Women in Science Enabling Research Faculty Research Proposal

Faculty Name and Department: John Kelly, Department of Biology
Project Title: Can Microplastics Increase Antibiotic Resistance in Bacteria?

1) Please provide a short discussion of your research agenda and goals for Summer 2024.

Rivers and streams are some of the most important ecosystems on earth. They provide us with important resources, including freshwater and food, which is why humans throughout the world often live in close physical proximity to rivers and streams. Pharmaceuticals (including antibiotics) and microplastics are common contaminants that are both frequently detected in urban rivers and streams due to human use of pharmaceuticals and products that contain or produce microplastics. Many antibiotics readily adsorb to microplastics due to their hydrophobicity and high surface area, resulting in high antibiotic concentrations on microplastic surfaces. Bacteria also attach to microplastic surfaces in freshwater ecosystems, which could increase the exposure of these bacteria to antibiotics and potentially increase their development of antibiotic resistance. Antibiotic resistant bacteria are a significant risk to public health because they are difficult to treat when they cause infections. In this project the student will use quantitative polymerase chain reaction (qPCR) to measure the abundance of several antibiotic resistance genes in bacteria growing on the surface of microplastics experimentally exposed to antibiotics in artificial model streams to determine if the presence of both bacteria and antibiotics on the microplastic surfaces increases the frequency of antibiotic resistance genes. This study will improve our understanding of the potential risks associated with these two common stream contaminants, pharmaceuticals and microplastics.

2) In what capacity will the student participate in your project? What tasks might the student be expected to complete and what skills might be required of the student?

The student will be responsible for measuring the abundance of several antibiotic resistance genes using qPCR. This will require extraction of DNA from the bacteria growing on the microplastic samples using a commercial extraction kit, analysis of this DNA by agarose gel electrophoresis, quantification of resistance genes using qPCR, and analysis of qPCR results. The student will be trained in all the necessary techniques and will work in collaboration with Dr. Kelly and other students in the Kelly lab.

3) Provide a short paragraph including both personal and professional biographical information.

I obtained my B.S. degree in Biology from Dartmouth College in Hanover, NH, and my M.S. and Ph.D. degrees in Environmental Microbiology from Rutgers University. I worked at Northwestern as a post-doctoral fellow for three years, and I joined Loyola as a faculty member in the Biology Department in 2001. Here at Loyola, I teach General Biology (BIOL 101) and General Microbiology (BIOL 302), and I have an active research lab that includes both graduate students and undergraduate students. My research generally focuses on the impacts of human activities on the structure and function of bacterial communities in the environment, with a focus on aquatic habitats. You can find more information about my work on my lab website (http://kellymicroecolab1.wix.com/kelly). I live in the city of Chicago in the Andersonville neighborhood, which is just a few miles south and west of Loyola. I live with my wife Eva, my 15-year-old son Liam, and our dogs Charlie and Hank. Charlie is a 6-year-old labrador retriever and Hank is a 9-month-old St. Bernard.

Women in Science Enabling Research
Faculty Research Proposal

Faculty Name and Department: Jennifer Mierisch, Department of Biology

Project Title: Exploring the genetic mechanisms regulating gametogenesis

1) Please provide a short discussion of your research project and goals for the Summer of 2024.

Continued species propagation hinges on the ability of males and females to produce quality sperm and eggs via the process of gametogenesis. The development of sperm and egg occurs via a stepwise process that begins with a germline stem cells that divides mitotically, undergoes meiosis, and completes maturation. This process requires supporting somatic cells that signal to the developing sperm and egg to ensure its proper development. Defects in signaling between the somatic support cells and the developing sperm and egg can arrest this process and lead to infertility. Therefore, characterizing the signals sent and received by each cell type and identifying the downstream outputs of these signals is needed to understand the infertility can arise. My lab is particularly interested in the role of Notch signaling in gametogenesis. Notch signaling in the somatic support cells is needed to promote proper sperm development, but how it indirectly regulates in the developing sperm is unclear. The importance of this pathway is highly conserved across species.

In our studies, we are utilizing the fruit fly to examine the role of the Notch signaling pathway, due to the short generation time and numerous genetic tools available in this organism. We recently examined the effects of increasing and decreasing Notch signaling in the somatic cells of the testes and have identified numerous potential downstream targets of Notch signaling, allowing us to determine how defects in Notch signaling lead to infertility. We will genetically manipulate the expression levels of these potential Notch target genes to characterize their roles during spermatogenesis. Students will generate flies with decreased and/or increased levels of potential targets and will dissect testes to analyze the process of spermatogenesis by immunofluorescence assay. These studies will allow us to identify the specific stages of sperm development requiring the function of the target genes. We expect these studies to result in the identification of previously uncharacterized regulators of spermatogenesis.

2) In what capacity will the student participate in your project? What tasks might the student be expected to complete and what skills might be required of the student?

Students will learn how to perform each step of the project, from genetics to acquire flies of the required genotype to tissue dissection and processing, sample visualization on the confocal microscope, and data analysis. Students will work alongside Dr. Mierisch and other students in the lab to learn each step and will progressively work toward performing the procedure independently, based on their comfort level. Students need only have an interest in research to get started, as all other skills will taught through the course of the project.

3) Provide a short biographical paragraph to introduce yourself to students. Please include both personal and professional information.

Since I was an undergraduate student, I have been interested in how cells signal within and to each other to regulate basic cellular processes. I started with studying the signals that promote endocytosis in yeast and later moved up the food chain to studying the signals that promote the development of different cell types during organ development in the fruit fly. My lab is currently exploring the cell signaling mechanisms that occur between different cell types to promote gametogenesis in the fruit fly, as fertility is critical for species propagation. We use a variety of approaches from genetics to immunohistochemistry and microscopy to examine how genes function to regulate gametogenesis. Outside of the lab I enjoy reading, traveling, and spending time with my husband and two sons and our menagerie of pets.

Women in Science Enabling Research
Faculty Research Proposal

Faculty Name and Department: Robert G. Morrison, PhD, Psychology/Neuroscience

Project Title: Enhancing Creativity using Electrical Brainstimulation and Scalp Electroencelphalography

1) Please provide a short discussion of your research agenda and goals for the Summer of 2024.

Creative thinking involves generating and evaluating new ideas in response to a problem. Generation of new ideas, or divergent thinking has recently been shown to correlate with activity in the default mode network (DMN) of the human brain. This project seeks to demonstrate the causal role of the DMN in divergent thinking and the creative process and investigate whether non-invasive transcranial electrical stimulation can be used to enhance these processes. To do this we will use Transcranial Alternating Current Stimulation (tACS) along with Scalp Electroencephalography (EEG) to alter DMN activity and connectivity while people perform creativity tasks. We will monitor their brain activity during this with EEG and see whether changes in EEG activity as a result of brain stimulation are related to changes in creativity.

2) In what capacity will the student participate in your project? What tasks might the student be expected to complete and what skills might be required of the student?

Our WISER student will be working with Dr. Morrison and other members of the CAN lab to collect data from human participants using electrical brain stimulation and scalp electroencephalography (EEG). They will complete CITI training on how to work with humans ethically in experiments as a part of this experience. Students will also be exposed to the analysis of these types of data. Prior experience with psychology (AP Psychology in High School or PSYC 101 at Loyola) or Neuroscience (High School or NEUR 101 at Loyola) would be an advantage as would some prior experience collecting data from humans, but none of these things are strictly necessary if the student is interested in participating in Psychology and/or Neuroscience research and willing to learn. Cognitive/Behavioral Neuroscience Majors preferred.

3) Provide a short paragraph including both personal and professional biographical information.

Robert G. Morrison, PhD, Associate Professor of Psychology and Neuroscience uses behavioral, computational, neurostimulation and neuroimaging methods to investigate memory and reasoning throughout the lifespan. He has published numerous scientific articles and chapters, edited books for Cambridge and Oxford University Press and received a number of grants for his research. Bob enjoys his time in the classroom and lab where he has taught and mentored many talented students who have gone onto exciting careers in science and medicine. He received the Edwin T. and Vivijeanne F. Sujack Award for Teaching Excellence in 2013 and the Langerbeck Award for Undergraduate Research Mentoring in 2012 and became the Undergraduate Program Director for the Department of Psychology in 2016.

Bob lives with his wife and step-children (17 and 19) in the South Loop. He was initially attracted to cognitive science while he was a full-time artist and continues to love to take photographs and occasionally exhibits his work (studiotheia.com). He's also a huge music fan and audio geek thanks to his dad. Bob is also a certified yoga teacher and enjoys practicing yoga and meditation every day.

You can learn more about Dr. Morrison and the Cognitive & Affective Neuroscience lab (canlab.org) on the web.

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Women in Science Enabling Research
Faculty Research Proposal

Faculty Name and Department: Ken Olsen, Department of Chemistry and Biochemistry

Project Title: Molecular Dynamics of Drug-Protein and Drug-Polymer Interactions

1) Please provide a short discussion of your research project and goals for the Summer of 2024.

The projects in my laboratory are computational simulations of molecular interactions. We are working with several systems simulating how small molecules bind to proteins or to po[ymers. . In the past we have studied the binding of gasses to globin proteins like hemoglobin and myoglobin and metal ions to the signaling protein calmodulin. We have also examined the control mechanisms of allosteric enzymes and G-proteins involved in signal transduction. These projects have enabled us to develop a new method to study the binding of pharmaceutical drugs to proteins. We want to apply the method to a number of interesting projects, including the design of new antibiotics. We are also interested in drug-polymer and drug-surfactant interactions and their effects on drug crystal dissolution. This is a very important topic for the pharmaceutical industry. The student would learn about computational methods used to both simulate the motions of proteins and other molecules and to display these motions as a movie on her own computer. The simulations would be run on advanced computers in my research laboratory that allow the problem to be broken into many smaller calculations, speeding up the entire process. **No computer programing is required for this project.** All of the programs already exist and are easy to use. The emphasis of the project is on understanding how molecules interact in solution and on crystal surfaces. If the results are as good as previous simulations, the project is likely to lead to a publication.

2) In what capacity will the student participate in your project? What tasks might the student be expected to complete and what skills might be required of the student?

The student would be responsible for her own project within the larger scheme of my laboratory's research. The project would be computational. In this case the student would be using mini-super computers to predict how the properties of a protein change due to binding a small molecule or how drug dissolution is affected by excipients. The analysis of these results could be done at home using the student's computer. I currently have six undergraduate students and one graduate student working in my laboratory during the academic year. They are all doing computational projects. These projects fit into their schedules better than wet chemistry experiments because they do not require her to be in the laboratory at specific times. She can set her own hours to work on the project.. No special skills are assumed before joining the laboratory. I will teach you what you need to know during the summer. If the student continues in my laboratory during the academic year, I will help her apply for Carbon, Mulcahy and Provost scholarships to support her and her research.

3) Provide a short biographical paragraph to introduce yourself to students. Please include both personal and professional information.

I received my BS in Biochemistry from Iowa State University in 1967 and my PhD in Biochemistry from Duke University in 1972. I then did post-doctoral research in protein crystallography at Purdue University for 3 years before taking my first faculty position at the University of Mississippi Medical Center. I moved to Loyola University in 1983 as an Associate Professor of Chemistry. I was promoted to full Professor in 1991 and was Chair of the Department for nine years beginning in 1993. During my tenure at Loyola, I have been a visiting scholar at Harvard, Northwestern and the University of Illinois. I gave up the chair's position in the Summer of 2002 so that I could devote more time to research and teaching. In 2020 I became a Senior Professor (a research-active emeritus professor). My current research group consists of one graduate student and 6 undergraduates. The group will be smaller during the summer because most of the undergraduates are either graduating or are gone for the summer. There will be only a few undergraduates involved in my research during that time period, so that I will have plenty of time to train the WISER fellow. I have published 84 papers on my research, five of which have been published since I retired in 2020.

Women in Science Enabling Research
Faculty Research Proposal

Faculty Name and Department: Martina Schmeling, Chemistry and Biochemistry department
Project Title: Environmental Sampling of Chicago Industrial Corridors

1) Please provide a short discussion of your research project and goals for the Summer of 2024.

Industrial pollution is a common occurrence in many urban areas including Chicago which has been a center of industrial production and a major transportation hub for more than a century. Special zones, known as industrial corridors, have been set aside to accommodate the different industries, but concerns have grown on the pollution these industrial corridors produce and their impacts on the surrounding neighborhoods. Whereas air pollution is being monitored per state requirement, very little is known about soil pollution and how it might affect residential communities in the vicinity of these industrial zones. One way to recognize soil pollution is through the use of bioindicators. Bioindicators are living species, typically plants, that accumulate pollutants within their tissues. When growing and harvested at pollution sites they can indicate the presence of pollutants including heavy metals. Many heavy metals are toxic to organisms when they exceed a certain threshold concentration. Our study seeks to identify the presence of heavy metals within and adjacent to Chicago's industrial corridors and whether their concentrations are above threshold values. To accomplish this, we have been collecting plant and soil samples from locations within the Pilsen, Little Village and Calumet industrial corridors. We are currently in the process of analyzing those for heavy metals.

Our plan for the upcoming summer is to collect additional samples from the same sites to account for annual as well as seasonal variations. We also will obtain plant and soil samples from non-industrial sites such as Loyola's Lake Shore campus for comparison. All samples are going to be prepared for analysis following a predetermined protocol which includes washing to remove surface dirt, drying and crushing as well as digestion in the microwave oven. For analysis we will use atomic absorption spectrometry (AAS) since it can measure very small concentrations of the major toxic heavy metals lead, cadmium, and chromium. The results will then be compared with threshold values and a map made showing the distribution of heavy metals at the different locations.

2) In what capacity will the student participate in your project? What tasks might the student be expected to complete and what skills might be required of the student?

When you decide to join our research group for the summer, you will participate in every aspect of the research related to the project. This will include washing, drying, and crushing collected plants and soil; the digestion of plants and soil using a microwave oven and the analysis of the resulting samples for heavy metals using atomic absorption spectrometry. If needed, you will also help in collecting additional plant and soil samples at the industrial sites and around Loyola's Lake Shore campus. These tasks will help you to get a sense of how a combination of field and laboratory research can aid in identifying environmental concerns surrounding our society. Additionally, you will also hone your laboratory and learn how to operate analytical instrumentation, process raw data, and interpret the results. If you have already acquired some laboratory skills such as pipetting or preparing solutions this will be helpful but is not a must to join us for the summer.

3) Provide a short biographical paragraph to introduce yourself to students. Please include both personal and professional information.

My research interests are focused on the analysis of pollutants in a variety of samples, mostly found in the environmental and biomedical field. Some of my former projects involved the study of air pollution in Chicago and the analyses of beverages for heavy metals. Current research projects are dealing with the identification of trace metals in human cataract lens tissues, heavy metals in vinegars, and as said bioindicators. I am also involved in a long-term study about cleaning and analysis of samples returned from space by the NASA Genesis mission. Each type of sample has its own unique challenge, and our lab tries to overcome those by developing sample preparation methods specifically tailored for obtaining the most optimal procedure.

In my more than 20 years at Loyola, I have taught a variety of courses ranging from freshmen chemistry to graduate level advanced analytical chemistry and honors courses about environmental pollution and climate change. Our lab has a longstanding collaboration with researchers at the Stritch School of Medicine and with members of the Genesis science team.