Undergraduate Research Opportunity Program
Summer Fellows

ABSTRACT BOOKLET

Program Description:
IUPUI UROP Grants are available for the academic year or the summer to support independent, faculty-mentored research. Students may apply either for a stipend or for funds for research materials.

UROP Summer Fellows take part in the CRL's nine-week summer program, in which 75% of a student's time is spent working on an individual project with a faculty mentor (in any discipline), and 25% attending professional-development sessions.

Program Leader:
Richard E Ward, Ph.D.
FORGOTTEN LIVES: DISCOVERING THE ROLE OF DOMESTIC SERVANTS AT THE BENJAMIN HARRISON HOME

Emily A. Baker (Rebecca Shrum), Department of History, IU School of Liberal Arts, IUPUI

This project investigates the lives of the domestic servants who worked for U.S. President Benjamin Harrison. Located at 1230 N. Delaware St. Indianapolis, Benjamin Harrison’s house is currently a historic site known as the Benjamin Harrison Presidential Site. While the Benjamin Harrison site provides ample information on Benjamin Harrison, his wife, and his family, there is currently little to no information on the servants who lived and worked in the house. My research has been an investigation into the forgotten lives of these individuals who were employed by Harrison. Discovering the role of the servants at the Benjamin Harrison Home will help Americans appreciate the forgotten lives from the past that have been crucial in shaping the future.

This work was supported in part by the summer Undergraduate Research Opportunities Program (UROP) through the IUPUI Center for Research and Learning.

THE ROLE OF YOUTH NGOS IN BUILDING UP A SUSTAINABLE PEACE IN GAZA THROUGH EDUCATION

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The research is about building up a sustainable peace in Gaza Strip through peace education. The purpose of this research is to explore different methods of peace education and understand their adaptability to Gaza, like youth peace-building activities which aims to develop the knowledge, attitudes, and skills necessary to motivate a desire for conflict resolution and the initiation of peace. This study focuses on NGOs in general because the nature of conflict let it to play a fundamental role in building up sustainable peace during conflicts and offer a model for bringing human beings closer by breaking the cycle of violence, and on youth NGOs in particular, because youths are a creative and energetic individuals who seek to achieve many goals through activism and play a critical role in a society’s transformation. However, their activism creates a double-edged sword since it may lead them to peace or to serve as agents of violence. Youth between the ages of 15-29 make up 29.8 percent of Gaza strip population, the proportion of male to female is 104:100, this sheer number as well as youth prominent role in Arab Spring demonstrates the necessity of engaging them in peace-building, because they are more likely to abstain violence if they are granted constructive alternatives. The research method includes literature review of case studies in a global perspective, as well as a specific inventory and review of youth-based NGO’s active in Gaza, The review of existing youth NGOs will include a scanning of the landscape for peace education and identification gaps and areas of improvement where the effective and innovative tools can be applied as discovered by the study. The ultimate goal of this research is to contribute in peace process to shift the Gaza strip from a high conflict area to a peaceful one.

This work was supported in part by the summer Undergraduate Research Opportunities Program (UROP) through the IUPUI Center for Research and Learning.
ROLE OF TELOMERE-DRIVEN GENOMIC INSTABILITY IN SPORADIC COLON CANCER

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Cancer is a genetic disease caused by undesirable genetic changes. These aberrations range through hundreds of genes acting in different ways to allow for or even create the uncontrolled and destructive growth. It has been apparent that acquisition of genomic instability is a crucial feature in cancer development. Over a decade, telomere dysfunction has emerged as having a causative role in carcinogenesis by promoting this genetic instability, however, there is little evidence in human carcinogenesis. Telomeres are a chromosomal end-cap, which function in protecting DNA from being eroded or altered, and are essential to cellular homeostasis. They do however shrink with time, which would kill off fast dividing cells like cancer were they not able to find a way to replenish the telomere sequence, and thereby become dysfunctional. Alternatively, the telomere function can be impaired by short end telomere fusions, which can create numerical and structural genetic abnormalities. In this study, to assess the extent of telomere-driven genomic instability in vivo, we analyzed telomere fusion, telomere length, telomerase activity, and TP53, KRAS, BRAF gene mutations in human tissue samples, via the TAR-fusion PCR, telomere qPCR, TRAP assay, and DNA sequencing respectively.

We have observed telomere fusions even in tissue adjacent to colon tumor, suggesting that telomere dysfunction initiates genetic instability even in pathologically non-cancerous lesions. Moreover, our results suggest that wild-type TP53 function is key to preventing telomere fusions during sporadic colon cancer development. Next, to explore the molecular mechanics of short end telomere fusions, we have been generating a very unique in vitro model system using mouse/human hybrid cells, which contain two individual human chromosomes in mouse cell line. We expect that these hybrid clones could be powerful tools in determining the causative role of telomere-driven genomic instability.

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THE EFFECT OF ACUTE TREADMILL EXERCISE ON RIGHT VENTRICLE CELLULAR APOPTOSIS IN A RAT MODEL OF PULMONARY ARTERIAL HYPERTENSION

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In pulmonary arterial hypertension (PAH) elevated pulmonary pressures increase the work of the right heart, which can lead to maladaptive wall hypertrophy, right heart failure and death. The purpose of this research is to determine in a rat model of PAH if a single bout of exercise at moderate relative intensity can be performed without promoting an acute and detrimental right ventricular (RV) wall stress-induced apoptosis. Apoptosis, or programmed cell death, is an energy dependent process that effects the controlled removal of a cell and is activated in response to cellular injury. Male Sprague-Dawley rats received monocrotaline (MCT, 40 mg/kg, intraperitoneally) to induce PAH (n=12), or saline, for healthy controls (n=8). After 2 wks, with MCT-induced PAH established, a single 45 min treadmill run was performed for a subset of PAH animals (n=6) and healthy controls (n=4) at moderate relative intensity, 75% of maximal aerobic capacity (VO2max). Animals were sacrificed and tissues were obtained immediately following the treadmill run. A group of PAH and healthy rats served as unexercised controls (n=6 and 4, respectively). Two methods were used to quantify post-exercise cellular apoptosis: Caspase 3 activity was assayed in RV homogenates and Terminal deoxynucleotidyl transferase dUTP nick end labeling (TUNEL staining) to mark nuclear DNA fragmentation associated with cell death was performed on RV cryosections. We hypothesized that a single treadmill run performed at moderate relative intensity will result in no greater RV apoptosis of PAH rats compared to that in healthy rats. Results and conclusions are pending final experiments; however data thus far shows a tendency for higher activation of Caspase 3 in PAH rats but no significant increase in exercise-induced apoptosis in either group.

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PERFORMANCE ANALYSIS OF EM/MPM AND K-MEANS CLUSTERING IN 3D ULTRASOUND BREAST IMAGE SEGMENTATION FOR STATISTICALLY SIGNIFICANT CASES

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Except for lung cancer, breast cancer causes the next highest cancer death rate. In this study, instead of using the harmful X-ray to look through the breast, we analyze Tomographic Ultrasound (UST) which is a harmless detection method to scan breast tissue. Many studies have shown that breast density ratio has a direct relationship to breast cancer; higher density ratio points to a higher cancer risk. Early targeting on high risk populations can help saving lives. Moreover, to detect and screen cancer, a good image segmentation algorithm is necessary. For textured images, Expectation-Maximization and Maximization of the Posterior Marginal (EM/MPM) and K-Means Clustering are two widely-used segmentation algorithms. A good segmentation algorithm can fit the ground data truth data better. We want to compare the EM/MPM and K-Means Clustering regarding segmentation accuracy by running large amount of clinical cases. As the result, we find that EM/MPM is able to find better localized segmentation, which performs much better results on the high density tissue scattered within low density tissue. As this study shows, for breast density evaluation, the superior EM/MPM presents higher accuracy.

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THE IMPACT OF HIP HOP BASED INSTRUCTION ON STUDENTS IN URBAN SETTINGS

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Hip Hop Based Education (HBBE) is offered as an instructional approach (HBBI) that has the potential to reach diverse populations of students in urban settings. Supporters advocate that the instructional approach provides a means by which to bridge the gap of students discourse from home to school, increase students’ classroom engagement, as well as positively influences the formation of Black racial identity. However, despite the argument that HHBI resonates well with urban youth, there is relatively little scholarship that empirically verifies the relationship between Hip Hop Based Instructions to student’s learning or academic achievement. The purpose of this study is to add to the knowledge base an understanding of the impact of HHBI on students learning, particularly those in urban settings. The study was designed to explore the impact of HHBI on three aspects of student learning: engagement, concept mastery and identity formation. Using an experimental design model, two groups of elementary-aged students received two; 30-minute lessons on mathematical concepts. For the first lesson, Group A served as the control group and received a lesson designed by the National Association for Teachers of Mathematics. Group B served as the experimental group received a similar lesson that was modified to reflect the tenets of HHBI. Throughout instruction students were assessed on their level of engagement by the use of an observational scale for measuring engagement. Concept mastery and identity formation were assessed post instruction. For the second lesson, Group B served as the control group and received the NCTM-designed lesson and Group A served as the experimental group received a similar lesson that was modified to reflect the tenets of HHBI. Implications from findings will serve as an informational tool for K-6 teachers working in urban settings seeking to implement Hip Hop pedagogical practices in their classrooms.

This work was supported in part by the summer Undergraduate Research Opportunities Program (UROP) through the IUPUI Center for Research and Learning.
MICRO-COMPUTED TOPOGRAPHY ANALYSIS OF FRACTURE HEALING IN MICE TREATED WITH OSTEOSTIMULATORY FACTORS

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Many types of bone fractures and trauma present serious challenges to orthopedic surgeons in attempting to surgically reconstruct the injured area. This is particularly true for combat related injuries such as gunshot wounds, shrapnel, and high-explosive injuries. In attempting to achieve successful bone repair, many surgeons turn to tissue engineering technologies such as osteostimulatory factors due to their ability to promote tissue growth and healing. Bone Morphogenetic Proteins (BMPs) are commonly used by orthopedic surgeons for bone healing. However, these agents are expensive and are linked to a number of adverse side effects, thereby leading to an intense interest among clinicians to find a suitable alternative osteostimulatory therapy. Our research seeks to investigate the regenerative potential of the main megakaryocyte growth factor, thrombopoietin (TPO), in bone healing. In this study, we sought to compare the short term tissue response of TPO after addition to the site of an incomplete fracture with currently existing molecular agents (BMPs). Unicortical fractures were surgically created in 10 week-old male C57BL/6 mice and the fracture site was wrapped in a collagen sponge containing a solution of either TPO, BMP, or saline solution. After two to four weeks, the mice were sacrificed and both the fractured and non-fractured femurs were excised and micro-computed tomography (μCT) analysis performed on both femurs. Software analysis of the excised femurs demonstrated a significant difference in total callus volume as well as the percentage of callus that was calcified. Femurs treated with TPO displayed a much smaller total callus volume than those treated with BMP. However, the percentage of calcified callus was significantly higher in the TPO treated femurs as compared to BMP treated femurs. Although preliminary, these results suggest that TPO may act as a novel osteostimulatory agent for bone healing.

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FLUORESCENT INTERCALATOR DISPLACEMENT (FID) ANALYSES OF DNA BINDING BY BLEOMYCIN

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Bleomycins constitute a class of DNA-targeted antitumor antibiotics used clinically against several forms of cancer. The clinical efficacy of the bleomycins is thought to derive from their ability to bind Fe(II) and O2 leading to the site-selective strand scission of DNA, predominantly at the pyrimidine residue of 5’-GT(C) sites. Recently, one of us was involved in reporting the first crystal structure of DNA-bound Co(III)-bleomycin, a structural analogue of Fe(III)-bleomycin. These structures revealed that the bleomycins bind to DNA encompassing a 5 base pair “footprint” with sequences of the general form 5’-XYGTZ, where the 5’-GT dinucleotide reflects the preferred 5’-GT(C) cleavage selectivity of this agent and X, Y and Z represent undefined nucleotides (A, G, T, or C) that likely impact bleomycin-DNA recognition. To determine the extent to which the identity of the nucleotides X, Y, and Z influence the binding and cleavage selectivity of bleomycin, we employed a well-established fluorescent intercalator displacement (FID) assay and a library of synthetic oligonucleotides containing a variable five base pair cassette. The oligonucleotides employed contained all possible combinations of DNA residues at the X, Y, and Z positions of the sequences of interest (5’-XYGTZ and 5’-XYGCZ) and permitted the identification of preferred X, Y, and Z nucleotides to be established upon direct comparison and association with bleomycin through use of the FID assay. A rank-ordered comparison of the identities of preferred X, Y, and Z nucleotides will be presented. The determination of the exact identities of any preferred nucleotides at X, Y, and Z, thus also defining preferred 5 base pair target sequences, will likely assist in our fundamental understanding of bleomycin-DNA targeting and may ultimately lead to the development of more potent and less toxic derivatives of the bleomycins.

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USING MATHEMATICS TO INVESTIGATE THE ROLE OF INTEGRIN ACTIVATION IN CELL MIGRATION

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The process of wound healing requires the migration of cells into the wounded region to restore the function of the tissue. Cell migration is governed by a cyclic mechanism that is regulated by a complex signaling network involving the activation of protein structure known as integrins. Integrins play an important role in the adhesion and release processes of cell migration. If integrin activation is too high or too low, cell migration is reduced or inhibited. In healthy cells, positive stimulatory and inhibitory signals provide the positive and negative feedback necessary to keep integrin activation at an appropriate level. In disease cases such as necrotizing enterocolitis (NEC), cell migration has been observed to be impaired, likely in part due to an overexpression of integrin proteins. In particular, lipopolysaccharide components of bacterial walls bind with Toll-like receptor 4 on the intestinal epithelium and trigger a signaling cascade that yields integrin activation. An increased presence of bacteria is hypothesized to cause increased integrin activation and thus decreased cell migration and impaired wound healing. This study aims to elucidate the steps in the signaling cascade which contribute most significantly to the overactivation of integrins. The key players in the integrin signaling cascade have been outlined through extensive literature review. A mathematical model of ordinary differential equations has been developed to study the relationship between the components of the signaling cascade, including inside-out and outside-in integrin signaling. Using the model, multiple scenarios are simulated to investigate the factors that have the greatest influence on integrin activation and consequently cell migration.

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DEVELOPING INTERCULTURAL COMMUNICATION SKILLS FROM A COMMUNICATION COMPLEX PERSPECTIVE: A PILOT STUDY OF STUDENTS FROM TWO COUNTRIES

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Intercultural communication in the 21st century is taught on a very basic level even though there is evidence stating it is not as simple as many educators would claim it is. Undergraduate students are urged, and in some disciplines, required to take classes that build their intercultural communication skills. These students, however, are seldom prepared for their own cross-cultural encounters once in the workforce. The reason behind this is, that in many cases intercultural communication is not addressed appropriately in conjunction to larger communication settings such as group communication or organizational communication. To rectify this issue; educators must create curriculum that reshapes students’ perspectives on culture through concepts and theories. This study addresses this complexity known a Communication Complex, which recognizes that the brain, mind, and relationships work reflexively in communication, shaping people and their understanding of the world. To more deeply understand pedagogical possibilities, a comparison study was done in which European and American students were interviewed using opened ended questions related to intercultural communication. Students interviewed had been involved in communication based classes and had intercultural interaction through a study abroad program. Through analysis of the interviews there is hope to find ways of modifying patterns in undergraduate classrooms that mimic real world applications of intercultural communication.

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CHARACTERIZATION OF STEP-GROWTH GELATIN NORBORNENE HYDROGELS

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Hydrogels are ideal systems for cell encapsulation and tissue regeneration. Synthetic macromers such as poly(ethylene glycol) (PEG) can be cross-linked to create networks which allow for the diffusion of nutrients and other biomolecules while maintaining highly tunable mechanical properties. However, purely synthetic hydrogel platforms are limited because they require the addition of bioactive peptide sequences in order for cells to interact with their environment. As an alternative, this project aims to develop a hydrogel platform that readily incorporates multiple bioactive motifs through a gelatin derived monomer. We hypothesize that norbornene functionalized gelatin (GelNB) will allow for the creation of an inexpensive, naturally cell-responsive environment capable of maintaining a range of physiologically relevant mechanical profiles. So far, GelNB has been successfully synthesized and found to undergo rapid gelation under UV light exposure. In addition, stiffness and swelling properties were found to be tunable by varying the GelNB concentration, demonstrating the mechanical potential of this scheme. As the optimization of hydrogel properties continues, the cytocompatibility of this system will be tested by encapsulating human mesenchymal stem cells. We hope that this project can contribute to a variety of 3D cell encapsulation and tissue regeneration applications.

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EPIGENETIC MODIFICATION IN TRAUMATIC BRAIN INJURY

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Traumatic brain injury (TBI) derived from local external impact often develops into long-lasting and broad psycho-neurological disorder such as posttraumatic stress disorder (PTSD). To this date, the mechanism underlying the etiology is unclear. Research is demanded how the extended disorder beyond local injury is derived. Epigenetics is the study of chemical modifications to the primary sequence of DNA that ultimately affects gene expression. Recent studies have shown that epigenetic modifications 5-hydroxymethylcytosine (5hmC) and 5-methylcytosine (5mC), DNA methylation marks, play a role in neural and developmental systems by either upregulating or downregulating gene expression. How TBI impacts the epigenetic programing of the cortical regions of the brain has not been clearly established. In order to better understand how TBI impacts the epigenetic profile of the brain we will examine specific epigenetic markers (5mC and 5hmC) in the cortical regions. In this study, adult C57BL/6 mice were treated with the established TBI controlled cortical impact (CCI) protocol on the right cortical area either once or twice and sacrificed at an interval time afterwards (6 hours, 2 days, 7 days). Tissue was characterized for 5hmC and 5mC profiles using immunohistochemical techniques. In the cortex we found a decrease in both epigenetic markers when compared to the sham controls. There was a loss of 5mC in the prefrontal, primordial, and junction to temporal cortices is bilateral, indicating a contrecoup impact. Also we found a loss of 5hmC in the cingulate, olfactory, and prefrontal cortices, while layer 4 in cortical regions appeared removed. TBI interfered with the normal epigenetic programing of the cortex. Elucidating the effect of TBI on epigenetic programing may be the first step toward answering questions regarding the global effects of concussions, their duration, and investigating the phenotypic effects of traumatic brain injuries such as PTSD.

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