SPECIAL ISSUE
SUMMER RESEARCH 2006 IN BIOLOGY, CHEMISTRY, MATHEMATICS, PHYSICS & PSYCHOLOGY

BIOLOGY DEPARTMENT

Diane Angell – Small Mammals and Prairies

During the coming summer I am looking for a student to continue projects trapping small mammals. Small mammals play crucial roles as predators, prey, seed dispersers and grazers. We know little about the distribution and abundance of prairie small mammals in southern Minnesota. Last summer we surveyed prairies in and around Rice County focusing on prairie voles, a species classified as a "species of special concern". I would like to repeat and expand upon this work by increasing the numbers of prairie remnants surveyed. Research students may need a car, and need to be independent and motivated! Evenings setting traps and early morning trap checks are required. I would prefer students that have had 125, 126 and either Ecology, Genetics or Conservation Biology.

Eric Cole and Doug Beussman – *Tetrahymena* Gene Stream Project

Doug Beussman and Eric Cole are collaborating on research related to the biology of nuclear exchange during mating in the ciliate *Tetrahymena thermophila*. More specifically, we are attempting to identify and characterize all the proteins that constitute the nuclear exchange junction between mating cells. This work involves two projects this summer. First, one student will work to develop 2-dimensional SDS PAGE (electrophoresis), in order to separate and purify proteins based on molecular weight and pH characteristics. Meanwhile, two students will use mass spectrometry to determine

precise molecular weights for these proteins and bio-informatics in order to identify, and characterize the relevant genes from the published *Tetrahymena* genome.

Most of this work will take place in chemistry under the supervision of Doug Beussman.

Eric Cole – Sex determination in the Atlantic Pearl Oyster

Learn classic light microscopy and paraffin histology in order to study sex determination in the Atlantic Pearl Oyster. We are studying two discrete populations of oysters on the Island of San Salvador in the Bahamas (sorry, you'll not get to go there this summer). These bivalves are sequential hermaphrodites, beginning life as males and becoming females as they grow older. We want to determine the sex of individuals as a function of size/age, and compare a colony that has been subjected to extreme population decimation due to hurricane activity with a colony that has not been severely effected. We are testing a prediction that the hurricane-decimated population should be quicker to mature, and quicker to change sexes as a consequence of their severe and repeated population bottlenecks, and size-dependent mortality. The work consists of examing fixed oyster gonads under the microscope in order to evaluate sexual maturity and gender.

Kevin Crisp – Rhythmic locomotion

Rhythmic locomotion, such as walking or swimming, is generated in a many animal species by rhythmically active neuronal circuits called central pattern generators (CPGs). When appropriately stimulated with neurotransmitters (chemical signaling molecules of the nervous system), spinal CPGs generate rhythmic, coordinated body movements, even in the absence of input from the brain. Observations of rhythmic walking-like movements in patients paralyzed from spinal cord injuries have lead researchers to suggest "neurotransmitter replacement therapy" as a potential strategy to improve their walking capabilities. Relatively little is known, however, about how neurotransmitters activate CPGs.

Swimming movements in the medicinal leech are controlled by a CPG that is activated by serotonin, and represents one of the best-studied examples of the control of CPG activity by a neurotransmitter to date. Students in my lab this summer will use a variety of electrophysiological, pharmacological and biochemical to determine the signal transduction pathway(s) used by serotonin to activate the swim CPG. Of particular interest are putative interactions between calcium-signaling and the cAMP-signal transduction pathway.

Jean Porterfield – Freshwater Fish Phylogenetics

In general, I study the evolutionary biology of freshwater fishes. Specifically, my work with St. Olaf students has focused mainly on phylogeography, or the use of

phylogenetic (genetic relationship) data to interpret geographic (distribution) data. For example, our work on the genetic variation of Johnny darters in Minnesota and Wisconsin suggests some past geographic connections among streams that are no longer closely connected today. More information on past student research can be found at www.stolaf.edu/people/porterfi/research.htm. Students in my lab can expect to spend some time in the field collecting and observing fish, some time in the lab working on molecular genetic techniques (DNA extractions, PCR, etc.), and some time on the computer conducting analyses of DNA sequences (alignments, phylogenetics, etc). The exact balance of these three activities will depend on the specific project, so please come talk to me about your interests in and ideas for this work, or just to learn more!

John Schade – Nutrient Cycles and Consumer-Resource Interactions

My current research interests center on studying feedbacks between multiple nutrient cycles and consumer-resource interactions. I am currently involved in a project in which we ask where and when are biotic interactions and biological stoichiometry important determinants of nutrient transport and retention in river networks, and what are the consequences for downstream communities? I am looking for 1 or 2 students to participate in a project studying these processes in a network of streams at the Angelo Coast Range Reserve in Northern California. Students would be responsible for developing a research project and assisting in the lab and field. They will also gain valuable experience in fieldwork involving collection of water, algae and stream invertebrate samples, as well as exposure to standard and novel approaches to studying stream ecosystems. In addition, this project will provide opportunities to interact with collaborators at the University or California-Berkeley and from the University of Minnesota.

Kathy Shea – Forest Ecology and Population Genetics

My research will focus on two aspects of forest ecology: forest restoration and population genetics. With students over the last 14 years I have conducted studies on the growth and survival of trees in the forest restoration areas that are part of the natural lands surrounding the campus. There has been increased interest in how to restore natural systems as more landowners see the benefits of having adjacent natural habitat. Trees in the forest restoration areas were mapped using a GPS system and then map location and tree/site characteristics were transferred to a GIS database. New data, including tree size and soil characteristics, will be collected this summer and added to the existing database on the St. Olaf Natural Lands.

Another area of research will examine population level genetic variation in balsam fir DNA. Methods will be established and DNA from previously collected samples from large and small populations will be compared. Population genetic data provide information on the genetic health and past history of populations. Loss of genetic diversity is a concern for conservation, especially in small isolated populations. Parts of these projects will form the basis for an independent research project next year.

Charles Umbanhowar – Linkages of fire, climate, and culture in Mongolia

Does climate change more directly affect vegetation or fire? How do changes in vegetation and fire feedback on each other? To what extent does herding and other cultural practices affect burning. I am looking for 1-2 students to work with me on a continuing project that addresses these questions using the landscapes of western Mongolia as a testing ground. This summer our research will focus on lake sediment cores that are 5000-6000 years old and were collected in western Mongolia in 2005.

Students will learn how to extract charcoal from sediment cores and how to quantify charcoal abundance using a dissecting microscope mounted with a CCD camera and connected to a computer running NIH image capture software. They will also learn LOI analysis of sediments as well as the analysis of the carbon and nitrogen content of sediment organic matter.

Anne Walter and Doug Beussman – lipid component of plant tonoplast membranes

We will be continuing our efforts to understand the lipid component of plant tonoplast membranes by isolating the membranes, isolating total lipids and analyzing them by LC-Mass Spec and thin layer chromatography. Preliminary analysis of the lipids reconstituted in membranes tells us these lipids are designed to minimize membrane permeability. The motivation for this project is to understand how a plant compound, dihydrowyrone, induces proton leakage across this membrane and how it inhibits the proton ATPase function--two properties that have been well characterized by previous student researchers. This is an important project if you are interested in the critical, subtle and regulated properties of the membrane lipid environment.

CHEMISTRY DEPARTMENT

Douglas Beussman – Research Opportunities for 2006

There will be several opportunities for students to engage in research with me during the summer of 2006. All projects will rely to some extent on the use of mass spectrometry, as well as on various separation methods.

One project includes collaborating with Dr. Cole in the Biology Department on the identification of proteins isolated from *Tetrahymena thermophila*, using proteomic methods. These proteins will be digested and analyzed using mass spectrometry techniques with the new LC-MS instrument and screened against a database. Peptides from potentially identified proteins will be reintroduced into the mass spectrometer and tandem mass spectrometry will be performed in order to sequence the peptides for confirmation of protein identification. A second, similar collaboration with a research group at Drake University will also likely be available.

A second opportunity for summer research involves developing sensitive and selective forensic science methods of analysis using mass spectrometry. The ability to detect and identify analytes at low concentrations is crucial for early detection of toxins and trace analysis of drugs or other poisons in various sample matrices. This work will likely use solid-phase micro extraction (SPME) to selectively concentrate target molecules prior to analysis. The project may include developing methods for the analysis of economic poisons, date rape drugs, or performance enhancing drugs.

Paul Jackson – Green chemistry in analytical and p-chem laboratories

This project seeks a student willing to benchmark the green chemistry character of current laboratory experiments and develop new experiments in green chemistry. The student would work with Professor Jackson and consult with other faculty on experiments suitable for analytical and physical chemistry lab courses, and would build on the work conducted by the 2005 Environmental Analytical Chemistry class. The work will range from identify aspects of green chemistry that apply to these laboratory settings, developing and applying appropriate green chemistry metrics, adapting green experiments already developed elsewhere, and inventing new experiments utilizing green chemistry. Another project would involve the use of Raman spectroscopy in real-time analysis of organic reactions, such as those done in synthesis lab. Students interested in this work should have completed either physical chemistry lab or analytical chemistry lab by the summer of 2006.

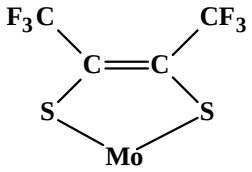
Marc Klingshirn - "Green" Laboratory Design

This project will continue the efforts of bringing green chemistry into the first year chemistry laboratory curriculum here at St. Olaf College, and it will involve one student collaborator. Last summer, two first-year labs were totally redesigned with an additional two having minor changes made to improve their “shade of green.” Principles and examples of green chemistry were also included in the laboratory manual to make tangible relationships to work being conducted in academia and industry. These changes were successfully implemented into the current curriculum.

With continued assistance from a generous grant provided by the W. M. Keck Foundation, plans are to continue this work and redesign other laboratories currently in place here at St. Olaf or modify/redesign other experiments that are traditionally used at other colleges/universities. New chemistry could also evolve from this work and the project could potentially produce manuscripts suitable for publication in educational journals. As with the previous work, the possibility of presenting this work at regional or national scientific meetings is possible. Those students who are interested in this work should have at least completed first year chemistry, and organic chemistry by the summer of 2006.

Gary Miessler: Transition Metal Dithiolene Complexes and Their Mass Spectra

My main research interests are in the organometallic chemistry of molybdenum and tungsten. Primarily I hope to develop syntheses of new compounds of these metals that contain dithiolene ligands in addition to organic ligands such as CO and η^5-C_5H_5. Some important molybdenum- and tungsten-containing enzymes have dithiolene ligands (the structure of one dithiolene is shown below), and I hope to prepare compounds that might serve as models for the metal sites in such enzymes.



A dithiolene ligand bonded to Mo

In the laboratory, students participating in this work will gain experience in vacuum line synthesis and purification techniques. APCI (Atmospheric Pressure Chemical Ionization) mass spectrometry been a valuable tool in characterizing dithiolene and dithiocarbamate complexes, and special emphasis this summer will be placed on this technique, to explore the range of organometallic compounds on which it can be used effectively and to develop procedures for its optimum use. Students will also use a variety of spectroscopic methods, especially NMR, IR, and UV-vis.

Greg Muth - Biochemistry and Bio-Organic Research Opportunities

My group is currently working on two projects, each centered on the structure and function of ribonucleic acids (RNA).

Gene Regulation by mRNA-Thiamin Recognition: Recent advances in genomics, the mapping of genes and their functions, have provided a wealth of information for researchers. One of the areas that has benefited is the study of gene regulation, the ability of an organism to selectively turn off and on certain genes in response to environmental conditions or at specific times during its lifecycle. To better understand the details of these genetic switches, we are comparing the regulatory regions of the thiamin (vitamin B1) biosynthesis gene from *E. Coli*, *R. Etli* and *B. Subtilis* using a variety of biochemical and biophysical techniques. The project utilizes interdisciplinary techniques from biochemistry, microbiology, genetics, cell biology and bioinformatics.

Design and Synthesis of Conformationally Constrained RNA Oligonucleotides: Small, highly structured fragments of RNA have been shown to play important roles in numerous biological processes. For example, specific genes can be turned off by the presence of small interfering RNA, and the presence of small RNA molecules has also been shown to disrupt the binding of the nucleocapsid protein to HIV-1 RNA or the binding of the Rex fusion protein to its target in human T-cell leukemia virus type 1. While the sequence of these RNA fragments plays a role in their binding, we hypothesize that the overall structural architecture of these RNA fragments is also a vital component. To address this, we are chemically synthesizing a series of RNA nucleotides with varying degrees of bend and then incorporating them into short RNA oligonucleotides. We will

test for the presence of unique structural attributes using nuclear magnetic resonance spectroscopy, gel-shift and various protein binding assays.

The project utilizes interdisciplinary techniques from biochemistry, physical chemistry and organic chemistry.

Jeff Schwinefus – Summer 2006 Research Opportunities

Water plays an integral role in the structure and function of nucleic acids. Water molecules hydrate DNA double helices and folded RNA, aiding in the overall stability of these important nucleic acid structures. Removing the "waters of hydration" destabilizes nucleic acid folded structures, making it easier to pull apart nucleic acid strands involved in hydrogen bonding. To understand how hydration affects the chemical and physical properties of nucleic acids, we need information about the extent of nucleic acid hydration and the changes in hydration when a folded nucleic acid structure undergoes a physical or chemical change.

As a probe of nucleic acid hydration, our group uses neutral organic molecules termed cosolutes to lower the temperature required for unfolding nucleic acid structures (often referred to as melting). Cosolutes such as alcohols, amino acids, and sugars influence the number of water molecules released in this transition by binding to nucleic acids directly or modifying the overall hydration pattern on the folded structures. How these cosolutes influence nucleic acid structure in living organisms is unclear. Cosolutes are just one component of a complex mixture of salts, organic solutes, and macromolecules that modify nucleic acid structure and stability.

Our focus this summer is to elucidate the effect of these cosolutes on the stability of DNA and RNA folded structures. Using ultraviolet spectroscopy, differential scanning calorimetry, and laser light scattering, students involved in my research will correlate the stability of nucleic acid structures with the number of water or cosolute molecules released or bound to the nucleic acid surface during the melting transition. RNA studies will be done in collaboration with Dr. Greg Muth. Our ultimate goal is to understand the role of nucleic acid hydration in nucleic acid structure determination and stability.

Gary Spessard – Developing green organic chemistry experiments

This project will require two students to continue working on the development of new organic chemistry experiments that emphasize green chemistry. The work could range from adapting green experiments already developed elsewhere all the way to inventing new chemistry (basic research) that would be suitable for use in our organic laboratory courses. Students interested in this work should have completed at least first-year and organic chemistry by the summer of 2005.

Developing new green chemistry experiments is an exciting opportunity for student scientists to both do research and to see the fruits of their work applied directly in the teaching laboratory. Your work will play an integral role in our current program, supported generously by the W. M. Keck Foundation, to adopt the principles of green

chemistry throughout our chemistry laboratory courses. We anticipate that the outcome of your work will be disseminated outside the college, and thus students who do green chemistry development will not only have opportunities to attend regional and national scientific meetings and report their work, but also see their results appear in articles published in the *Journal of Chemical Education* or *The Chemical Educator*.

MATHEMATICS, STATISTICS, AND COMPUTER SCIENCE DEPARTMENT

Center for Interdisciplinary Research

Funding will be available for up to 8 students in statistics to participate on interdisciplinary research teams in summer 2006. The Center for Interdisciplinary Research (CIR) brings together undergraduate statistics students supervised by statistics faculty with faculty and students from other disciplines to share in the excitement and challenge of working across the traditional academic boundaries to collaborate on research. Ideal candidates would be students who have taken Statistical Modeling and who are working toward a statistics concentration, but students with some statistical background and an interest in applying statistical problem solving skills to research questions in specific disciplines will also be considered.

Dick Brown – Computer Science Systems Applied to the Sciences

The field of *systems* in Computer Science encompasses areas such as operating systems, databases, networking, and client-server applications. I'm seeking students with solid CS backgrounds (preferably but not necessarily including systems courses) and good programming skills to continue work on one or both of the following projects with interdisciplinary applications in the sciences. (1) CPET, the Co-Process Extension Tool, is a browser plug-in and server that adds capabilities to existing web pages. Bryan Anderson added a feature for automatically adding reference links to science research articles in Summer 05; we plan to extend his work next Summer, improve security and update the IE plugin, and add CPET interactions with other scientific systems. (2) St. Olaf's exploration of Beowulf clusters begins in Interim 2006 and continues this Spring with a Physics application. We will continue next Summer with further development of the cluster and applications to Biology and possibly other fields.

Jill Dietz – Finite Group Theory

I am looking for one student interested in doing a part-time research project in finite group theory. The exact number of hours is up for negotiation, but probably 5-10 hours

per week. One big stipulation is that the student will need to be able to meet me once a week or so* ***in*** Minneapolis*. The other requirement is that the student should have taken, done well in, and enjoyed Math 252: Abstract Algebra. Finally, the exact project in group theory will depend somewhat on the student's interest: whether the student wants to combine group theory with graph theory, or would prefer writing and executing Maple procedures, or wants a more abstract experience, and so on.

Olaf Hall-Holt – The Palantir Project

Are you interested in graphics, 3D visualization, and measurement sensors? Do you have some familiarity with the C++ programming language? The Palantir project is a team effort that will focus on one or both of the following:

Project #1: extracting 3D information from video sequences. Given digital video clips taken with two synchronized cameras, our challenge is to find patterns in the data that allow us to infer information about the shape and position of objects in the scene. We will explore a new type of algorithm for robust feature detection. This is a joint project with Gary Muir in psychology, who will be applying the new tools to study the way that rats navigate through space.

Project #2: video teleconferencing on Internet2. St. Olaf College has just this year been added to the new, faster Internet that connects many educational institutions. How can we make use of this network to allow closer collaboration between researchers at different institutions? This project will be concerned with both the technical aspects of video capture and compression, as well as human interface issues of presence.

Matt Richey – Applied Neural Networks

Neural Networks are a computational tool for decision making. They are particularly useful in situations where the inputs and outputs are not well-connected (e.g. predicting the stock market based on weather trends). In this project, I will be implementing a neural network to assist a government agency predict a certain class of individuals. The background required includes some proficiency in programming and applied mathematics. Most work will be done here at St. Olaf, but some travel might be involved.

Amelia Taylor – Applying Polynomial Ring Theory to Biology

I am looking for students interested in applying polynomial ring theory to Biology. The work we will do concerns ideals that arise in two contexts: molecular phylogenetics and gene regulatory networks. While the motivation comes from biology, this is a mathematics project concerning ideals in polynomial rings and their structure, so no prior biological background is needed, but abstract algebra (math 252) is a necessity.

PHYSICS DEPARTMENT

Brian Borovsky – Molecular Origins of Friction

I am interested in studying what gives rise to the force of friction. What are the microscopic interactions that determine the frictional force opposing the sliding of one surface over another? How does this force generate heat at the interface? In my lab, we investigate these questions experimentally. By pressing a force probe onto a vibrating surface, we create a microscopic high-speed contact subject to friction. The speeds and contact sizes involved are the same as those encountered in working devices such as computer hard drives and micromachines. Currently we are studying ultrathin lubricant films made from chain-like hydrocarbons. Our goal is to determine how the length of the lubricant molecules affects the level of friction. Theoretical results predict that longer molecules will result in lower frictional forces because of increased ordering of the lubricant films. This model emphasizes the importance of mutual interactions among the molecules in eliminating pathways for energy dissipation. Our results will put this model to the test.

James Cederberg & David Nitz – Molecular Beam Spectroscopy

The molecular beam spectrometer in SC150-152 was obtained from Harvard University in 1981, and has been in use here at St. Olaf ever since. The project involves using the spectrometer to record data on the molecules, and developing and using software for the analysis of the data. The purpose is to measure molecular properties that quantify the interactions between the molecular and external electric and magnetic fields and the nuclei.

The summer of 2005 was devoted to the analysis of past data on several molecules (^{6}LiI, RbF, RbCl, KBr), taking additional data on RbCl, and beginning a new investigation of RbOH. In the process of fitting the data for ^{6}LiI (taken mostly during 2000), John Nichol recognized that there was an effect we could not account for using the expected interactions and their dependence on the vibration and rotation of the molecule. The interaction between the iodine nucleus and the electric field created by the rest of the molecule changed with the substitution of the Li isotope (replacing ^{7}Li by ^{6}Li) by an amount that we still cannot explain. This study was published in the *Journal of Chemical Physics*, 123, 134321, 2005.

The analysis of KBr, RbF, and RbCl went smoothly, leading to a determination of all the expected interactions. The puzzle in the case of LiI, however, raises questions about similar but smaller shifts in these molecules that we are hoping to understand more fully as we prepare them for publication over the next few months.

For the future, we will continue to observe hyperfine spectra in sequences of vibrational and rotational states in small molecules, such as alkali halides or hydroxides (in particular RbBr and RbOH), using this high-resolution molecular beam electric resonance spectrometer. Students are colleagues in the process, helping to decide what molecules to examine, what data to take, analyzing the data, maintaining the apparatus, writing software, etc. The three students from the summer of 2004 (John Nichol, Jimmy Randolph, and Sara Fortman) are all graduating, so we will be taking on new people for 2006.

Jason Engbrecht - Positron Research

The Positron Research Group focuses on properties of and applications for the exotic atom Positronium. Positronium (Ps) is the exotic atom formed by the electron and its antiparticle the positron. This summer we will be pursuing two projects. The first will be the interaction of Ps scattering off ordinary gas atoms and molecules. The second will investigate the possibility of using Ps to study structural changes in biological systems.

Students on this project will play an important role in the design and construction of scientific apparatus. Additionally, they will be exposed to computer laboratory interfacing techniques and data analysis methodology. I would encourage any interested students to apply. More information can be found at http://www.stolaf.edu/academics/positron/ <http://www.stolaf.edu/people/engbrech/research.htm> or feel free to contact me with any questions.

Robert Jacobel, Brian Welch (Physics) & Rickard Pettersson (Environmental Studies) - Summer Research with the Center for Geophysical Studies of Ice & Climate (CEGSIC)

Changes now underway with the world's glaciers and ice sheets make the cryosphere (the earth's icy surfaces) a critical element in the global climate system. Our group uses ice-penetrating radar and satellite imagery to examine the surface, interior and base of glaciers and ice sheets. The characteristics of internal ice layers and basal geology that we measure with the radar lead to understandings of the relationship between ice flow and climate change.

Currently we are working on recently acquired data from two projects in Antarctica and will be making preparations for a third that will take place in 2006-08 during the International Polar Year (IPY). Summer research in 2006 will focus on preparations for the upcoming IPY traverse and data analysis and interpretation from our ongoing project on Kamb Ice Stream in West Antarctica.

Students involved in our group will use existing software to analyze ice-penetrating radar data and satellite imagery as well as learn to write new code in Matlab. We also work with GPS, GIS, and remote sensing software/data to establish a spatial context for our radar results.

PSYCHOLOGY DEPARTMENT

Shelly Dickinson – Alcohol and Adolescents (mice)

Despite widespread use of alcohol (and other drugs) by teenagers and young adults, most basic research on its behavioral and neurobiological effects has been conducted on

adult animals. However, we know that a great deal of neural development occurs during adolescence, and we cannot assume that adolescents will respond to alcohol and other drugs in the same way as adults. One summer project will be to determine whether adolescent mice drink more or less than adults, and then to see whether exposure as an adolescent affects drinking as an adult. We'll also continue to look at place conditioning with adolescent animals and we'll be setting up electrochemistry equipment to assess genetically determined differences and drug-induced changes in brain neurochemistry in mice and rats. This is particularly exciting in conjunction with the adolescent work, since we will be able to actually measure how various proteins work at different times during brain development.

Students involved will start at the beginning with experimental design, will learn animal handling and injection techniques and, in some cases, *in vivo* voltammetry techniques, including stereotaxic surgery. Everyone in the lab is expected to contribute to data analysis and manuscript preparation. Students interested in continuing to work in the lab during the academic year doing independent research are particularly encouraged to apply.

Jumi Hayaki – Emotional (Dys)regulation and Psychopathology

My research program examines the role of dysfunctional emotional processes in adult psychopathology. Specifically, I am interested in the role of emotional dysregulation in two phenomenologically related areas of clinical distress: eating disorders and substance use disorders. Previous research has shown that individuals who experience symptoms of eating disorders and substance abuse—even at subclinical levels—exhibit deficits in emotional regulation, including a greater tendency to experience negative emotions (e.g., shame), the inability to cope effectively with unpleasant emotions such as anxiety, and a general lack of experiential emotional awareness. I am currently developing a model of emotional dysregulation in eating and substance use disorders by further specifying the maladaptive emotional correlates of these two clinical syndromes. Ultimately, this research could have implications for treatment, such as (a) early detection of those individuals most at *emotional* risk of developing an eating or substance use disorder and (b) operationalization of emotional targets for clinical intervention.

I am interested in collaborating with students who wish to explore these facets of psychopathology and have a strong background in psychology (preferably including Abnormal Psychology and Research Methods). Students interested in continuing this work into the academic year (e.g., as an Independent Research project) are especially encouraged to apply.

Gary Muir – The Neural Basis of Navigation

My research program is guided primarily by questions about the neural mechanisms of spatial cognition and navigation. The firing activity of certain neurons is thought to represent the animal's perceived location ("place" cells) and head direction ("head direction" cells), but how is information contained in the firing activity of these cells used

by the animal when solving a spatial task? I am also particularly interested in how learning a spatial task may alter the firing activity of these cells to represent the animal's newly acquired knowledge. To answer these questions, students will have the opportunity to observe a "behaving" brain in action by recording the activity of single neurons while freely-moving rats perform spatial tasks. How does this neural activity relate to the animal's navigational behavior? Students will be involved in all stages of the project: designing the experiment, small animal handling and training, single-unit electrophysiology, data collection and analysis, and public presentation of the results. Students interested in continuing the project into the academic year as independent research are especially encouraged to apply.