

2008 OWU SUMMER SCIENCE RESEARCH PROGRAM

RESEARCH PROJECT INFORMATION SHEET

(Faculty information sheet)

Submission Deadline: 14 January 2008

GENERAL AREA OF RESEARCH (broad overall area such as genetics, biochemistry, environmental science, etc.)

Avian microbiology

SPECIFIC TITLE OF RESEARCH PROJECT

Evolution of feather color as a defense against feather-degrading microorganisms.

FACULTY SUPERVISING RESEARCH

Name: Edward H. Burtt, Jr.

Department: Zoology

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ANTICIPATED RESEARCH DATES, (ten weeks):

Requested Number of Students:

Beginning: 14 May 2008

one

Ending: 20 July 2008

two X

MINIMUM QUALIFICATIONS OF STUDENT RESEARCHER (be as specific as possible)

Students should have a strong interest in either zoology or microbiology with a declared or intended major in one or the other field. Successful candidates should have completed one or more introductory courses (Zool 115, 120 or BoMi 125) in either or both fields and should be familiar with microbiological culture techniques, identification of microorganisms, **or** identification of birds (Zool 341) and capture, handling and sampling of wild birds (Zool 190.1 or 341). Demonstrated quantitative and writing skills (Zoology 115, 341, English 312) are an advantage, but not a requirement. Students must be willing to work through some weekends as laboratory experiments and field work may continue for more than one week.

DESCRIPTION OF RESEARCH PROJECT (attach statement; one page maximum)

Evolution of feather color as a defense against feather-degrading microorganisms.

The colors and patterns of color of birds are assumed to have evolved as signals to other animals, either to

broadcast the presence of males and females during territorial disputes and courtship or to hide the presence of an individual that wishes to blend with its background and remain undetected by predators or rivals. These colors and patterns are produced by pigments in the feathers and these chemicals have properties in addition to their color. For example, melanin, which produces black, gray, brown, buff, and some yellows, is a granule that is deposited in the structural matrix of the feather and thereby reinforces it against abrasion (Burt 1986), material fatigue (Weber *et al.* 2005), and bacterial degradation (Goldstein *et al.* 2004). Biogeographical variation in color of birds coincides with variation in abundance and activity of feather-degrading bacilli. Song Sparrows (*Melospiza melodia*) that live in the humid forests of the Pacific northwest are darker and have more, and more active feather-degrading bacilli in their plumage, than Song Sparrows that live in the arid southwest (Burt and Ichida 2004). The color variation found in Song Sparrows is a common pattern first described by Gloger (1833) and shown to be one of the most widely occurring biogeographical patterns of morphological variation (Zink and Remsen 1986). Swamp Sparrows (*M. georgiana*) that live in coastal salt marshes are darker and have many more feather-degrading bacilli in their plumage than Swamp Sparrows that live in freshwater bogs (Peele *et al.* submitted). A general trend for populations and species that live in salt marshes to be darker than their closest inland relatives was first noted by Grinnell (1913), but why this should be has never been explained, until now.

Most recently we have begun to explore the possibility that other feather pigments have antibacterial properties that help birds reduce the damage and loss of function in feathers exposed to feather-degrading microorganisms. Summer students will focus on several projects that address the relationship between avian feather pigments, their ability to reduce feather damage by feather-degrading microorganisms, and the anatomical, taxonomic and geographic distribution of the different pigments.

- 1. Parrots and the ecological distribution of psittacofulvins:** Recent data on psittacofulvins, which are the brilliant feather pigments produced by parrots, suggest that some, but not all, of these effectively reduce bacterial degradation. The effectiveness of the pigment appears to depend on the number of carbon-carbon double bonds in the pigment molecule. We will replicate our recent pilot experiments, analyze the data, and prepare a manuscript for publication. We will then analyze the distribution of the different psittacofulvins within the order Psittaciformes (parrots) for anatomical patterns and evolutionary relationships. We will also look for relationships between color, pattern of color and habit following the example of Gloger's Rule. The work on distribution of color will be done during a visit to the Smithsonian Institution, which has the largest collection of parrot specimens in North America. Funds for the trip have been requested from the Smithsonian Visiting Researchers Program.
- 2. Not all melanin is black:** Melanin comes in two forms. Eumelanin is a spherical granule and produces black and shades of gray whereas pheomelanin is an elliptical granule and produces red-browns and yellows. Eumelanin retards bacterial degradation of feathers. Pheomelanin is untested. We propose to test the ability of pheomelanin to retard bacterial degradation and compare it to the effect of eumelanin. We will use electron microscopy to look at variation in the occurrence of melanins in different feathers and different species and at the geographic pattern of melanin variation in birds.
- 3. Turacos and copper based pigments:** The red and green pigments of African turacos are unique among avian feather pigments in that they are based on copper. A pilot study from my honors tutorial suggests that these pigments are antibacterial, but we need to replicate these initial experiments. We have developed contacts with a number of zoos throughout North America, which ensures that we will have a supply of turaco feathers for testing.

References cited

- BURTT, E. H., JR. 1986. An analysis of physical, physiological and optical aspects of avian coloration with emphasis on Wood-Warblers. Ornithological Monographs 38: x + 1-126.
- Burt, E. H., Jr. and J. M. Ichida. 2004. Gloger's Rule, feather-degrading bacteria, and color variation among Song Sparrows. Condor 106: 681-686.
- Gloger, C. L. 1833. Das Abändern der Vögel durch Einfluss des Klimas. Breslau.
- Goldstein, G., K. R. Flory, B. A. Browne, S. Majid, J. M. Ichida, and E. H. Burt, Jr. 2004. Bacterial degradation of black and white feathers. Auk 121: 656-659.
- Grinnell, J. 1913. The species of the mammalian genus *Sorex* of west-central California with a note on the vertebrate palustrine fauna of the region. University of California Publications in Zoology 20: 179-205.
- Peele, A. M., E. H. Burt, Jr., M. R. Schroeder, and R. M. Greenberg. Dark color of Coastal Plains Swamp Sparrows may be an evolutionary response to occurrence and abundance of salt-tolerant, feather-degrading bacilli in its plumage. Condor (submitted).
- Weber, T. P., J. Borgudd, A. Hedenstrom, K. Persson, and G. Sandberg. 2005. Resistance of flight feathers to mechanical fatigue covaries with moult strategy in two species of warblers. Biology Letters 1: 27-30.
- Zink, R. M., and J. V. Remsen, Jr. 1986. Evolutionary processes and patterns of geographic variation in birds. Current Ornithology 4: 1-69.

2008 OWU SUMMER SCIENCE RESEARCH PROGRAM

RESEARCH PROJECT INFORMATION SHEET

(Faculty information sheet)

Submission Deadline: 14 January 2008

GENERAL AREA OF RESEARCH (broad overall area such as genetics, biochemistry, environmental science, etc.)

Cognitive Psychology

SPECIFIC TITLE OF RESEARCH PROJECT

Enhancing the Long-Term Retention of Knowledge Acquired in School

FACULTY SUPERVISING RESEARCH

Name: Lynda Hall, Harry Bahrack, and Melinda Baker

Department: Psychology

Campus phone: Hall: x3810, Baker: x3813

Email user name: Hall: lkhall@owu.edu, Baker: mkbaker@owu.edu

ANTICIPATED RESEARCH DATES, (ten weeks):

Requested Number of Students:

Beginning: _May 12, 2008_____

one ____

Ending: _July 18, 2008_____

two X

MINIMUM QUALIFICATIONS OF STUDENT RESEARCHER (be as specific as possible)

Students must have completed Introduction to Psychology and one other Psychology course. Preference will be given to those who have completed one or more of the following courses: Quantitative Methods, Research Methods, or Cognitive Psychology.

DESCRIPTION OF RESEARCH PROJECT (attach statement; one page maximum)

Enhancing the Long-Term Retention of Knowledge Acquired in School

Many of our current educational practices assess memory for material learned in school over relatively short time intervals. However, cognitive psychologists have produced compelling evidence that practices that enhance short-term performance are often associated with worse performance on tests of long-term retention. In order to encourage students to adopt study strategies that best enhance long term retention, we must increase their awareness of the differential benefits of particular study strategies for different retention intervals. Furthermore, when students are free to study material under their own direction, they control the quantity of time devoted to various sections of the material on the basis of their judgments of mastery of the content and on their predictions of retention of that content for a future test. Such metamemory judgments commonly overestimate future retention and therefore lead to inadequate rehearsals. The purpose of our research this summer will be to explore the relationship among metamemory judgments, allocation of study time, and long term retention for students who vary in age from middle school to early adulthood. We are especially interested in identifying educational practices that will increase the accuracy of metamemory judgments, the efficiency of the allocation of study time, and the amount of material remembered over relatively long time intervals.

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Submission Deadline: 14January 2008

GENERAL AREA OF RESEARCH (broad overall area such as genetics, biochemistry, environmental science, etc.)

Astronomy

SPECIFIC TITLE OF RESEARCH PROJECT

Photometric Study of Starspot Evolution on Magnetically Active Stars

FACULTY SUPERVISING RESEARCH

Name: Robert Harmon

Department: Physics and Astronomy

Campus phone: 3778

Email user name: roharmon

ANTICIPATED RESEARCH DATES, (ten weeks):

Requested Number of Students:

Beginning: Monday, May 19

one X

Ending: Friday, July 25

two

MINIMUM QUALIFICATIONS OF STUDENT RESEARCHER (be as specific as possible)

The student must have completed the laboratory portion of PHYS 111.

DESCRIPTION OF RESEARCH PROJECT (attach statement; one page maximum)

DESCRIPTION OF RESEARCH PROJECT

Light Curve Inversion (LI) is a technique for mapping the surfaces of stars from their rotational light curves. With only a few exceptions, stars other than the Sun cannot be directly imaged using current technology because of their small angular size as seen from Earth. Even through the *Hubble Space Telescope*, stars appear to be featureless pinpoints. As a result, it is necessary to use indirect techniques in order to obtain information about their surface features.

Of particular interest are “starspots”, which are analogous to sunspots on the Sun and are known to be present on certain classes of stars. Sunspots are known to be associated with regions of enhanced magnetic field strength on the Sun, and starspots are believed to have a similar origin. Starspots are of interest to astronomers because studying them can give us additional insight into the nature of the magnetic dynamo process which generates stellar magnetic fields beyond that which can be obtained by studying a single example, the Sun.

If there is a dark spot on the surface of a star, then every time the star’s rotation carries the spot into view from Earth, there will be a decrease in the star’s brightness. If we knew in detail the appearance of the star’s surface along with the inclination angle between the star’s rotation axis and the line of sight, a relatively straightforward calculation would allow us to predict the star’s observed brightness as a function of time, i.e., its light curve.

With LI we attempt to go in the other direction: knowing the light curve, determine the appearance of

the star's surface. This is not a simple matter, because the problem is ill-posed: very different surfaces can give rise to nearly identical light curves. Many researchers have circumvented this problem by assuming a fixed number of spots having given shapes, and then varying the sizes, locations and possibly the temperatures of the spots until an acceptable fit to the light curve is found. LI, originally developed by Dr. Walter Wild, has the important advantage that no *a priori* assumptions are made regarding the number of spots or their shapes. I have developed a Fortran implementation of LI which has significantly extended and refined Dr. Wild's original algorithm.

The student who works with me this summer would be involved in selecting a suitable spotted star or stars for investigation, most likely in collaboration with a student from another school funded by the National Science Foundation Research Experiences for Undergraduates program. Following this, images through B, V, R and I photometric filters of a field containing the target star will be obtained using an SBIG ST-8E CCD camera in conjunction with a Meade LX200 telescope at Perkins Observatory. Standard techniques (dark subtraction and flat fielding) will be used to reduce noise and systematic errors in the images, and then differential aperture photometry will be employed to generate light curves (plots of brightness vs. time) of the target star through the four filters. The light curve(s) obtained by the student will then be analyzed to yield images of the starspots.

It is also possible that in addition we will obtain data for other stars gathered by other researchers and map starspots on the surfaces of these stars in addition to the star for which we gather our own data.

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RESEARCH PROJECT INFORMATION SHEET

(Faculty information sheet)

Submission Deadline: 14 January 2008

GENERAL AREA OF RESEARCH (broad overall area such as genetics, biochemistry, environmental science, etc.)

Experimental Physics

SPECIFIC TITLE OF RESEARCH PROJECT

Nuclear Structure of Selenium-71

FACULTY SUPERVISING RESEARCH

Name: _____ Bob Kaye

Department: _____ Physics and Astronomy

Campus phone: _____ x 3774

Email user name: _____ rkaye

ANTICIPATED RESEARCH DATES, (ten weeks):**Requested Number of Students:**Beginning: May 19 one X Ending: July 25 two **MINIMUM QUALIFICATIONS OF STUDENT RESEARCHER** (be as specific as possible)

Completion of PHYS 280 (Contemporary Physics) with a “C” or better

DESCRIPTION OF RESEARCH PROJECT (attach statement; one page maximum)

A common way to explore the atomic nucleus is under extreme conditions, analogous to the way that one would expose macroscopic objects to extreme temperatures or stresses in order to learn about their structural or chemical properties. One such method involves stressing the nucleus near the limits of binding, where the addition of even a single proton or neutron could cause it to become unbound. Such systems offer unique opportunities to study the fundamental nuclear interaction because this interaction is known to be sensitive to the total number of protons and neutrons (collectively called “nucleons”) and the difference in the number of protons and neutrons. Another method involves the study of nuclei having extreme angular momentum (or “spin”), where the entire nucleus rotates about an axis at a rate on the order of about 10^{20} revolutions per second! This is possible due to the highly energetic reaction mechanism by which the nuclei under investigation are created in the laboratory.

In order to test the most current nuclear models, the experimental study of relatively heavy systems is needed, where the number of protons Z is nearly equal to the number of neutrons N (so called “proton-rich” nuclei). Of particular interest are $N \approx Z$ nuclei with masses between 60 and 100 total nucleons, since these are the heaviest for which protons and neutrons occupy similar energy states. In these nuclei, several interesting phenomena have been predicted to occur, but as yet have not been observed conclusively from experiment. For example, the spin pairing of protons and neutrons, where protons and neutrons “dance” together in a coupled fashion, is predicted to be strongly enhanced for proton-rich nuclei compared to their heavier, “neutron-rich” isotopes.

This proposed research aims to strengthen the knowledge of nuclear science through the experimental investigation of Selenium–71 (^{71}Se), an $N \approx Z$ nucleus which already has shown a rich set of energy states based on previous work found in the literature, but which also contains several questions about the organization of these states. For example, this nucleus could be expected to show a structure that is similar to its neighboring isotope Selenium–73 (^{73}Se) since it is only two neutrons lighter, and yet the most recent level scheme (a “map” of all the observed discrete energy states of a nucleus and hence a strong indicator of structural properties) of ^{71}Se shows a very different pattern of observed states. This research aims to probe and understand these possible differences by providing a thorough investigation of the level scheme of ^{71}Se , checking what has already been investigated and expanding on what is known by looking for new states at both low and high spin (and energy). The goal will be to achieve a more complete understanding of how the level scheme of ^{71}Se compares with those of its isotopic neighbors, and to see how its structure fits the picture predicted by current theoretical models.

The relevant data were collected as part of the 2005 OWU Summer Science Research Program during an experiment performed at Florida State University, but the analysis of the data will begin this summer. The research student will use a Linux workstation running specialized software in order to perform the data analysis. No previous experience with Linux or the specialized data analysis software is necessary; I will teach the student all of the needed techniques to perform the analysis successfully.

In order to help the student gain some experience with the experimental techniques that led to the acquisition of their data, I am also planning on taking the student to an experiment at Argonne National Laboratory near Chicago to become part of an international collaboration of nuclear physicists with the goal of studying the exotic ^{94}Ag nucleus using the most advanced gamma-ray detector array in the world. (Although the experiment has already been approved, the extent of our participation will depend on its scheduling, which is still pending.) Prior to the experiment, I will train the student on the basic experimental techniques of gamma-ray spectroscopy using the campus laboratory I have developed, which utilizes detector technology very similar to that which will be used in the actual experiment.

By the end of the summer program, a preliminary ^{71}Se level scheme will be constructed and compared with the results from appropriate theoretical models and other neighboring nuclei. The student will then have the opportunity to present the results at a national meeting of nuclear physicists in October through the Conference Experience for Undergraduates program sponsored by the National Science Foundation. If the student is interested in continuing with this project beyond the summer, he or she will have the opportunity to contribute to the writing of a paper containing the final results, which will likely be published in an internationally-recognized journal such as *Physical Review C*.

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Submission Deadline: 14 January 2008

GENERAL AREA OF RESEARCH (broad overall area such as genetics, biochemistry, environmental science, etc.)

Coordination Chemistry: Green Chemistry Catalysis

SPECIFIC TITLE OF RESEARCH PROJECT

Preparation of Complexes as Robust Catalytic Oxidants

FACULTY SUPERVISING RESEARCH

Name: *Kim A. Lance*

Department: *Chemistry*

Campus phone: *368-3527*

Email user name: *kalance*

ANTICIPATED RESEARCH DATES, (ten weeks):

Beginning: *May 19, 2008*

Ending: *July 25, 2008*

Requested Number of Students:

one ____

two X

MINIMUM QUALIFICATIONS OF STUDENT RESEARCHER (be as specific as possible)

Successful completion of Organic Chemistry II (Chem 261)

DESCRIPTION OF RESEARCH PROJECT (attach statement; one page maximum)

Metalloenzymes often catalyze important oxidation reactions by forming reactive intermediates containing high valent middle and later transition metal (MLTM) centers. Several of these intermediates are too reactive to be isolated or thoroughly characterized outside of their biological environments. Thus metalloenzymes have inspired the design of ligand systems for yielding complexes that mimic their catalytic utility and ability to stabilize high valent metal centers.

Our research is focused on developing ligands that stabilize rare high valent MLTM complexes with the goal of using some of these complexes to catalyze reactions of biological, chemical and environmental relevance. We are particularly interested in reactions involving oxidations of various organic substrates with O-atom transfer oxidants such as *tert*-butyl hydroperoxide (TBHP) and iodosylbenzene. These ligands will require resistance toward oxidative degradation and will thus follow previously published ligand design rules.

The ligands that we intend to prepare involve diamide-diamine donors (Figure 1).

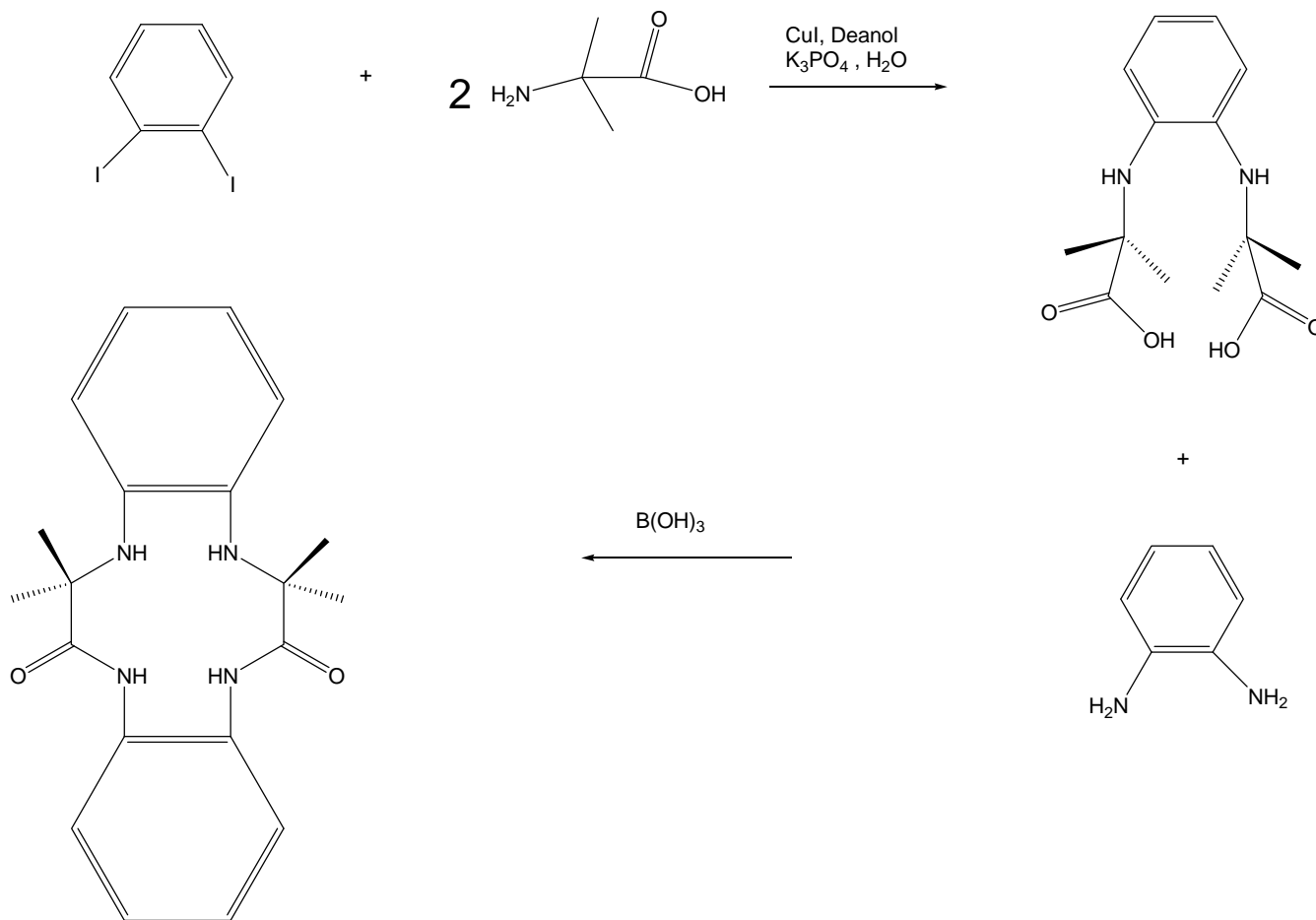


Figure 1. The synthetic scheme for the preparation of a diamide-diamine ligand.

Complexes of this ligand series will be prepared for the first row transition metals Mn, Fe, Co, and Cu. A strong base such as *n*-butyllithium or lithium bis(trimethylsilyl)amide will be added to an anaerobic tetrahydrofuran suspension of the ligand to deprotonate the amides/amines. An appropriate metal salt or complex with labile ligands will be added to insert the desired metals. If the resulting complexes are diamagnetic, they will be characterized by UV/Visible spectroscopy, ¹H and ¹³C spectroscopy, IR spectroscopy, and mass spectrometry. If they are paramagnetic, we will be additionally characterized at Ohio State University with electron paramagnetic resonance (EPR) spectroscopy.

The synthesized metal complexes will be reacted with TBHP or iodobenzene in the presence of simple substrates to check for the formation of oxygen atom inserted products similar to those formed in P-450 oxidations. The substrates styrene, ethylbenzene and 2,3-dimethyl-2-butene will be tested initially in an oxidatively robust solvent such as methylene chloride or acetonitrile. The resulting products will be analyzed by gas chromatography and compared to known standards to determine percentage yields.

It is hoped that the diamide-diamine metal complexes can be used to oxidize substrates of environmental concern, such as models of halogenated organics or pesticides. They also can be considered green catalysts for oxidations involving hydrogen peroxide as the oxidant.

2008 OWU SUMMER SCIENCE RESEARCH PROGRAM

RESEARCH PROJECT INFORMATION SHEET

(Faculty information sheet)

Submission Deadline: 14 January 2008

GENERAL AREA OF RESEARCH (broad overall area such as genetics, biochemistry, environmental science, etc.)

Physics (condensed matter)

SPECIFIC TITLE OF RESEARCH PROJECT

Coupled Nonlinear Oscillatory Systems: the Rich Physics of Josephson Junction Arrays and Nanoelectromechanical Oscillators

FACULTY SUPERVISING RESEARCH

Name: Brad Trees

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ANTICIPATED RESEARCH DATES, (ten weeks):

Requested Number of Students:

Beginning: May 19

one X

Ending: July 25

two

MINIMUM QUALIFICATIONS OF STUDENT RESEARCHER (be as specific as possible)

Two semesters of calculus-based introductory physics (Physics 110,111 or equivalent)

Two semester of calculus (Math 110, 111 or equivalent)

DESCRIPTION OF RESEARCH PROJECT (attach statement; one page maximum)

Coupled Nonlinear Oscillatory Systems: the Rich Physics of Josephson Junction Arrays and Nanoelectromechanical Oscillators

- Project 1: Systems of oscillators show a wealth of interesting behaviors. For example, synchronization due to coupling between all or some of the oscillators in a set has been observed in many scientific disciplines, e.g. physics, chemistry, and biology. Josephson junctions (JJs) are superconducting electrical oscillators, and an *array* of Josephson junctions is a system of coupled oscillators. JJ arrays are perhaps the quintessential nonlinear system for studying the causes and stability of synchronous behavior. Well-controlled, modern fabrication techniques allow the design of JJ arrays with precise geometries and junction parameters. The result is an exquisitely controlled “test bed” for the study of complex dynamical systems. This project involves the computer simulation of JJ arrays coupled both to each other as well as to external loads that result in synchronous time-dependent behavior of the junctions. Specifically, we wish to determine if coupling a nanoelectromechanical (NEM) oscillator to a JJ array can result in stable synchronization of the junctions in the array. As the name implies, a NEM oscillator is a very small oscillator, i.e. a microscopic version of a block on a spring. Such coupled NEM oscillator and JJ systems are currently of interest because of their potential use as quantum bits in a quantum computer and because of the expanding expertise in growing/fabricating NEMs. This research topic is in the growing field of synchronization of quantum mechanical systems, which has received much less attention to date than the study of the synchronization of classical, i.e. Newtonian, oscillators. The nonlinear nature of the JJ array requires that most of this research will be computational, so an interest in scientific computation is needed.
- Project 2: For a student with a stronger background in physics and mathematics and who desires a more advanced project, we can focus on studying the effects of quantum tunneling and decoherence in a coupled NEM oscillator and JJ array. This project would be analytical in nature and would make use of Mathematica. It would be a continuation of the work done by last summer’s research students, Yaser Helal (OWU) and Joshua Schiffrin (Carnegie-Mellon).
- Project 3: A third possibility is to study the basic physics of NEMs themselves. These devices are interesting not only for reasons discussed above (see description of Project 1), but also because they could allow for a fundamental study of quantum mechanics. The possibility of studying the displacement and momentum of a microscopic system that is

close to the limits set by the Heisenberg uncertainty principle is intriguing and of considerable recent interest. NEMs are promising candidates for such systems and there is still basic research to be done on their behavior.

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RESEARCH PROJECT INFORMATION SHEET

(Faculty information sheet)

Submission Deadline: 14 January 2008

GENERAL AREA OF RESEARCH (broad overall area such as genetics, biochemistry, environmental science, etc.)

Genetics, development, plant biology

SPECIFIC TITLE OF RESEARCH PROJECT

Plant Gravity Sensing and Growth Regulation

FACULTY SUPERVISING RESEARCH

Name: ___Chris Wolverton_____

Department: ___Botany & Microbiology_____

Campus phone: ___3503_____

Email user name: ___scwolver_____

ANTICIPATED RESEARCH DATES, (ten weeks):

Requested Number of Students:

Beginning: ___May 12_____

one ___

Ending: ___July 18_____

two ___x___

MINIMUM QUALIFICATIONS OF STUDENT RESEARCHER (be as specific as possible)

- Completion of BOMI 110, BOMI/ZOOL 120, 271 and 351 preferred but not required
- Ability to work both independently and as part of a team
- Eagerness to learn
- Attention to detail
- Aptitude for using computer applications like Excel, Photoshop, and file managers

DESCRIPTION OF RESEARCH PROJECT (attach statement; one page maximum)

Plants are extremely sensitive to environmental signals, constantly integrating signals like gravity and light into directional growth responses. My lab is interested in understanding how plants sense and respond to these signals. One of the key signal molecules involved in all of these directional growth responses is the plant hormone auxin. However, after over 80 years of research, the mechanisms by which auxin causes changes in growth remain unclear. We are using a combination of molecular genetics, computer image analysis, and confocal imaging to study the role of signals like auxin during growth responses.

Recently, my lab has focused on primary and lateral roots as a model system to study plant growth responses. Over the past several summers, students have transformed plants with a reporter construct designed to act as an auxin biosensor. The construct has a promoter region that is highly responsive to auxin, and this promoter controls the expression of green fluorescent protein (GFP). With this construct, we have identified cells with high levels of auxin during gravitropism based on the presence of GFP. Last year, students began analyzing auxin flow in a starch biosynthesis mutant using the auxin biosensor and confocal microscopy, making significant progress toward a publication. One of the goals for this summer's project is to introduce this reporter gene into a number of other known gravitropism mutants and analyze the patterns of gene expression. One such mutant is defective in potassium transport. As such, it offers a molecular genetic tool to address whether potassium transport and auxin transport are linked. Students will transform and select mutants for the reporter gene, then characterize the expression of GFP using the confocal microscope.

In addition to this mutant study, students will over-express several genes in plants and determine whether the expression levels of these gene have a regulatory role in gravitropic curvature. Work on this project is currently underway in the lab, but it is expected to require ongoing analysis throughout the summer.

Another area of interest in the lab is to understand how lateral roots "choose" an angle to orient themselves that maximizes nutrient and water uptake. Students will contribute to an ongoing project in the lab that straddles whole-plant ecological level of inquiry and cellular-molecular level of inquiry. All of these projects will acquaint students with the tools of a modern cellular and molecular biology lab. Student will routinely perform PCR, plasmid isolation, plant genomic DNA isolation, and various forms of molecular cloning, gene expression analysis, as well as detailed phenotypic analysis. In addition to these bench skills, students will also become familiar with a collection of bioinformatics tools and databases. However, it is not expected that students have extensive previous experience in any of these techniques.

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RESEARCH PROJECT INFORMATION SHEET

(Faculty information sheet)

Submission Deadline: 14January 2008

GENERAL AREA OF RESEARCH (broad overall area such as genetics, biochemistry, environmental science, etc.)

Neuroscience

SPECIFIC TITLE OF RESEARCH PROJECT

Evaluation of GGF-2 (glial growth factor-2) in immune cell infiltration and structural and functional integrity following spinal cord injury in the guinea pig.

FACULTY SUPERVISING RESEARCH

Name: _____ Jennifer R. Yates _____

Department: _____ Psychology _____

Campus phone: _____ x3814 _____

Email user name: _____ jryates _____

ANTICIPATED RESEARCH DATES, (ten weeks):

Requested Number of Students:

Beginning: _____ May 14 _____

one _____

Ending: _____ July 20 _____

two X

MINIMUM QUALIFICATIONS OF STUDENT RESEARCHER (be as specific as possible)

The students must be willing to work with research animals including performing surgeries, behavioral protocols, euthanasia and tissue harvesting. They needn't have performed these procedures before, only be willing to learn them. The students must also be willing to work some days with odd hours (including occasional weekend days) to cover post-surgical care, behavioral testing and drug administration. Interest in neuroscience, zoology, and/or physiological psychology is imperative.

DESCRIPTION OF RESEARCH PROJECT (attach statement; one page maximum)

Following spinal cord injury, there are several secondary pathological processes that contribute to further tissue damage and functional decline. In other words, these processes make the injury worse...on top of a primary injury caused by a car accident or a fall, the body's response to the injury can worsen the outcome or lessen the chance of recovery. One of these mechanisms is mediated by the immune response to the injury and involves the production of the neurotoxic molecule, quinolinic acid (QUIN). Previous research (Blight et al, 1993, 1995; Yates et al, 2006) has shown that this mechanism of damage is therapeutically available, meaning that we can interrupt the process of QUIN production and see functional and structural benefits in a guinea pig model of spinal cord injury.

New evidence exists for the usefulness of a compound called glial growth factor-2 (GGF-2), a neuregulin molecule produced by neurons, in preventing secondary pathological processes in stroke and reducing the severity and relapse rate in experimental autoimmune encephalomyelitis (an animal model of multiple sclerosis). One of the likely mechanisms of these benefits is that GGF-2 appears to lessen the ability of the immune system to respond to the injury, thereby preventing some of these secondary pathological processes. Because of the known role of the immune system in the secondary pathological processes in the guinea pig, we will be testing this molecule as a therapeutic intervention in this model. We will be measuring functional integrity as well as the infiltration of immune cells to the injury site and the structural integrity of the spinal cord at the injury site. Additionally, GGF-2 has been shown to increase the survival of oligodendrocytes, the cells that produce myelin. There is often a loss of myelination, even on surviving neurons, after injury which contributes to motor and sensory dysfunction. If GGF-2 is effective

in increasing survival of oligodendrocytes in this model, we should see improved function and increased myelin on the surviving neurons. This project will allow the student to learn the surgical procedures for the spinal cord injury model, the methods for behavioral analysis (both motor and sensory function will be tested), and the immunocytochemical and histological methods that will be used to measure the infiltration of immune cells to the injury and spinal cord tissue integrity.

Another cool aspect to this project is that the molecule, GGF-2, is in pre-clinical testing at a biotech company called Acorda Therapeutics. So this project will contribute to the data that indicates whether or not this molecule will go on to clinical trials in humans. It's a great opportunity to see how basic science research contributes to and results in clinical use of a therapeutic compound.