

Summer Undergraduate Research with Faculty (SURF)

1. **Student: Annalisa Baker-Whitcomb** **Major: Communication**
Mentor: Beth Sundstrom **Department: Communication**

Title: *Beyond "the pill": A qualitative Analysis of Long-acting Reversible Contraception (LARC)*

Since the U.S. Food and Drug Administration approved the sale of oral contraception in 1960, it has become the most commonly used method of birth control among women under 30 years of age (Mosher, 2010). Despite the ubiquity of the oral contraceptive pill in the United States, half of all pregnancies remain unplanned (Trussell & Wynn, 2008). Long-acting reversible contraceptive (LARC) options, such as the intrauterine device (IUD) and the implant, offer increased effectiveness and address women's concerns and dissatisfaction with "the pill." Despite these benefits, little research has been done to understand why women reject long-acting reversible contraceptive (LARC) options. This study addresses this gap by investigating young women's knowledge, perceptions and use of these contraceptive options.

Qualitative methods are essential for gaining a richer, detailed understanding of the role of contraception in the lives of college-age women. These women make important contraceptive choices that are paramount in determining their health and well-being. This study will examine participants' history of contraceptive use, satisfaction and dissatisfaction with contraceptive methods, and what is important to women when choosing a method of contraception. Through in-depth interviews, this study seeks to understand "how" and "why" college-age women choose certain contraceptive options. This will be among the first studies of long-acting reversible contraception (LARC) since the American Congress of Obstetricians and Gynecologists (ACOG) recommended the use of IUDs by adolescents for the first time in October 2012. Findings from this study will extend theoretical and practical opportunities to reduce unplanned pregnancies among college-age women.

2. **Student: Robert Bassett** **Major: Philosophy**
Mentor: Andrew Alwine **Department: Classics**

Title: *Aesthetic Innocence? Ancient Views on the Relationship between Art and the Political Animal*

Last year the members of a band in Russia called, "Pussy Riot", were imprisoned for making provocative statements during an unapproved concert in a Russian Orthodox Church. This act of "Aesthetic Disobedience" has been praised as a courageous political protest, but the question arises as to whether this is a legitimate use of artistic license. What is the role of art within the context of politics and society at large?

This project seeks to investigate the nature of art's effect on government and that government's constituents. Aesthetic Disobedience's bent toward political activism and protest is nothing new. In ancient Greece playwrights such as Aristophanes expressed political dissent openly, and it is my position that looking at his works and others, as well as the philosophical and political responses, such as those by Aristotle and Plato, to this type of art can cast a light on the potential problems and moral conflicts that arise. It is my intent in pursuing this topic to find parallels between early aesthetic dissidents and their modern descendants. The crux of the conflict on how art is viewed is based on two disparate ideas about man's place in political society. On the one hand, the Greeks viewed art as inextricably intertwined with the political and social fabric of life, while on the other hand we moderns view art as occupying an autonomous sphere. And, in fact, maybe we moderns are the ones who need to modify our views on art and consequently man's position in the public sphere.

3. **Student:** Parker Bednar **Major:** History
Mentors: Katie Hladky **Departments:** Religious Studies
Heather Gilbert Lowcountry Digital Library

Title: *Race and Religion in Charleston's Public Memory*

Charleston, South Carolina, has become one of the most desirable tourist destinations in the country. Known as the "Holy City" for its religious diversity and abundant churches, Charleston's public image emphasizes the special history of the city-one characterized by American heroes, beauty, culture, and southern charm. Many institutions are responsible for creating and disseminating this image: tourism companies, governmental organizations, historical societies, and the College of Charleston. Despite Charleston's history as the center of the North American slave trade and a stronghold of racial segregation, popular views of Charleston's history are largely silent on race. In contrast, scholarly work focuses heavily on racism and slavery arguing that this history is essential for understanding Charleston of the past and present.

"Race and Religion in Charleston's Public Memory" intends to bridge the gap between popular and scholarly histories of Charleston by documenting and publishing an accessible and historically accurate overview of African American religious life in Charleston before the civil war in an interactive, online exhibition hosted by the Lowcountry Digital Library. The exhibit will guide visitors through photos, historical documents, an interactive map, and a timeline, all accompanied by original narrative and analysis. Through these features, the exhibit will allow the public to better understand the differences between historical facts and scholarly understandings and popular romanticized history. Informed by scholarship on tourism and public history, this project will make difficult scholarly ideas accessible and interesting while challenging Charleston's popular romantic views of history, race, and religion.

4. **Student:** Tomika Caldwell **Major:** Biology
Mentor: Anastasia Zimmerman **Department:** Biology
Title: *Tomika Caldwell*

Tuberculosis (TB) is the second greatest killer worldwide, caused by a tiny, microscopic bacterium, *Mycobacterium tuberculosis*. Approximately 33%, of the world's population has latent TB and although the CDC reports that the numbers are decreasing, everyone is still at risk. One proposed a solution that will contribute to further studies of strengthening the human immune system using a mycobacterium model organism. In this study, we will use zebrafish and analyzing the IgH genes expressed, we expect IgH gene segment diversity to reveal mutations associated with an immune response against mycobacterium infection. Discerning these mutations will enhance the utility of using zebrafish as a model for human immunology and biomedical research.

5. **Student:** F. Jamie Claire **Major:** Chemistry
Mentor: Justin Wyatt **Department:** Chemistry & Biochemistry
Title: *Designing Novel Dual-Action Anticancer Agents Targeting Cell Division*

In the fight against cancer, antitumor compounds are being developed that reduce the cancerous cells' ability to divide. One way of killing tumors more effectively is to make compounds that affect two or more specific targets that are involved in cell division within the cancer cell. As well as being more effective against cancer cells, these dual-action drugs will reduce the cytotoxicity that harms non-cancer cells. Many patients who receive chemotherapy become sick due to the cytotoxic compounds put into their bodies to kill the cancer cells. Dual-action drugs are more efficient than single-action drugs and will therefore have less of a negative effect on the rest of the healthy cells in the body. The first specific aim of this project is to

determine if a compound that is already used as an anticancer drug is dual-action or not. This compound will be tested on prostate cancer cells as well as healthy brain cells to determine the level of cytotoxicity. The second specific aim of the project is to design, synthesize, and assess new anticancer compounds that will target two specific areas within the cancer cell to inhibit cell division. After being synthesized by the undergraduate students, these compounds will be tested similarly to the previous compound to determine if it inhibits cell division effectively and has low cytotoxicity to healthy cells. As the results of the tests are studied, the group will create second and third generation derivatives of the compounds to increase anticancer activity.

6. **Student: Lundy Davis** **Major: Biology**
Mentor: Brooke Van Horn **Department: Chemistry & Biochemistry**
Title: X-ray Contrast in Biodegradable Materials: A Conjugation Strategy

X-ray imaging is a common technique used in medicine in which contrast agents injected in the body are illuminated to detect and diagnose disease states. Currently, radiologists are using small molecule contrast agents that contain iodine. However, these small molecules are quickly excreted from the body and result in non-specific imaging of tissues, which challenges their overall utility. Our lab aims guide X-ray imaging science away from small molecule contrast agents and toward polymer systems. The polymeric systems we are building have the benefit of being tunable in size and the potential to target tissues, diagnose/image and treat disease through personalized medicine. As a lab, we are working to prepare polymer chains that contain extra chemically reactive groups for the attachment of iodine-containing molecules, which will provide our desired X-ray contrast. The effort of this SURF project will be focused on (1) preparing larger quantities of our currently used iodinated molecule and (2) synthesizing a new small molecule that contains 3 iodine atoms to attach to the polymer chains. These results will help us optimize the iodine to carbon ratio needed for the polymers to be X-ray visible. We will be sharing our iodine-bearing polymer products with Dr. Frank Alexis at Clemson University to evaluate their X-ray capability. We will travel to Clemson to collaborate with his current research students to conduct some preliminary animal and toxicology studies of our samples where we expect to learn about their viability as a biomaterial in biological systems.

7. **Student: Jessica Dugan** **Major: Psychology**
Mentor: Mark Hurd **Department: Psychology**
Title: The Effects of Caffeine and Stimulated Activity on Circadian Rhythms in Young and Aging Zebrafish

Zebrafish are an important model organism for the study of physiology and behavior. Early research focused on physiology, however more recent work has examined behavior- specifically locomotor activity (movement) rhythms. Research indicates that young and adult zebrafish are more active during the daytime (Hurd and Cahill, 1998). Comparatively less attention has been given to aged zebrafish activity rhythms. Evidence suggests that zebrafish show behavioral changes that are similar to those observed in humans-activity rhythms become fragmented and general activity levels decline with age. Similar rhythm effects are observed very early in development. Melatonin exposure, if given at the proper time of day, improves activity rhythms in aged zebrafish (Zhdanova, et al., 2008).

The goal of this project is to determine if caffeine or stimulated activity can improve circadian rhythms in young and aged fish. Caffeine is the most commonly used central nervous system (CNS) stimulant in the world; it has been shown to stimulate activity in humans (Julien, 2008; Higdon & Frei, 2006; Reissig, Strain, and Griffiths, 2009). Animals will be exposed to caffeine at nighttime and stimulated activity during the daytime to determine if either variable have an effect on circadian rhythms. Stimulated activity has been shown to improve rhythms in humans

(Schroeder et al., 2012). In a second set of experiments, we will test whether stimulated activity will improve rhythmicity in zebrafish. Based on previous research, we expect that caffeine or stimulated activity will improve activity rhythms in young and aged zebrafish.

8. **Student: Madison Edwards**
Mentor: Tim Carmichael

Major: History
Department: History

Title: *Africans in the American South: Charleston and its Gambian Links, 1750s-1790s*

Many scholars who examine Atlantic history see Europeans as dominating Atlantic interactions and shaping transformations. They equate the Atlantic basin with European civilization as well as reduce Africans' contributions to the construction of an Atlantic World to merely labor alone. However, this project examines the demographic and cultural linkages between the Gambia and its diaspora in eighteenth century Charleston. Eighteenth century Charleston was essentially an African city with Mandinka, Igbo and Mende and speakers of other African languages. Between 1766 and 1771 about 40% of the African slaves in South Carolina (and Georgia) came from the Gambia region. In unraveling the historical connections between these Atlantic locations, the authors of this project travel to several archives in South Carolina and The Gambia, West Africa. They also adopt a methodology that involves utilizing African oral sources and reading various types of archival documents such as plantation records, newspapers, shipping records, the Trans-Atlantic Slave Trade database, runaway slave ads, European travelers' accounts and missionary accounts. The study will show that Africans from the Gambia region created new or recreated old cultures in Charleston. If complete, this project will place Charleston in the broader Atlantic World and more especially the Gambia River region.

9. **Student: Samuel Feldman**
Mentor: Agnes Ayme-Southgate

Major: Biology
Department: Biology

Title: *The Myoproteome of Manduca sexta: Gene Annotation and Transcript Analysis*

In insect flight, there are two different muscle systems and mechanisms in which the insects beat their wings. These are known as synchronous and asynchronous muscle types. For every nerve impulse the synchronous muscle receives, there is one contraction in the muscle. Asynchronous muscle uses a different approach—for every one nerve impulse there is more than one contraction in the muscle. Asynchronous muscles are more efficient for insects needing faster flight abilities and asynchronous physiology is considered a derived (evolved) characteristic. Insects that have asynchronous flying muscles, such as the model organism *Drosophila melanogaster*, are known to have protein variants that are only found in asynchronous flight muscles. *Manduca sexta* (Carolina sphinx) is an organism that exhibits the synchronous flight mechanism, and we propose that *M. sexta* will have no flight muscle specific protein forms. This project will conduct an analysis on several muscle proteins that can be found in different muscles of *M. sexta*. This analysis will help further our phylogenetic understanding of the species and the differences in muscle physiologies.

10. **Student: Erin Fisher**
Mentor: Amy Kolak

Major: Psychology
Department: Psychology

Title: *Coparenting and Toddlers' Self-Regulation Skills*

The purpose of this research is to determine how toddlers' emerging self-regulation skills are influenced individual and environmental factors. Specifically, this research will examine how compliance, an early indicator of self-regulation in children, is impacted by children's temperament and coparenting behavior. Eighty two-parent families participated in a laboratory visit when their toddlers

were approximately 2 1/2 years old. Compliance was assessed using a "don't touch task" where parents were asked to reinforce the experimenter's instructions (i.e., "don't touch") to the child for 5 minutes. Children's behavior will be coded from these recorded observations. Children's temperament will be assessed through parents' responses to questionnaires that include items about children's behavior. Coparenting behavior will be coded from a 15-minute family freeplay that were also recorded when families participated in this research. We hypothesize that innate characteristics, such as temperament, and environmental characteristics, such as coparenting, will be associated with compliance in young children. The proposed research will expand our understanding of the role that family dynamics play in children's development during early childhood.

11. **Student:** Annemarie Galasso **Major:** Biology
Mentor: Elizabeth Meyer-Bernstein **Department:** Biology
Title: *Molecular Regulation of Tidal Rhythms in the Starlet Sea Anemone*

Biological oscillations are found in all organisms and are expressed at various frequencies; such as, ultradian (<24hr), circatidal (12.4hr) circadian (24hr) and circalunar (30days). We have been investigating two of these (circadian and circatidal) in the starlet sea anemone, *Nematostella vectensis*. We are particularly interested in the contribution of known circadian genes to rhythms of different frequencies. While it is not unusual for intertidal marine organisms to exhibit rhythms with both of these frequencies, the co-existence of these behavioral oscillations in an animal for which we have genomic information makes *Nematostella* a unique and exciting model organism. Made popular by developmental biologists, we know very little about the expression and regulation of their rhythmic behavior. Previously, we described oscillations in locomotor behavior and established the presence of an internal circadian clock. Recently, we have successfully established circatidal rhythms in the laboratory by synchronizing their locomotor behavior to a simulated tidal environment where high and low tide fluctuate on a 12 hr cycle. We are now well positioned to delve into the molecular mechanisms underlying their manifestation. Recent studies indicate that circadian genes similar to those found in mammals and insects are also present in *Nematostella*. Using molecular techniques, we have identified the location of a putative circadian clock in *Nematostella*. In this study, we will apply these techniques to identify cells that may contribute to the generation of circatidal rhythms. These experimental findings will provide insight into the molecular mechanisms underlying rhythmic behavior in Cnidarians and circadian clock evolution.

12. **Student:** Ann Galizio **Major:** Psychology
Mentor: Adam Doughty **Department:** Psychology
Title: *Behavioral Mechanisms Underlying Operant Variability*

Reinforcement is the process by which behavior is strengthened by its consequences such that behavioral repetition is the typical outcome. Importantly, however, variable, or non-repetitive, behavior can be reinforced under particular circumstances. This reinforced behavioral variability, or *operant variability*, has been observed across many species. For example, hungry pigeons can be trained to emit seemingly random four-peck sequences by delivering food after a sequence only if it is one that has occurred infrequently relative to the other possible sequences. Despite the sizeable literature documenting operant variability and its social significance (e.g., increasing variable behavior in individuals with autism or depression), the mechanisms underlying this variability remain unclear. Our research will examine these potential mechanisms by exploring further the leading approach to explaining how organisms vary, the *endogenous-random-generator* approach. According to this approach, organisms vary their behavior across sequences by treating each response of the sequence as analogous to a coin-flip. By randomly flipping the coin a sufficient number of times across the sequence, variation emerges. We will explore this account further by assessing the role of attention and memory in the production of operant variability. Specifically, we will test whether varying is less likely in situations that

promote attention to and memory of one's own behavior. By understanding how organisms vary their own behavior, our findings will inform treatment strategies of increasing behavioral variability in people with repetitive behavior (e.g., autism), and improve our understanding of related areas of study in which behavioral variation is integral (e.g., creativity, problem solving).

13. **Student: Jamie Harrell**
Mentor: Jennifer Wilhelm

Major: Psychology
Department: Psychology

Title: *Effects of Estrogen on Axon Regeneration after Peripheral Nerve Injury*

The Center for Disease Control reports hundreds of thousands of peripheral nerve injuries occur each year. Unlike cells in the central nervous system, cells in the peripheral nervous system have the ability to regenerate. However, regeneration is often slow and functional recovery is generally incomplete. Patients often are left with some form of long-term disability. Exercise has been shown to promote peripheral nerve regeneration and improve the recovery of function. Treadmill training for injured patients is now a central part of rehabilitation therapy. Recent research has shown that the sex of the patient may be a critical aspect in the effectiveness of treadmill training. The mechanisms that underlie sex differences in exercise-mediated regeneration are unknown. Gonadal steroids, such as testosterone, are known to enhance axon regeneration in peripheral nerves, but the effects of estrogen are relatively unknown. In this study, we propose to examine the role of estrogen in promoting regeneration after peripheral nerve injury. Following sciatic nerve cut, adult mice will be treated with estrogen or saline, and regeneration will be assessed. We predict that mice treated with estrogen will show enhanced regeneration compared to control saline-treated mice. Better understanding of the mechanisms that underlie the sex-dependent response of patients to exercise will lead to more effective rehabilitative therapies to treat patients sustaining peripheral nerve injury.

14. **Student: Timothy Hayward**
Mentor: Gardner Marshall

Major: Physics
Department: Physics & Astronomy

Title: *An Evaluation of Models for Electroweak Symmetry Breaking*

Over the years, the Standard Model of particle physics has proved itself to be an extremely durable theory. A key component of the Standard Model is the Higgs mechanism that is responsible for giving particles mass. Despite this mechanism's importance, very few empirical clues have emerged about the nature of this process. With results from the large hadron collider (LHC) now coming in, this is beginning to change. In addition to these results, there have also been new discoveries from an experimental group at the Daya Bay nuclear reactor. In this project we will first update an important model of the Higgs mechanism to incorporate the Daya Bay findings. We will then compare the predictions of this model to experimental data from the LHC. This will allow us to refine the model to more accurately describe observations at the LHC and will provide additional insight into the nature of the Higgs mechanism.

15. **Student: David Hester**
Mentor: Anton Vander Zee

Major: English
Department: English

Title: *Transformational Classicism in Poetry and Prose of Hart Crane*

Literary modernism is often described as a violent rupture from the past; the modernist novelist Virginia Woolf famously describes the shift in quieter-though no less momentous-terms: "On or about December 1910," she writes, "human character changed." In light of such declarations, this project explores a central tension in modernist literature: namely, how the literary period that broke intentionally from the past through the experimental drive to "make it new" also had a deep interest in classical antiquity. Hart Crane's work serves as a fitting test case for exploring this tension insofar as the effort to bridge the past and future informs his most important work, the aptly named epic poem *The Bridge* (1930). Though often viewed as a product of a narrower nationalism, I argue that the defining feature of Crane's poetic work is its transformational and

strategic blending of classical and romantic traditions. Crane's hybrid poetics is particularly notable given the contentious debate early in the 20th century surrounding the competing values romanticism and classicism. Informed by the recent work of scholars such as Thor Junyk, this project analyzes how Crane's work challenges the notion that a modernist return to classicism must reject romanticism in pursuit of classical aesthetics of stability, clarity, and precision. By incorporating apparently conflicting literary figures and influences into his work, Crane melds the emotional register of romanticism with the seemingly incompatible classical aspirations of his peers, thus aptly reflecting an era torn between a lost and stable past, and a precarious and unknown future.

16. **Student:** Ian Hubbard
Mentors: Isaure de Buron
Jennifer Hein

Major: Biology
Departments: Biology
SC Department of Natural Resources

Title: *Eel Ramps: Too Stressful for Infected Eels?*

This summer I will work with Dr. de Buron to investigate the effects of an invasive parasitic roundworm, *Anguillicoloides crassus*, on the survival of juvenile American eels crossing the Goose Creek eel ramp. Eels are in sharp decline in the USA and such ramps are designed to help them migrate upstream past the many dams built throughout our river systems. Such a ramp was built last summer in Goose Creek. However, observations of dead juvenile eels on this ramp remain unexplained and worrisome. Since this parasite causes severe damage to the swimbladder of infected eels, we hypothesize that high rates of parasitism may result in eels not coping well with the stress generated from using the ramp, in their failing to pass the ramp successfully, and in dying before reaching the top. In order to test this hypothesis I will determine the parasite numbers and weight as well as swimbladder damage in failed eels found dead on the ramp and compare them to successful eels that reach the top of the ramp alive. I will compare all results and perform a statistical analysis to verify whether there are significant differences between the two groups of eels. If such differences occur with failed eels being more infected and/or displaying more swimbladder damage than live and successful ones, our test would provide evidence that parasites directly affect the survival of juvenile eels in stressful conditions.

17. **Student:** Megan Judd
Mentor: Erik Sotka

Major: Marine Biology
Departments: Biology

Title: *Salt Marsh Herbivory Along a Salinity Gradient*

Salt marshes are the most ecologically and economically important shoreline communities along the eastern coastline. *Spartina alterniflora* (a marsh grass) dominates the low-marsh habitat, which is covered by daily tides. Thus the plants are exposed to stress based on the tides and salinity of the water. Previous work suggests that *Spartina alterniflora* growth may differ due to the amount of stress upon the plant, as both salinity stresses and grazing can potentially harm vegetative growth of *Spartina alterniflora*. The most abundant *Spartina alterniflora* grazer is *Littoraria irroata*, the periwinkle snail.

With this study I will be focusing on the effect that water salinity has upon the growth of *Spartina alterniflora* along with the grazing affects of *Littoraria irroata*.

Within each salinity zone, I will cut blocks of substrate containing healthy *Spartina alterniflora*. These blocks will be watched and raised for a growing season in the College of Charleston Greenhouse or on the grounds of Grice Marine Laboratory. After being raised, the clones will be redistributed to various areas of salinity. The clones will be contained with an herbivore inclusion cage to control the consumers. This will ensure a measure of the *Littoraria irroata* and it's direct affects on *Spartina alterniflora*.

By doing this I expect three things. First, plants in higher salinities are exposed to more physical stress and therefore grow more slowly relative to plants in lower salinities. Second, *Spartina alterniflora* has adapted (via natural selection) to marshes that are consistently lower vs. higher salinity. Third, *Littoraria*

irrata regulates growth of *Spartina alterniflora* and their herbivory effect is greater in lower salinity habitats because there is less physical stress.

18. **Student:** Jonathan Lamkin **Major:** Biochemistry
Mentor: Amy Rogers **Departments:** Chemistry & Biochemistry
Title: *Investigation into the role tetrahydrobiopterin plays in the catalysis of nitric oxide synthase using the novel synthetic pterin analogs 4-methoxy- and 3-methyl-tetrahydrobiopterin.*

It is not uncommon to hear about molecules that are harmful and should be avoided. But have you ever heard of a dangerous molecule that you actually need? Nitric oxide (NO), a toxic, free-radical gas, is just that molecule. In fact, it was awarded Molecule of the Year in 1992 for its surprising role as a neurotransmitter, vasodilator, and anti-cancer agent. So how is this toxic molecule made in the body with such precision as to provide Dr. Jekyll's effect and not evil Mr. Hyde's? The enzyme nitric oxide synthase (NOS) produces NO *in vivo* by converting the molecule L-Arginine into L-citrulline and NO but exactly how this is done is not well understood. There are several cofactors that are needed by NOS in order for the reaction to proceed; one of them is called tetrahydrobiopterin (BH₄). Without BH₄, the reaction does not proceed and toxic products are formed. But the exact role of the BH₄ is unknown. We believe that one key factor in understanding how NOS produces NO lies in understanding what the BH₄ is doing during catalysis. Our studies focus on probing the role of BH₄ by spectroscopic and catalytic assays as well as X-ray crystallography. We believe this important cofactor provides not only reducing equivalents to the reaction center, but also a proton. Uncovering the role of BH₄ could provide insights into how NOS produces a toxic gas in the perfect concentration as to allow such beneficial things as neurotransmission or cardiac blood flow.

19. **Student:** Michael Lis **Major:** Mathematics
Mentor: Gary Harrison **Departments:** Mathematics
Title: *Sources of Variability and Reducing Variability in Hospital Patient Census*

A computer model for the patient flow through a hospital will be constructed in attempt to understand the underlying factors behind the variability in hospital patient census. This model allows hospital administration test methods to reduce the variability and to better predict how many patients they should expect at a given time. The model will also include an estimate of the costs of overcrowding or maintaining empty beds. The cost information will allow administrators not only to predict costs better, but even alter their admission strategy in order to reduce costs. The final stage of this project is to construct a user interface such that administrators and other interested parties with minimal computer programming background are able to interface with the model and test varying admission strategies in attempt to reduce patient census variability and cost.

20. **Student:** Danielle Masse **Major:** Physics
Mentor: Ana Oprisan **Departments:** Physics & Astronomy
Title: *Free Diffusion Experiments to Investigate Gold Colloidal Suspension*

Nanoparticles are used in many applications, from highly efficient solar cells to cancer treatment. However, little is known about the solubility, mobility, and toxicity of nanoparticles when used for biomedical applications. The purpose of this project is to determine both thermal and mechanical properties related to microscopic dynamics of nanoparticles dispersed in viscous fluids. We will experimentally and numerically investigate fluctuations produced at the interface between pure water and dense silver and gold nanocolloidal suspensions. The experiments will use water-soluble nanocolloid. The nanocolloid consists of tiny spherical particles of gold with diameters in the range of 5 to 100 nanometers suspended in a water-soluble inert agent. In order to observe the interface between water and a water-

miscible nanocolloid, the nanocolloid must have a relatively high concentration of nanoparticles. Thermal and concentration inhomogeneities inside the fluid lead to local differences in fluid properties. As a result, the interface is not perfectly flat but has microscopic local “bumps” (fluctuations) that can significantly change the speed of the diffusion process. Since in addition to temperature and fluid properties the fluctuations of the interface are strongly influenced by the concentration of nanoparticles in suspension such interface fluctuations are called *concentration fluctuations*.

We will record images of a sample cell unit that experiences concentration fluctuations and analyze the images offline. We will use image analysis methods such as Fourier transform, wavelets, to compare the results obtained for the correlation time of fluctuations in each experiment and to derive the power laws governing these fluctuations.

21. **Student:** R. Elliot Murphy **Major:** Biochemistry
Mentor: Pamela Riggs-Gelasco **Departments:** Chemistry & Biochemistry
Title: *Structural and functional Comparison of the Enzymes manganese Ribonucleotide Reductase and Manganese Catalase*

X-ray absorption spectroscopy, a technique that probes chemical structure, will be applied to the enzymes *manganese catalase* and *ribonucleotide reductase*. The catalase enzyme converts toxic hydrogen peroxide to harmless oxygen and water and the ribonucleotide reductase enzyme converts ribonucleotides to deoxyribonucleotides, the molecular precursors needed for DNA synthesis. The proposed studies will determine the structures of these unique manganese enzymes found in many pathogenic bacteria. Both of these manganese-containing enzymes are highly novel, given that most organisms utilize iron to catalyze these crucial reactions. A solid understanding of the differences between human iron forms of the enzymes and the bacterial manganese forms could lead to the development of new antibiotics.

21. **Student:** Samantha Nicolau **Major:** Biology
Mentor: Brooke Van Horn **Departments:** Chemistry & Biochemistry
Title: *Improved X-ray Contrast in Biodegradable materials for Degradation*

Given the vast utilization of X-ray imaging in diagnostic medical science, our lab is interested in improving the current technologies by moving radiology away from small molecule contrast agents, which suffer from fast excretion from the body and non-specific imaging of tissues, to polymeric systems where further control over circulation time, level of contrast, and localization in the body are possible. We are preparing long chain polymer molecules that contain reactive functional groups through which we can attach iodine-containing molecules to the polymers to give us the necessary X-ray contrast. Our Summer 2013 efforts of this portion of the project will be focused on (1) optimizing the necessary amount of iodine in the polymers to be X-ray visible in both particle and film-like formulations using already available ligands and (2) developing new conditions for polymerization that are more "green" using a microwave instrument currently underutilized in research in our department. The physical polymer products will be shared with a collaborator at Clemson University to evaluate their actual X-ray capability and we will travel to Clemson to witness these studies in part. Finally, we believe these samples will also provide the raw materials for preliminary degradation studies, needed to explore their biocompatibility, toxicity, and any long-term fate of the degradants in biological systems.

22. **Student:** Alicia Olejar **Major:** Astrophysics
Mentor: P. Chris Fragile **Departments:** Physics & Astronomy
Title: *Numerical Simulations of Optically Thick Accretion onto a Black Hole*

The ultimate goal of this project is to develop a method to produce computer simulations of black hole accretion disks.

A black hole accretion disk is a structure formed by material (gas, plasma, etc.) in relatively close orbit around a black hole. Accretion disks of black holes are not just theoretical constructs; they are how we identify many black holes, as these are visible, whereas the black holes themselves are not.

The best way to gain a better understanding of black hole accretion disks is to computationally model them using highly advanced computer programs. Much work has been done to simulate these systems accurately, but there has yet to be a code developed that enables a simulation that includes all the physics of a black hole accretion disk. To correctly model an accretion disk, the code must include: radiation, magnetism, general relativity (curvature of space time as a result of extreme gravity and/or energy), and fluid dynamics.

Having added radiation to our code, Cosmos++, over this past summer we now have a computational method to model black hole accretion disks with the full physics. This summer it is our goal to employ the newly adapted code and simulate various types of black hole accretion disks, in ways that have never been possible before.

24. **Student: Philip Philipouse**

Mentor: David Boucher

Major: Biochemistry

Departments: Chemistry & Biochemistry

Title: *Toward Controlled Organization of Polymer-Carbon Nanotube Materials*

Materials made by blending conducting polymers (CPs) and carbon nanotubes (CNTs) are promising candidates for new renewable energy technologies. These CP-CNT mixtures are ideal for solar cell devices because of their ability to generate an electrical charge when they absorb light. More importantly, these materials have the capacity to produce electrical charges when they absorb thermal energy (heat) and our ability to make devices that can use waste heat from industrial machinery and our everyday appliances is an important addition to our growing set of alternative energy resources. One of the largest hurdles with these blended materials is finding the best way to mix the conducting polymers and carbon nanotubes to obtain the arrangement of the CP and CNT constituents that enhance their interactions and improve their electrical energy conversion efficiencies. Our research uses a novel approach, wherein we use mixtures of different organic liquids to grow the CPs and CNTs into well-defined molecular assemblies before we blend them into functional materials suitable for electronic devices. The goal is to find specific liquid phase assemblies that give the best CP-CNT arrangements in the solid state. We use several standard light absorption and emission techniques to characterize the nature of the liquid phase assemblies and an atomic force microscope to image and study the surface structure of the solid CP-CNT materials. Additionally, our experimental procedures and practices have been designed to help us contribute to our understanding of the fundamental aspects of polymer solution thermodynamics.

25. **Student: Matthew Rabon**

Mentor: Jonathan Neufeld

Major: Philosophy

Departments: Philosophy

Title: *Resonant Loop: A Definition of Art that Survives the Multiple Ontologies of Music*

What IS an artwork? The reason for asking the question is also the cause; of the question's difficulty: there is a staggeringly diverse set of objects and practices that we group under a single concept. Moreover, it is not clear how to distinguish artworks from ordinary objects that they (sometimes exactly) resemble. On the one hand, it is tempting simply to say there is no accounting for such a motley bunch. On the other, it often matters very much that we specify why something is art. For example, is this a sculpture or a piece of industrial material? If it is the latter, then it is taxed one way, if the former, another. Is this photograph art or not? If not, then we can call it obscene and prevent it from being displayed. If so, then we can't. Is this community center the headquarters of a political party or is it a long-term performance project where actual members of the community (who participate in political actions) are part of the work? If it is the latter, then it can receive tax-exempt donations from a non-profit museum. If the former, not. Each of these questions is based

on a real example. The question of our project, then, is far from *merely* philosophical: is it possible to unite all of what we take to be art under a single definition that is flexible enough to explain them all? If not, how do we classify and identify diverse objects in practical settings?

26. **Student:** Joshua Schmidt **Major:** Chemistry
Mentor: Marcello Forconi **Departments:** Chemistry & Biochemistry
Title: *Chemical Rescue of a Mutant Version of a Computationally-designed Enzyme*

Chemical reactions are carried out in cells by specific macromolecules called enzymes. Although Nature has evolved many enzymes to catalyze a diverse array of chemical reactions, we are still distant from understanding the principles that allow the construction of new, unnatural enzymes. These new enzymes have the potential to be extremely useful in many applications, such as the degradation of toxic wastes and the development of better catalyst for the industry. Computation is one of the emerging tools to help researchers in the design new enzymes; indeed, a handful of computationally-designed enzymes have been produced following inputs from computer simulation.

Here, we will test the importance of a functional element found in the design of a particular enzyme by removing this element from the enzyme and putting it back as a chemical compound added in solution. In such way, we will eliminate the covalent attachment between the enzyme and the designed element, allowing this element to adopt multiple conformations. Because natural enzymes precisely position their functional elements, we expect the system formed by the modified enzyme and the exogenous chemical compound to be less active than the original enzyme if the computational design managed to recapitulate the important feature of enzymatic catalysis. Further, systematic variation of the properties of the chemical compound will allow us to determine whether the environment within the computationally-designed enzyme is significantly different from that of the bulk aqueous solution.

27. **Student:** Brett Snyder **Major:** Chemistry
Mentor: Neal Tonks **Departments:** Chemistry & Biochemistry
Title: *Production and Characterization of Flexible and Rigid Polyurethane Foams Using Green Chemistry Auxiliary Chemicals*

A major push in industrial and academic research these days is developing alternative materials based on renewable biological sources. The use of renewable materials from readily cultivated bio-based sources is one of the key tenets of the “Green Chemistry” movement, and will allow for the long term supply of critical reagents for engineered materials, medicines, and other chemical products. Polyurethanes are one major class of polymers that have been impacted by the “Green Chemistry” movement and are our specific area of focus. Polyurethanes are a class of polymers that have applications in paints, fibers, and foams. Last summer we focused on creating bio-based surfactants. This summer, we plan to synthesize polyurethane foams using our own bio-based surfactants as an alternative to the petroleum-based surfactants commonly used throughout the polyurethane industry. By incorporating bio-based surfactants into our foam synthesis, we plan to produce environmentally friendly foams that meet the industrial standards for foam quality. We have secured the necessary components for making foams along with our own bio-based surfactants. After synthesizing “green” polyurethane foams, we will analyze the foams using confocal microscopy and imaging analysis software. Aside from product quality, we are ensuring that our foams meet environmental standards. As environmental awareness has grown over the last decade, chemists in the Polyurethane industry are now expected to abide by standards set forth in CertiPur. CertiPur certified foams have best tested to ensure that foams do not give off any volatile gas emissions when heated, and in general have improved environmental impact.

28. **Student:** Erica Tracey **Major:** Biology
Mentor: Chris Korey **Departments:** Biology
Title: *Sensory neuron plasticity during claw transformation in the snapping shrimp, *Alpheus angulosus**

Asymmetry in nerves and brain structures is present in all organisms throughout the animal kingdom. This asymmetry is perhaps most drastic in crustaceans, like snapping shrimp, that have extreme differences in the size and function of their front claws. Snapping shrimp have a small pincer and a very large snapper that serve very different purposes. They stand out from the rest of crustaceans because if one claw is removed, the “handedness” of the shrimp often becomes switched, with the small claw slowly growing into a large claw while a new small claw is grown on the other side. Our aim is to map the different nerve structures in these two claws and visualize how the changes in these nerves allow such a drastic transformation. We will label and trace the nerves of the original claws as well as how these compare to nerves in claws that are transforming. This map will allow us to begin analyzing how snapping shrimp organize their nervous system and how they are able to regenerate their nerves so efficiently.

29. **Student:** Derek Tuck **Major:** Physics
Mentor: Sorinel Oprisan **Departments:** Physics & Astronomy
Title: *Investigation of Stimulus Shape Contribution to Phase Resetting Curve*

Neurons are excitable cells that are silent most of the time and only briefly produce a burst of electrical activity called action potentials (APs) in response to inputs received from other neurons. Some neurons are intrinsic burster capable of producing a periodic sustained electrical activity. Such spiking neurons are frequently encountered as part of autonomous neural networks responsible for rhythmic activities, such as flying, swimming, walking, chewing, etc., called central pattern generators (CPG). The main mechanism used by neurons to respond and adapt to environmental stimuli is through changing their firing frequency proportional to inputs received. The relationship between the external stimulus timing and the change in the firing rate of the neuron is called a phase resetting curve (PRC). In addition to its application to investigating the mechanisms that allow the same neural network to generate multiple patterns of activities, e.g., the gait network can produce walk, trot, gallop, etc., the PRC can predict the synchronous firing of a large network that occurs during epileptic seizures. Our work this summer will focus on investigating numerically the relationship between the shape of the external perturbation and the PRC. For this purpose, a model neuron will be used to map the effect of external perturbations, such as the amplitude, duration, rate of change of inputs from other neurons, and the PRC.

30. **Student:** Sarah Turner **Major:** Biology
Mentor: Allison Welch **Departments:** Biology
Title: *Chronic Effects of Pharmaceuticals and Their Photodegradation Products on Local Amphibians*

Ibuprofen and naproxen, commonly known as Advil and Aleve respectively, are two of the most commonly used pain-relievers. Like many pharmaceuticals, these compounds pass through the human body and eventually end up in wastewater treatment plants. However, significant amounts of these compounds are not removed during water treatment processes and are instead released into natural waterways. Upon exposure to sunlight, naproxen and ibuprofen break down into compounds that may remain in water systems for long periods of time. Little is known about how these chemicals affect aquatic life, including amphibian larvae, which are specifically important because amphibians are the most endangered group of organisms in the world. To test these effects, we will expose tadpoles to these pharmaceuticals and their degradation products at levels expected in the environment; exposures will continue until metamorphosis is reached. Because mixtures of chemicals can be particularly harmful, and because each pharmaceutical is

expected to be found together with its breakdown products in the environment, we will expose tadpoles to “cocktails” of each pharmaceutical and its degradation products. These treatments will be combined with predator cues, because pollutants can be more toxic when animals are stressed. Tadpoles will be tested for adverse effects including increased mortality, physical abnormalities, reduced size or activity levels, or impaired development. If these compounds are found to be harmful to tadpoles, they may also be dangerous to other aquatic organisms. Therefore, conservation efforts could be encouraged to better aid in the removal of these compounds before they reach natural habitats.

31. **Student: Amanda Wimbish**

Major: Biochemistry

Mentor: Justin Wyatt

Departments: Chemistry & Biochemistry

Title: *Synthesis of a Novel Dual-Action Cytosporone E/Triazole Antibiotic*

Antibiotic resistance is an issue that has recently taken precedence in the medical community and is rapidly becoming difficult to combat. As more antibiotics are introduced into our water supply, soil, and food, bacterial resistance to these antibiotics escalates, which reduces the effectiveness of current commercial antibiotics. The goal of this project is to create a series of new antibiotics, to which bacteria have not yet grown resistant. To do this we will be combining cytosporone E, a compound shown to have antibiotic properties, with key features of other antibiotic compounds. These new compounds will then be tested against different strains of bacteria to determine how effective they are compared to current antibiotics. The results from these tests will give us insight into how to change and design the next generation of antibiotic derivatives.