health, industry, and other professions. This experience would also be highly applicable to future study in a diversity of fields including computational biology, ecology, agriculture, and biomedical sciences.

= = = = = = = = = = =

Jianfeng Xu – Professor, Arkansas Biosciences Institute
Contact Info: jxu@astate.edu; 870-680-4812, Office: ABI 306

Research Project: Engineering designer biologics in plant cells for oral treatment of inflammatory bowel disease (IBD)

Inflammatory bowel disease (IBD), including two major subtypes Crohn's disease and ulcerative colitis, is an autoimmune inflammatory disease of the gastrointestinal tract system that affects ~7.0 million people worldwide. Currently available therapies fail to control the symptoms adequately in a significant number of patients. Since IBD, particularly ulcerative colitis, predominantly affects the colon, colon-targeted oral drug delivery systems have received significant attention for the treatment of IBD. This project aims to develop a new class of low-cost and effective plant cell-produced oral biologic drugs to treat IBD. Specifically, a designer tumor necrosis factor alpha (TNFα) inhibitor molecule consisting of a human TNFα receptor (TNFR) fused with the Fc domain of a human antibody will be designed and expressed in tobacco BY-2 cells. The protection, drug release and bioactivity of the plant cell-capsulated TNFR-Fc in gastrointestinal tract will be investigated in vitro in simulated gastric fluids and simulated intestinal fluids. The therapeutic effectiveness of the orally administrated designer anti-TNFα biologic in mitigating the IBD symptom will be assessed in a dextran sulfate sodium (DSS)-induced colitis mouse model.

ABI Mission compatibility: This project adheres to ABI's mission statement "to improve the health of Arkansans through new and expanded agricultural and medical research initiatives". It leverages the synthetic biology and genetic engineering techniques to create a new plant cell-based oral drug for the treatment of IBD. The ABI at A-State selects "Plant-based production of medicinal molecules" as one of major research growth areas and this project dovetails nicely with this effort.

Contributions to the scholarly or creative community: This project will potentially provide a new platform for the cost-effective production of oral biologic drugs with improved efficacy for treating IBD treatment and other diseases in the colon. It is a highly interdisciplinary research project that will provide an excellent training venue for the student. The extensive hands-on research experience will stimulate the interest of student in pursuing a career in biomedical sciences.

= = = = = = = = = = =

Dr. Fabricio Medina-Bolivar - Professor of Plant Metabolic Engineering, **Department of** Biological Sciences
Contact Info: fmedinabolivar@astate.edu; (870) 680-4319; Office: ABI 308
Lab website: https://www.fabriciomedinabolivarlab.com

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.

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.

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. Philip Tew – Economics and Finance
Contact Info: ptew@astate.edu; 972-3742; Office – Business 332B

Research Project:

Health Literacy has been defined as "the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions." A primary component of making "appropriate health decisions" is understanding health insurance including basic knowledge, terms, and the ability to evaluate the best health plan for the person. The average American spends approximately $5,000 on health care between insurance premiums and out-of-pocket costs, which amounts to approximately 12.5% of their average income. The vast majority of first-year college students begin college directly out of high school where they were financially, and insurance-wise, supported by a

family member or legal guardian. This research proposes to analyze the financial and insurance knowledge of first year students and its implications on their current and future health literacy.

Relationship with ABI Mission Statement:

ABI's primary mission centers on the health of Arkansans. This research focuses on first year college students and their ability to make appropriate health decisions based on their knowledge and evaluation skills in regard to health insurance plans. Failure to properly understand and evaluate health insurance plans can and will lead to incorrect health decisions for these students later in their life.

Contributions to Scholarly Community:

There has been prior research that has looked at health literacy, and a smaller body of work that looked at health care literacy with even much smaller research focused on health care literacy and college students. No prior research has focused on students newly "on their own" to determine their knowledge of health care literacy as well as any drivers that may cause differences in this knowledge. This will allow Universities, through their financial literacy programs, to focus workshops on students and areas whose expenses are likely to make up 10% or more of the students' future incomes.

= = = = = = = = = = =

Dr. Sudeepa Bhattacharyya
Contact Info: sbhattacharyya@astate.edu; 972-3712; Office – ABI 309

Research Project:

My research interest is in mental health disorders which has currently reached epidemic proportions in the US and around the world. Major Depressive Disorder (MDD), commonly known as mental depression, is one such disorder that affects millions of people annually in the US. So far, no clinical tests are available for diagnosis of MDD. Our research focuses on detecting biomarkers and gaining mechanistic insights into the disease using a data-driven approach. We collect multimodal patient data such as genetics, metabolomics, imaging, clinical and demographic data and using data science approaches we aim to understand the inner workings of the disease in these patients. We have published several manuscripts on our findings and several more projects are in the pipeline for further research. From a public health research perspective, we are also looking into mental health disorders prevalence among different populations in AR, such as children, young adults, elderly, women and other minority population and how treatment/therapy/care are being utilized by these subgroups of patients. Understanding these parameters are of utmost importance for implementing effective health policies in the state.

Compatibility with ABI mission:

My research projects that aim at investigating biomarkers and gain mechanistic insights into mental health disorders as well as understanding how these disorders impact different sections of the population in AR, perfectly aligns with ABI's mission to improve the health of Arkansans through new and expanded medical research initiatives.

Contributions to scholarly community:

Students participating in these research projects would learn how to make sense of patient data by managing, processing, analyzing data, interpreting results and presenting findings using powerpoint slides in meetings within and outside A-state. If manuscripts materialize from the research work, which we strongly believe would happen, student contributors will be included as co-authors in the manuscript.

= = = = = = = = = = =

Dr. Viswanathan Rajagopalan, NYIT Assistant Professor
Contact Info: vrajagopo@nyit.edu; 680-8822; Office – Wilson 144

Research project:

The leading cause of death in the United States, in Arkansas, and worldwide are all Cardiovascular disorders. In addition, the most common associated disorder in the ongoing COVID-19 pandemic is cardiovascular disorders. Dr. V. Raj's laboratory investigates both mechanisms of cardiovascular diseases and strategies to improve cardiovascular health. Diverse set of samples employed include molecular, cellular, live animal (since 2017), human, etc.

Various types of diseases studied include, but not limit to, heart attack, heart muscle disease, heart failure, associated disorders such as hormonal disorders, obesity, diabetes, high blood pressure, etc. New projects are also emerging. Publications and other information are available at nyit.edu/bio/vrajagop

Compatibility with ABI mission:

With combined expertise in both biological and clinical aspects of the leading killer of Arkansas, the laboratory's goals directly aim to improve the health of Arkansans through new and expanded medical and plant-based initiatives. The diagnostic and therapeutic agents being studied and developed are expected to benefit our state and beyond.

How will this contribute to the scholarly or creative community:

Students in the laboratory have successfully presented, won multiple awards and have published in leading journals. The students get opportunities to learn and work with cutting-edge biological/medical technologies in molecular biology, physiology, genetics, biochemistry, pharmacology, biostatistics, histology, bioinformatics, etc. Students learn how to maintain laboratory notebook, teamwork and communicating scientific findings. Productive student contributions can yield opportunities to present in local, national/international conferences and co-author in publications that also positively impacts the scholarly biological and medical community.

= = = = = = = = = = =

Asela Wijeratne– Assistant Professor, Bioinformatics
Contact Info: awijeratne@astate.edu; 870-972-3311, Office ABI 303

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.

= = = = = = = = = = =

Drew Fleming – Assistant Professor, Mechanical Engineering, College of Engineering & Computer Science
Contact Info: rofleming@AState.edu; 870-972-3743, Office: ABI 201

Research Project: Development of Functional Coatings for Energy and Biomedical Applications

Surface engineering is a cutting-edge scientific field which entails the strategic modification of material surfaces to impart functional properties that are not observed in bulk materials. These modifications span length scales from the nanoscale to the macroscale, utilizing both additive and subtractive processes such as coatings, surface patterning/texturing, and chemical functionalization to realize enhanced mechanical, optical, electrical, and chemical properties, among others. This control of surface properties, and therefore surface interactions, is a powerful and exciting approach for designing materials with unique properties and adds another facet to the role of material selection in engineering design. In this project, functional surface coating technologies will be developed using a combination of aqueous nanoparticle dispersions and sol-gel chemistry, with a goal of producing coatings with unique functional properties. Of particular interest are coatings with enhanced optical properties, modified surface wettability, adhesion control, photocatalytic activity, and combinations thereof. Development of these coatings will support a variety of applications, including anti-bacterial surfaces, bone integration in medical/dental implants, water harvesting, and anti-soiling/self-cleaning surfaces.

ABI Mission compatibility: This project is related to ABI's mission to support medical research initiatives, especially the development of anti-bacterial surfaces and coatings for medical/dental implants. Successful

development of the proposed coating technologies will facilitate high-impact collaboration opportunities at both Arkansas State and external institutions.

Contributions to the scholarly or creative community: The proposed project is synergistic with existing federally-funded research in my group on anti-soiling mechanisms for energy applications. Beyond the proposed coating development work, the Undergraduate Research Scholar will be exposed to nanoscale surface characterization techniques, X-ray surface analysis facilitated by DOE National Labs, and supporting materials modeling using high-performance computing facilities. The Scholar will benefit from this unique breadth of research activity by giving them direct experience with a variety of different research areas, which will be appropriate for students planning graduate studies in engineering, chemistry, physics, and materials science.

= = = = = = = = = = =

Dr. Maureen Dolan, Therapeutic Protein Production using Plants as "Bio-factories"

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 new project in the lab is in collaboration with Dr. Susan Motts in Physical Therapy, using a rat model for wound healing. The project entails looking at the gene expression profile of infected wound sites with the goal of testing our plant made therapeutic as a topical antimicrobial and wounding healing treatment.

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, animal cell culture and microscopy and gene expression (RTqPCR). 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