Undergraduate Research @ Missouri University of Science and Technology



Undergraduate Research Day at the Capitol Tuesday – March 4, 2014



MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY

Office of the Chancellor

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March 4, 2014

Dear Legislator:

Welcome to Missouri University of Science and Technology's Undergraduate Research Day at the Capitol! Our students are excited to have this opportunity to present to you their research projects.

As the state's technological research university, Missouri S&T is committed to engaging undergraduate students in learning experiences beyond those in the traditional classroom setting. With research touching on everything from energy to the environment, I think you'll see these students are already making important contributions.

Featured on the cover of this publication is just one example of Missouri S&T undergraduate students involved in research each year. Melissa Buechlein is a senior in environmental engineering with a minor in geological engineering from St. Louis. Her project, "Methamphetamine Exposure from Contaminated Clothing," shows how methamphetamine contamination in a house can persist and later contaminate the clothing of future occupants.

Melissa's contributions toward an increased understanding of meth's long-term dangers will help our state and national policymakers better address this issue. Her study also typifies the type of relevant, real-world research projects Missouri S&T students undertake on a regular basis.

I am proud of the accomplishments of the students you will meet today. Thank you for taking time out of your busy schedule to meet a few of our outstanding undergraduate students and for your words of encouragement. I appreciate your continued support of Missouri S&T and higher education in our state.

Warmest regards,

Cheryl & Schrader

Cheryl B. Schrader, Ph.D. Chancellor

Formerly University of Missouri-Rolla An equal opportunity institution

*Joint project with Jordan Verslues

Optimal Number of Factors for Choice Experiments in Mining Community Consultation

The overarching purpose of this study and future studies is to use choice experiments to determine the factors that will lead participants to either support or not support a mining project. Choice experiments allow researchers to assess participants' preferences regarding mining projects in their community. Before this goal can be achieved, the optimal number of variables to include in these choice experiments before participants' cognitive abilities become overloaded must be determined. An online surveying tool called Qualtrics was used to collect data (e.g., demographic information, choice experiment preferences, effort ratings, difficulty ratings, and response time). Data collection has been completed, and data analysis is in progress. It is hypothesized that higher numbers of variables will lead to greater amounts of cognitive load (i.e., slower response times, higher effort ratings, and higher difficulty ratings) and decreased consistency of responses on the choice experiments. Through testing a range of different numbers of variables, the appropriate number of variables to be used in choice experiments before the experiments become too cognitively taxing will be determined. It is anticipated that this study will result in finding the ideal number of variables to use in choice experiments, and this will result in more accurate mining community consultation.

Major: Faculty Mentor: Mentor's Department: Funding Source: Psychological Science Dr. Brandi Klein Psychological Science Opportunities for Undergraduate Research Experiences (OURE)



Brittney Abel Republic, MO

House District 130 Senate District 20

Brittney Abel is a senior in the Psychological Science Department. She helped found the first psychology club of Missouri S&T history, PsyCo. While she's not doing club activities, she spends her time volunteering in the Rolla Community. In her spare time she enjoys playing softball, racquetball, video games, and walking her dog.

"Working with engineering students was quite an interesting experience and I am thankful to get the opportunity. They contributed such a different perspective than what I'm used to. Our group was really balanced out in intellect, skills, and views."

- Brittney Abel



Melissa Buechlein St. Louis, MO

House District 094 Senate District 01

Melissa Buechlein is a senior in environmental engineering with a minor in geological engineering. She is a member of the Eta Theta chapter of Zeta Tau Alpha, of Chi Epsilon (the civil engineering honors fraternity), of Tau Beta Pi (the engineering honor society), and EcoMiners (a Missouri S&T going-green club). Her interests include: outdoor activities, sports, drawing, and baking.

"Working with Dr. Morrison has enhanced my desire to learn and discover, which has given me insight as to my future goals."

- Melissa Buechlein

Research Project

Methamphetamine Exposure from Contaminated Clothing

Clothing has the potential to emit or absorb chemicals depending on the concentration difference between the material and the air. A fluid-mechanical boundary layer surrounds the human body acts as a resistance to skin uptake of chemicals from the air. We hypothesized that clothing contaminated with a chemical reduces the effective boundary layer thickness which causes the skin to absorb chemicals at a higher rate. This study seeks to quantify the flux of methamphetamine (meth) from contaminated cloth to a skin oil coated surfaces as a function of separation distance.

A 0 cm by 20 cm piece of cotton shirt material was equilibrated in a 10 L flow through chamber at ~77 ppb methamphetamine, 25 °C, and at a flow rate of 2.3 L/min. In each experiment, 47 mm filters were each coated with ~5 mg of artificial skin oil, and then placed on a metal sheet in the chamber with a the cotton cloth at a distance of 1 to 10 mm of separation. Filters removed at 24 hours and 48 hours for each distance. One filter, the control, was only exposed to the chamber air_with no overlaying cloth. Filters were extracted in6.5 ml of 1% ethyl acetate in hexane and analysed using the gas chromatography-mass spectrometry (GS-MS).

The methamphetamine flux was higher for a shorter separation distance. For a 3 mm separation distance the concentration was 0.78 μ g/(cm^{2*}hr) for a 10 mm separation distance the flux was 0.36 μ g/(cm^{2*}hr). The flux for control samples was 0.15 μ g/(cm^{2*}hr). Thus, the concentration for close-fitting clothing (3 mm separation distance) is a little over five times greater than for simulated bare skin (control). The flux verse distance results are consistent with predictions based on Frick's law for a stagnant film (between cloth and skin oil).

These findings support the hypothesis that the flux from air-equilibrated clothing to skin is higher than from air to bare skin. Clothing inside a remediated methamphetamine lab that has equilibrated with the surrounding air can increase dose by increasing transfer to skin oil. These observations suggest that clothing-to-skin transfer may bean a important vector for uptake of many chemicals. The chemicals that would most be affected are those that have a relatively high partition coefficient with cloth, equilibrate over reasonable time periods (less than a month or so), and that readily transport through skin.

Major: Faculty Mentor: Mentor's Department:

Funding Source:

Environmental Engineering Dr. Glenn Morrison Civil, Architectural, and Environmental Engineering None

Assessing Transpiration Rates of Full Scale Phytoremediation

Volatile organic compounds (VOCs) such as perchloroethylene (PCE) and trichloroethylene (TCE) are contaminants found frequently in the environment, including sites across the state of Missouri. Due to their location in the groundwater, detection and remediation of VOCs are difficult, but these steps are important in protecting human health. As plants have been shown to uptake VOCs, they have been increasingly used for site remediation and monitoring. Phytoremediation and phytoscreening have been found to be cost-effective, easily implemented, and more ecologically friendly when compared to traditional methods. Phytoscreening has been applied to 7 sites in Missouri that are currently undergoing investigation or remediation.

In this work, a full scale phytoremediation plot located at Schuman Park in Rolla, MO is being monitored using: 1) in-planta testing methods, 2) groundwater pollutant testing with passive sampling devices, and 3) evapotranspiration measurement and modeling techniques using thermal dissipation probes. Each aspect is unique and the specific topic, target of an individual undergraduate research project. The three assessment techniques have not previously be integrated to evaluate the efficacy of phytoremediation systems

The work carried out in this specific project utilizes thermal dissipation probes and novel evapotranspiration (ET) modeling based on daily climate input, and is the key element in projecting the removal rate for pollutants at the site. The data collected on ET will provide hourly measurements of the actual ET and the model are the first such approach for phytoremediation systems. The ET model and data are being integrated with in-planta pollutant assessment (Amanda Holmes) and 3-D groundwater pollution profiling using these S&T patented samplers (Katelyn Denby) and the integrated approach is the first of its kind in the world and will be presented this year at the International Phytotechnologies Conference.

Faculty Mentor: Mentor's Department:

Funding Source:

Major:

Environmental Engineering Dr. Joel Burken Civil, Architectural and Environmental Engineering Opportunities for Undergraduate Research Experiences (OURE)



Melissa Elder Waynesville, MO

House District 122 Senate District 16

Melissa Elder is a senior in Environmental Engineering minoring in psychology. She is secretary of the Society of Hispanic Professional Engineers, a mentor for the Student Diversity Mentoring Program, and a member of Eco Miners and Engineers Without Borders. She also lives with her sister in the Solar Village on campus. Her interests include Native American history and culture, reading, traveling, skiing and skydiving.

"After having an internship researching and developing sustainable packaging, I realized I would like to do research long term. This undergraduate research experience is offering the opportunity to gain more experience in an area that I am passionate about: protecting human health and the environment."

- Melissa Elder



Brianne Heisinger Florissant, MO

House District 00 Senate District 13

Brianne Heisinger grew up in the city of Florissant, MO. She developed a love for science and mathematics at an early age and thrived in all of her related high school classes. During the summer before her senior year of high school, Brianne decided to pursue a degree in Nuclear Engineering at Missouri S&T. Brianne also enjoys reading, listening to music, and watching movies. In May 2014, Brianne will graduate with her B.S. and then go on to graduate school for her M.S. and Ph.D. She hopes to work for a national laboratory after receiving her Ph.D.

"Undergraduate research made me realize what I want to do with my Nuclear Engineering degree. My experience has encouraged me to continue with research that will help change the world."

- Brianne Heisinger

MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY

Research Project

Development of A Flat-panel X-ray Source

A novel flat-panel transmission type X-ray source was developed for both medical and industrial use. Depending on the geometry of the given situation the flat-panel X-ray source could be used in tomography, radiography or tomosynthesis. Furthermore, the unit could be used as a portable X-ray scanner or an integral part of an existing detection system. The design incorporates a field emission cathode made of ultrananocrystalline diamonds (UNCD) doped with nitrogen. These field emitters show great electron output at low power and can be deposited over large areas as the case with carbon nanotube "forest" (CNT) cathodes. This work includes the first generation of the UNCD based FEA prototype which was manufactured at the Center of Nanoscale Material within Argonne National Laboratory with standard microfabrication techniques. The prototype is a 3x3 pixel FEA, with a pixel pitch of 500 microns. The fabricated cathode was developed using a microfabrication process which allows for individual electrically addressable UNCD gated arrays on-chip and demonstrate monolithic integration of the electron extraction grid.

The transmission target consists of tungsten for X-ray generation which is sputtered directly upon a thin aluminum sheet as an X-ray filter. A low voltage power supply (< 100 V) allows for electron extraction between the cathode and the grid while a high voltage power supply (< 100 kV) accelerates the electrons towards the anode. A special low energy (> 3 keV) X-ray high purity germanium detector (HPGe) is mounted outside of the vacuum chamber for X-ray detection and measurement.

Major: Faculty Mentor: Mentor's Department: Funding Source: Mining & Nuclear Engineering Dr. Hyoung Lee Mining & Nuclear Engineering DARPA

Full Scale Phytoremediation: *In-planta* Monitoring Approach

Volatile organic compounds (VOCs) such as perchloroethylene (PCE) and trichloroethylene (TCE) are contaminants found frequently in the environment, including sites across the state of Missouri. Due to their location in the groundwater, detection and remediation of VOCs are difficult, but tehse steps are important in protectign human health. As plants have been shown to uptake VOCs, they have been increasingly used for site remediation and monitoring. Phytoremediation and phytoscreening have been found to be cost-effective, easily implemented, and more ecologically friendly when compared to traditional methods. Phytoscreening has been applied to 7 sites in Missouri that are currently undergoing investigation or remediation.

In this work, a full scale phytoremediation plot located at Schuman Park in Rolla, MO is being be monitored using in-planta, groundwater, and evapotranspiration measurement and modeling techniques. The work carried out in this specific project has led to advanced mapping of the contaminant plume using patented *in-planta* samplers, and is the key element in projecting the removal rate for pollutants at the site. The inplanta samplers used in this specific OURE project directly relate to mass removal rates, expressed as mg of PCE or TCE per day, and are also linked to predictive models for evapotranspiration (ET) based on local weather conditions. This combined data and modeling is the first of its kind in the world and will be presented this year at the International Phytotechnologies Conference. This work is also related to concurrent OURE projects on assessing actual groundwater and soil concentrations using these patented samplers (Katelyn Denby) and also will utilized actual ET measurements that are part of another OURE project (Melissa Elder) using thermal dissipation probes (TD) to get hourly measurements of the actual ET.

Amanda Holmes Rolla, MO

House District 062 Senate District 16

Amanda Holmes is a junior at Missouri S&T studying mathematics. She is thankful to have had the opportunity to participate in environmental research under Dr. Joel Burken since she was in high school. Her hobbies include cooking, trout fishing, hiking, and watching movies.

"Participating in research at Missouri S&T has been an invaluable experience. The chance to apply concepts learned in the classroom to real-world situations has helped me understand science on a deeper level."

- Amanda Holmes

Major: Faculty Mentor: Mentor's Department:

Funding Source:

Mathematics Dr. Joel Burken Civil, Architectural and Environmental Engineering Opportunities for Undergraduate Research Experiences (OURE) EPA Greater Research Opportunity



Sahitya Injamuri Ballwin, MO

House District 098 Senate District 15

Sahitya Injamuri was born in India and moved to the United States when she was four. She is a junior in Biological Sciences at Missouri University of Science and Technology. She is also the president of Helix, the university's chapter of the American Society of Microbiology. After graduation, Sahitya plans to go to graduate school.

"I am grateful for the opportunity to participate in undergraduate research. It has allowed me to present my research to professionals in my area of study and network with them for future projects."

- Sahitya Injamuri

Research Project

Mathematical Modeling of Sleep and Wake in Drosophila Melanogaster

The regulation of how and why we fall asleep and wake up are not yet understood. Unfortunately, much of the transition data and bout relationships are lost in the standard presentation of sleep data from *Drosophila melanogaster*. We used mathematical modeling of fly sleep to uncover underlying patterns that may help to understand how and why sleep transitions occur in normal flies and how sleep is dysfunctional in future mutants.

We recorded activity from male and female wild-type flies and circadian clock mutants, *cycle* (*cyc*⁰¹), using *Drosophila* Activity Monitor system in one minute bins. Flies were allowed to adapt to constant darkness (DD) for 2 days and recorded for 4 days under DD. Sleep was defined as 5 continuous minutes of inactivity. We applied time series and exponential algorithms to determine the relationships between prior sleep and wake bouts to the current bout lengths.

Exponential models better described the relationship of sleep and wake bouts compared to linear models as determined by statistical improvement. Importantly, a fly's bout duration data needed to be standardized by its own average bout length to correct for individual differences in typical bout length. To validate the model, we compared contour plots of actual and predicted bout length relationships, which showed that as the wake bouts decreased the sleep bout typically increased. Plotting the bout relationships over time suggested that a particular pattern of transitions may precede long bouts.

Initial results suggest a more complicated relationship between sleep and wake bouts. Mathematical modeling may uncover a pattern to the bouts at points of transition from sleep to wake and vice versa. Moreover, these statistical techniques may be applicable to human actigraphy measurements as they use similar recording methods to determine if a person has a sleep or neurological disorder.

Major: Faculty Mentor: Mentor's Department: Funding Source:

Biological Sciences Matthew Thimgan Biological Sciences None

*Joint project with Lindsey Koerperich and Caitlin Wilkes

Energy Tradeoff between Growth and Maintenance under Food Restriction

The basic thrust of this project is to understand the controversial correlation between metabolic rate and health maintenance in both free fed and food restricted (FR) animals from the viewpoint of energetics and life history theory. Food restriction (FR) has been shown to be the major environmental intervention to extend the lifespan of a diverse set of animals. Numerous field and laboratory studies have shown that in free-fed animals, low Metabolic Rate (MR) is beneficial for health maintenance and longevity. Based on these observations, it was postulated that lowering MR may also be one of the underlying mechanisms of FR, which keeps animals in relatively healthy states and extends their lifespan. However, this idea is challenged by the empirical data from animals under FR. The unclear role of MR in the health maintenance and longevity of FR animals has been a long-standing question in the field.

Our preliminary results suggest that food restriction (FR) alters animals' energy budget and induces energy tradeoffs between metabolic rate (MR), growth, and health maintenance. In this project, we test the following hypothesis: lowering MR in animals that are under FR may diminish FR's effects on suppressing growth, and results in less energy for health maintenance. So, for animals under FR, lowering MR may have negative effects on health maintenance, opposite of what have been observed in free fed animals. We measure the rates of growth, food assimilation and metabolism of the *Manduca sexta* larvae with different metabolic rates and food supplies. Using these physiological parameters, the model makes comparisons of health maintenance between the larvae. To test the model's predictions, we measure two types of cellular damage and the activity of an anti-oxidant enzyme, as the proxies of health maintenance.

Major: Faculty Mentor: Mentor's Department: Funding Source: Biological Sciences Dr. Chen Hou Biological Sciences None



Kathryn Koerperich Kansas City, MO

House District 016 Senate District 17

Kathryn Koerperich is a junior in Biological Sciences with a double minor in Chemistry and Cognitive Neuroscience. She is a member of the Helix Life Sciences club and Phi Sigma Biological Sciences Honors Fraternity. She enjoys outdoor activities, playing video games, and reading.

"Having the opportunity to participate in undergraduate research has positively influenced my college experience and allowed me to become a better student and scientist."

- Kathryn Koerperich



Lindsay Koerperich Kansas City, MO

House District 016 Senate District 17

Lindsay Koerperich is a junior in Biological Sciences with a double minor in Chemistry and Cognitive Neuroscience. She is a volunteer with Phelps Regional Homecare and works as an ER scribe at Phelps County Regional Medical Center. She has a passion for using her knowledge of biology to help others, and plans to attend medical school after graduating.

"Being an undergraduate researcher has refined my ability to act as a leader and team player, and instilled in me a drive to better my community through science."

- Lindsay Koerperich

Research Project

*Joint project with Kathryn Koerperich and Caitlin Wilkes

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Major: Faculty Mentor: Mentor's Department: Funding Source:

Biological Sciences Dr. Chen Hou Biological Sciences None

Environmental Presence in Virtual Environments: Antecedents and Impacts

Presence is a multi-dimensional construct that is profoundly important towards the development of life-like experiences in a virtual environment. It is often characterized by a user's sense of "being there" within an environment. This research study seeks to explain what presence is, and as well the different elements of a virtual environment that can contribute to a user's sense of presence. In this study we've developed a conceptual and research model to help explain the relational links of environment design with user perception, and their resulting impact and effect on establishing user presence. Additionally, we will produce a survey and experimental design model by which to test our theories on how user presence is generated, and its impact on a user's experience in a virtual environment. It is our goal to establish a framework of how environmental presence impacts user presence, and hopefully spurn off other research models of which to understand and develop user presence in an environment. The purpose of this research study though is to examine the impact and effect environmental design constructs on user presence as influenced by user perception constructs.

Major: Faculty Mentors: Mentor's Department: Funding Source: Information Science & Technology Nick Lockwood Business & Information Technology Opportunities for Undergraduate Research Experiences (OURE)



Thanh Nguyen Chesterfield, MO

House District 089 Senate District 26

Thanh Nguyen is a Missouri S&T senior in Information Science & Technology with a minor in Business. He is the lab manager for Laboratory for Information Technology Evaluation (LITE), and specializes in Human-Computer Interaction (HCI) studies. His interests include tennis, travelling, foreign languages, virtual- and augmented reality, and game design.

"Undergraduate Research has given me the opportunity to explore and develop more passion in my area of study. It has also helped me build a more personal relationship with my professors and develop a clearer vision of what I want to focus on in the future."

- Thanh Nguyen



Chidiebere Onukogu Florissant, MO

House District 00 Senate District 13

Chidiebere Onukogu is a senior studying Petroleum Engineering with a minor in Geology at Missouri S&T. He is the treasurer of the Pi Epsilon Tau Petroleum Honor Society, the event coordinator of the Society of Petroleum Engineers, and a member of the American Association of Drilling Engineers. After graduation, Chidiebere plans to further his education by pursuing a Masters' in Petroleum Engineering and eventually his PhD. His interests include sports, working out, researching, and spending time with his family.

"Conducting research as an undergraduate has opened my eyes to many opportunities beyond that of a typical engineer. The vast amount of knowledge that can be obtained through research is overwhelming. Being able to take theoretical concepts learned in the classroom and researching the depths of these concepts and applying them in a more practical sense as an undergraduate is a state of the art way to develop a valuable student."

- Chidiebere Onukogu

Research Project

The Effects of In-Situ Condition Curing on Oil Well Cements Properties of CO2 Sequestration Injection Wells

CO₂ sequestration is a method to counteract the large amounts of CO₂ being produced into the atmosphere. It works by pumping CO₂ in super critical phase into the subsurface where it is stored in the same manner as hydrocarbons. Missouri has been working on CO₂ sequestration projects to help reduce the state's carbon emissions from power plants. CO₂ is injected through wellbores into the holding formation which are cased and cemented wellbores. Cement is one of the primary barriers of leakage and this integrity is based off the cement's physical properties. Many of the cement properties are known at atmospheric conditions, but the cement properties will vary once the cement is cured at in-situ conditions. Curing is one of the most important steps in cement construction, because proper curing greatly increases cement strength and durability. Cement hardens as a result of hydration which is the chemical reaction between cement and water. Cement requires a moist, controlled environment to gain strength and harden fully. The cement paste hardens over time, initially setting and becoming rigid though very weak and gaining in strength in the weeks following. In around 4 weeks, typically over 90% of the final strength is reached, though strengthening may continue for decades. Properly curing concrete leads to increased strength and lower permeability and avoids cracking where the surface dries out prematurely. A set of the same cement was prepared to conduct the lab experiment. The samples will be cured under simulated wellbore curing conditions for 7 days at 180 degrees Fahrenheit and 1500 psi initially. A measurement of each sample's physical properties was then conducted. These measurements include compressive strength, thermal conductivity, thermal expansion, Young's modulus, Poisson's ratio, permeability, volume changes (shrinkage or expansion), Rheology, and Settling. Then integrity will be checked using finite element analysis. In conclusion, the physical properties of cement at atmospheric conditions differ from the physical properties of cement at in-situ conditions. These in-

differ from the physical properties of cement at in-situ conditions. These insuit conditions must be known when considering the integrity of your cement for CO_2 sequestration. Otherwise, the integrity of the injection well cannot be predicted.

Major: Faculty Mentor: Mentor's Department: Funding Source: Petroleum Engineering Dr. Runar Nygaard Geological Sciences and Engineering Opportunities for Undergraduate Research Experiences (OURE) Program U.S. Dept. of Energy

Generalization of Stereotype Threat Interventions in Women

Stereotype threat occurs when people experience anxiety in a situation where a stereotype about them might be confirmed, and their performance is negatively affected. For example, a stereotype exists that women do not perform as well at math as men do. If women are directly or indirectly reminded of this stereotype before taking a math test, perhaps by asking them about their gender or indicating that the test is a test of innate math ability, their scores will be lower than those of men. This project examines whether an informative stereotype threat intervention for one particular stereotype (that women do not perform math problems as well as men do) will protect women against the negative effects of different stereotype against the group (that women do not perform visual rotations as well as men do). We exposed women to a math-related stereotype threat, gave some of them a math-related stereotype threat intervention, and gave all of them a math test. One to two weeks later, we gave all of them a mental rotation stereotype threat and observed whether the women who had received the math-related stereotype threat intervention score better on a mental rotation test. Data is currently being collected and analyzed, but this will determine whether women can generalize a stereotype threat intervention to a different stereotyped domain. We expect to find that women who received a stereotype threat intervention for math will perform better at mental rotation. If this is the case, researchers and educators who wish to protect against stereotype threat do not need to (a) administer stereotype threat interventions before each potential stereotype threat incident or (b) tailor every stereotype threat intervention to the situation.

Major: Faculty Mentor: Mentor's Department: Funding Source: Psychological Science Dr. Brandi Klein Psychological Science None



Natasha Stoneking Kearney, MO

House District 038 Senate District 12

Natasha Stoneking is a senior in psychology at Missouri S&T. Since fall 2011, she has been the president of the Free Thinkers Society, a philosophical discussion group. She currently works as a peer tutor at Missouri S&T's Writing Center. Her interests include dogs, hiking, and traveling.

"Research as an undergraduate has made me feel much more prepared to do research in graduate school and my future career. This experience has allowed me to grow as a researcher and a writer."

- Natasha Stoneking



Anthony Tedeschi Rolla, MO

House District 062 Senate District 16

Anthony Tedeschi is a sophomore in nuclear engineering with a minor in math. He is a member of the American Nuclear Society, as well as Vice President of the S&T Longboarding Club. After graduation he plans on serving in the U.S. Navy as a submarine officer. His interests include music, outdoor activities, and computer gaming.

"The ability to complete research while still an undergraduate has allowed me to expand my horizons by studying topics that are interesting to me, even if those topics don't fall under my major. The experience gained while performing research has also unlocked even greater opportunities for my personal development."

- Anthony Tedeschi

Research Project

Nanoporous Metals for Energy Applications: Synthesis of Silica-Supported Iron, Cobalt and Ruthenium Nanoparticles for use as Fischer-Tropsch Catalysts

Our group at Missouri S&T has been a pioneer in the synthesis of interpenetrating networks of polymeric and metal oxide nanoparticles. When the polymer is carbonizable (e.g., at 800 oC) we discovered that interpenetrating networks undergo a smelting reaction that, depending on the chemical identity of the oxide, yields pure metals (cases of Fe, Co, Ni, Sn, Cu, Ru) or carbides (cases of Si, Cr, Ti, Hf, V). Interpenetrating polymer-oxide networks are synthesized by using the chemical properties of the oxide-forming precursors to catalyze polymerization of suitable monomers. That approach will be expanded for the synthesis of supported catalysts, specifically of iron, cobalt, ruthenium and alloy nanoparticles on silica aerogels. The exploration of the synthesis of silica-supported binary and tertiary nanoalloys among those metals, along with investigation as Fischer-Tropsch catalysts are both within the scope of this project.

Major: Faculty Mentor: Mentor's Department:

Funding Source:

Nuclear Engineering Dr. Nicholas Leventis Chemistry Army Research Office

Statistical Methods for Detection of Differential Methylation in Human Disease Studies

DNA methylation is an epigenetic modification that occurs when a methyl group is added to cytosine sites on the DNA sequence. Aberrant DNA methylation patterns have been shown to be characteristic of several human diseases, including many types of cancer. With the advent of new technologies, DNA methylation can be measured in ways not possible just ten years ago. Methylation microarrays, such as Illumina's. HumanMethylation450, and high-throughput sequencing technology, such as Illumina's HiSeq 2000, are a result of these new methods. Both technologies enable the quantification of the percent methylation at hundreds of thousands of cytosine locations. Statistical analysis of data from such studies allow researchers to determine which sites exhibit significant differences in their average methylation levels between normal and diseased groups. Using R, an open-source statistical analysis software package, each site can be tested to determine if a relationship exists between methylation level and disease status.

The primary method for testing for differences between related samples is the paired *t* test and between independent samples is the two-sample *t* test, which measure the likelihood that the true means of the two groups are the same. Sites in which the sample results indicate this likelihood is very small provide evidence for a significant difference in average methylation level between disease status groups. The next stage of analysis is to measure the influence each methylated site exerts on nearby sites. This stage of the analysis is not well-established and is the focus of ongoing research. In this project, we examine and apply statistical methods to methylation data in studies of cancer and other human diseases with the goal of obtaining a list of significant sites to test for methylation as an indicator of disease. Furthermore, these statistical methods are highly replicable and can be applied to the plethora of current data sets available on various archives to test for differentially methylated sites with any number of diseases and conditions. This is the first step to using methylation as a predictor for an innumerable set of characteristics.

Major: Faculty Mentors: Mentor's Department: Funding Source: Applied Mathematics Dr. Gayla Olbricht Mathematics & Statistics Opportunities for Undergraduate Research Experiences (OURE)



Samuel Turpin Jefferson City, MO

House District 059 Senate District 06

Samuel Turpin is a senior in applied mathematics. He is particularly interested in statistical studies and biological statistics. Sam is engaged to be married to Sarah Padgett in June and plans to continue studying statistics at KU in August. His hobbies include reading, card games, and video games.

"Undergraduate Research has given me the opportunity to combine independent study with furthering scientific knowledge. Working with the faculty has helped me learn about academia and taught me what to expect in graduate school and beyond."

- Samuel Turpin



Jordan Verslues Rocheport, MO

House District 047 Senate District 19

Jordan Verslues is a senior in Mining Engineering. He is enrolled in the Army ROTC program at Missouri S&T as well as a member of the school's Mine Rescue Team. He loves being involved with the Gamma Lambda chapter of Pi Kappa Phi. His interests include doing anything outside, hanging out with friends, intramural sports, and relaxing.

"By participating in this undergraduate research, I have had the opportunity to work with another discipline that isn't an engineering related. This is great experience because it has shown me how to work effectively with a different discipline by sharing my knowledge and learning from them at the same time. "

- Jordan Verslues

Research Project *Joint project with Brittney Abel

Boint project with Britiney Aber

Optimal Number of Factors for Choice Experiments in Mining Community Consultation

The overarching purpose of this study and future studies is to use choice experiments to determine the factors that will lead participants to either support or not support a mining project. Choice experiments allow researchers to assess participants' preferences regarding mining projects in their community. Before this goal can be achieved, the optimal number of variables to include in these choice experiments before participants' cognitive abilities become overloaded must be determined. An online surveying tool called Qualtrics was used to collect data (e.g., demographic information, choice experiment preferences, effort ratings, difficulty ratings, and response time). Data collection has been completed, and data analysis is in progress. It is hypothesized that higher numbers of variables will lead to greater amounts of cognitive load (i.e., slower response times, higher effort ratings, and higher difficulty ratings) and decreased consistency of responses on the choice experiments. Through testing a range of different numbers of variables, the appropriate number of variables to be used in choice experiments before the experiments become too cognitively taxing will be determined. It is anticipated that this study will result in finding the ideal number of variables to use in choice experiments, and this will result in more accurate mining community consultation.

Major: Faculty Mentor: Mentor's Department: Funding Source: Mining Engineering Dr. Brandi Klein Psychological Science & Mining Office of Undergraduate Research Experience (OURE) Fellows Program

The Promotion of Las Vegas by Local Newspaper Editors (1905-1950)

Everyone knows the extravagant, glitzy Las Vegas of today, but what about the city's humble beginnings as a desert railroad town? This research explores how local newspaper editors used their papers to promote Las Vegas. Based on *Las Vegas Age* and *Las Vegas Review Journal* articles, prominent editors acted as boosters for the city's development during the first half of the twentieth century by emphasizing its attractions, supporting the Chamber of Commerce, and advocating for town improvements. By the 1950s, the residents of Las Vegas had attempted to promote agriculture, mining, and natural desert wonders. Despite these attractions, Las Vegas was widely unknown throughout the country until the construction of Hoover Dam in the early 1930s. The newspaper editors used their media to promote Las Vegas construction and organizations, encourage resident participation, and downplay unfavorable news of the city.

Major: Faculty Mentors: Mentor's Department: Funding Source:

History Dr. Larry Gragg History & Political Science Opportunities for Undergraduate Research Experiences (OURE)



Laura Welsh Lee's Summit, MO

House District 034 Senate District 08

Laura Welsh a senior history major. She is president of Phi Alpha Theta and works in the university archives. She enjoys reading, music, and baking. She hopes to pursue a career in museum or archival work after graduation.

"Undergraduate Research has allowed me to expand my research skills and work closely with a professor who is an expert in the field."

- Laura Welsh



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Caitlin Wilkes is a junior in Biological Sciences with a minor in Chemistry. She plans on attending graduate school for marine biology, inspired by her love of sharks and other aquatic life. Her hobbies include playing video games, drawing, and listening to music.

"Being a part of an undergraduate research team has provided me with the opportunity to network and connect with a variety of research fields and prepare me for my future career."

- Caitlin Wilkes

Research Project

*Joint project with Kathryn Koerperich and Lindsay Koerperich

Energy Tradeoff between Growth and Maintenance under Food Restrictions

The basic thrust of this project is to understand the controversial correlation between metabolic rate and health maintenance in both free fed and food restricted (FR) animals from the viewpoint of energetics and life history theory. Food restriction (FR) has been shown to be the major environmental intervention to extend the lifespan of a diverse set of animals. Numerous field and laboratory studies have shown that in free-fed animals, low Metabolic Rate (MR) is beneficial for health maintenance and longevity. Based on these observations, it was postulated that lowering MR may also be one of the underlying mechanisms of FR, which keeps animals in relatively healthy states and extends their lifespan. However, this idea is challenged by the empirical data from animals under FR. The unclear role of MR in the health maintenance and longevity of FR animals has been a long-standing question in the field.

Our preliminary results suggest that food restriction (FR) alters animals' energy budget and induces energy tradeoffs between metabolic rate (MR), growth, and health maintenance. In this project, we test the following hypothesis: lowering MR in animals that are under FR may diminish FR's effects on suppressing growth, and results in less energy for health maintenance. So, for animals under FR, lowering MR may have negative effects on health maintenance, opposite of what have been observed in free fed animals. We measure the rates of growth, food assimilation and metabolism of the *Manduca sexta* larvae with different metabolic rates and food supplies. Using these physiological parameters, the model makes comparisons of health maintenance between the larvae. To test the model's predictions, we measure two types of cellular damage and the activity of an anti-oxidant enzyme, as the proxies of health maintenance.

Major: Faculty Mentor: Mentor's Department: Funding Source:

Biological Sciences Dr. Chen Hou Biological Sciences None





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