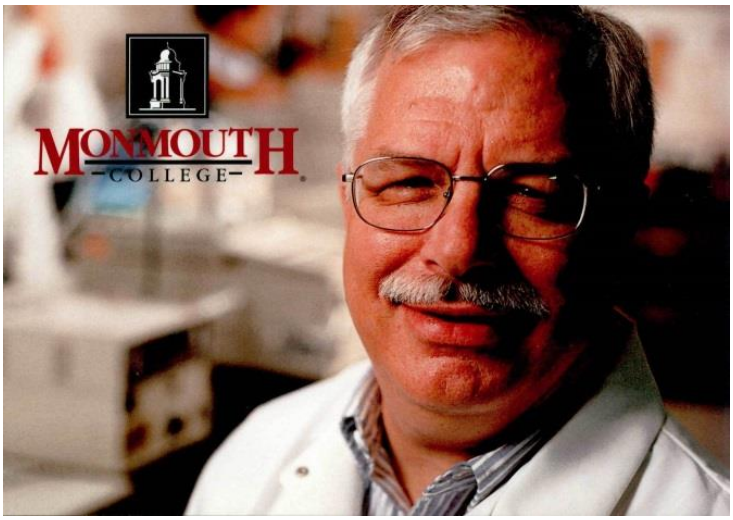
Doc Kieft Summer 2021 Undergraduate Research Talks

July 16, 2021

CSB 100, Monmouth College

starting at 9:45am



Isaac Asplund – Chemistry – Dr. Michael Prinsell

Cal Bigham – Computer Science/Political Science – Dr. Robert Utterback

Riley Bigham – Chemistry – Dr. Brad Sturgeon

Amanda Dybal – Biochemistry – Dr. Laura Moore

Brendan Guenther – Biochemistry – Dr. Audra Goach

Shay Hafner – Data Science/Political Science – Dr. Robert Utterback

Talia Long – Biochemistry – Dr. Laura Moore

Jonathan Oradiegwu – Biochemistry – Dr. James Godde

Gabriela Peterson – Chemistry/Political Science – Dr. Audra Goach

Sreya Roy – Biochemistry – Dr. Michael Prinsell

Jaidlyn Sellers – Biology – Dr. James Godde

Matt W. Simonson – Biochemistry Major – Dr. Brad Sturgeon

Schedule of Events

9:45am-10:00am – Talk Setup – **Refreshments**

10:00am-10:10am – **Introduction/Reflection on Richard "Doc" Kieft (special visitors Dr. Steve Murmann and his father Professor Kent Murmann class of 48')**

10:10am-12:05am – Morning Session of Talks

10:10am-10:35am – **Gabriela Peterson**
Observing Membrane Interactions of American Propolis Constituents with Lipids

Propolis is a plant-derived product of Apis mellifera L., the common honeybee, which they utilize for construction and protection purposes. Propolis decreases the occurrence of mold and bacteria within the beehive. Recent studies suggest that the phenolic fraction of propolis displays bioactivity, including antitumoral, anti-inflammatory, antifungal, antibacterial, and antioxidant properties, among others. Cinnamic acid is identified as a prominent constituent in American propolis, which is scarcely studied compared to propolis from other locations. Cinnamic acid is tested against various lipids from cellular membranes. Lipids are responsible for selective transport as the barrier of the cellular membrane. Changes in cellular membranes are investigated as cinnamic acid is introduced to lipids in several concentrations. The Langmuir trough model membrane system aided in determining that cinnamic acid contains potential for permeating bacterial, fungal, and prevalent lipid membranes. These findings will hopefully enhance pharmacological applications and the importance of propolis. Future research will include testing other principal propolis compounds, such as pinocembrin, against lipids and standardization of American propolis using Gas Chromatography-Mass Spectrometry.

10:35am-10:55am – **Amanda Dybal**
Investigating the Microbial Makeup of Soil

Microbes in soil can essentially determine the health of the environment and growth of the plants which live in the ecosystem. The environment of soil can be studied to isolate the DNA and analyze the bacteria. The goal of this project is to identify specific bacteria in the microbiome that can increase the health of the environment in the soil. Contrasting different soil samples, different bacteria can be analyzed to make conclusions on the health of the environment. Adding the primers to the DNA allows the amplification of the V3 and V4 regions. Before the 16S sequencing can occur, the DNA must be isolated from the samples using kits and amplified using PCR. Using the 16S rRNA gene, the genetic material can be used to identify the bacteria in the sample. The same is done with fecal, oral and many different samples to determine the microbiome.

10:55am-11:15am – **Sreya Roy**
Role of Chalcones in Preventing αβ Plaque Formation in Alzheimer's Disease

Alzheimer's, a degenerative disease commonly observed in the elderly population, affects the ability of a person to recall recent events and results in other neurological disorders, such as problems with language and disorientation. Research suggests that Alzheimer's Disease (AD) is caused when the concentration of the enzymes acetylcholinesterase (AChE) and butyrylcholinesterase (BuChE) are abnormally high. This can lead to a decrease in the concentration of the neurotransmitter acetylcholine and the formation of αβ plaques. It is believed that inhibiting these enzymes could decrease the formation of these plaques in the brain, slowing the progress of AD. Chalcone derivatives, which are AChE inhibitors, are easy to synthesize and can be constructed with a broad range of functionality. This is accomplished via an Aldol Condensation using a ketone and an aldehyde. Products are purified using column chromatography, the reaction is monitored using High Performance Liquid Chromatography (HPLC) and verified using Nuclear Magnetic Resonance (NMR). A future goal of this project is to test pure products on model organisms which contain αβ plaques.

11:15am-11:40am – **Cal Bigham and Shay Hafner**
Improvements to an Online, Interactive Text Analytics Dashboard for Academics

Text analytics, including machine learning, can be an extremely powerful tool when used alongside traditional literature research methods. The overall motivation of this project is to make this type of text analysis accessible to more people within and outside academia, by making it usable from any web-connected device and allowing powerful machine learning capabilities. Our goal is to use the existing tool for several real-life case studies, in the process testing it and adding features to improve usability, flexibility, and interactivity.

11:40am-12:05pm – **Matt W. Simonson**
Alternative Mechanism of Acetaminophen Induced Hepatotoxicity

Acetaminophen (APAP) is a common analgesic and an active ingredient in many painkillers such as Tylenol and Percocet. APAP misuse can lead to Acetaminophen Induced Liver Injury (AILI), which accounts for a striking proportion of acute liver failures in the United States. Better understanding of how APAP toxicity disseminates can provide insight on alternative treatments for APAP overdose. Research in our group is focused on characterizing the potential mechanism of a one electron oxidation cascade catalyzed by cytochrome P450s (CYPs) under saturated glutathione conditions with the goal of better understanding the pathophysiology behind AILI. This has been investigated by using Horseradish peroxidase (HRP) as an enzyme to model the effects of CYPs in order to elucidate the radical nature of this proposed oxidation mechanism using Electron Spin Resonance (ESR). High Performance Liquid Chromatography (HPLC) was utilized as well to characterize the oxidation products of this reaction via their differing polarities, which resulted in the acknowledgement of the existence of aqueous insoluble APAP polymers. Further analysis using Nuclear Magnetic Resonance has confirmed the formation of an APAP dimer as one of the early products of this radically mediated polymerization. To investigate this occurrence, cyclic voltammetry and bulk electrolysis were carried out on APAP and flash isolated oxidation products in order to better understand their potential to be oxidized and their resulting reactivities, which is synonymous with their hepatotoxic effects. Our findings have important implications in understanding the potential one electron oxidation cascade by which AILI propagates and deals damage within the liver under times of APAP overdose.

12:10pm-1:00pm – Lunch in the Nutrition Lab

1:00pm-1:30pm – Picture Time

1:30pm-3:10pm – Afternoon Session of Talks

1:30pm-1:50pm **– Riley Bigham**
Understanding the Aquatic Microbiome

The microbiome is a unique set of microbes living in a particular environment. The microbes that make up the human microbiome are established at birth and evolve throughout life. These microbes are essential for our well-being by regulating our immune system, synthesizing vitamins, and protecting us against certain disease-causing bacteria. The demand for new research has risen in popularity in the past 20 years allowing new discoveries connecting the microbes to the human condition. An example is the use of fecal transplants for treating obesity. New developments have allowed us to understand cause and effects from the rich community of microbes within different environments. As with the human microbiome, aquatic systems also contain a unique collection of microbes. The goal of this project is to evaluate the microbes present in aquatic systems and to correlate the presences of these microbes to the overall health of the aquatic ecosystems.

1:50pm-2:10pm – **Brendan Guenther**
Investigating the Surface Molecular Interactions of Cannabidiol with Phospholipids via the Langmuir Monolayer Technique

Langmuir monolayers were used as a model system to investigate whether cannabidiol (CBD) can act as an antibacterial. CBD is a cannabinoid found in hemp and is commonly used to treat anxiety and chronic pain. However, recent animal studies have shown that CBD promotes wound healing. Model membranes formed through Langmuir monolayers allow for the molecular area of cellular membrane lipids, surface active molecules, to be measured as a function of pressure at an air-water interface. CBD has minimal surface activity and can be induced upon a lipid monolayer to determine how it affects the organization of lipids as an indication of its interaction in a cellular membrane. The lipids used in this study include E. coli lipid extract as a model of gram negative bacteria, dipalmitoylphosphatidylcholine (DPPC), and dipalmitoylphosphatidylethanolamine (DPPE). Both DPPC and DPPE are common cellular membrane phospholipids that allow for a systematic investigation of the intermolecular/intramolecular bonding that can help deduce the mechanism behind the possible wound healing effect of CBD. In the future, further investigate of how CBD affects brain chemistry will involve Langmuir monolayer studies with brain lipid extract.

2:10pm-2:30pm – **Talia Long**
Expressing Vanillin Resistant gene in Escherichia coli

With rising climate concerns, many are looking to biofuels to ease our carbon footprint. As of now, current biofuels are inefficient—for example, byproducts of corn ethanol releases a similar amount of greenhouse gases as fossil fuels. Experts have found that the fermentation of lignocellulosic biomass by Escherichia coli produces significantly less greenhouse gases than fossil fuels, proving to be a promising alternative. However, pretreatment of the lignocellulosic biomass tends to create byproducts, such as vanillin, which are toxic to E. coli. This project aims to overexpress and isolate the toxin resistant protein in E. coli which was previously selected to have toxin resistance through directed evolution. Protein expression is measured by comparing the growth of mutated pET11a/Azure D plasmid to the original pET11a plasmid when challenged with vanillin. Expression was controlled with IPTG to maximize the efficiency of the protein production. Successful isolation will allow for identification of the protein and lay groundwork for genetically engineering E. coli for more efficient production of biofuels from lignocellulose.

2:30pm-2:50pm – **Jonathan Oradiegwu and Jaidlyn Sellers**
The Analysis of Coronavirus in Eptesicus fuscus & Myotis grisescens

There is obviously intense interest concerning coronaviruses these days. Prior to the pandemic, however, research on coronavirus diversity was fairly sparse. COVID19 has a single stranded RNA genome of 30 kb, about the size of an average bacteriophage, and its original reservoir is thought to have been in bats. We collected fecal samples from grey bats, Myotis grisescens, in Tunnel Dam cave, Mack's Creek, MO, and from big brown bats, Eptesicus fuscus, in Columbia, MO. After purification of the RNA from the guano, cDNA was made from the RNA using reverse transcriptase, then PCR amplification of the DNA using coronavirus-specific primers was performed. The resulting amplicons will then be separated using gel electrophoresis and sent to UIUC for sequencing. The sequences that we obtain will then be compared to each other, as well as to previously characterized coronaviruses in the GenBank database, by building phylogenetic trees.

2:50pm-3:10pm – **Isaac Asplund**
Formation of Substituted Nitrogen-Nitrogen Bonds

Natural molecules containing Nitrogen-Nitrogen (N-N) bonds have exhibited promising biological activity. The traditional method of synthesizing these substituted N-N bonds is through linearly substituting functional groups onto a protected hydrazine (H_2N-NH_2). This method is inefficient due to the number of steps required to complete the synthesis. In addition, hydrazine is a particularly dangerous compound that is toxic when inhaled, corrosive to the eyes, and easily combusted as evidenced by its role as jet fuel. Due to these factors, a new method is desired. The proposed method utilizes a chlorinated nitrogen compound and a separate deprotonated nitrogen compound to act as the electrophile and nucleophile, respectively, in an S_N2 reaction that forms the N-N bond directly. This method is convergent, allowing for fewer linear steps, which theoretically increases yield in addition to being much safer.