Research at the Capitol- Abstracts

Student: **Christine L. Spartz**

Year: Senior

Department: Chemistry

Mentor: Christer B. Aakeröy and John Desper

Title **Changing the bioavailability of a known cancer drug**

Abstract: One of the main problems which plagues the pharmaceutical industry is related to the optimization of a drug's formulation and delivery, so that its medicinal properties are fully realized and maximized within a therapeutic setting. Successful drug development hinges greatly upon the physical properties of the active pharmaceutical ingredient, such as thermal stability, solubility, and particle shape. Far too often a particular drug will never be brought to the market, not because it is toxic or because it has low efficacy, but simply because it has insufficient solubility in water. As a result, the options for drug-delivery are very limited and may not deliver sufficient amounts of the drug to the patient in a safe and effective manner.

Unfortunately, the compound 5-fluorouracil, a common anti-cancer drug used for treating breast and colorectal cancer, exhibits this problem. In order to potentially alter the methods of administration for such an important cancer fighter, the water solubility of the drug must be altered. One technology that may accomplish this feat is cocrystallization, whereby the active pharmaceutical ingredient is combined with another molecule (that can safely impart high aqueous solubility) within a crystalline material held together by intermolecular interactions. The first step in such an approach involves identifying potential coformers for cocrystallization; in this presentation we describe a systematic effort geared towards finding suitable 'partners' for 5-fluorouracil, with a view to enhance its physical properties. Several new cocrystals of this drug have been fully characterized and some of the physical properties of these new solid forms of 5-fluorouracil will also be described.

Student: **Daniel Dissmore**

Year: Sophopmore

Department: Music Education/History

Mentor: Wayne Goins

Title: **Miles Davis: *Kind of Blue***

Abstract: In March 1959, in the Columbia recording studio in New York City, Miles Davis, one of the most innovative and influential jazz trumpet players, led the recording sessions that would produce one of history's most beautiful and influential albums, Kind of Blue. Both the music and ensemble were put together as a result of Davis' unique vision.

My research project explores what makes Kind of Blue so beautiful and unique, not only by analyzing the album – how the music was composed and arranged and how the ensemble was put together – but also by researching the life and music of the most prominent figure behind the album – Miles Davis, a very famous jazz trumpeter who had been actively playing for nearly a decade.

My research was divided into three parts: reading, listening, and musical analysis. I read two books: the first focused on Miles Davis' life and music; the second focused on the album Kind of Blue. I listened to over 300 recordings by Miles Davis

and analyzed the style, form, techniques, composition, and arrangements used by Davis, especially on the album Kind of Blue. For this project, most of my analysis focused on "So What", the first song listed on the album.

Student: **Emma Brace**

Year: Senior

Department: Biological and Agricultural Engineering

Mentor: Lisa Wilkens

Title **BioseparationsResearch of Plant-derived Biotherapeutics in Kansas: Extraction of Recombinant Human Serum from Transgenic Rice**

Abstract: Transgenic plant systems have successfully been used to express a variety of recombinant proteins, including rice seed-expressed recombinant human serum albumin (rHSA). HSA is a 66 kDa, single chain protein with an isoelectric point of 4.7 and is the most abundant protein in blood plasma. Ventria Biosciences has expressed rHSA at high-levels in rice, but the ability to efficiently extract rHSA (quantity and quality) would allow for it to replace blood-derived HSA used for medical applications. InVitria, a division of Ventria BioScience, is currently developing and manufacturing plant-derived therapeutics, such as rHSA, in Junction City, KS. They are part of a growing sector of innovative bioscience companies in Kansas investing in the research and development of novel human and animal therapeutics. The goal of the Bioseparations and Bioprocessing Lab at Kansas State University is to develop novel strategies for separation of recombinant and native biomolecules and to understand the unique constraints posed by using plant systems for production of nutraceuticals, industrial enzymes, and biotherapeutics, such as rHSA.

The objectives of this research were to determine extraction conditions (pH and time) that would maximize rHSA concentration and minimize the amount of native protein in rice extract. The concentration of rHSA extracted varied with pH, while the amount of native proteins extracted varied with pH and time. Kinetic experiments with high-expressing rHSA rice flour also indicated that significant degradation of rHSA occurs in crude and clarified extracts at low pH. Preliminary results showed that rHSA concentration and purity decreased over time due to protein degradation and resulted in 60% loss of full-length rHSA within an hour. In addition, we also focused on identifying the cause of rHSA degradation by using casein and gelatin zymograms and by using protease inhibitors.

Student: **Fernando Y. Roman**

Year: Senior

Department: Mathematics

Mentor: Dan Volok

Title **Backward Shift Realization of discrete analytic functions**

Abstract: Discrete function theory is a branch of mathematics which deals with functions defined on a discrete set of points, such as the vertex set of a graph. Due to numerous applications in electrical engineering, computer science, mathematical physics and probability/statistics, this area has recently become very active. One of the main objects of

interest is the class of discrete analytic functions. This class is the discrete counterpart of classical continuous analytic functions (i.e. power series) which play an important role in practically every area of mathematical analysis.

A noticeable peculiarity of discrete complex analysis is that the usual point-wise product of two discrete analytic functions is not discrete analytic, in general. For example, on the integer lattice in the complex plane the functions z and z^2 are discrete analytic, but the function z^3 is not. Thus it is not an easy task to describe even the simplest algebraic discrete analytic functions, such as polynomials or rational functions. A workaround for this problem is to consider a suitable, non-pointwise product which preserves discrete analyticity.

In our research project with Dr. Dan Volok we describe the structure of discrete analytic functions which are rational with respect to this new multiplication/division. In particular, we obtain a certain canonical representation of such functions, called a realization, which originates in the linear input-state-output system theory in electrical engineering.

Student: **Hector Martinez**

Year: Junior

Department: Architecture

Mentor: Michael D. Gibson

Title **Exploring a New Architectural Application for Rubble Gabion Construction**

Abstract:

Gabion construction is a highly efficient, inexpensive method for constructing massive walls from steel mesh and rubble. Mainly used for retaining walls and in erosion prevention, a handful of avant garde projects around the world have used this construction method. In these applications, gabions introduce some important limitations to the construction's accuracy and performance as a weather barrier.

Current research examines how gabions can be reconsidered as a construction system using emerging computer technologies for fabrication and design. A gabion building system is proposed that uses material more efficiently with greater structural effectiveness. This experimental method seeks to better match the needs of architectural construction while preserving the advantages of building with gabions, including their potential use for low-cost construction worldwide.

Prototypes of various scales, computer models, and computer simulation are used to evaluate this experimental system for constructability and thermal performance, particularly as part of a low-energy building strategy.

Student: **Jeffrey Murray**

Year: Junior

Department: Physics

Mentor: Dr. N. Sanjay Rebello

Title: **Visual Cueing and Feedback Influencing Undergraduate Students' Reasoning Resources on Conceptual Physics Problems**

Abstract:

Research has demonstrated that attentional cues overlaid on diagrams and animations can help students attend to the pertinent areas of a diagram and to facilitate problem solving. In this study we investigate the influence of visual cues and correctness feedback on students' ability to activate and coordinate the cognitive resources that they currently possess. The participants (N=90) were enrolled in an algebra-based physics course and were individually interviewed. During each interview students solved four problem sets each containing an initial problem, six isomorphic training problems, and a transfer problem. The cued conditions were given visual cues on the training problems, and the feedback conditions were told whether their responses (answer and explanation) were correct or incorrect, but the interviewer did not distinguish whether the source of their incorrectness was because of their explanation, or their answer. We found that the combination of both correctness feedback and visual cueing, were the most effective means to assist participants in not only the activation of the proper reasoning resources to successfully solve the problems, but also in the coordination of those resources.

Student: **Jessica Wheeler**

Year: Junior

Department: History

Mentor: M.J. Morgan

Title **Chetolah: One Place, Many Faces, Ellis County, Kansas**

Abstract:

The historic town site of Chetolah, Ellis County, Kansas, exemplifies how the availability of resources attracts settlement to an area. However, without the ability to harness these resources, it is difficult to maintain an established community. Chetolah was first settled by Pawnee Indians, then optimistic railroad speculators, and finally hopeful gold prospectors. In the 1920s, the abandoned town site was revitalized as a tourist attraction known as Golden Springs Beach. In each instance, the town's geographic features attracted settlers who later abandoned it when these features could not be made to yield. This study provides a comprehensive history of Chetolah using maps, newspapers, photographs, and an interview of the longtime property owner.

Student: **Joshua Ames**

Year: Senior

Department: Plant Pathology

Mentor: Dorith Rotenberg

Title **Expression of innate immunity in *Frankliniella occidentalis* during *Tomato spotted wilt virus* infection**

Abstract:

Arthropod vectors disseminate numerous and diverse viruses that cause diseases in humans, animals, and plants. All viruses are obligate, intracellular, and infectious agents, however, their relationship with the host varies from parasitism to mutualism. The aim of our research is to identify and characterize the ecological and molecular insect host factors associated with acquisition, infection, and transmission of a plant-pathogenic virus*, Tomato spotted wilt virus* (TSWV), by the primary insect vector *Frankliniella occidentalis*, the western flower thrips (WFT). TSWV infects, propagates, and spreads to various insect tissues with no apparent pathogenic effect on WFT. We hypothesize that virus titer is modulated by the combined activities of insect innate immune pathways known to be associated with known antiviral defense mechanisms in various well-characterized arthropod systems. The objective of our research was to determine the effect of TSWV on expression of four putative insect immune genes (*i.e.*, Defensin-4, Caspase-1, STAT, and Serpin) in WFT during the virus transmission cycle. We hypothesize that there is a difference in magnitude of innate immune gene expression between virus-infected and non-infected WFT. To test this hypothesis, time-course experiments were conducted to determine TSWV titer and expression levels of the four WFT genes during virus infection and replication in larval to adult thrips using real-time quantitative reverse transcriptase-PCR. There was no significant effect of virus on gene expression at any given stage of development as compared to non-infected WFT ($P > 0.1$). However, linear regression analyses revealed subtle, yet significant positive relationships between virus titer harbored by WFT and the magnitude of gene expression of Caspase-1, STAT, and Serpin ($P < 0.05$). Regardless of virus infection, there were significant differences in innate immune gene expression among developmental stages ($P < 0.05$), revealing a possible link between innate immunity and WFT development. In conclusion, this research contributes new knowledge regarding quantitative associations between virus accumulation and gene expression in an insect vector.

Student: **August Fitch**

Year: Sophomore

Department: Philosophy

Mentor: Scott Tanona

Title: **Consequences for the Epistemology of Computer Simulation from an Analysis of Computer Simulations as Heuristic Methods**

Abstract:

The epistemology of computer simulation in science is an issue being debated in philosophy of science. What do we learn from a computer simulation? How can we justify our inference that the results on the simulation match the real world system being simulated? These are essential epistemological questions eluding neat answers. Philosophers of science disagree on computer simulation's place in the epistemological framework. Some say the issues about the information or knowledge gained from a computer simulation are not new, but are just new instances of old problems. Others argue that computer simulations introduce fundamentally new challenges. Among a host of other purposes, simulations can serve a heuristic role, although no one has shown how this impacts the epistemological debate. I analyze how "heuristic" is used in science, specifically psychology and computer science, and apply that meaning to computer simulations. Under this new understanding of computer simulations as heuristic methods, I explore some of the implications this may have for the epistemological debate, and I attempt to clarify some of the epistemic issues that have so far gone unlabeled.

Student: **Mark Mathis II**

Year: Sophomore

Department: Civil Engineering

Mentor: Dr. David Steward

Title: **Reservoir Water Routing Analysis**

This study analyzes reservoir water routing. Water routing from streams to reservoirs is the problem when severe flooding situations threaten regions of North America. Destruction of land, homes, and lives raise the question as to what is being done to prevent such devastation. In 2011 the largest reservoir system in the United States and responsible for draining one sixth of the United States had undergone severe flooding. The Missouri River Basin, stretching 2300 miles long, has six mainstream reservoirs that currently operate with a capacity of 73.1 maf of flood storage, but failed in time of severe flooding. Water routing between streams and reservoirs was the leading contributor to such severe flooding. Analyzing and recording each reservoir water elevation by the corresponding day throughout the month and each stream that flows into and out of each reservoir is the first step in resolving the Missouri River Basin water routing problem. Data from each reservoir stream-gag will help in understanding how water and land interaction effect the movement of water up and down stream in time of severe flooding. Discovering more storm-effective and storm-reliable ways of routing stream systems to reservoirs ultimately reducing destruction of land, homes, and death toll is vital. After further research, water routing plans, between streams and reservoirs, will be designed for better performance in controlling water movement to and from reservoirs during severe flooding situations. We anticipate that siltation federal reservoirs and at subsequent loss of storage capacity will be important for long term water management.