UK Undergraduate Research Program

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UK Undergraduate Research Program

The UK Undergraduate Research Program (UKURP) provides undergraduates, especially first- and second-year students, with the opportunity to identify and connect with faculty members who are seeking undergraduates to work with them on their scholarly projects. Projects are available in all disciplines and require varying levels of experience and sophistication.

Students who are actively engaged in a mentored scholarly inquiry project and who are spending an average of approximately ten hours per week on that project are eligible to register for a course on Methods of Scholarly Inquiry, DSP 200, taught each year. The final project in that course is for the student to prepare an abstract of his or her scholarly inquiry. The following are samples of those abstracts from the spring semester, 2008, class.

Too Young to Die: The Execution of Minors and the Role of International Law in Constitutional Interpretation

Jenna Brashear, International Studies
Mentors: Dr. Melynda Price, Dr. Robert S. Tannenbaum

In light of the ongoing discussion of the role of the courts and the process by which they interpret and apply the law, this paper contains an examination of issues of interpretation. The Supreme Court has decided cases using domestic and international law as sources of authority and has made decisions in which those areas of law have sometimes clashed. This intersection and conflict of laws is especially evident in the Court’s decisions on capital punishment.

In Stanford v. Kentucky (1989), the Supreme Court decided that the death penalty for juveniles was Constitutional, before later overturning that decision in Roper v. Simmons (2005). The United States was the only country in the world to legally permit the execution of juveniles when Roper was decided — an indication of the disapproval by other nations of capital punishment for minors and also of the growing condemnation of the death penalty in general in the international community.

In 1998, the decision of Breard v. Greene examined the role of international politics and multinational courts in domestic death penalty decisions, and the United States’ obligation under treaties. Breard was not a minor, but was a citizen of Paraguay living in the United States at the time of his crime. He was eventually executed, signaling the U.S.’s rejection of international treaties and affiliations, particularly the parts thought to be inconsistent with the U.S. Constitution or other domestic laws.

Seven years later, Roper became the first case to significantly cite international norms as an argument against domestic law, specifically death penalty statutes. In this relatively short time, the approach of the Supreme Court shifted, and shifts such as this often bring up the question of judicial activism. This paper includes an attempt to explain the complexities of these decisions and to examine the implications for the future of capital punishment deliberations in the United States Supreme Court.
Maternal Mortality in Sub-Saharan Africa: Global Effort and Achieving the Millennium Development Goals

Alecia Fields, Topical Major in Women’s Health Advocacy
Mentor: Dr. Joanna M. Badagliacco

Half a million women die every year due to complications of pregnancy or childbirth (UNICEF, 2008). These deaths are not evenly distributed around the world and correlate to regions of high poverty. Developing countries account for 99 percent of maternal deaths worldwide and Sub-Saharan Africa accounts for slightly more than half of these maternal deaths (UNICEF, 2008). These numbers have not changed noticeably over the past two decades.

At the Millennium Summit in 2000, a set of time-bound goals was established to address extreme poverty and related issues. These goals are known as the Millennium Development Goals (MDGs). The fifth goal addresses maternal health. The target for goal five is to reduce the maternal mortality ratio by 75 percent by the year 2015. In Sub-Saharan Africa, where obstetric risk is the highest, little progress has been made on improving maternal health and reducing the maternal mortality ratio. Currently, the maternal mortality ratio in Sub-Saharan Africa is falling at only 0.1 percent annually compared to the 5.5 percent of annual decline needed to achieve goal five by 2015 (UNFPA, 2008).

Sub-Saharan Africa is currently at the greatest risk of not achieving the MDGs by 2015. In my research, I am investigating why individuals of developed countries should be committed to addressing the high maternal mortality ratios in Sub-Saharan Africa in light of goal five of the MDGs. In addition to two other arguments, an argument for global health was made for why countries should care about the women of Sub-Saharan Africa. The global health argument holds the entire global community accountable for achieving goal five of the MDGs. The success of this argument depends on international partnerships, which first must be created and maintained. The function of a global health network is to address epidemics, public health emergencies, natural disasters, and conflict areas that overwhelm health systems on a national level. It is then the obligation of the international system to provide assistance. Currently, some regions, such as Sub-Saharan Africa, need more assistance than others. However, by investing in the global health system and the health systems of developing nations, the United States utilizes the most effective strategy for protecting itself from threatening epidemics. Improving global health is synonymous with reducing poverty, improving education, and strengthening the global economy.

The question of why countries, particularly those wealthier nations, should care about the high maternal mortality in Sub-Saharan Africa does not have a linear answer. There are many arguments; however, it is the global health argument that holds individual countries responsible for the well being of everyone. Currently, there are not sufficient resources available in Sub-Saharan Africa to improve maternal health without aid. As a member of the global health community, the United States must become more actively involved in offering assistance to Sub-Saharan Africa. Improving maternal health and eradicating extreme poverty is only possible with the corporation of the entire global network.

My experiences this past semester with Undergraduate Research have been invaluable. I would highly recommend being actively involved in scholarly work and research to any undergraduate with a passion and enthusiasm for learning. The complete process, from developing a research question to presenting your research to others, is an extremely rewarding experience.

Sources:

Exploration of Membrane Fusion pH Dependency of Vesicular Stomatitis Virus Glycoprotein G

Angela Marie Jones,
Agricultural Biotechnology
Mentor: Dr. Robert Geraghty

Vesicular stomatitis virus, commonly referred to as VSV, is an arthropod-borne virus in the family Rhabdoviridae (which also includes the well-known Rabies virus). It is a zoonotic agent for humans, causing influenza-like symptoms. More notably, it is an important cause of vesicular disease in cattle, swine, and horses, and is clinically identical to foot-and-mouth disease.

Rhabdoviruses typically carry genes for five different proteins. It has been reported that VSV membrane fusion is pH dependent and is induced by the membrane glycoprotein G at an acidic pH. However, previous research in the Geraghty lab has found that, in CHO cells, glycoprotein G seems to initiate fusion at a neutral pH as well as at an acidic pH.
Experiments were designed to produce general preliminary data to determine whether or not fusion occurs at pH 5.0 and pH 7.0 in three different cell lines: CHO, B7, and Vero. The selected cell lines were transfected with the VSV glycoprotein and Green Fluorescent Protein and then allowed to grow and express the protein on the cell surface. Cell membrane fusion was indicated by the formation of large, multi-nucleated cells called syncytia. Syncytia could be seen in all cell lines in acidic conditions at pH 5.0, but only in the CHO and B7 cells in neutral conditions at pH 7.0. This suggests that CHO and B7 cells are not fusion pH dependent.

The overall hypothesis is that the pH dependence of fusion activity in VSV is cell line dependent. This is an interesting and potentially valuable observation considering that virus fusion pH requirements rarely differ among cell lines for any one virus. Studies in the future will try to discover characteristics or properties of CHO and B7 cells that cause a variance in VSV fusion pH dependence.

### Differential Gene Expression in Fungal Endophytes

**Lesley Mann, Agricultural Biotechnology**  
**Mentor: Dr. Christopher L. Schardl**

Several endophyte-host symbiota exist that involve a fungus inhabiting a plant. The interaction between the species varies considerably, spanning from pathogenic to mutualistic. *Neotyphodium coenophialum* is a seed-transmitted fungal endophyte that benignly colonizes the intracellular spaces of cool season grasses. It offers a variety of fitness-enhancing characteristics to its host, including enhanced biotic and abiotic stress tolerance, associated with highly efficient stand longevity. *N. coenophialum* is related to *Epichloë festucae*, which also inhabits cool season grasses. *E. festucae*, however, is capable of benign seed transmission as well as disease development (production of stromata that choke inflorescences) on different tillers within the same host plant. This study has been aimed at finding key genes that are involved in disease development versus benign plant colonization.

Expression analysis was conducted using 454 sequencing of mRNA from endophyte-infected inflorescences and stromata. In total, 1734 differentially expressed genes were identified (1268 potentially upregulated in inflorescences and 466 potentially upregulated in stromata). To verify these findings, a high-throughput real-time PCR protocol was developed. For that protocol, mRNA samples from fungal mycelium and endophyte-infected plant tissues (pseudostem, inflorescences, and stromata) from four different *festuca pratensis / Epichloë festucae symbiota* were extracted. Reverse transcription was performed, and real-time PCR conducted. Because tefA is not differentially expressed in the various tissues, it was chosen as an endogenous control. For high-throughput analysis, a standard curve is generated for each gene, and if amplification efficiency is comparable with that of tefA (slope within 0.2), ΔΔCT analysis is conducted on stromata and inflorescence samples. Of the 29 genes tested so far, 16 genes had comparable standard curve slopes. ΔΔCT analysis showed that, in most cases, real-time PCR results validated significant 454 results (p ≤ 0.05).

**Cartilage Regeneration for Growth Plate Defects and Degradation in Poly-lactic-glycolic Acid (PLGA) Scaffolds**

**Aparna Nigam, Biosystems and Agricultural Engineering**  
**Mentor: Prof. David Puleo**

Tissues require certain mechanical and structural characteristics in order to sustain proper bodily functions. Tissue engineering covers a broad range of applications including repairing or replacing portions of whole tissues. One particular tissue, cartilage, is the subject of our study. Cartilage is a type of dense connective tissue found in many places of the body including the growth plate. The growth plate is the area of growing tissue at the end of the long bones in children and adolescents. The growth plate cartilage is frequently injured as a result of sports related trauma, but because cartilage is not associated with blood, it has very limited capability for repair. The primary goal in our lab is to regenerate cartilage for injured growth plates.

Scientific advances in biomaterials have created unique opportunities to fabricate tissues in the laboratory. A combination of cells and biologically active molecules (DNA and growth factor proteins) help create the proper environment for cartilage regeneration. Cells are made up of poly-lactic-glycolic acid (PLGA). These cells are used to make the initial framework, or scaffold, for cartilage regeneration. Cartilage cells grow when initiated by biological molecules (DNA and growth factor proteins) found in the PLGA cells of the scaffold. The objective of this particular study is to find the time of degradation in varying concentrations of PLGA scaffolds. Concentration in scaffolds is measured in mass by PLGA. PLGA and salt are mixed to make a one hundred percent mixture scaffold. A scaffold with more salt will degrade faster than a scaffold with less salt. The time for degradation is important because, as a scaffold degrades, the cartilage cells must multiply and replace
the scaffold’s implantation site (implantation site in the growth plate).

During the first several weeks of my study, I made two types of cells: blank cells and cells with growth factor protein. The cells were then used to make scaffolds for the degradation part of the study. Circular scaffolds were quartered and placed into vials. The vials were filled with a buffer solution so that all of the samples maintained the same pH. The pH can change degradation of a scaffold; therefore, it is important to maintain a steady pH. After thirty days of monitoring the samples, it was easily observed that higher salt concentrated scaffolds had lost their framework. Lower salt concentrated scaffolds still maintained some structure.

Delayed Non-matching to Place Acquisition in Water T-maze Following Traumatic Brain Injury

Peter Rock, Biology
Mentor: Prof. Steven Scheff

Traumatic brain injury (TBI) is a common occurrence, with new injuries in the United States being diagnosed every year in the millions. This increasing occurrence of TBI demands a better understanding of pathophysiology and the development of possible novel treatments for neurotrauma. To observe the effects of TBIs on working memory, I studied a rat model that applies a TBI to the rat and then tests the cognitive working memory of the rat.

Key to this research is having adequate animal models and behavioral tests sensitive enough to monitor changes in cognitive status. The purpose of this experiment was to analyze the effects of experimental TBI on a delayed non-matching to place (DNMP) task, which evaluates working memory. The DNMP task was adapted to a water T-maze to effectively monitor memory retention in rats in this study.

Because TBI does not always occur in the same brain location, different animal models have been developed. This research incorporates two common animal models, unilateral lateral cortical contusion (ULCC) and bilateral frontal cortical contusion (BFCC), to better illustrate the commonality of separate brain injuries to memory deficiency.

The experimental rats were randomly assigned to one of four different groups: a) unilateral lateral cortical contusion (ULCC), b) unilateral lateral sham (ULS), c) bilateral frontal cortical contusion (BFCC), d) bilateral frontal sham (BFS). Initial training of the DNMP task began 7 days post-surgery. The procedure consisted of 5 days of acquisition training (15 trials/day) followed by 3 days of delayed testing phase with 15, 30, and 120 sec. delays respectively. The sham groups, BFCC, and ULCC all performed equally well during acquisition and in the initial 15 sec. delayed testing phase. The two injury groups (BFCC, ULCC) demonstrated significant impairment when the delay was increased to 30 and 120 seconds. The results support the idea that the DNMP task, a sensitive behavioral measure that targets working memory, may be useful in screening possible therapeutic interventions following TBI.

The research I participated in this previous semester allowed me to experience a whole new view of college. I had no prior experience in laboratory studies and did not know it was even possible to do research, but I am now fully involved in all the steps of research. I have learned a great deal about the process and the significance of conducting research. This opportunity has lead me to develop a greater appreciation for being allowed to be part of this research community and I feel that my term at the University of Kentucky has more significance than just obtaining a degree. I believe that all students should become involved in research within their individual fields if possible. Research allows a students to experience firsthand what their field of study is truly about and can help them decide if a career in research is a possible option.

Developing High Efficiency Solar Cells

Joshua Shank, Electrical and Computer Engineering
Mentor: Prof. Vijay Singh

Because of the increasing criticism of fossil fuels with regard to their environmental impact and price, clean and renewable energy sources have recently become a frequent subject of research. Of the developing technologies, solar energy has perhaps received the most attention and criticism with regard to cost and efficiency. Efficiency is defined as the percent of solar energy exported from the cell as electrical energy. Traditional silicon solar cells are reasonably efficient (14-24%) but are expensive to create, and thin-film solar cells are inexpensive but not very efficient (13-20%).

Solar cells work by optically exciting electrons to a higher state of energy. The difference in energy between these two levels is called the bandgap. Ideally, the bandgap energy should be approximately 1.4eV. Any variance from this ideal, reduces the solar cell’s efficiency. Crystalline silicon has a bandgap of 1.1eV and CIS (Copper Indium Diselenide), a common thin-film material, has a bandgap of 1.04eV. We believe it is possible to adjust this property by exploiting known quantum effects. Aside from the bandgap there are several other device characteristics that determine the
cell performance. My research does not address these other characteristics.

For the last two semesters I have been involved as an undergraduate researcher in Dr. Singh’s solar cell project group. Our goal is to produce low cost solar cells that are more efficient than current commercial models. We have proposed that this can be accomplished by exploiting the quantum-mechanical property of quantum confinement. The theory of quantum confinement states that an electron confined to a very small space may possess energy levels different from the energy levels allowed when the electron is free to move. This causes changes in the particle’s optical and electrical properties. By restricting the size of each solar cell to a quantum wire, we can manipulate the quantum confinement effect to increase the bandgap of CIS and make it a more ideal solar cell material.

In order to restrict the size of each solar cell, we deposit the photovoltaic material into a nanoporous template (AAO). My research has been to aid in the development of a system to mass produce these templates. We produce these templates by means of an electro-chemical anodization of aluminum, which can take anywhere from 2 to 50 hours and may or may not produce a usable template. One of the obstacles faced by many nanoscale researchers has been the creation of these templates in a timely manner. The system we have developed should be able to produce up to 30 templates at once and, if successful, could be expanded to a significantly larger scale.

The impacts of this research will not be limited to the solar cell industry. Once developed, the resulting AAO templates will be a marketable product that could impact nanoscale research. Nanoscale research is currently being conducted in fields as varied as medicine and computer power.

Aside from societal benefits, this research has been very beneficial to me. Classrooms are an effective way of getting a small amount of information to many students. Apprenticeship is the effective way of getting a large amount of information to a small group of students. Because of this research, I have developed a deeper understanding of solar cells, a deeper understanding of material from classes, and friendships with students and faculty who are willing to assist me if I ever need help. I recommend that any student who wishes to fully develop his or her mind engage in a research project with a faculty mentor.

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Forgotten Fathers: Homeless in Kentucky
Jennifer Strange, Accounting
Mentor: Prof. Joanna M. Badagliacco

Until the present study, homeless fathers in Kentucky and the Appalachian region who remain with their families have not been the subjects of research. This work is part of an ethnographic study of 86 homeless families in Kentucky. Only 18 husbands/fathers were present. Having 18 husbands/fathers present is quite significant, because the number nationwide who remain with their families is small, so this is a reasonable sample. In this study we attempt to understand who these men are who remain with their families, when leaving is not only easier but also indirectly is encouraged by some homeless shelters and agencies; often times, shelters do not allow men to stay in the same facility as women and children. In this study, we address the following research questions: how are these men coping with their housing distress? How do they approach fathering? What is their perceived quality of life?

The men were interviewed about various aspects of their lives, using in-depth interviewing. They explained their life histories, and were questioned about growing up, their current relationships, as well as their parenting. Overall, the men have quite distressing lives. In addition to having had unstable childhoods that involved at least one family member with alcoholism, the men had few skills for sustained employment. Several men suffered physical and sexual abuse in the past, and acknowledged that violence continues in their lives. It is clear, however, that these men are exceptional, because they chose to stay with their families. Even though these fathers desire to be with their wives and children, they face many obstacles that keep them from being the types of fathers they wish to be. There are multiple examples of obstacles, including the difficulty of providing for their children, working, and helping to break the chain of intergenerational poverty and violence. In examining the lives of these fathers, we are attempting to expand on theoretical understandings of fatherhood under severely constrained political, personal, and structural situations.

I assisted Dr. Badagliacco with her research. I did mostly bibliographic work for her, including creating citations and maintaining a library of sources. I traveled to my first conference, the Appalachian Studies Association Conference, at which I learned more about research and conferences. Before I began working on this project, my research skills were only somewhat proficient and my knowledge of the library resources was limited. Through this experience, my research skills have improved significantly and I have become more familiar with the library resources. Working on this research project has been a great experience; I encourage all undergraduate students to become involved in research.