

FALL UNDERGRADUATE



RESEARCH FAIR

**Thursday, October 25, 6–9p.m.
Jordan Hall of Science**



**UNIVERSITY OF
NOTRE DAME**

College of Science

College of Science – Fall Undergraduate Research Fair 2012

Welcome!

The purpose of this event is to provide science students with an opportunity to get many of their questions answered about undergraduate research. Not only about how to get more involved in research, but also how to get more out of the research experience itself.

Throughout and beyond the College of Science there are many different ways in which students can get involved in research. Often it's just a question of looking in the right places and being persistent in the hunt for the right opportunity. However, getting the right opportunity is also about getting as much information as possible from a diversity of sources. This could be as simple as a fellow student but there are also many organizations, institutes, and centers on campus that are also more than willing to help a student find and support their research endeavors. Furthermore, there are many ways for students to get even more out of their research experience, through publishing and presenting their research to their peers.

Through a combination of listening to speakers, poster presenters, and representatives from various institutions, students should be able to get some ideas about how best to get started looking for research opportunities. Also, students should be able to see how they can add value to their research experience by participating in other related activities. The sooner a student begins the search, the sooner they will be able to start participating in undergraduate research and getting the most from that experience!

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Research Poster Presentations - Jordan Galleria

Prediction the effectiveness of chemical defenses based on the physical defenses of three gastropods in the presence of two crayfish predators

Nick Anderson

Major: Environmental Sciences

Mentor: Shayna Sura, Dept. of Biological Sciences, University of Notre Dame.

Predation poses a serious threat to prey species' fitness. Prey species invest energy into morphological and behavioral defenses to avoid predation. While these defenses offer the benefit of reduced predation, they also incur costs for the defended organism. Predators counteract defenses with their own adaptations and by selectively foraging on prey items that offer enough nutritional benefit to outweigh the costs of consumption. We explored this interaction by observing the preferential browsing of two crayfish species—*Orconectes propinquus* and *Orconectes virilis*—on three gastropod species—*Bellayma chinensis*, *Lymnaea stagnalis*, and *Helisoma trivolvis*. Possible chemical defenses were isolated by removing the snail species' physical defenses. We predicted snails that invest more in physical defenses would possess fewer chemical defenses and they would be preferentially browsed upon. We found this was not always the case and that *H. trivolvis*, the species with the fewest physical defenses, was more often preferred by the crayfish species over the other snail species. Further study is needed to adequately assess chemical defenses and the nutritional value of these gastropods as well as the relative effectiveness of their defenses against predation.

Characterizing the Protein-Protein Interactions of XAB2 and PPIE Both In and Outside of the Spliceosome

Elena Brindley

Majors: Biological Sciences and Psychology

Mentor: Tara Davis, Dept. of Biochemistry and Molecular Biology,
Drexel University College of Medicine, Philadelphia, PA

Splicing refers to the critical biological process in which the pre-mRNA transcript of a eukaryote is modified before being translated into protein. This phenomenon is vital to all eukaryotic life and is relevant to human health because over 95% percent of human genes are spliced, and improper splicing generates mutations that often lead to disease. The purpose of splicing is to remove the non-coding introns of pre-mRNA and rejoin the coding exons, and the molecular machinery behind this editing is the spliceosome. As a large complex comprised of small nuclear RNA and many core and non-core proteins, the spliceosome contains many uncharacterized RNA-RNA, RNA-protein, and protein-protein interactions. The current study focuses on interactions of the non-core family of peptidyl-prolyl isomerases, known as the cyclophilins, with other core spliceosomal proteins, and how these interactions regulate splicing. In particular, this experiment focuses on the cyclophilin, PPIE, and its proposed interaction partner, XAB2, both of which are have been found in active spliceosomes and are known to have extra-spliceosomal activity. Several specially designed constructs of each protein were PCR amplified and inserted into vectors suitable for ligation-independent cloning (LIC). After 100% cloning efficiency was achieved, all constructs were placed into small-scale protein expression trials, and successful or interesting constructs were advanced to large-scale trials and purification. While the large size of our XAB2 constructs led to difficulties with protein expression, future directions include beginning again at cloning with a new set of constructs. Hopefully, this will allow us to move forward to our ultimate goal of crystallization trials, co-crystallization and co-purification, protein-protein interaction assays, and a splicing assay.

Thermal Detection of Inaccessible Plate Corrosion

Matthew Charnley

Majors: Mathematics and Chemical Engineering

Advisor: Kurt Bryan, Dept. of Mathematics, Rose-Hulman Institute of Technology

Coauthors: Andrew Rzeznik, Cornell University, Ithaca, NY

In engineering and industrial applications, it can be very valuable to know if an inaccessible portion of a structural element has been corroded, for both safety and efficiency. We wish to use a completely non-contact thermal method to approximate the corrosion profile, as this method would be easy to apply to a physical situation. Different properties of this mathematical "inverse problem" were analyzed and a method of solution was developed. In the two-dimensional simplified case, computational reconstruction of the corrosion profile from the input heat flux and the temperature data on the accessible surface of the object results in a reliable estimation of the corrosion profile, within an acceptable error. Future research could extend this problem to appropriate physical parameters and a three-dimensional model, which would allow for application in real-world situations.

Enrichment for and analysis of hematopoietic stem cell subfractions

Sienna Durbin
Major: Biological Sciences

Mentor: Stuart Orkin, Dept. of Hematology/Oncology, Children's Hospital, Boston, MA
Coauthors: Sidinh Luc and Guoji Guo, Department of Hematology/Oncology,
Children's Hospital, Boston, MA

Hematopoietic stem cells (HSCs) are the origin of all blood cell lineages; they develop into progenitors that differentiate into mature blood cells. HSCs have been studied extensively, leading to a highly detailed understanding of the hematopoietic system that has been accepted as the norm in the scientific and medical communities for decades. However, recent research suggests that there is likely some degree of heterogeneity in the most primitive HSC population, which was once considered to be homogeneous. These HSC subfractions, including myeloid-biased, lymphoid-biased, and balanced stem cells, could have important implications in the fundamental way that the blood system is understood, including the way that the composition of blood changes as an individual ages. Although there is significant research supporting HSC heterogeneity, many questions remain. The basis for this heterogeneity is a mystery; factors such as epigenetic modifications and extracellular factors could play a previously unknown role in HSC development. In addition, the need for more effective techniques of purification of and enrichment for these stem cells remains. My project used fluorescence-activated cell sorting (FACS) analysis to elucidate an effective method of enrichment for these subfractions and real time (RT) PCR to explore differences in gene expression that may account for the observed biases.

Preferential foraging behavior of forest deer mice (*Peromyscus maniculatus gracilis*) on native and non-native *Picea* seeds

Lauren Eckert
Major: Environmental Sciences

Mentor: Michael Cramer, Dept. of Biological Sciences, University of Notre Dame

Exotic plant invasions can lead to serious biodiversity and economic losses, with negative effects on many ecosystems. The factors leading to invasive plant success have been well documented and studied, but little is known about the impact of granivory on invasive plants. *Peromyscus maniculatus* is the most widely distributed *Peromyscus* species, and has been suggested to cause substantial loss of tree seed crops through seed predation. In this experiment, I study the preferential feeding behavior of deer mice on the seeds of the non-native, non-invasive blue spruce (*Picea pungens*) and the native white spruce (*Picea glauca*) in the Upper Peninsula of Michigan. Mice were captured and allowed to feed freely on equal amounts of both seeds, and were revealed to significantly prefer the larger non-native *P. pungens* seeds to *P. glauca*. Though factors that contribute to invasive plant success are highly complicated and non-exclusive and further experimentation is necessary to understand the complex aspects of the optimal foraging theory when applied to granivory, preference for *P. pungens* seeds by the widespread deer mouse may suggest that seed predators play an important role in invasive plant establishment and improve our understanding of invasive flora as well as suggesting mitigative action.

Carbon 14 detection with FN Tandem Accelerator

Mason Faulk
Major: Physics

Mentor: Philippe Collon, Dept. of Physics, University of Notre Dame

Equal Entries in a Totally Positive Matrix

Mitchell Faulk

Major: Honors Mathematics

Mentor: Charles Johnson, Dept. of Mathematics,
College of William and Mary, Williamsburg, VA

Coauthors: Evan Marzion and Miriam Farber

We asymptotically bound the number of equal entries in a totally positive matrix. In particular, we show that the number of equal entries in an n -by- n totally positive matrix is $\tilde{O}(n^{4/3})$. We build on the work done by Pach and Tardos concerning positive orthogonal cycles to identify those configurations of equal entries that are maximal. Our work has further applications to totally positive completion problems and to point-line geometry in the plane.

Susceptibility genes and antibodies as biomarkers for type 1 diabetes in NOD mice

Jeffrey Hansen
Major: Biological Sciences

Mentor: Kenneth Brayman, Dept. of Surgery, University of Virginia, Charlottesville, VA

Type 1 diabetes (T1D) is an autoimmune disorder that ultimately results in the complete destruction of insulin-producing islet cells of the pancreas. By the time the onset of T1D is realized, 80-90% of all islet cells have already lost function, making the preservation of these cells futile. To remedy this situation, biomarkers can be used to predict the onset of the disease in order to administer treatment prior to the destruction of islet cells to preserve cell mass. Such biomarkers include genes linked to susceptibility of the disease, autoantibodies found within the blood prior to disease onset, and genes linked with general inflammation linked to autoimmune disorders. Specifically the expression of GAD65, IA2, IL6, IL18, CTLA4, IFN-gamma and CXCL1 was analyzed at various stages of disease progression. Gene expression was analyzed through RNA isolation from the pancreata of NOD mice using RT-qPCR to determine relative levels of expression at pre-diabetic (3-4wk), pre-hyperglycemic (7-11wk) and diabetic (>12wk) stages. While RNA degradation due to faulty pancreatic isolation techniques made analysis difficult, increases in expression of IL18, CXCL1 and ICA1 was visible. This experiment sets the stage for future experimentation with perhaps other target genes using improved isolation techniques.

Silver nanoparticles alter mRNA expression of cytokines in mouse macrophage and hepatoma cells

Madelyn Huang
Major: Biochemistry

Mentor: David Eaton, DEOHS, University of Washington, Seattle, WA
Coauthors: Terry Ward and Wesley Smith

Nanosized, encapsulated silver particles (AgNP) are widely used in several consumer products, such as clothing and personal care products, because of their bactericidal properties. Although AgNPs have widespread consumer use, there have been relatively few studies of their potential toxicity to mammalian cells. This study investigates the potential pathway of AgNP toxicity by observing changes in mRNA expression of inflammatory cytokines (CXCL-1, TNF, IL-6) in mouse leukemic macrophages (RAW 264.7) and mouse hepatoma cells (Hepa-1). Cells were incubated for three hours with 20 nm and 110 nm silver nanoparticles encased in either citrate or polyvinylpyrrolidone (PVP) at 6.25, 12.5, 25, and 50 µg/ml. Quantitative RT-PCR results showed increased CXCL-1 and IL-6 expression in Hepa-1 cells, and only TNF expression in RAW cells. Differences in cytokine expression may be indicative of different immune responses to 20 nm and 110 nm AgNPs. Additionally, AgNPs may induce a slight immune response in Hepa-1 cells but lower immune response in RAW cells after treatment with 20 nm particles. Results further suggest that PVP and citrate may not be the best coatings to enhance nanoparticle bioavailability. Additional experimental replicates are required to fully assess the effects of AgNPs on these cell lines.

Schematic memory and the ventromedial prefrontal cortex

Samuel Jones

Majors: SCPP and Psychology

Mentors: Kathleen Kolberg, Dept. of Pre-Professional Studies and

Anre Venter, Dept. of Psychology, University of Notre Dame

Coauthors: David Warren and Daniel Tranel

In psychology, schematic memory is a person's memory of the way something normally is or should be, based on previous experience. By examining false memory in individuals with focal brain lesions, it is possible to determine the role of different areas of the brain in schematic memory. Recent theories suggest that the medial prefrontal cortex of the brain is involved with suppressing activity of the medial temporal lobe and hippocampus in the encoding of semantically congruent memory objects. Here, a version of the Deese-Roediger-McDermott paradigm was used to provoke intrusions of schematically congruent "critical" words on recall and recognition into lists of studied words. Performance on this test was measured for individuals with damage to the ventromedial prefrontal cortex (vmPFC) and the medial temporal lobe, and was compared to individuals without brain damage (functioning as a normal comparison). In preliminary results, it was found that individuals with damage to the vmPFC displayed relatively normal recognition and patterns of recall. However, these vmPFC-damaged individuals showed reduced proportional recall of critical items in contrast with normal comparison subjects, indicating that damage to the vmPFC could result in reduced awareness of critical items only during recall.

The role of claudin and tight junction protein in the developing zebrafish kidney

Jonathan Jou
Major: Biological Sciences

Mentor: Rebecca Wingert, Dept of Biological Sciences, University of Notre Dame

The kidneys are crucial organs for the maintenance of homeostasis. Through the use of nephrons, the kidneys remove metabolic waste products, adjust blood pH and regulate electrolyte content. Proper filtration is made possible by specific cell-cell interactions that create tight or leaky junctions between nephron epithelial cells. The claudin and tight junction protein families are two of the four protein families predicted to be involved in the formation of tight junctions during development. The claudin family consists of 24 members in mammals and the tight junction family consists of 5 members. Recently, claudins have been shown to have segment-specific expression in the murine kidney, where they play important roles in maintaining selective permeability. Tight junction proteins have been detected in the zebrafish pronephros, although their segment specificity is unknown. We found that two claudin genes, *claudin 15a* and *claudin 8*, are expressed in the proximal and distal segments, respectively. The expression of *claudin 15a* and *claudin 8* appeared to partially overlap in the first distal segment. We also found that contrary to the published literature, transcripts encoding *tight junction protein 2a* and *2b* are expressed in the pronephros as opposed to the somites.

*An Estimation of Sensitivities for Neutrino Magnetic Moment Measurement
in NO ν A Near Detector*

Kevin Kelly

Majors: Physics and Mathematics

Mentor: Ken Heller, School of Physics and Astronomy,
University of Minnesota, Minneapolis, MN

Coauthors: Jaroslaw Nowak

This poster covers an attempt to reconstruct and observe magnetic moment interactions in NO ν A (NuMI Off-Axis Electron Neutrino Appearance) Near-Detector data and Monte Carlo Samples. These events occur when a single neutrino and electron interact, exchanging helicities, and scatter very cleanly compared to most events in the detector. If, in fact, these interactions exist, the neutrino's magnetic moment can be measured to some accuracy, showing that the neutrino may be a composite particle.

In addition, this paper summarizes my time spent during the Summer 2012 REU program in the Department of Physics at the University of Minnesota, including the previous analysis as well as time spent working at the NO ν A "Module Factory" where the 15,000 modules for the detector are being constructed.

Bose-Einstein Condensation: Optics and Cold Atoms in São Paulo, Brazil

Ryan Ketterer
Major: Physics

Mentor: Carol Tanner, Dept. of Physics, University of Notre Dame

The work of the Optics Group in São Carlos, Brazil (*Grupo de Óptica, Instituto de Física de São Carlos, Universidade de São Paulo*) includes research with Bose-Einstein Condensates in Rb-87. A sophisticated laser setup is capable of reaching temperatures below 100 nK, with samples of 7×10^4 atoms. Electric dispensers feed atoms into extreme vacuum chambers, where a magneto-optical trap secures the atoms and cools them down; a second vacuum chamber is utilized to enable further cooling. The atom cloud is then passed to an optical dipole trap, where evaporative processes can be used to cool the atoms enough to observe Bose-Einstein condensation. After weeks of optimization of the experimental setup, I continued assisting in the accrual of images of atom clouds of various size, shape, and temperature. Data continues to be processed; the thousands of images will further our understanding of the transition between a simply thermal atomic cloud to a condensed cloud.

Genetic and pathway analyses of quantitative white matter changes in mild cognitive impairment and Alzheimer's disease

Jason Kippenbrock
Major: Biological Sciences

Mentor: Li Shen, Dept. of Radiology and Imaging Sciences,
Indiana University School of Medicine, Indianapolis, IN
Coauthors: Vijay Ramanan, Sungeun Kim, Shannon Risacher,
John West, Andrew Saykin, and Li Shen

Alzheimer's Disease (AD) is a deadly form of dementia which currently affects more than 5 million U.S. patients. While AD is generally associated with the formation of amyloid plaques and neurofibrillary tangles in the brain, the integrated mechanisms of AD onset and disease progression are not yet fully understood, and known genetic variants do not account for a substantial portion of disease prevalence. To complement the extensive explorations of AD-related gray matter changes, we analyzed quantitative indicators of brain white matter integrity and assessed their underlying genetic architectures. Genome-wide association studies (GWAS) were performed in PLINK using data from the Alzheimer's Disease Neuroimaging Initiative (ADNI). Three phenotypes were analyzed: T2 white matter hyperintensity volume, T1 white matter hypointensity volume, and corpus callosum volume. Subsequent pathway analyses on the GWAS results were performed in MetaCore to identify functional sets of genes with variants contributing moderate but collective effects toward each phenotype. Several genes exhibited genome-wide significant association ($p < 5 \times 10^{-8}$) to a white matter phenotype, including *ATRN* and *COL9A1*. Pathway analyses implicated the MAPK-ERK signaling pathway and autoimmune mechanisms are also contributing to white matter morphology. Replication in independent data sets and further exploration of the potential roles of these genes and pathways in white matter structure and AD neuropathology appear warranted.

Molecular Shuttles: Squaraine Rotaxanes As Ratiometric Chloride Sensors

Patrick Kramer
Major: Chemistry

Mentor: Bradley Smith, Dept. of Chemistry and Biochemistry, University of Notre Dame

The development of versatile optical chemosensors in imaging applications is an increasingly relevant research focus. Our group has previously encapsulated squaraine fluorophores inside tetralactam macrocycles, creating a mechanically interlocked structure that is stable in varied chemical environments. We have now synthesized a squaraine rotaxane (SR) that utilizes an anthracene-functionalized macrocycle and dihydroxylated (DiOH) squaraine dye as a two-component molecular machine. A more labile bond between the macrocycle and dye allows the macrocycle to shuttle from the dye core to secondary sites on the dye. The shuttling capabilities of the DiOH SR were confirmed and quantified through absorbance and fluorescence studies, as the non-hydroxylated control SR showed no change in the same studies. The addition of chloride greatly enhanced the shuttling effect, as significant blue shifts in absorbance and fluorescence were observed with chloride titration. The removal of chloride from solution resulted in a restoration of the original properties of the DiOH SR, indicating the ability of the macrocycle to reassociate with the dye core. The reversibility of the shuttle is a significant improvement in SR sensing capabilities, and may find further application in biological and environmental settings as a reversible chemosensor for various anionic compounds.

Exciton and Biexciton Binding Energy in InGaAs/GaAs Quantum Dots

Sarah Krug
Major: Physics

Mentors: Eoin O'Reilly and Stefan Schulz, Tyndall National Institute, Cork, Ireland

A quantum dot occurs when a semiconductor with a smaller energy gap between its valence and conduction bands is surrounded by a semiconductor with a larger energy gap, trapping an electron inside a 3-dimensional quantum well. Recently, Emanuele Pelucchi's Epitaxy group at Tyndall National Institute discovered how to grow InGaAs quantum dots surrounded by GaAs. Inside a quantum dot, an electron can jump between energy levels. When an electron jumps from the valence to the conduction band, it leaves a hole in the valence band. This electron-hole pair is an exciton. Two interacting excitons are a bi-exciton. Numerical methods were used to input the matrix form of Schrödinger's equation into MatLab in order to model the wavefunctions and energies of the electron and hole. An algorithm was written to calculate the effect of the Coulomb interaction on the binding energy for various sizes and shapes of a quantum dot. It was found that the bi-exciton binding energies approached a bulk value close to 0 as the size of the quantum dot increased. Also, the exciton binding energies were compared with previously published models and experimental results and were found to fit almost perfectly, which helped to verify the code.

miR-24 Required for Blood Development from Embryonic Stem Cells

Danica Lapid
Major: Biological Sciences

Mentor: Richard Dahl, Indiana University School of Medicine - South Bend, IN

MiRNAs are small, noncoding RNAs that regulate gene expression. Previously it was observed that overexpression of the miRNA, miR-24, affects the development of adult hematopoietic progenitors. To determine if miR-24 is required for blood development, we knocked down miR-24 expression in embryonic stem cells (ESCs), and assayed hematopoiesis in the ESC derived embryoid bodies (EBs). Hematopoiesis was reduced from miR-24 knockdown ESCs. Reduction in red blood cells and hematopoietic gene expression was observed. FACs analysis demonstrated that reduced miR-24 resulted in a decrease in the CD41⁺ hematopoietic progenitor population. Gene expression analysis was performed to identify where a block in differentiation was occurring. We observed reduced expression of GATA2, and ETV2, which are required for the development of the hemangioblast, a progenitor for blood and endothelial cells. Consistent with a defect in generating the hemangioblast we observed reduction in the expression of the endothelial gene CD31. The defect in blood development is not a defect in generating mesoderm as FACs analysis demonstrated that paraxial and lateral plate mesoderm are produced. Additionally, cardiac tissue was detected by the appearance of beating EBs expressing Nkx2.5. In conclusion, the results indicate that miR-24 is essential for the differentiation of ESCs into blood.

Genetics and Identity: Ethnogenesis in a Jamaican Maroon Community

Holden Lombard

Major: Physics in Medicine and Anthropology

Mentor: Jada BennTorres, Dept. of Anthropology, University of Notre Dame

In this study, the biological relationship between an ethnic minority, Accompong Maroons, and majority Jamaican population are accessed using genetic data. Accompong Maroons reside within St. Elizabeth parish in western Jamaica. They are the descendants of the island's indigenous population, known as Taíno and escaped enslaved Africans. Due to their physical location in the hinterlands of the island and a series of wars with the British, the Maroons developed into an isolated semi-autonomous community on the outskirts of colonial society. This isolation seeded the beginnings of a subpopulation with distinct linguistic and cultural traits, and land inheritance patterns that differed from the larger population. With the abolition of slavery in 1834, isolation became less of a factor and inter-marriage between Maroons and other Jamaicans occurred. According to 19th century ethnohistorians, Maroons appeared both culturally and phenotypically different than the general Jamaican population. These distinctions, however, were not visible to later researchers. In spite of such assertions, Maroon identity remains strong within the community reinforced by annual rituals and access to un-taxed land.

To address the question of Maroon distinctiveness, the CODIS panel was genotyped in a sample of 53 Accompong residents and compared to other Caribbean populations. Summary statistics and multidimensional scaling plots based on genetic distances suggest that the Accompong Maroons are distinct from other Caribbean populations. Though further studies are needed to corroborate these findings, this study contributes to the general body of knowledge regarding the process of ethnogenesis as it occurred in the Americas.

Monitoring Techniques for Temperate Bird Diversity: Uncovering Relationships between Soundscape Analysis and Point Counts

Jack McLaren
Major: Environmental Sciences

Mentor: Luke Degroote, Powdermill Avian Research Center,
Carnegie Museum of Natural History, Rector, PA

Our goal was to establish a relationship between measures of avian diversity from point counts and soundscape metrics such as normalized difference soundscape index (NDSI), biophony levels, technophony levels, and sound file species richness. Soundscape analysis and the recording devices it uses are far less invasive than point counts, collect more high-quality data, and can be immediately uploaded to the internet for long-term storage and further analysis. Consistent with our hypotheses, we found that observed species richness was positively related to sound file species richness. NDSI values were significantly positively related to Shannon's diversity index, species richness, and sound file species richness while technophony values significantly negatively related with Shannon's diversity index, species richness, and sound file richness. Biophony values showed no relationships with point count data, which ran contrary to our hypotheses. The link we established between point count diversity and soundscape data could allow scientists to use recording devices to non-invasively monitor diversity which would allow for far more efficient diversity monitoring and open new opportunities for further study.

ALICE Trigger and Event Selection Quality Assurance

Kevin McDermott
Major: Physics

Mentors: Alexander Kalweit and Michele Floris, CERN, Geneva, Switzerland

The ALICE detector is a dedicated heavy ion experiment at the CERN LHC, designed to study high energy nuclear interactions. ALICE has a significantly worse signal-to-background ratio than the other LHC experiments. The events used in offline analyses need to be selected in order to remove contamination from beam-induced background and to validate the online triggers. This is achieved at ALICE through a process known as Physics Selection (PS). The quality of the selection needs to be monitored, and the previous PS Quality Assurance (PSQA) code needed streamlining and automation. The results of this project produce run by run trending plots to monitor PS by only specifying a few input and output parameters. In addition, this process is now fully automated so that these plots can be generated automatically and instantly viewable via a webpage. Examples of these results are displayed on the poster.

Green Design to Prevent Toxic Arsenic Leaching from PADs Post-Disposal

Sean McGee

Major: Biological Sciences

Mentors: Kathleen Eggleston, Center for Nano Science and Technology, and Marya Lieberman, Dept. of Chemistry and Biochemistry, University of Notre Dame

The purpose of this project is to consider the full product life cycle of a developing technology, explore any potentially harmful side-effects, and develop a green solution to would-be problems. The product I am investigating is a Paper Analytical Device (PAD) to detect iodine in human urine. This simple field test, developed as part of a larger project by Dr. Marya Lieberman and Dr. Toni Barstis, is an important detector of good thyroid health. However, this tool designed to improve human well-being in the developing world contains high quantities of ionic arsenic, mainly As(III) and As(V), which is severely toxic and a large environmental risk. Analysis of current PADs via the toxicity characteristic leaching procedure (TCLP) developed by the US Environmental Protection Agency (EPA) and inductively coupled plasma optical emission spectroscopy (ICP-OES) show that they qualify as hazardous waste according to EPA standards. A solution under active investigation is adding various iron-based oxides such as Fe₂O₃ and goethite to the PAD solution *in situ* to adsorb ionic arsenic, cause it to precipitate from solution, and thus prevent it from contaminating local groundwater.

Genetic origins of a rural Jamaican Maroon community

Nicole Madrilejo

Major: Science Pre-Professional

Advisor: Dr. Jada Benn-Torres, Dept. of Anthropology

Coauthors: Holden Lombard and Dr. Jada Benn-Torres

The maternal genetic ancestry of the Maroons of Accompong was examined in order to illuminate this community's ancestral origins. Some historical accounts note that the Maroons of Accompong are descendants of the indigenous people of Jamaica and escaped enslaved Africans that built their own semi-isolated communities to escape the abuses associated with Spanish colonial encomiendas and later English plantations. Other sources suggest that nearly all the indigenous people were gone by the time Africans arrived to Jamaica and that Maroons are only descended from African peoples.

Mitochondrial sequence data from hypervariable region I (mtHVI) was studied to determine the genetic origins of the maternal lineage of the study participants. DNA was collected from 53 Accompong Maroons and stored on FTA cards. Each sample was amplified and then sequenced at the mtHVI region. The DNA sequence was then queried using HaploGrep to learn of the mitochondrial haplogroup. Preliminary analysis of ten sequences demonstrates that the majority of sequences belong to African haplogroups, L1 and L2, while a small number belong to haplogroup H which is most common in Europe. Though no native ancestry was present among the study participants, this study indicates that the maternal origins of Accompong Maroon may be more complex than historical sources suggest.

Developmental Regulation of miRNA Activity in Caenorhabditis elegans

Rebecca Marton
Major: Biological Sciences

Mentor: Chris Hammell, Cold Spring Harbor Laboratory, NY

The temporal regulation of gene expression is essential to animal development. MicroRNAs normally function to negatively regulate the expression of target mRNAs. Alterations in miRNA expression lead to defects in the normal developmental progression. *Caenorhabditis elegans* mutants that under-accumulate lin-4 miRNA inappropriately reiterate early larval stages, resulting in overt defects including a lack of adult gene expression. While the genetic relationships between lin-4 and its primary target lin-14 have been well studied, we only have a general understanding of how the fidelity of these interactions is maintained *in vivo*. We reason that there must be components that ultimately function to ensure the proper expression and activity of lin-4, as well as other miRNAs involved in development. In an effort to discover these components, a high throughput RNAi screen was developed to identify suppressors of lin-4 phenotypes. Two genes, *inx-14* and Y48G1C.7, were identified that were capable of suppressing lin-4 mutants as well as two other miRNA mutants. *Inx-14*, a predicted member of the innexin family, likely plays a role in gap junction formation, while relatively little is known about Y48G1C.7. Further study is necessary to elucidate the role of these two genes in the regulation of the normal developmental progression.

An Evaluation of the Uganda Perceptions of NGOs in Hoima and Gulu

Emily Mediate

Major: Arts and Letters Pre-Professional Studies

Mentor: Christian Smith, Dept. of Sociology, University of Notre Dame

Through research, personal observations, and articles, I was shocked to find that not a single charity-rating organization evaluates the opinion of aid recipients. This is problematic, because millions of dollars go to NGOs in developing countries every year. It is remarkable; because the basic tenant of any business should be, What do customers demand/want to by? However, none of these articles or websites look at specific organizations or talk to recipients (“customers”) of the aid as a way of evaluating the organization’s reputation. The question that I sought to answer was: What are the Ugandan perceptions of various non-governmental organizations in Uganda?

I randomly selected a spread of 40 interviewees and if they consented, I conducted an interview. Ugandans were very willing to share their experiences and give their perspectives. I found that the Catholic Diocese of Hoima was perceived the most effective NGO, Invisible Children was second and Compassion International was third. Also, I found that the biggest need is clean water and school fees.

I ran into a number of issues in conducting interviews, but was able to gain general information about the way NGOs operate in Uganda. This research could serve as groundwork for future projects.

Growth of Long, Highly Aligned Single-Walled Carbon Nanotubes on Crystal Quartz for Terahertz Spectroscopy

Grace Meikle
Major: Physics

Mentor: Shigeo Maruyam, Department of Mechanical Engineering,
University of Tokyo, Tokyo, Japan

Coauthors: Taiki Inoue, Daisuke Hasegawa, Saifullah Badar

Horizontally aligned single-walled nanotubes (HA-SWNTs) with lengths in the range of 500 μm – 1 mm have potential applications in THz devices. We aimed to grow dense, highly aligned arrays on ST and R cut crystal quartz substrates using chemical vapor deposition (CVD). To maximize SWNT length, we tested different catalysts and deposition methods. We hypothesized that Cu would grow longer SWNTs than previously tested catalysts such as iron and cobalt because it uses a tip-growth mechanism. The catalyst was deposited by (1) vacuum deposition or by (2) drop-casting a solution over a physical mask. For CVD we used pure ethanol at partial pressures of 0.1 – 0.2 kPa at 800 C. The longest nanotubes (300 – 500 μm) were grown from Cu on R cut using the solution-based method. The highest density arrays were also grown from Cu and showed a narrower diameter distribution than Co-grown arrays in the 1-2 nm range, suggesting that the Cu sample contained fewer bundled nanotubes. Furthermore, Cu-based SWNTs only grew from very low concentration solutions (0.1 mmol/L CuCl_2 and PVP in ethanol). We observed through AFM that the range of catalyst particle sizes was broader for the solution-based method than for vacuum deposition. We suggest that Cu has the most promise for THz applications because it can inherently grow longer SWNTs due to tip-growth. We further conclude that Cu has a more limited range of active particle sizes than other catalysts, such as Co, and that this range can be most easily found by reducing concentration using the solution-based method.

Effects of Invasive Plant Species on Bird Nesting Preferences

Chelsea Merriman
Major: Environmental Sciences

Mentor: Kerri Martin, Dept. of Biological Sciences, University of Notre Dame

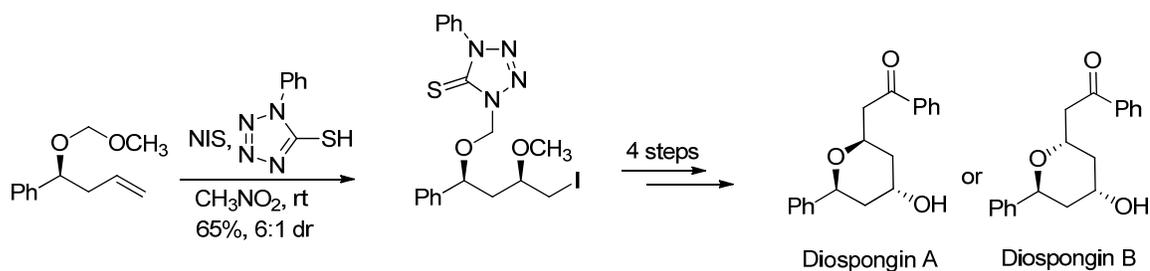
The spread of invasive species is a problem in most areas of the United States. Currently, little is known about invasive species' affect on animals, particularly grassland birds. Grassland birds, which are used as indicators of ecosystem health, could be used to help determine effects of invasive species on an ecosystem. In the grasslands of northern Montana, nesting preferences of vesper sparrows, meadowlarks, and grasshopper sparrows were analyzed. Vegetation at nest sites and random plots was classified as invasive or native, measured, analyzed, and compared to characteristics of known native and invasive vegetation. Grassland birds were shown to avoid nesting in invasive species. Birds favored nest sites with smaller heights, litter depths, visual obstruction readings, and overall coverage than offered by invasive species. These results show that grassland species can be affected by invasive species, and can help scientists and conservationists to better monitor ecosystems and more effectively combat invasive species.

Concise Enantioselective Synthesis of Diospongins A and B

Ansel Nalin
Major: Chemistry

Mentor: Richard Taylor, Dept. of Chemistry and Biochemistry,
University of Notre Dame
Coauthor: Eric Stefan

Natural products exhibit diverse biological properties, and many have potential utility as pharmaceutical agents for cancer therapy. As these compounds are investigated, it is necessary to develop new methodologies for efficient laboratory synthesis. The ether transfer reaction developed in our group is one such method that can be applied to synthesize structural units of natural products. New conditions were developed for the formation of *syn*-1-3-diol mono- or diethers. This methodology was successfully applied to the synthesis of Diospongins A and B, two natural products possessing interesting biological data. Both Diospongins are accessed through a common intermediate, shortening the number of steps from existing synthesis pathways. By modifying the ether transfer, we will also be able to access analogs for further biological testing through similar methodology.



***Recombineering the genome of the obligate intracellular
pathogen Chlamydia trachomatis***

Hoang Ho-Pham
Major: Biochemistry

Mentor: Ashok Aiyar, Louisiana State University Health Sciences Center
Department of Microbiology, Immunology, and Parasitology, New Orleans, LA
Coauthors: Shardulendra Sherchand

Chlamydia trachomatis is an obligate intracellular bacterium, which causes millions of cases of sexually transmitted diseases and blinding trachoma annually. Currently, *C. trachomatis* is the world's most prevalent sexually transmitted bacterium and the leading cause of infectious blindness. Therefore, there is a pressing need to elucidate the virulence factors that contribute to the outstanding success of this organism as a human pathogen.

Unfortunately, identification of *C. trachomatis* virulence determinants has been frustrated by the paucity of available methodologies to genetically manipulate intracellular bacteria such as *Chlamydia*. There has been a single report of a site-specific homologous recombinant being constructed in any of the *Chlamydia* sp. This recombinant was recovered at an efficiency of approximately 1 in 10⁶ transformants.

During my summer research project, we have attempted to develop an alternative strategy to create site-specific *Chlamydia* homologous recombinant. This strategy relied on using the Red recombination locus from bacteriophage Lambda to drive homologous recombination in *Chlamydia*. The Red locus consists of three genes: *alpha*, *beta* and *gamma*. Red-mediated homologous recombination, termed recombineering, relies on the inhibition of the host RecBC double-stranded DNA (dsDNA)-specific exonuclease by *gamma* (Gam). Red *alpha* (I exonuclease) partially single-strands the input dsDNA, after which Red *beta* (Bet) promotes strand hybridization. *Chlamydia* RecBC has diverged considerably from the RecBC proteins of bacteria in which Red recombination has been used successfully; therefore, we anticipated that I Red would not mediate recombination of input dsDNA and the *Chlamydia* genome.

An alternative to the use of dsDNA is the use of single-stranded DNA (ssDNA) corresponding to the lagging strand during genome replication. When ssDNA is used, the functions of Gam, and I exonuclease are not required. Bet is sufficient to anneal the input ssDNA to the leading strand during genome replication. The annealed DNA is recognized as an Okazaki fragment and ligated during the completion of genome replication, thus "fixing" the desired mutation in the genome.

Using ssDNA, I have attempted to mutate two genes on the *Chlamydia* genome, namely *ksgA*, and 16S rRNA. These loci were chosen because *ksgA* is a single-copy gene and there are two copies of 16S rRNA. In addition, mutation of either *ksgA*, or both copies of 16S rRNA results in resistance to the aminoglycoside antibiotic kasugamycin. The results from these experiments are described.

Synthetic Pathway to (-)-Zampanolide

John Rieth
Major: Chemistry

Mentors: Richard Taylor and Matt Wilson, Dept. of Chemistry and Biochemistry,
University of Notre Dame

Several natural products have incredible biological significance. One such compound that has greatly interested the Taylor lab is (-)-zampanolide. First isolated in 1996 from the sea sponge *Fasciospongia rimosa*, (-)-zampanolide has demonstrated anti-cancer activity, which makes this compound critical to cancer research. Recent studies indicate that (-)-zampanolide behaves as a microtubule stabilizing agent by covalently bonding to tubulin. This process hinders cellular reproduction, and specifically affects cancer cells due to their rapid rate of reproduction. One of the critical components of this compound is the side arm of the molecule, which fits into the binding pocket of tubulin, increasing the effectiveness of this compound. In order to obtain material for analysis, a unique synthetic pathway to (-)-zampanolide was developed. This pathway uses the catalytic chemistry developed by Christina Moberg to install a chiral hemiaminal side chain on zampanolide. A model system was used to test the effectiveness this chemistry in the synthesis of zampanolide. Future endeavors include the modification of the hydroxyl group on the side chain of zampanolide by quenching zirconium catalyzed reactions with nucleophiles. These analogues will then be studied to determine the significance of this hydroxyl group in microtubule bonding and stabilization.

Characterization of Aedes aegypti larval opsins

Manuel Rocha

Major: Biological Sciences

Mentor: Joseph O'Tousa, Dept. of Biological Sciences, University of Notre Dame

Coauthor: Matthew Leming

The visual system of *Aedes aegypti* is involved in host seeking strategies and other behaviors. *Ae. aegypti* larvae contain ocelli for light detection. Also, the development of the adult *Ae. aegypti* eye begins during the first larval instar period and continues to develop throughout the larval and pupal periods. In all photoreceptors, vision is initiated by a well-characterized family of G-protein coupled receptors (GPCRs) known as rhodopsins. The genome of *Ae. aegypti* has ten predicted rhodopsin genes, classified into five different groups based on sequence similarity and expected functional properties. These are long-wavelength, short wavelength, UV-sensitive, a pteropsin, and Aaop10. To further understand the organization of the *Ae. aegypti* visual systems, we sought to determine which rhodopsins are expressed during the larval periods. We used antibodies specific to different rhodopsins and immunofluorescence analysis of whole-mounted and cryosectioned larval heads. These studies revealed that Aaop7, a long wavelength opsin ($\lambda_{\max} > 500$ nm), is a major rhodopsin expressed in larval ocelli and the developing adult retina.

Feline Herpesvirus-1 in the Development of a Contraceptive Vaccine for Cats and Dogs

Lucy Smith
Major: Biological Sciences

Mentors: Michael Munks and Pippa Marrack, National Jewish Health, Denver, CO

Every year, 65,000 cats and 35,000 dogs are euthanized. It has been estimated that there are somewhere between 12 and 100 million feral cats nationwide (Humane Society of the United States). This presents major issues for natural and endangered wildlife who become the prey of cats. In many third world countries, wild dogs carry diseases such as rabies that can be transmitted to humans. The current ways to combat this issue, including trap-neuter-release surgeries and euthanizations, are expensive and time consuming.

My research represents different supporting experiments for a product that will meet the criteria proposed by the Gary Michaelson Grant for a Non-Surgical Sterilant for Cats and Dogs: must be a safe, cost effective, sterilant for both male and female cats and dogs that can be administered in a field setting.

Our plan in creating a non-surgical sterilant was to use a recombinant Feline Herpesvirus -1 (FHV-1) as a carrier for the reproductive protein Gonadotropin Releasing Hormone (GnRH) that could be targeted by the immune system. FHV-1 is safe and highly immunogenic, meaning that it only infects cats, and cats produce a high antibody titer in response to it. GnRH is the perfect target because it is in both males and females early on in the reproductive cascade, with no other functions outside of reproductive purposes.

In the course of twelve weeks, I was able to develop a standardized Enzyme Linked ImmunoSorbant Assay (ELISA) in order to measure the antibody response of our experimental cats in future experiments. I also sequenced the repeat regions of the attenuated FHV-1 BACs (bacterial artificial chromosomes) to confirm that no major mutations were introduced. In addition, I tested the infectivity of the virus stored in different solutions to confirm that it would not be damaged through multiple freeze-thaw cycles or in PBS.

Lipid Binding Properties of Ebola Matrix Protein VP40

Sylvia Yong
Major: Biochemistry

Mentor: Robert Stahelin, Indiana University School of Medicine and Dept. of Chemistry and Biochemistry, University of Notre Dame
Coauthors: Jordan Scott

The Ebola virus (EBOV) is a pathogen that causes haemorrhagic fevers in humans. It is most prevalent in Africa, where outbreaks affect many people with fatality rate of up to 90%¹. It also poses global implications as infections can be rapidly spread. While it is known that EBOV infections function by inhibiting the immune system, the specific cellular secretion pathway of the virus has not been discovered. As no treatment for this deadly virus exists, it is important to understand how the EBOV functions in order to target secretion of the virus from cells. VP40, one of the seven structural proteins that EBOV encodes, appears to play a role in the membrane binding process^{2,3}. In the current study, lipid binding assays, such as multilamellar liposome vesicle (MLV) and large unilamellar vesicle (LUV) assays are being used to understand the lipid binding properties of VP40. In addition, surface plasmon resonance (SPR) is used to find the binding specificity of the wild type VP40 and mutant VP40 A299W. VP40 A299W appears to bind with a slightly enhanced binding affinity to phosphatidylserine (PS), a membrane lipid, than the wild type protein. Further experimentation observing the binding of VP40 to different lipids and the binding of different mutant proteins to PS will elucidate the behavior of VP40 in the secretion of EBOV.

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- (2) Mehedi, M.; Falzarano, D. ; Seebach, J.; Hu, X.; Carpenter, M. S.; Schnittler, H.; Feldmann, H. A new Ebola virus nonstructural glycoprotein expressed through RNA editing. *J. Virol*. **2011**, 85, 5406-5414.
- (3) Silva, L. P.; Vanzile, M.; Bavari, S.; Javad Aman, J. M.; Schriemer, D. C. Assembly of Ebola virus matrix protein VP40 is regulated by latch0like properties of N and C terminal tails. *PLoS One*. **2012**, 7, 1-10.

*Development of a Multimedia Robot Movement Database to Use in Therapy
for Children with Autism*

John Vernon

Majors: Science Pre-Professional Studies and Psychology

Mentor: Charles Crowell, Dept. of Psychology, University of Notre Dame

Coauthors: Joshua Diehl, Charles Crowell, Mike Villano, Kristen Weir, and Karen Tang

At the University of Notre Dame, researchers are analyzing the effects of robots on children with Autism. The predominant approach being investigated uses robots as co-therapists to interact with these children to determine what actually works to improve their communication skills. In the course of studying the interaction between the children and robots, many different robotic movements have been created for the Aldeberan Nao Robots. The present project focused on compiling a concise multimedia database of all the movements and capabilities of the robots. This project helped organize all of the existing files, and also identify any new movements that may need to be developed. A major goal was to create a comprehensive database of robot movements, both to document the current work being done at Notre Dame as well as to provide free access for other universities and centers that are planning to use robot assisted therapy. A website has now been developed as a link to this database and is available as a resource that will make it much easier for those who want to start using robots in their work. The Robot Movement Database includes the type of movement that the robot performs, the location of the file that contains the movement commands, and a video clip of the activity so that users can actually see the actual movement being performed. The Nao robot comes from the manufacturer with, a series of predesigned movements are already provided. However, the Robot Movement Database offers a more comprehensive reference with a proven success rate for use in therapy sessions with children with Autism. In addition, new robot movements will be added to the database as they are designed and tested in our ongoing research. This project was accomplished in collaboration with the eMotion and eCognition Labs with Professors Joshua Diehl, Charles R. Crowell, and Michael Villano.

Expression and Purification of Malaria HT proteins

Jing Wang

Major: Science Pre-Professional Studies

Mentor: Kasturi Haldar, Dept. of Biological Sciences, University of Notre Dame

Plasmodium falciparum parasites cause the most virulent form of human malaria. Every year, more than 300 million people are infected and results in over 1 million deaths. The malaria parasite exports around 400 proteins to the host red blood cells that alter its structural, functional and antigenic properties. Deadly pathology of malaria, like cerebral and placental malaria, is caused by cytoadherence of red blood cells to the endothelium of small capillaries. This is mediated by proteins present at the surface of infected red blood cells. Recent studies by Dr. Kasturi Haldar's lab provide considerable insights into this protein trafficking mechanism. These studies show that the host (cell)-targeting (HT) signal present in the exported proteins bind to the lipid phosphatidylinositol 3-phosphate (PI3P) present in the parasite endoplasmic reticulum (ER), and this binding provides the first sorting step for protein export. Experiments are ongoing to unravel the mechanism of HT-PI3P interaction and provide structural insights using NMR and other techniques. A primary requirement for these analyses is the availability of purified proteins. Thus, this summer I cloned, expressed, and purified malaria HT proteins for their future use in PI3P binding assays and NMR protein characterization. In addition, I also characterized the reactivity of a custom-made anti-PfEMP1 (anti-PFL1960w) antibody in order to use it as a diagnostic tool to detect HT processing.

Information Tables - Jordan Galleria

Biology Club (www.nd.edu/~bioclub/new/new.htm)

Biology Club aims to encourage an interest in Biology and fellowship among the club's members. These goals are accomplished by multiple avenues. The club holds meetings and discussions among student members throughout the school year, and works to provide special biology related activities to encourage learning outside the classroom, such as dissection night during Geek Week. Furthermore, Biology Club offers educational and entertaining activities for student members and non-members such as the Faculty Student Research Networking Dinner or science themed movie watches.

Contact: Jon Savakus (jsavakus@nd.edu), Academic Commissioner.

The Career Center (careercenter.nd.edu/)

The Career Center offers resources for all students including ideas on searching for an internship or job, tips on writing your resume and cover letters, and contacting and networking with Notre Dame alums and others. Lists of past internships at which science students have participated and hints on making a successful internship connection are also available. Workshops on the Internship Search for Science Students will be held monthly from October through January, so watch for details and attend one of these informative sessions.

Contact: Laura Flynn (lflynn@nd.edu), Science and Engineering Career Counselor.

The Center for Undergraduate Scholarly Engagement (CUSE, cuse.nd.edu)

CUSE has a mission to promote the intellectual engagement of Notre Dame students through undergraduate research and post-graduate fellowship application. It also promotes engagement through student-run initiatives like The Hub, an online, multimedia networking site where students can exchange ideas and information, and share scholarly and creative work.

Contact: Darlene Hampton (cuse@nd.edu), Assistant Director.

The Four Horseman Society (www.nd.edu/~horsemen/likebox.html)

This is a student-run organization of graduate and undergraduate members meeting to learn more about the process of vetting and capitalizing innovations. Since its inception, the club has continued to gain momentum, with a regular attendance of 50 or more at its events. Starting in 2009, the club welcomed students in the College of Science, greatly adding to our ranks. Recent events have included those on how to identify ideas with commercializing potential, entering the McCloskey business plan

Contact Person: Lynette Prezyna (Lynette.A.Prezyna.1@nd.edu), Faculty Advisor.

Hesburgh Library (library.nd.edu)

The Hesburgh Libraries system includes the main Hesburgh Library, as well as the O'Meara Mathematics Library in Hayes-Healy, the Engineering Library in Fitzpatrick, the Chemistry-Physics Library in Nieuwland, the Architecture Library in Bond Hall, and the Mahaffey Business Information Center in Mendoza. The Libraries provide critical support for your research, including access to thousands of online databases, journals, DVDs, books, maps and more. Librarians are prepared to assist you with your research by providing individual research consultations, or through a variety of library workshops and in-class instructional sessions. There's also the Library's Undergraduate Research Award, <http://guides.library.nd.edu/subject-guide/77-2012-Undergraduate-Library-Research-Award>. To contact your subject librarian use www.library.nd.edu/directory/subjects or the Ask-A-Librarian service at asklib.nd.edu/. Register for a workshops at www.library.nd.edu/instruction/workshops.shtml

Contacts: Parker Ladwig (ladwig.1@nd.edu), Biological Sciences and Mathematics librarian; Thurston Miller miller.115@nd.edu, Chemistry and Physics Librarian; Carol Brach (brach.10@nd.edu), Engineering Librarian; Cheri Smith (Cheryl.S.Smith.454@nd.edu), Coordinator for Library Instruction.

The Harper Institute for Cancer Research (harpercancer.nd.edu/)

Investigators in the Harper Cancer Research Institute (HCRI) are dedicated to conducting innovative and integrative basic and clinical research that confronts the complex challenges of cancer. Our programmatic structure fosters multi-disciplinary cancer research by promoting interactions among research groups with distinct expertise and by training young scientists to work across scientific fields. Clinical partnerships provide key translational insight and strengthen the mission of discovery. HCRI is facilitating collaborations between faculty in the College of Science, College of Engineering, College of Arts and Letters, and the Indiana University School of Medicine - South Bend. Some of the research projects currently taking place on campus involve using nanotechnology to better target chemotherapeutics, searching for new cancer markers and targets, and developing less expensive and more accurate diagnostics.

Contact: Angela Cavalieri (cavalieri.2@nd.edu) Administrative Coordinator.

The Hub (thehub.nd.edu)

The Hub is a student-run website sponsored by CUSE with the tagline, "Your academic life online". This academic networking site provides a space for students to discuss their ideas and to share their academic work in an online setting. Additionally, the Hub provides resources such as a virtual poster wall and PDF copies of student publications.

Contacts: Christine D'Alessandro (cdaless1@nd.edu), Editor.

The Institute for Scholarship in the Liberal Arts (ISLA) - Joint Undergraduate Research Opportunity Program (UROP) (isla.nd.edu/)

The Undergraduate Research Opportunity Program (UROP) provides grants to students who wish to pursue independent research or creative projects. The UROP program, which is open to any student pursuing a major or a minor in the College of Arts and Letters, offers four major types of grant: the Conference Presentation Grant; the Research and Materials Grant; the Senior Thesis Grant; and the Summer Grant. Students who wish to apply must submit a proposal, budget and a letter of recommendation to urapply.nd.edu.

Together with the College of Science, UROP also offers COS/A&L Summer Grants for those students who wish to engage in research or creative projects that cross the traditional boundaries between the sciences and the liberal arts. These grants are open to College of Science/Arts and Letters double majors as well as those students who have a minor in the College of Arts and Letters.

Contact: Karla Cruise (kcruise@nd.edu), UROP Advisor.

The Kellogg Institute (kellogg.nd.edu)

The Kellogg Institute is an international research institute that focuses on democracy and human development. To engage undergraduate students in its mission, the Institute offers a variety of programs including funded internships, research grants, and fellowships. Information regarding all of these programs can be found at <http://kellogg.nd.edu/students/index2.shtml>

Contact: Holly Rivers (Holly.Rivers.7@nd.edu), Assistant Director.

M.D. Anderson Cancer Center - Summer Research Program for College Students
(www.mdanderson.org/education-and-research/education-and-training/)

MD Anderson Cancer Center offers a number of education and training opportunities for undergraduates, graduates, postgraduates, residents, fellows and those seeking continuing medical education.

The purpose of the summer Science Program for College Students is to interest and challenge qualified college students in biomedical research as it relates to cancer. The program provides firsthand research experience in various areas of cancer research, and points out the varied career opportunities available in the biomedical sciences.

Contact: Dennis Hughes (DPHughes@mdanderson.org), Professor.

Museum of Biodiversity (science.nd.edu/jordan/about/museum-of-biodiversity.shtml)

The Museum of Biodiversity, located near the northern end of Jordan Hall, showcases the Department of Biological Sciences' extensive collection of amphibians, fishes, birds, mammals, and insects that have been collected over the last 150 years. As part of the museum, the herbarium preserves the scientifically important collection of dried and pressed plants of the

Greene-Nieuwland Herbarium. There are many opportunities for undergraduate research projects including identification and organization of specimens contained in museum collections, development of databases of plants and animals and their distributions, identification of rare, endangered, or invasive species, and development of thematic displays. Projects can be supported by the Robert E. Gordon Museum of Biodiversity Undergraduate Research Support Fund.

Contacts: Barbara Hellenthal (bhellent@nd.edu), Curator, and Ron Hellenthal (Ronald.A.Hellenthal.1@nd.edu), Professor.

National Science Foundation Research Experience for Undergraduates (NSF-REU)

Notre Dame currently has two extant NSF-REU programs in the Depts. of Physics and Biology, which reflect similar programs available across the nation. For many years there was also very successful program in the Dept. of Mathematics. Programs usually consist of 10 weeks of full-time research, together with a intensive schedule of various enrichment activities, and typically provide stipend, housing, and travel allowance. Application materials for the Biological Sciences program can be found at <http://nd.edu/~biosreu/>, and for the Physics program at physics.nd.edu/research/reu/. Such REU programs at other institutions funded by NSF can be found at www.nsf.gov/crssprgm/reu/index.jsp.

Contacts: Michelle Whaley (Michelle.A.Whaley.3@nd.edu), Teaching Professor and Director, and Frank Connolly (connolly.1@nd.edu), Professor.

NDnano Undergraduate Research Fellowship (NURF) Program

With expert scientists, research facilities and the latest equipment, the University of Notre Dame's Center for Nano Science and Technology (NDnano) is one of the leading nanotechnology centers in the world. Our mission is to understand how to manipulate and control the properties of materials, devices and their interface to living systems at the nanoscale. With this knowledge, we aim to be a force for good. The Center's activities currently fall within five research "pillars": new materials and nano structures, nanobioelectronics, physical limits to computation, energy harvesting technologies, and nanomaterials and the environment. Each year, NDnano awards several paid fellowships to undergrad students who spend 10 weeks of their summer engaged in a research project. Summer 2013 will mark the NURF program's fifth year. To date, 120 students from Notre Dame and several different universities have participated in the program, gaining valuable skills and experience. The 2013 application process will open the first day of classes in January. Meet the 2012 NURF recipients and learn about their projects: http://www.nd.edu/~ndnano/education/2012_NURF_project_summaries.html

Contact: Heidi Deethardt (deethardt.1@nd.edu), Administrative Assistant.

Notre Dame Chapter of the American Chemical Society
(sites.google.com/a/nd.edu/ndsaaacs/)

The ND Chapter for ACS strives for excellence and unity within their major, providing assistance through tutoring for underclassmen and mutual support for our peers. We advocate success through teamwork and excellence in Chemistry and Biochemistry.

Contact: NDSAACS@nd.edu.

Notre Dame Society of Physics Students (www.nd.edu/~physclub/)

The Notre Dame Society of Physics Students (SPS) is a local branch of the national SPS, committed to preparing students to be contributing members of the professional physics world through exposure to research, networking opportunities, and undergraduate community building (a.k.a "physics fun"). SPS sponsors tours of nearby research facilities, including FermiLab, Argonne, Notre Dame, and Michigan State, and hosts other events including movie watches and Lunch with Professors.

Contact: Kevin McDermott (kmcderm3@nd.edu), President.

Scientia (scientia.nd.edu)

Scientia, ND's own student-run Undergraduate Journal of Scientific Research, is looking for student reviewers and news writers for this year's publication. Reviewers should have some research experience and be interested in reading, critiquing, and commenting on student research. News writers can be from any discipline and must simply want to write about some of the cool things happening in the College of Science. Interested students should email the editors at scientia@nd.edu or the addresses below. Don't have time to work for Scientia but still want to be involved? Come to Scientia's next 'Talk Science' seminar on November 8th to hear a student and faculty member each present their research in a fun and informal setting. Pizza is always provided and everyone is welcome.

Contacts: Rachel Cotton (rcotton1@nd.edu), Rebecca Marton (rmarton@nd.edu), Co-Editors.

University of Cincinnati, College of Medicine - Summer Undergraduate Research Fellowship (med.research.uc.edu/SURF.aspx)

The University of Cincinnati College of Medicine and Cincinnati Children's Hospital offers several programs to students that provide a great opportunity to get great hands on experience in a biomedical laboratory. Most programs are 10 weeks in length and offer flexible starting dates. The online application will be open soon and applications will be accepted until mid-February. SURF, a cooperative group of summer undergraduate research programs at UC COM and Cincinnati Children's, provides biomedical research fellowships to talented undergraduate students in STEM disciplines. We seek talented sophomores, juniors and non-graduating seniors in the STEM disciplines to join us in Cincinnati for a summer in one of our state of the science biomedical laboratories, under the mentorship of experienced, caring faculty. We especially welcome applications from students who are underrepresented in the biomedical sciences. Across all SURF programs, we place about 150 students per summer, from all parts of the US.

International undergraduates who have a student visa to study here in the U.S. are also eligible. The program features a variety of academic, social and cultural experiences, including our annual Summer Research Welcome Picnic, laboratory tours, research seminars, career counseling, a research poster forum, and one-on-one training in biomedical research techniques.

Contact: Laura Hildreth (hildrele@ucmail.uc.edu), Assistant Dean of Research & Graduate Education.

**University of Notre Dame Environmental Research Center (UNDERC,
www.nd.edu/~underc/)**

UNDERC offers two 9 ½ week, 6 credit summer programs: East in the Upper Peninsula of Michigan and West in western Montana. Each has a set of modules (East: amphibian/reptile, insect, forest, aquatic, and mammal/bird ecology; West: environmental history tour, grassland/wildlife, montane, avian, and Native American ecology), but the focus is an independent research project for each student mentored by a faculty member or Ph.D. candidate. Admission to East is open to sophomores and above, and West requires attending East. Apply by early November on the UNDERC webpage and decisions are announced in early December to enroll in the preparatory course (1 cr., Spring semester).

Contact: Gary Belovsky (belovsky.1@nd.edu), Professor and Director.

The Writing Center (writingcenter.nd.edu)

The University Writing Center offers free, one-on-one consultations with writers from all disciplines, at any level of study, at any stage in the composing process--from understanding an assignment, to developing a thesis, to organizing the paper, to revising the first draft, to editing the final product. To make an appointment, visit the online appointment scheduler at the website.

Contact: Matthew Capdevielle (mcapdev1@nd.edu), Director.

Undergraduate Research Internships Information Night - Jordan 105

Organizer - Mark Olsen (olsen.2@nd.edu)

8:00 - 8:05 Introductions

8:05 - 8:20 Rachel Cotton - National Inst. of Allergy and Infectious Diseases, Bethesda, MD

8:20 - 8:30 Jeff Hansen – University of Virginia, Charlottesville, VA

8:30 - 8:40 Courtney Currier – University of Colorado at Boulder, CO

8:40 - 8:50 Rebecca Marton – Cold Spring Harbor Laboratory, NY

8:50-9:00 Questions and Answers