Jessica Aldinger and Leah Dvorak. ANALYZING CHARCOAL AND BIOGENIC SILICA CONTENT DURING BIG WOODS TRANSITION PERIODS.

The Big Woods region was a large expanse of land that encompassed much of south-central Minnesota. Over the past 12,000 years it has transformed from woodland to prairie and back. These transformations are believed to be caused by the interactions among vegetation, fire, and climate (Grimm 1984). In this paleoecological study vegetation and climate transition periods of the Big Woods region were examined using sediment analysis. Biogenic silica (BSi) and charcoal analysis were performed on lake sediment from Sharkey Lake and Kimble Pond (two lakes in the Big Woods region). These analyses produced similar trends in the transition periods of both lakes indicating regional changes in climate, fire frequency, and vegetation. BSi and charcoal changed at the same time in the same direction within both lakes. Also, in both lakes it is possible that a change in fire preceded a change in lake productivity. These findings allow us to reconstruct the history of the Big Woods region and to make inferences regarding future environmental changes.

Traci Bartz and Tim De Chant. SIZE AND STRUCTURE STUDIES OF TREES: RESTORED MAPLE-BASSWOOD AND RELIC BALSAM FIR POPULATIONS.

Restoration is the returning of the landscape to its pre-disturbance state. In the case of the St. Olaf Natural lands, this means restoring former farmland to the maple-basswood forest type. This project presented us with a unique opportunity to study the growth patterns of young trees and determine the success of the restoration. Two replanted fields were sampled. On each, tagged trees were measured (height and diameter) and located via GPS. Thus far, the data has yielded some basic patterns as to the progress of the restoration. White ash and black walnut dominate the forest numerically. Additionally, white ash has the highest overall mean height while black walnut is in the lower third. The present structure of the forest is by no means permanent. We expect future studies to track successional changes as the forest matures.

Michael Bongard, Kathryn Huber, Lee Langer, and Heather Tollerud. PUSHING THE LIMITS: HIGH RESOLUTION MOLECULAR BEAM SPECTROSCOPY.

St. Olaf’s molecular beam electric resonance spectrometer, known as the Molbeam, has been pushing high resolution spectroscopy to the limits. The St. Olaf physics department uses the spectrometer to study the hyperfine interactions of molecules, which are interactions between the nuclei of the atoms in the molecule. This summer, research was conducted on the RbF and RbCl molecules to determine the nuclear quadrupole ratio of the Rubidium isotopes. The precision with which we measured this molecular interaction and the small uncertainty given made it necessary to acknowledge the contribution of an interaction called the pseudo-quadrupole moment. In addition to the actual physics research, improvements were made to the MolBeam’s data acquisition program, including updating it from DOS to Windows, adding new user features and documenting the code for the program. These upgrades, along with the intricate nature of our research, will continue to push the limits of molecular spectroscopy.
Matthew Christianson and Gary Miessler. SYNTHESIS OF MOLECULAR MODELS: COMPLEXES OF MOLYBDENUM WITH AMINO ACIDS AND DITHIOLENE LIGANDS
There are many biologically important enzymes that contain molybdenum (Mo) in their active sites. These compounds also commonly have dithiolene ligands and the amino acid cysteine acting as a ligand. In order to more fully understand the chemistry at these active sites, it is desirable to synthesize model compounds that mimic these interactions. A reaction of Mo(CO)$_6$ and cysteine ethyl ester yields a compound that appears to have the amino acid ester bonded to Mo. A reaction of this compound with the ligand tfd [$S_2C_2(CF_3)_2$] yields many compounds. Included is a green compound that contains the tfd ligand.

Nik Duy, Brian Odlaug, and Howard Thorsheim. SUBVOCALIZATION & WORKING MEMORY.
For this independent research we were studying working memory (also known as short term memory) and how the phenomenon of subvocalization ties in with that. Specifically, are subjects subvocally rehearsing items to remember before they are asked to recall them? And if so, how does this affect their recall? We also attempted to answer the long debated question of whether forgetting is due to trace decay or interference by having subjects do various activities while trying to remember items.

Molly Fee, Jess Theorin, and Jean Porterfield. POPULATION GENETICS OF THE BANDED DARTER (ETHEOSTOMA ZONALE) IN MINNESOTA
*Etheostoma zonale*, the banded darter, is a small, freshwater, non-game fish whose northwestern boundary consists of several isolated populations in southern Minnesota. The mitochondrial DNA of the banded darter contains the cytochrome b (cyt b) gene, a gene used widely in fish genetic studies. Mitochondrial genomes have been shown to evolve faster than nuclear genomes, thus mitochondrial genes are often useful in population genetic studies. This study assessed nucleotide differences in the cyt b gene of 30 banded darters from seven localities in Minnesota and compared them to the sequence of a banded darter from central Illinois. A high degree of similarity was found among individuals of all populations, with pairwise sequence divergences reaching only 0.6%.

Cory Fix and Dr. Patrick Riley. LIGAND SYNTHESIS AND THE PREPARATION OF TRANSITION METAL COMPLEXES.
The development of new ligands to support inorganic and organometallic chemistry has been a cornerstone of research in chemistry for many years. In this context, we have decided to examine the synthesis and reactivity of complexes containing hydroxyindole ligation. The ligand 2-hydroxymethylindoline has been prepared and purified, and will soon be reacted with early transition metals titanium, tantalum, and zirconium. The resulting complex may be useful as an olefin polymerization catalyst or a homogeneous model for hydrodenitrogenation catalysis.
Esther Lee and Kim Kandl. HIGH COPY SUPPRESSOR SCREENING OF AN ACTIN MUTATION IN SACCHAROMYCES CERVISIAE.
Numerous studies have suggested a role for actin in protein synthesis (translation), but the molecular details of this role are unknown. Previous work in our lab has identified actin mutations that show defects in translation (Kandl et al., 2002). The most interesting of these actin mutations is the cold-sensitive actin mutation, act1-122. This mutation shows a 6-fold increase in read through of a stop codon during translation and hypersensitivity to paromomycin, an inhibitor of translation. In an effort to identify proteins that interact with this mutant actin in translation, we decided to screen for high copy suppressors of the cold sensitive and paromomycin hypersensitive phenotypes of the act1-122 mutation. To do this, we transformed yeast with the act1-122 mutation with a high copy genomic library. Then we screened for suppressors of cold and paromomycin sensitivity. The plasmid of the potential suppressors was extracted, purified, and characterized by restriction endonuclease digestion and PCR. Purified plasmids were transformed back into yeast and retested to confirm the suppressor phenotype. Plasmids that were reconfirmed for suppression will be sequenced and the gene responsible for suppression will be identified. Future work will focus on studying the interaction between the suppressor protein(s) and actin.

Erin May. WHAT IS THE PKA OF 16-MERCAPTOHEXADECANOIC ACID WHEN TETHERED TO GOLD?
The behavior of molecules in complex systems, such as a cell membrane, can be modeled by simplified systems of aggregates of molecules. Molecules terminated with a thiol, such as 16-mercaptophexadecanoic acid, will spontaneously form a monolayer on Au surfaces when vapor deposited Au slides are immersed in dilute ethanolic solutions of thiol. By combining the equilibrium expressions for the acidic monolayer, an acid/base indicator dye Oregon Green 514, and water, a simultaneous equilibrium expression can be written and solved for the pK$_a$ of the monolayer. This requires the determination of three unknowns: the surface coverage of the monolayer, the pK$_{ln}$ of the indicator dye, and the pH of the solution. The surface coverage was determined electrochemically using a potential-current curve generated by reductive desorption, yielding a value of $3.7 (±0.6) \times 10^{-9}$ mol/cm$^2$. The pK$_{ln}$ of Oregon Green 514 was found to be 4.58 by plotting the absorbance ratio of the maximum (deprotonated) and minimum (protonated) difference wavelengths versus pH for a series of citric acid buffers containing Oregon Green 514. The pH of the system can likewise be determined by comparing the absorbance ratio of an unbuffered solution of Oregon Green with the standard curve. The simultaneous equilibrium expression can be solved using the surface coverage, pK$_{ln}$, and the pH, resulting in the determination of the pK$_a$ of 16-mercaptophexadecanoic acid.

Joshua Mayer and Kim Kandl. CAN A BACTERIAL ELONGATION FACTOR FUNCTIONALLY REPLACE A YEAST ELONGATION FACTOR?
Eukaryotic Elongation Factor 1A (eEF1A) functions during protein synthesis by guiding charged aminoacyl-tRNAs to the elongating polypeptide at the ribosome. In the budding yeast, Saccharomyces cerevisiae, eEF1A is encoded by two genes, $TEF$1 and $TEF$2, and
it has been shown to bind and bundle actin in vitro (Munshi et al., 2001). Although the actin-eEF1A interaction has been studied in vitro, it is not known whether this interaction is essential in vivo. Bacteria have a homolog to eEF1A called EF1A, but they do not possess an actin cytoskeleton. Therefore, we decided to determine whether the bacterial elongation factor could functionally replace the yeast elongation factor in yeast. To do this, we have cloned TUFA, one of the two genes that codes for EF1A in E. coli, into a plasmid vector. Yeast with a TEF1/TEF2 deletion will be transformed with the TUFA-containing plasmid, and viability will be assessed. The ability of EF1A to bind and bundle actin will also be studied and assayed via cosedimentation.

Paul Menzel. SEXUAL SELECTION IN THE CABBAGE BUTTERFLY: A STUDY IN FLUCTUATING ASYMMETRY.
Relationships between mating success and fluctuating asymmetry (FA), the random deviation from perfect bilateral symmetry, for wing length and eyespot size in the cabbage butterfly Pieris rapae were investigated. Previous studies have suggested that organisms with low fluctuating asymmetry enjoy enhanced mating success. The aim of this investigation was to determine whether fluctuating asymmetry is related to mating success and sexual selection in Pieris rapae. Analyses indicate that there was a significant negative correlation between eyespot size FA and male mating success and a non-significant negative correlation between wing length FA and male mating success. Thus, FA of both eyespot size and wing length are important in the sexual selection of this organism.

Craig Nelson. SMALL MAMMAL POPULATIONS IN BURNED VS. UNBURNED PRAIRIE ECOSYSTEMS.
Small mammal populations in burned vs. unburned prairie ecosystems were investigated on the St. Olaf Natural Lands. Trapping with transect lines of Sherman live traps was conducted between 30 May and 24 July. The most abundant small mammals captured were the meadow vole (Microtus pennsylvanicus) and deer mouse (Peromyscus maniculatus). Two transect lines were set in an area of prairie burned in the spring of 2002, and two identical transects were set in an adjacent section of unburned prairie. A significant difference was found between the species captured in the burned and unburned areas. The meadow vole was found almost exclusively in the unburned prairie, while the deer mouse was captured predominately in the burned site. There was also a significant difference in the average weight of individuals caught from the unburned prairie transects, with lighter individuals occurring at the edge of the habitat. Results show that a separation occurs between vole and mice populations in burned and unburned prairie ecosystems, and that this separation is not a result of behavioral exclusion.

Erin M. Peterson, Douglas R. Stone and Robert W. Jacobel, Center for Geophysical Studies of Ice and Climate, Department of Physics. RADAR STUDIES OF ENGLACIAL WATER IN STORGLACIAREN, SWEDEN
This summer we completed a second season of ground-based ice-penetrating radar studies on Storglaciaren, a polythermal glacier in arctic Sweden. The purpose of this research is to investigate the morphology and hydraulics of englacial channels - a problem of central importance to understanding glacier movement, and thus to climate
change in this part of the Arctic. Previous work has for the most part been limited to theoretical studies with few observations. We used a multi-frequency ground penetrating radar in conjunction with borehole video operated by colleagues from Portland State University to image englacial water passages. The radar surveys together with the borehole experiments suggest a new model for englacial drainage, wherein crevasse-like features are the main conveyors of water and form a fracture-like network consisting of numerous pathways rather than the traditional view of a few melt-enlarged conduits in ice.

**Justin L. Seningen and Kyle G. Halvorson.** ANALYSES OF ORGANIC POLLUTANTS IN THE CANNON RIVER

A common fate of therapeutic compounds is to pass unscreened through wastewater treatment facilities, or as agricultural runoff, into natural waters. The United States Geological Survey (USGS) recently conducted a nationwide study in an attempt to analyze the presence of therapeutics in natural waters. Such a study has not been performed at the local level. The goal of our project was to apply the USGS analytical method to the Cannon River. River water samples were collected and filtered prior to extraction using Waters-Oasis cartridges. Eluents were analyzed using High Performance Liquid Chromatography (HPLC) incorporating a water/methanol gradient and a C18 Hypersil-BDS column. Standards were obtained of common antibiotics and used as a basis for comparison. Limit of detection was found to be 10 mg/L after extraction. No antibiotic compounds were identified in river samples. Results suggest that tetracyclines are not concentrated by the USGS extraction method. In conclusion, this method is not applicable to our laboratory.

**Gregg Sydow, Stephanie Skladzien, Mike Purnell, and Bob Hanson.** DESIGN AND IMPLEMENTATION OF A 24/7 DYNAMIC NUCLEAR MAGNETIC RESONANCE SPECTROMETER

In the Spring of 2002, the St. Olaf College Chemistry Department purchased a Nuclear Magnetic Resonance Spectrometer from Bruker Corp. to replace the existing Varian spectrometer. In order to increase instrument access and availability to both students and faculty at St. Olaf College a web-based interface was designed to allow users to access the spectrometer from any computer on campus 24 hours a day, 7 days a week. The software program, entitled “OleNMR,” was written with two computing languages, HTML and JavaScript. Multiple servers were employed to supply the user with HTML and other documents. A form is sent from the client to the server each time a change is made to OleNMR, and the server sends back JavaScript to the browser window indicating if such a change is allowed and, if so the change is implemented. Users will log into OleNMR using their St. Olaf username and passwords and will belong to one or more teams depending on their level of activity in the Chemistry Department. OleNMR allows users to run experiments, view the status of all experiments, switch teams, and search for and view all of the spectra they’ve obtained. Upon arrival of the Bruker spectrometer in the fall of 2002, OleNMR will be implemented and possibly altered to work with the new instrument and based on users’ reactions to the software.
**Paul Tlucek.** DEVELOPMENT OF A DUAL ENZYMATIC REPORTER ASSAY FOR TRANSLATION TERMINATION FIDELITY.

Reporter genes are nucleic acid sequences encoding easily assayed proteins. We wish to use reporter genes to explore the role of various proteins on the fidelity of translation termination. To do this, we are creating a dual enzymatic reporter gene containing the genes for β-galactosidase and luciferase. We were able to test for levels of β-galactosidase using a spectrophotometer measuring absorbance at 420 nm. We also developed a method for utilizing the Lumi Imager to quantify the intensity of light emitted from a luciferase-catalyzed reaction. This method correlates light intensity with luciferase activity. Although we determined the details for these assays, in order to utilize them *in vivo*, we needed the dual enzymatic reporter genes cloned into a suitable vector. After attempting many cloning strategies, we failed to clone the reporter construct into an appropriate vector. However, once this has been accomplished, it can be used to explore the effect of various proteins, such as Upf1 and Actin, on the fidelity of translation termination.

**Katherine Van Heuvelen and Dr. Gary Miessler.** MIXED MARRIAGES OF THE MOLECULAR WORLD: SYNTHESIS OF CHROMIUM-MOLYBDENUM HETEROBIMETALLIC COMPLEXES

The compound \([\text{Cp Mo S}_2\text{C}_2\text{(CF}_3\text{)}_2]\) was synthesized and characterized in 1986. Molybdenum shares many chemical properties the Group VI metals chromium and tungsten. This project explores the synthesis and characterization of a similar compound containing both chromium and molybdenum, as well as two bridging \(\text{S}_2\text{C}_2\text{(CF}_3\text{)}_2\) ligands. Cyclopentadienyl \((\text{Cp, C}_5\text{H}_5\text{)}\) and pentamethylcyclopentadienyl \((\text{Cp*, C}_5\text{(CH}_3\text{)}_5\text{)}\) were used as chemical tags; Cp was attached to Mo and Cp* to Cr. Cp and Cp* show distinctly different chemical shifts on a proton NMR spectrum. Fourteen compounds were produced in the course of the synthesis. Based on \(1H\) NMR and Mass Spectral evidence, it appears that one compound contains both Cr and Mo, as well as tfd, Cp, and Cp*. Further work to characterize the remaining products has yet to be completed.

**AmberBeth VanNingen and Angela Weiss.** NEST BOX COMPETITION ALONG THE ST. OLAF BLUEBIRD TRAIL.

In 1992 St. Olaf College set up a nestbox trail for the nesting of the Eastern Bluebird \((\text{Sialia sialis)}\). The trail is constantly being modified to better suit the bluebird’s preferences and to discourage competition from other cavity-nesting bird species such as tree swallows \((\text{Tachycineta bicolor)}\), house wrens \((\text{Troglydotes aedon)}\), and house sparrows \((\text{Passer domesticus)}\). In order to better modify the trail, we monitored the trail to record active nesting, and analyzed data from past years to determine the bluebird’s box type and habitat preferences as well as the preferences of competing species. We found that the bluebird prefers the Peterson box to the tree branch or slot box and that it likes areas of mowed grass or savanna. From this information we have come up with a proposed modified trail.