St. Olaf College
Faculty of Natural Science and Mathematics (FNSM) Grants

Howard Hughes Medical Institute

Undergraduate Science Education
Project Director: Charles Umbanhowar
Amount: $1,000,000
Project Dates: 9/1/12-8/31/16

At St. Olaf, part of the grant will be used to hire a new faculty member who holds a doctorate in a science discipline and also has recent experience teaching at the high school level. That faculty member, who will likely have a shared appointment between the Education Department and the Natural Sciences and Mathematics faculty, will play a key role in mentoring students who are interested in becoming teachers. The grant will also enable the college to hire two visiting master teachers — experienced high school science or mathematics teachers who will spend a year at St. Olaf teaching half-time.

Students interested in becoming educators will also have increased opportunities to teach and perform research during both the academic year and the summer through a new peer teaching program. They will be trained to become teaching assistants in courses on campus and will be encouraged to gain hands-on experience in research labs.

The grant will also support efforts to incorporate science into other disciplines on campus. One way that will be achieved is having science and mathematics faculty involved in the first-year writing course on campus. Their input in developing course topics and structures will help bring science to a much broader group of students. Another part of the initiative will be the development of a new general education course that will examine the intersection of science and society. The grant will also provide funding to expand St. Olaf's long-standing Summer Bridge program, a for-credit summer session that has to this point focused on providing incoming students with the skills needed for college academics. Bridge I will have two tracks: one with a focus on potential science majors and the other with a more general focus. Bridge II will target rising sophomores and will focus on the more advanced skills needed in science and mathematics.

All of these initiatives will combine to support an overarching goal of better integrating science into other disciplines and programs on campus.
Link to full story: http://www.stolaf.edu/news/index.cfm?fuseaction=NewsDetails&id=5313

Biology, Environmental Studies, and Chemistry

National Science Foundation
MRI: Acquisition of an Isotope Ratio Mass Spectrometer as a catalyst for faculty-student research in chemistry and environmental science
Grant #0923439
Amount: $576,780
Project dates: 09/01/09-08/31/12

Project Directors: John Schade (Principal Investigator), Charles Umbanhowar Jr (Co-Principal Investigator), Douglas Beussman (Co-Principal Investigator), Stephanie Schmidt (Co-Principal Investigator)

This award is funded under the American Recovery and Reinvestment Act of 2009 (Public Law 111-5).
This instrumentation will allow the use of stable isotopes to pursue research projects ranging from carbon and nitrogen biogeochemistry, to food web dynamics, to paleoecological and forensic analyses. The presence of these instruments on campus will allow completion of these research projects without sending samples to outside laboratories and will enhance research and teaching activities in an almost unlimited range of science disciplines, from physical chemistry to molecular biology and ecology. All of the projects represent significant contributions to our understanding of environmental and chemical processes, and enhance interdisciplinary research at St. Olaf College. The instrumentation will also be used in classes as part of a growing tradition of research-based teaching at St. Olaf College. Several current courses will benefit directly, providing research opportunities for up to 40 students per year.

Chemistry and Biology

National Science Foundation
RUI: The Gene Stream II: from Sequence to Cell Function
Grant #0817993
Amount: $480,000
Project Dates: 10/01/08-09/30/11
Project Directors: Eric Cole (Principal Investigator), Douglas Beussman (Co-Principal Investigator)

Tetrahymena is an unusual organism that exists in nature as a single cell. As a ciliate, the unicellular Tetrahymena possesses not one, but two nuclei that are fundamentally different. The larger macronucleus is actively expressed and responsible for driving the daily activities of the cell. The smaller micronucleus is usually silent, and serves as a genetic archive for the cell, storing two copies of every gene that will be ultimately shared when the organism engages in nuclear exchange with a mating partner. In this regard, ciliates such as Tetrahymena resemble multicellular embryos, in which certain cells differentiate into the body (soma) of a developing organism while other cells are set aside to become a part of the germ line (future eggs or sperm). Remarkably, researchers have found that many of the same proteins that help distinguish the germline of an animal from the soma may play a similar role in distinguishing the germline micronucleus of a ciliate from the somatic macronucleus.
The project here is to explore the structure and function of the conjusome, a small intracellular structure found in mating Tetrahymena that resembles the P-granules in animal embryos that have been shown to house proteins that bring about genome modifications leading to the distinction between soma and germline.

Chemistry and Biology

Research Corporation, Cottrell College Science Award
The function and targeting of perilipin 2, a lipid droplet-associated protein
Grant #20189

Amount: $35,000
Project Dates: 07/01/11-06/30/13
Project Director: Laura Listenberger

Listenberger's research focuses on the lipid droplet, a compartment each cell in the human body uses to store excess fat. Understanding how the lipid droplet works is key in understanding obesity-related diseases like diabetes and heart disease. Listenberger will use this grant to investigate the function and targeting of perilipin 2, a lipid droplet–associated protein.

Chemistry

ACS-Petroleum Research Fund
Nickel Catalyzed C-H Arylation using C-O Electrophiles
Project Dates: 9/1/12-8/31/14
Amount: $50,000
Project Director: Dippanita Kalyani

Atom economical, cost-effective, and environmentally friendly synthetic methods for the construction of C-C bonds using abundant and inexpensive hydrocarbon substrates is very desirable. The overall goal of the proposed research is the development of a mild, general and efficient method for the construction of C-C bonds by nickel-catalyzed coupling of phenolic electrophiles with hetereoarenes, arenes, and alkanes. The use of earth abundant nickel is expected to make this methodology a significant advancement over the known direct C-H arylations, majority of which employ costly transition metal catalysts (Pt, Pd, Rh, Ir, Ru).

Chemistry

National Science Foundation
S-STEM: Providing Suppport Structures for Chemistry Majors (PSSCM)
Grant #0806792
Amount: $583,414
Project Dates: 08/15/08-07/31/13
Project Directors: Mary Walczak (Principal Investigator), Douglas Beussman (Co-Principal Investigator), Kathy Glampe (Co-Principal Investigator)

This project is establishing a new program, Providing Support Structures for Chemistry Majors (PSSCM), to support 15-20 students throughout their undergraduate chemistry education. To qualify for PSSCM scholarships, students must demonstrate significant financial need and show promise for success in chemistry. The goal of this project is to provide significant academic support for this cohort of students. This program builds on three existing St. Olaf resources: (i) a nationally-recognized chemistry program; (ii) TRiO/Special Students Services (SSS) program, which supports students in overcoming financial, social, and cultural barriers to success in higher education; and (iii) St. Olaf's Center for Vocation & Career, which uses workshops, internships, and career counseling to link students' undergraduate experiences to future careers.

Chemistry

National Science Foundation
MRI: Acquisition of a Molecular Imaging System to Continue Faculty-Student Research in an Interdisciplinary Biomolecular Science Program
Grant # 0722852
Amount: **$27,669**
Project Dates: 01/01/08-12/31/10
Project Director: Greg Muth

An award has been made to Saint Olaf College under the direction of Dr. Greg Muth to acquire a molecular imaging system for use in biology and chemistry research and teaching. The system will allow researchers to make digital images of various kinds of gels used to study proteins and nucleic acids (DNA) in cell biology and chemistry. Research includes study on gene regulation in protozoa, antimicrobial compounds in bacteria, and proteins important in the structure of cell membranes. The images produced by the system can be share over the internet through an associated computer system. Such imaging systems are essential tools in courses on cell biology, biochemistry, and analytical chemistry.

Chemistry

National Institutes of Health
AREA: DNA and RNA Stability in Glycine Betaine, TMAO, and Urea Solutions: Correlating Small Molecule Interactions with Nucleic Acid Surfaces.
Grant #1R15GM093331-01
Amount: $195,592
Project Dates: 06/01/10-05/31/13
Project Directors: Jeff Schwinefus and Greg Muth

The investigations in this proposal will quantify accumulation or exclusion of glycine betaine, trimethylamine oxide (TMAO), and urea at nucleic acid surfaces to correlate cosolute interactions with chemical functional groups on the nucleic acid surfaces. The specific aims of this proposal will combine thermal unfolding and vapor pressure osmometry (VPO) studies with molecular dynamics (MD) computer simulations to: 1.) assess the strength of glycine betaine, TMAO, and urea as nucleic acid secondary structure stabilizers/destabilizers by quantifying the accumulation or exclusion of these cosolutes from chemical functional groups on double-helical DNA and RNA surfaces exposed during thermal denaturation; MD simulations will also be used to predict the roles solvent accessible chemical functional groups and base sequence-mediated hydration play in cosolute accumulation or exclusion at the double-helical DNA or RNA surface; 2.) quantify the accumulation or exclusion of glycine betaine, TMAO, and urea from nucleoside 5'-monophosphates (NMPs), the individual building blocks of DNA and RNA secondary and tertiary structures, using VPO and MD simulations and couple these results with those from the first specific aim to elucidate the mechanism of cosolute stabilization or destabilization of DNA and RNA double-helices; 3.) quantify the accumulation or exclusion of glycine betaine, TMAO, and urea from ribodinucleoside monophosphates (rDMPs) using VPO and MD simulations to assess the roles of base nearest-neighbor and stacking in cosolute interactions with DNA and RNA secondary and tertiary structures. These experiments will provide a foundation for an improved understanding of nucleic acid structural stability in cellular environments and a

broader understanding of biopolymer folding and unfolding processes, leading to insights into biopolymer function and biopolymer folding diseases.

Chemistry

Keck Foundation
Green Chemistry throughout the Curriculum
Grant # 041912
Amount: $500,000
Project Dates: 06/01/04-12/31/10
Project Directors: Gary Spessard, Paul Jackson and Robert Hanson

The Chemistry Department at St. Olaf College received support from the W. M. Keck Foundation to enable the development and implementation of a fundamentally new and more environmentally benign way of teaching chemistry, known as ***Green Chemistry***, throughout our laboratory curriculum. This project has far-reaching consequences for undergraduate science education and for the sustainable design and utilization of science buildings. The project includes funds for:

- the support of three faculty members to devote themselves to the development of Green Chemistry laboratory pedagogies,
- the salary of a postdoctoral fellow trained in green chemistry,
- the stipends of six student coworkers, and
- the purchase of necessary chemicals, materials, and equipment.

Environmental Studies

Henry Luce Foundation
Linking Asian Studies and Environmental Studies across the Liberal Arts
Amount: $50,000
Project Dates: 5/1/12-8/31/13
Project Directors: Kathy Tegtmeyer-Pak and John Schade

Our plan consists of three major initiatives that will result in a strong foundation of curricular links and international partnerships, forming the heart of future efforts to increase the number of students and faculty participating across campus. First, we plan to develop and pilot a number of on-campus initiatives to increase links between courses, communication between AS and ES faculty, and the number of opportunities students at St. Olaf College have to experience enriched study of AS and ES. Second, we will plan two summer trips to Asia by St. Olaf faculty and students to strengthen our partnerships with institutions in Japan and China, and to design and pilot a summer exchange program. Third, we will integrate on- and off- campus initiatives by creating a virtual community that links our students with their peers at partner institutions in Asia.

Environmental Science

Margaret A. Cargill Foundation
Environmental Studies/Department Chair
Amount: $625,418

Support student-faculty partnerships that forward an Environmental Studies related research agenda; build professional skills in undergraduates; broaden the range of ES related internship experiences/experiential components. Encourage students to have conversations about sustainability; ensure the longevity of STOGROW as a place of experiential learning for students; increase visibility of farm to students, teach students about organic agriculture and agronomy Build a GIS user group on campus.

Mathematics, Statistics and Computer Science

National Science Foundation
CCLI Type 2: Collaborative Research: CS in Parallel: Scaling an incremental modular aproach to injecting parallel computing throughout CS curricula
Grant # 1226172
Amount: $231,709
Project Dates: 8/15/12-7/31/15
Project Directors: Richard Brown, St. Olaf College; Libby Shoop, Macalester College; Joel Adams, Calvin College

This project demonstrates how colleges and universities can insert short (1- to 3-day) teaching modules on parallel computing into their courses. These self-contained modules present conceptual principles reinforced by hands-on experience and follow-up exercises, and are designed for flexible use in wide-ranging curricular contexts. They thus permit parallelism to be infused incrementally and fittingly throughout the CS curriculum. Having developed this modular strategy at two colleges in a predecessor CCLI Type I grant, this project will demonstrate its scalability to other universities and colleges by targeting two geographical regions with workshops and follow-up adopter support. Another focus of the project is to develop strategic new modules that incorporate (1) emerging curricular recommendations, (2) enticing applications to other fields, (3) parallel design patterns developed by experienced practitioners, and (4) new developments in the parallel computing community as they arise.

Mathematics, Statistics and Computer Science

National Science Foundation
CCLI Type I: Collaborative Research: Responding to manycore: A strategy for injecting parallel computing education throughout the computer science curriculum.
Grant # 942190
Amount: $129,738
Project Dates: 01/15/10-12/31/12
Project Directors: Richard Brown, St. Olaf College; Libby Shoop, Macalester College

This collaborative project between St. Olaf College and Macalester College is developing a collection of ten learning modules with supporting software in the area of parallel computing.

For the foreseeable future, the dominant factor in CPU hardware performance will be the number of cores per CPU package, not speedup within an individual core. Thus, today's dual- and quad-multicore processors will soon give way to CPUs with dozens, and eventually thousands, of cores. To prepare today's computer science students for the manycore world that will be the reality during their careers, parallel computational concepts and programming must achieve a new prominence in the computer science curriculum. The modules developed in this project range in sophistication from the first-year introductory level to the fourth-year advanced technical elective level. The modules begin with Hadoop and progress to OpenMP and MPI. The modularity and varying complexity of the modules allows institutions to adapt them to their curriculum from a single course to a complete vertical curricular integration. The modules are supported by a selection of parallel platform packages, including software and documentation, that enable the modules to be used on a variety of hardware platforms. The modules are being freely disseminated through an interactive website, the National Digital Science Library, and through a workshop at the annual meeting of the ACM Special Interest Group for Computer Science Education. The project includes a comprehensive assessment and evaluation plan coordinated by an independent evaluator.

Mathematics, Statistics and Computer Science

National Science Foundation
EMSW21-MCTP – eCIR-The expanded Center for Interdisciplinary Research
Grant # DMS-1045015
Project Dates: 09/01/11-08/31/16
Amount: $1,584,039
Project Directors: Julie Legler (Principal Investigator), Matthew Richey (Co-Principal Investigator) and Paul Roback (Co-Principal Investigator)

The St. Olaf Center for Interdisciplinary Research will be expanding this year, thanks to a $1.6 million grant the college recently received from the National Science Foundation. The funding will support the work of the expanded Center for Interdisciplinary Research (dubbed the eCIR) over the next five years. The program will continue its original mission of partnering teams of statistics students to work with faculty on interdisciplinary research projects, but the new funding will enable students studying applied mathematics and computer science to participate as well.

The eCIR will support up to 30 student researchers during each academic year and up to eight fully funded student researchers each summer. An emphasis will be placed on supporting students from groups traditionally underrepresented in the fields of science, technology, engineering, and mathematics. The program will also include a focus on student writing and the submission of papers to peer-reviewed journals, as well as funding for students to travel to various conferences to present their research. Also included in the expansion of the program is funding for two postdoctoral fellows with expertise in applied or computational mathematics who will serve as mentors for eCIR students. The fellows, in turn, will also receive guidance and mentorship from faculty in the Department of Mathematics, Statistics, and Computer Science..

Mathematics, Statistics and Computer Science

National Science Foundation
S-STEM: Encouraging Careers in the Mathematical Sciences
Grant # 0630930
Amount: $499,465
Project Dates: 09/01/06-08/31/12
Project Directors: Matthew Richey (Principal Investigator) and Kathy Glampe (Co-Principal Investigator)

This project is establishing a new program, Encouraging Careers in the Mathematical Sciences (ECMS), to support financially needy students pursuing majors and careers in the mathematical sciences. ECMS Scholars are being attracted from traditionally underrepresented groups and from the first St. Olaf family income quartile. Scholars are being recruited from both incoming and matriculated students, and if progress is satisfactory, being supported through graduation. The project builds on three existing St. Olaf resources: (i) a nationally recognized and acclaimed mathematics program; (ii) TRIO Special Students Services (SSS) program; and (iii) the Center for Experiential Learning (CEL). Project features include student-oriented instruction, special support in the transition from basic to higher mathematics, attentive faculty mentoring, expanded use of Supplemental Instruction (SI), and career-related activities led by the CEL. A steering committee includes mathematics faculty and the directors of financial aid, admissions, the SSS program, and the CEL. The committee is guiding the program, recruiting and selecting ECMS Scholars, and overseeing program activities and mentorship. Whether students enter the workforce upon graduation or continue to graduate studies, mathematics opens doors to countless career options in an increasingly quantitative world.

Mathematics, Statistics and Computer Science

National Science Foundation
Collaborative Research: Assessing Secondary Teachers' Algebraic Habits of Mind
Grant # 1222340
Amount: $147,243
Project Dates: 8/15/12-7/31/16
Project Director: Ryota Matsuura

Boston University, Education Development Center, Inc. (EDC), and St. Olaf College will collaborate on Assessing Secondary Teachers' Algebraic Habits of Mind (ASTAHM), a Full Research and Development Assessment Strand project. The STEM discipline focus is mathematics—the project will develop a set of instruments to assess secondary (Grades 7–12) teachers' mathematical habits of mind (MHoM). The project defines MHoM to be the web of specialized ways of approaching mathematical problems and thinking about mathematical concepts that resemble the ways employed by mathematicians (e.g., discovering the structure that is not apparent at first by experimenting and seeking regularity and/or coherence). A growing base of evidence points to the importance of MHoM for students and for teachers of mathematics, particularly at the secondary level.

Mathematics, Statistics and Computer Science

Nygaard Foundation
Artwork for Regents Hall of Mathematical Sciences (RMS)
Amount: $5,000
Project Dates: 01/04/10-05/31/11
Project Directors: Kay Smith and Paul Zorn

Funds will be used to purchase mathematically-inspired art and sculpture and other art for student study areas and hallways in the facility for mathematics, statistics and computer science. Sculpture and painting inspired by foundational principles of mathematics unites the worlds of sciences.

Psychology

National Science Foundation
Good Computing: A Pedagogically Focused Theory of Professional Computer Ethics
Grant # 0822640
Amount: $95,056
Project Dates: 09/01/08-08/31/10
Project Director: Charles Huff (Principal Investigator)

This award by the NSF program in Science, Technology & Society supports research that examines ethics and values issues in computing. Work in computing ethics over the last 30 years has borne much fruit. Yet we still know very little about how computer professionals manage to be ethical in their everyday lives. This research investigates the skills and strategies computer professionals use to navigate normal and unusual stresses, conflicting demands, and multiple possibilities and difficulties of their careers. This inquiry follows the life stories of computer scientists who are known for their ethical commitment, and builds on previous work that documents the life stories of moral exemplars in computing in the United Kingdom and Scandinavia. Moral exemplars are people who are successfully integrating ethical concern into their practice of computing. This work will contribute to a multifaceted picture of how moral exemplars in computing structure their lives, make choices, and implement plans. Initial results suggest that there are at least two types of exemplars in computing: craftspersons who design software to help users (e.g., persons with disabilities) and reformers who attempt to change society (e.g., by changing laws and regulations on privacy). One outcome of the project will be a new direction in education that will promote ethical commitment as well as development of skills and knowledge for computer professionals.

Psychology

ABMRF/The Foundation for Alcohol Research
Ethanol-induced conditioned place aversion in adolescent and adult mice
Amount: $50,000
Project Dates: 08/01/09-08/31/12
Project Director: Shelly Dickinson

Despite widespread use of alcohol by human adolescents, much basic research on the behavioral and neurobiological effects of alcohol has been conducted on adult animals. However, since

multiple neural systems are changing during adolescence, it cannot be assumed that adolescents will respond to alcohol and other drugs in the same way as adults. lndeed, evidence is accumulating that age-related differences exist with respect to several of alcohol's effects. ln addition, it appears that early exposure to alcohol is a strong predictor of alcohol dependence later in life and it is possible that ongoing brain development during adolescence is impacted by alcohol exposure in ways that increase the likelihood of dependence in adulthood. The broad scientific objective of the proposed research is to investigate age-related differences in behavioral responses to alcohol using a mouse model. Previous research suggests that adolescent rodents are relatively insensitive to several effects of alcohol, including its acute aversive effects and the aversive effects associated with withdrawal states. Using a place conditioning model in adolescent and adult mice, the proposed experiments will examine the effects of prior exposure to alcohol on its aversive motivational effects. This will enable us to determine whether there are age-related differences in the development of tolerance to these effects.

Psychology

ACM-Associated Colleges of the Midwest
FaCE: Finding Our Way: Strategies for Internationalizing Undergraduate Psychology
Amount: $14,344
Project Dates: 2010-2011
Project Directors: Dana Gross, St. Olaf College and Ken Abrams, Carleton College

The proposed two-day workshop, to be held at St. Olaf and Carleton in early 2011, will bring together psychology faculty from across the ACM to network, share ideas, and develop strategies for internationalizing our curricula. Across the ACM, few international courses exist in psychology, despite strong interest among students and initiatives by the American Psychological Association. In addition to fostering communication and collaboration among ACM faculty, the proposed workshop seeks to identify international academic psychologists with whom ACM faculty can explore common teaching and research interests and to provide resources (an online database and listserv) to promote study abroad opportunities and internationalize on-campus psychology courses.

Physics

National Science Foundation
Collaborative Research: Integrative Study of Marine Ice Sheet Stability and Subglacial Life Habitats - Robotic Access to Grounding-zones for Exploration and Science (RAGES)
Grant # 0838854
Amount: $348,184
Project Dates: 09/01/09-08/31/14
Project Directors: Robert Jacobel (Principal Investigator)

This award is funded under the American Recovery and Reinvestment Act of 2009 (Public Law 111-5).
The RAGES project (Robotic Access to Grounding zones for Exploration and Science) is one of three research components of the WISSARD (Whillans Ice Stream Subglacial Access Research Drilling) integrative initiative that is being funded by the Antarctic Integrated System Science Program of NSF's Office of Polar Programs, Antarctic Division. The overarching scientific

objective of WISSARD is to assess the role of water beneath a West Antarctic ice stream in interlinked glaciological, geological, microbiological, geochemical, and oceanographic systems. The RAGES component of WISSARD concentrates on the stability of ice stream grounding zones (GZ), the area where the ice, ocean waters and glacial and sea floor sediment interact. Based on our present limited data and modeling efforts, GZs can be perturbed by (i) internal ice stream dynamics, (ii) filling/draining cycles of subglacial lakes, (iii) increased melting by warming ocean waters, and/or (iv) rates of subglacial sediment (till) supply to the GZ. GZs are seen as high priority targets to investigate due to their unknown contributions to ice sheet stability under future global warming scenarios. The three main science goals for RAGES are to assess: (a) West Antarctic Ice Sheet (WAIS) stability relative to the magnitudes of the four main variables listed above; (b) the degree to which grounding-zone sedimentary systems house important records of past WAIS dynamics; and (c) the importance of microbial activity and subglacial geochemical weathering in supplying nutrients to the WAIS grounding zone, the Ross Ice Shelf (RIS) cavity, and the highly productive Southern Ocean that may ultimately influence global biogeochemical cycles.

Physics

National Science Foundation
Collaborative Research: Integrative Study of Marine Ice Sheet Stability & Subglacial Life Habitats in W Antarctica - Lake & Ice Stream Subglacial Access Research Drilling (LISSARD)
Grant # 0838855
Amount: $331,684
Project Dates: 09/01/09-08/31/14
Project Director: Robert Jacobel (Principal Investigator)

This award is funded under the American Recovery and Reinvestment Act of 2009 (Public Law 111-5).
The LISSARD project (Lake and Ice Stream Subglacial Access Research Drilling) is one of three research components of the WISSARD integrative initiative (Whillans Ice Stream Subglacial Access Research Drilling) that is being funded by the Antarctic Integrated System Science Program of NSF's Office of Polar Programs, Antarctic Division. The overarching scientific objective of WISSARD is to assess the role of water beneath a West Antarctic ice stream in interlinked glaciological, geological, microbiological, geochemical, and oceanographic systems. The LISSARD component of WISSARD focuses on the role of active subglacial lakes in determining how fast the West Antarctic ice sheet loses mass to the global ocean and influences global sea level changes. The importance of Antarctic subglacial lakes has only been recently recognized, and the lakes have been identified as high priority targets for scientific investigations because of their unknown contributions to ice sheet stability under future global warming scenarios. LISSARD has several primary science goals: A) To provide an observational basis for improving treatments of subglacial hydrological and mechanical processes in models of ice sheet mass balance and stability; B) To reconstruct the past history of ice stream stability by analyzing archives of past basal water and ice flow variability contained in subglacial sediments, porewater, lake water, and basal accreted ice; C) To provide background understanding of subglacial lake environments to benefit RAGES and GBASE (the other two components of the WISSARD project); and D) To synthesize data and concepts developed as part of this project to determine whether subglacial lakes play an important role in (de)stabilizing Antarctic ice sheets.

We propose an unprecedented synthesis of approaches to studying ice sheet processes, including: (1) satellite remote sensing, (2) surface geophysics, (3) borehole observations and measurements and, (4) basal and subglacial sampling.

Physics

National Science Foundation
RUI/Collaborative Research: The Molecular Origins of Friction - A Study Across Velocity Regimes of Phosphonate Monolayers on Alternative MEMS-Type Surfaces
Grant # 0758330
Amount: $116,444
Project Dates: 05/01/09-04/30/11
Project Directors: Brian Borovsky, St. Olaf College and Erin Flater, Luther College

The purpose of this collaborative project is to combine the resources of three institutions to study the frictional properties of molecularly-thin films for a wide range of sliding speeds. These films, known as self-assembled monolayers (SAMs), will be composed of phosphonic acid molecules, long-chain carbon-based molecules that include phosphorous. These SAMs will be attached to oxidized metal surfaces and provide a model system for exploring how friction depends on molecular structure and the surface to which the molecules are attached. With intensive involvement of undergraduate students, Prof. Erin Flater at Luther College and Prof. Brian Borovsky at St. Olaf College will compare frictional measurements performed using two distinct micro/nanoscale friction measuring devices, an atomic force microscope and an integrated nanoindenter - quartz microbalance system, respectively. Prof. W. Robert Ashurst at Auburn University will prepare the samples in advance, to create identical frictional interfaces for study at Luther and St. Olaf.
Understanding the frictional properties of SAMs provides information about the nature of friction in general, and the results of this collaborative research program will help bridge the scientific and technical areas of friction research. As mechanical devices are made smaller in size, their functionality is limited by surface phenomena, such as friction and adhesion. In this way, low friction phosphonate SAMs may provide an alternative pathway for the development of microscale devices. This project exemplifies the dedication of St. Olaf College and Luther College to provide undergraduate students with access to mentored research opportunities and modern instrumentation. The techniques developed will be incorporated into existing advanced laboratory courses, maximizing the educational impact of the collaborators' research programs.

Physics

Department of Commerce, National Institute of Standards and Technology (NIST)
Atomic Transition Probabilities for Rare Earth Elements from Boltzmann Analysis of Fourier Tramsform Spectra
Grant # 70NANB11H092
Amount: $47,737
Project Dates: 06/01/1-08/31/12
Project Director: David Nitz

This proposal will support Professor David Nitz of St. Olaf College and a pair of undergraduate research assistants to continue work on a project whose long term goal is to significantly expand

the set of known atomic transition probabilities for rare earth elements. The outcome of this work is of great interest to scientists in the lighting industry who need comprehensive sets of transition probabilities for modeling rare earth doped metal halide discharges and to astrophysicists working to understand the details of heavy element abundances in stars. The project is also consistent with the goals of the Atomic Physics Laboratory at NIST since it has the potential to make a significant contribution to the spectroscopic database developed and maintained by NIST. A collaborator in these efforts is Dr. John Curry, leader of the NIST atomic spectroscopy group. The goals for this year's work are (1) to finish and publish the analysis of results obtained in our first year of support under this program, which will extend the set of known transition probabilities for Ce I by a factor of 3 to approximately 9,000; and (2) begin work on a new rare earth species (Pr I or a rare earth ion).

Physics

Xcel Energy Foundation Grants
St. Olaf Summer Engineering and Physics Camp for Girls
Amount: Xcel Energy $5,000
Project Dates: July 2012
Project Director: Jason Engbrecht

Offered for one week every summer, the camp will be designed to give 40 participating girls hands-on experience in engineering a large cooperative group project. As the girls participate in camp activities alongside other girls and are mentored by the camp directors and counselors, we hope to motivate them to pursue higher education in the promising and expanding fields of physics and engineering. A distinctive feature of the St. Olaf camp will be that it will target girls when they are old enough to seriously consider what they want to study in college and pursue as a career. The camp will center around the construction of Rube Goldberg Machines, defined as "comically-involved, complicated inventions, laboriously contrived to perform a simple operation" (Webster's New World Dictionary). The girls will learn not only from Jason Engbrecht, Ph.D. but also from female college physics students who will serve as camp counselors. Daily volunteer guest speakers with real-world experience in physics and engineering will address the girls every afternoon and add another dimension to what they will learn as they build. Many St. Olaf physics majors were part of the team that won the 2009 and 2012 National Rube Goldberg Contest, hosted by Purdue University.

Biology

National Science Foundation
REU Site: From Genes to Ecosystems: Environmental Science in a Changing World
Grant # 1004817
Amount: $286,298.00
Project Dates: 5/15/10-4/30/13
Project Directors: Steven Freedberg (Principal Investigator) and Stephanie Schmidt (Co-Principal Investigator)

The REU Site program will offer an array of research projects connected by the common theme of exploring the mechanistic basis of environmental change. In addition to laboratory and field experiences, students will participate in professional development activities that will prepare them for

careers in the life sciences. By examining pathways of nutrient cycling and gene flow in rare and protected ecosystems, this research can answer a range of vital questions that will significantly expand our knowledge of natural processes. Students will work directly with faculty and will select from research programs that utilize stable isotope and/or other innovative tools for environmental analysis to ask a broad, yet interrelated, set of questions. Students are expected to contribute meaningfully to hypothesis development, methodological design, data analysis and interpretation, and ultimately, dissemination of results. In addition to laboratory and field experiences, students will participate in professional development activities that will prepare them for careers in the life sciences. Because the program is focused on enhancing our understanding of natural processes in rare and protected ecosystems, society will benefit greatly from information that will inform environmental policy. By sharing their experiences and results with Tribal Colleges, the students involved in this program will further effect the appreciation of their work in environments that historically have had limited exposure to research in this field. Students from groups underrepresented in environmental science and students from Tribal Colleges are especially encouraged to apply.

Biology

National Science Foundation
IOS: Collaborative Research: The neurobiology of dopamine in the leech and the modulation of locomotor behaviors
Grant # 0924119
Amount: $ 45,376
Project Dates: 8/01/09-7/31/13
Project Director: Kevin Crisp (Principal Investigator)

This award is funded under the American Recovery and Reinvestment Act of 2009 (Public Law 111-5).
Dopamine (DA) is an important and universal modulator of motor control, but neuroscientists have yet to determine precisely how DA-containing neurons and their targeted circuitry choreograph specific locomotor programs. This has been an especially daunting task in studying the control and initiation of locomotion in higher vertebrate systems. Related to this issue of locomotor regulation is the idea of decision-making, and how one form of locomotion is selected instead of another, for example, the choice between crawling vs. swimming. This collaborative research project is addressing such important questions at the level of single identified neurons; often at times while the intact animal is behaving. The simpler nervous system of the leech, Hirudo medicinalis, was selected for study because it contains relatively large and physiologically accessible neurons and a hierarchical circuit organization, thus facilitating studies of locomotion, body movement and descending control. Specifically, the collaborative research team is characterizing constituents of the pattern-generating network underlying crawling-related behavior, and determining how DA changes the properties of neurons to facilitate their participation in crawling. This approach will lead naturally to an understanding of the neuronal bases of decision-making, because it has been found that whenever DA triggers crawling then swimming is inhibited.

Biology

National Science Foundation
S-STEM: Biologists for the Future (BFF)
Grant # 0727556
Amount: $599,545
Project Dates: 9/15/07-8/31/13
Project Directors: Anne Walter (Principal Investigator), Diane Angell (Co-Principal Investigator) and Kathy Glampe (Co-Principal Investigator)

This project is supporting 19-20 students through a biology major as excellent preparation for meaningful scientific careers. To qualify for BFF scholarships, students must demonstrate significant financial need and show promise for success in biology. Preference is given to students from underrepresented groups. The goals are to increase the number and improve the academic outcomes of this cohort of students. The project is building on the college's interdisciplinary and research-focused biology program and its existing federally funded TRiO/Student Support Services (SSS) program. It is also building on an existing pre-matriculation biology course and Supplemental Instruction (SI) offered to all SSS students taking introductory biology. The college's Center for Experiential Learning is helping to provide career exploration and support. The Offices of Admissions and Financial Aid are helping recruit qualified students. A new initiative is an optional summer reading and writing skills course using biological literature. Other activities include optional career-oriented field trips, additional peer SI leaders and tutors, seminars and workshops, social gatherings with visiting speakers, and involvement in summer research and internships. The primary impact of this program is on the students themselves. The freedom to study deeply and broadly, permitted by these scholarships, helps prepare them well as biologists and gives them time to take steps to realize future careers in biology.

Biology

National Science Foundation
Collaborative Research: The Polaris Project II: Amplyifying the Impact
Grant # ARC-1044180
Amount: $183,124
Project Dates: 8/1/11-7/31/15
Project Directors: John Schade (Principal Investigator) and Jo Beld (Co-Principal Investigator)

The Polaris Project II seeks to amplify the impact of Polaris I (now in its third and final year) through its extension, expansion, and enhancement. The three overarching objectives of Polaris II are to 1) train the next generation of arctic researchers, 2) advance scientific understanding of the Arctic, and 3) expand public awareness of the feedbacks between the Arctic and the global climate system. These objectives will be accomplished through a multi-faceted effort that includes a summer field course/research experience in the Siberian Arctic, a series of on-campus arctic-focused courses, and a wide range of outreach activities. While undergraduate students remain the primary focus of Polaris II, participation in the annual field course will be expanded

to include a K-12 teacher, graduate student, postdoctoral researcher, and visiting faculty member each year. Outreach activities will target K-12 students and teachers, undergraduate students and faculty, and a diverse public audience.

Biology

National Science Foundation
Coupling Consumer-Resource Interactions and Nutrient Spiraling in a Stream Network
Grant # 0543363
Amount: $651,991
Project Dates: 4/1/06-3/31/12
Project Directors: John Schade (Principal Investigator), Mary Power (Co-Principal Investigator), Jacques Finlay (Co-Principal Investigator),Steven Thomas (Co-Principal Investigator) and Jill Welter (Co-Principal Investigator)

The main objective of this study is to understand how stream network position influences feedbacks between nutrient cycles, stream metabolism, and consumer-resource interactions. The overall question is where and when are biotic interactions and biological chemical makeup important determinants of nutrient flux in river networks, and what are the consequences for downstream ecological communities? Recent theory addressing consumer-driven nutrient recycling suggests that shifts in elemental content of stream consumers, such as insects, are driven in part by resource availability and in part by the emergence of specific life history traits in response to changing environmental conditions along gradients of physical variables. The effects of resulting shifts in chemical imbalances between consumers and resources on nutrient fluxes is an exciting frontier in the study of streams. The investigators will examine feedbacks between stream metabolism, consumer-resource interactions and biogeochemical cycling at several network positions and during algal succession. They will use these measurements to estimate whole-system effects of changes in algal and dead organic matter and consumer-resource interactions on fluxes of multiple nutrients by exploring their specific effects on nutrient uptake and regeneration. This project and its science partnerships will provide liberal arts students with new and unique opportunities to explore ecosystem science and access to philosophies and lab facilities of large research groups.

Biology

National Science Foundation
Collaborative Research: RUI: Landscape-level Controls on Terrestrial, Aquatic, and Wetland Responses to Climate Change in the Southern Canadian Arctic
Grant # 0743236
Amount: $122,380
Project Dates: 7/1/08-6/30/12
Project Director: Charles Umbanhowar Jr. (Principal Investigator)

An extensive series of sediment cores from many connected lakes, wetlands, and upland tundra and forests in northern Manitoba, Canada will be collected and examined for several indicators of ecosystem composition and function over the past 8000 years. Although ecological responses to Arctic warming have been shown in previous research, such as increases in lake productivity, permafrost thaw, shrub expansion, and northward shifts in the subarctic tree line, most of this

work involves the study of a single ecosystem type, such as terrestrial forests, wetlands, or lakes. An objective of the new research is to examine how interactions among these ecosystems in the past have affected their responses to past climate change. Changes in one ecosystem may affect the response of others to climate change, such as when soil runoff from forests and wetlands alters the chemistry and productivity of the lakes into which they drain.
This project will be significant for determining how Arctic ecosystems may change in the future as a result of rapid warming. A better understanding of the linkages among these ecosystems will be essential for understanding ecological impacts on productivity, nutrient cycles, or biodiversity in the Arctic and will help inform the scientific community and the public about climate change, the direct impacts of this climate change on the people of the Arctic and extended global impacts on the carbon cycle and climate warming.

Biology

National Institutes of Health
AREA: Developmental Genetics of Tetrahymena thermophila.
Grant # 1R15HD064147-01
Amount: $175,443
Project Dates: 5/1/10-4/30/13
Project Director: Eric Cole (Principal Investigator)

This work aims to explore the developmental assembly and molecular mechanisms associated with two dynamic organelles within a unicellular model organism: *Tetrahymena thermophila*. The nuclear exchange junction represents a molecular theater for studying membrane trafficking and cytoskeletal dynamics as they pertain to developmentally programmed remodeling of the cell cortex. Membrane trafficking pathways have been implicated in numerous neuro-degenerative diseases (among others), and are critical to the proper functioning of the immune system during inflammation. The “conjusome” is a non-membrane bound electron-dense organelle resembling germ-plasm or nuage from metazoan embryos. As such, it represents a potentially tractable system for exploring mechanisms of small RNA-mediated remodeling of an organism’s genome in service of genome defense. The use of small RNA molecules (the RNAi phenomenon) has become a leading area for therapeutic research.

Long term objectives include:
1) Understanding the dynamics of cytoskeletal and membrane trafficking that remodel the cell cortex during nuclear exchange and mating in *Tetrahymena*. 2) Understanding the role of the *Tetrahymena* “conjusome”, a germ-plasm-like organelle assembled during a period of genome-reorganization in this ciliate model, and its potential evolutionary relationship to such structures in higher eukaryote embryos, and 3) providing interdisciplinary training for undergraduates conducting research into the developmental genetics of *Tetrahymena thermophila*.

Biology

State of MN, DNR: State Wildlife Grant Program
Life histories of the longear sunfish (Lepomis megalotis) and pugnose shiner (Notropis anogenus) in Minnesota, with examinations of other rare non-game fishes
Amount: $50,000
Project Dates: 5/10/10-5/30/12

Project Directors: Patrick Ceas and Jean Porterfield

We will conduct life history studies on two of Minnesota's SGCN fishes, the longear sunfish (*Lepomis megalotis peltastes*) and the pugnose shiner (*Notropis anogenus*). Additionally, as time and logistics permit, we will supplement life history data for the least darter (*Etheostoma microperca)*, a SGCN which has had two life history studies published for stream-dwelling populations but no studies on lake-dwelling populations, and we will gather data on three additional species that require high-quality habitat: blackchin shiner (*Notropis heterodon*), blacknose shiner (*N. heterolepis*), and banded killifish (*Fundulus diaphanus*). All six of these species co-occur in certain lakes in MN, and subsets can be found in other lakes, so this allows for numerous comparisons. Through field and aquaria observations, and laboratory examination of freshly preserved specimens, our goal is to produce life history studies that will provide valuable data and directly benefit the shoreland conservation/restoration efforts of many federal, state, and NGO programs. All of the proposed work will be done in collaboration with undergraduate students at St. Olaf College.

Biology

State of MN, DNR: State Wildlife Grant Program
Status and Conservation Needs of Smooth Softshell Turtles (Apalone mutica) in the Minnesota and Mississippi Rivers in Minnesota
Amount: $50,000
Project Dates: 4/15/10-12/31/12
Project Director: Steven Freedberg

We will study the population status and biology of the smooth softshell turtle, *Apalone mutica*, in the Minnesota and Mississippi Rivers in Minnesota. By estimating abundance throughout the species' range, we hope to identify factors correlated with population status and to suggest the ecological factors, such as water quality, that may contribute to the sustainability of the species in Minnesota. Along these lines, we hope to identify key aspects of their within-population movement and population genetic structure that will inform future conservation policies.
Three trapping sites will be monitored simultaneously with 24 traps being monitored at any given time. Traps will remain in place throughout June and July and will be checked a minimum of twice weekly, as well as immediately following rises in water levels. Traps will be re-set and monitored periodically throughout the late summer and fall. Captured turtles will be weighed, sexed, measured, marked, and immediately released. Trapping sites will be modified when data from radio-tracking becomes available, in order to identify population centers.