The Summer Research Symposium is an annual event where students present posters of their summer research projects for faculty, staff, and other students. It is a great opportunity to write an abstract, produce a poster and then explain the project to prepare for a professional conference.

Most of the students are Summer Research Assistants who receive stipends to work with a faculty mentor during the summer. Faculty benefit by having quality research assistance that can bridge the academic year and span multiple summers. Students benefit from the in-depth learning that is possible over the focused summer weeks. Research has been shown to be one of the high impact educational practices that students benefit from most in higher education.

Summer assistants are supported by multiple funding sources such as faculty and institutional grants and Middlebury College endowments. Funding sources are noted on the left column of the abstracts.

Statistics at the time of the symposium show over 100 students were Summer Research Assistants in 2010 in the following general departments or programs:

- American Studies (2)
- Biology (15)
- Chemistry (21)
- Computer Science (8)
- Economics (7)
- Education Studies (2)
- English & American Literatures (1)
- Environmental Studies (2)
- Geography (6)
- Geology (2)
- Physics (4)
- Political Science (3)
- Psychology (16)
- Sociology and Anthropology (2)
- Theatre (6)

Students worked an average of 30 hours a week during 10 weeks contributing over 30,750 hours of research time to the college in the summer of 2010!

Thank you to all the faculty, staff, and students for all your hard work and enthusiasm.

Undergraduate Research Office
Middlebury College

Jim Ralph, Dean of Faculty
Bob Cluss, Dean of Curriculum
Kathy Skubikowski, Director of the Center for Teaching, Learning, and Research
Colleen Converse, Administrative Assistant

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Social Perspective-taking: Ability, Propensity and Accuracy

Michelle Alto, Ellen Dahlberg and Suzanne Gurland
Department of Psychology, Middlebury College, Middlebury VT 05753

Whenever we consider the world from another’s point of view, we engage in social perspective-taking (SPT). Empirical research, however, requires a finer definition of this social phenomenon and is often not sufficiently precise. Does SPT measure ability (i.e., can you perspective-take?), propensity (i.e., how often do you perspective-take?), or accuracy (i.e., how well do you perspective-take?)? Further, research shows that SPT is important for supporting autonomy (the feeling of freedom to make a decision), which enhances teaching effectiveness. Using both self-report and behavioral means, we measured and analyzed the interrelationships among traits and levels of autonomy-supportiveness. Preliminary results reveal that participants are not always good at self-reporting about perspective-taking; their answers may actually reflect a different trait than expected. Additionally, autonomy-supportiveness results vary with each SPT trait. Clarification between traits will lead to more accurate future conclusions regarding SPT, and the links with autonomy-support will have important implications for teachers.

Role of Orexin Signaling in a Rat Model of Working Memory and Cognitive Flexibility

Jessica Appelson and Mark Stefani
Department of Psychology, Middlebury College, Middlebury VT 05753

Orexin is a neuropeptide synthesized by neurons in the lateral hypothalamus and plays a major role in the regulation of feeding behaviors, metabolism, arousal and sleep-wake cycles. Orexin works through two pathways to affect multiple brain regions, including other hypothalamic nuclei, brainstem areas, and the cerebral cortex. These other brain regions, in addition to the prefrontal cortex, are important for executive function. This study examines orexin’s role in executive function in male Sprague-Dawley rats using the spontaneous alternation task and the set-shift task. The spontaneous alternation task measures the animal’s working memory. Working memory holds information in an easily accessible state so that it can be used in an ongoing behavior. In this task the rat was placed in a 4-arm radial maze and we measured its ability to enter all four arms during each set of five entries. The orexin-A antagonist SB-33486 (0.01 mg/mL, 0.1 mg/mL, 0.01 mg/mL) was injected systemically (i.p.) 20 minutes prior to testing. The set-shift task measures the ability of an animal to change behaviors in response to a new set of environmental circumstances. The task is performed in a maze with four arms of different colors (dark or light) and texture (smooth or rough). During set 1 the rat is taught a rule about one dimension of the maze. 20 minutes prior to set 2, the rat is injected systemically (i.p.) with the orexin-A antagonist and taught a rule about the other dimension of the maze. If orexin does indeed improve cognitive functions mediated by the prefrontal cortex, injection of the orexin-A antagonist should impair the animals’ performance in these tasks relative to the control.
Towards More Realistic Stereo Vision Test Datasets

Gareth Aye, David Bell, Kelvin Gorekore and Daniel Scharstein
Department of Computer Science, Middlebury College, Middlebury VT 05753

Stereo vision algorithms compute 3D scene structure from two or more input images. Middlebury hosts several internationally-known benchmarks for stereo vision methods, consisting of input images and ground-truth (known) depth maps. Existing test datasets, however, do not exhibit important real-world challenges such as scenes with glossy surfaces with variable appearance, or images taken under varying lighting conditions with different camera models (like those retrieved from the Internet). The goal of this project is to generate new test datasets containing such challenges. Our work extends and improves a structured-light system for generating ground-truth stereo data that was developed by student researchers in previous years. For decoding the structured light pattern, we employ multiple digital SLR cameras that can image a scene simultaneously. In order to provide a varied set of test images, we add support for point-and-shoot cameras. We use an Arduino microcontroller to control mechanisms that push the shutter button of such cameras. The long-term goal of this work is to stimulate research into the next generation of 3D reconstruction techniques that can handle real-world challenges.

Transferrin Mediated Activation of Ru(III) Anticancer Complexes

Justin Bogart, Matthew Wolf and Sunhee Choi
Department of Chemistry & Biochemistry, Middlebury College, Middlebury VT 05753

According to the literature, ruthenium anticancer drugs are delivered into the cell via a transferrin (Tf) transport mechanism. The consensus is that the metal complexes bind to Tf and get released from transferrin in their +3 oxidation states. We hypothesize, however, that the metal complexes bind to Tf primarily in their kinetically labile +2 oxidation state, being reduced by ascorbic acid within the bloodstream prior to binding. We also hypothesize that rate of release of Ru from Ru(III)-Tf is increased by the reduction of Ru(III)-Tf to Ru(II)-Tf by glutathione within the cell. Although there are surface histidine sites on Tf available for surface binding of Ru, our current study focused on the kinetic effects of ascorbic acid and glutathione on the binding and release of HIm[RuIm2Cl4] (KP418) to the active site of apotransferrin (ApoTf). For the effect of ascorbic acid, UV/Vis spectroscopy results indicated a 31% increase in A245 nm when KP418 (3.0 x 10^{-5} M) and ApoTf (1.5 x 10^{-5} M) were reacted for 3 hrs in the presence of ascorbic acid (3.0 x 10^{-4} M) compared to 3 hrs of reaction without ascorbic acid present. Similarly, atomic absorption (AA) spectrometry analysis indicated a ratio of [bound Ru]/[ApoTf] of 0.82 ± 0.07 for the sample reacted with ascorbic acid present but only a ratio of 0.53 ± 0.05 for the sample reacted without ascorbic acid present. This corresponds to a 55% increase in Ru binding. Finally, kinetics analysis by circular dichroism (CD) spectroscopy on the binding reaction shows that ascorbic acid increases the rate of KP418-actApoTf formation, though quantitative values for the rate constants could not be obtained. Similarly, kinetics analysis by CD spectroscopy on the release reaction suggests that, at pH 7.4, glutathione reduces bound KP418. UV/Vis spectroscopy, AA spectrometry, and CD spectroscopy results, however indicate that KP418 remains bound at pH 7.4. Preliminary results have been obtained for the characterization of the surface bound adducts of KP418. The UV/Vis spectra of KP418 and KP418-actApoTf, KP418-sTf, and KP418-s-Ga-actApoTf all showed a new peak at 615 nm that was not present for only active site KP418 or hydrolyzed KP418. AA results indicated KP418 to protein ratios of 4:1, 3:1, and 2:4:1 for KP418-s-KP418-actApoTf, KP418 sTf, and KP418-s-Ga-actApoTf, respectively. This is consistent with 2 to 3 KP418 bound to the surface sites. Further tests are being conducted to confirm these results.
Stalin and the Sovietization of Czechoslovakia

Oksana Cherezova and Michael Kraus
Department of Political Science, Middlebury College, Middlebury VT 05753

Scholars have long debated whether the sovietization of Eastern Europe in the late 1940-s constituted a by-product of the Cold War or whether Stalin’s policies followed a blueprint. Based on the case study of Czechoslovakia, the findings of this study suggest that although a concrete plan of the East European communization got adjusted in accordance with the external factors, the general idea of the global proletarian revolution remained part of the Soviet agenda. In the 1940-s Soviet foreign policy, despite being exclusively run by Stalin, was shaped by a triad of institutions: the People’s Commissariat of the Foreign Affairs (Narkomindel), the Comintern - later known as the Department of Foreign Information of the CPSU (OMI), and the wide array of the secret police and intelligence operations. The Vyacheslav Molotov’s Narkomindel represented the “official” diplomacy of the USSR, demonstrating the apparent ability of the USSR to cooperate with its ideological rivals. As such, with Stalin’s blessing, the Narkomindel concluded several treaties and agreements with Czechoslovakia’s government-in-exile in London, always emphasizing the Soviet non-intervention in Czechoslovakia’s internal affairs. However, the close examination of the recently released Russian archival documents, which has been the primary focus of this project, show that such activity was no more than veiling of Stalin’s real objectives toward Czechoslovakia and the rest of the region. Despite being formally dissolved in June 1943, the Comintern continued in secret to monitor and supervise the activity of the communist parties abroad. Its reorganization as a department within the CPSU confirmed its subservience to the Soviet policy objectives. Formally, the Comintern supported the official Narkomindel’s efforts to defeat the Nazi regime by calling for the organization of the national liberation fronts in the occupied countries. However, the new documents reveal that the same national fronts were also to be used as a tool of legitimizing the rise of the local communists, whose activity was guided by the Soviet leadership through the Comintern’s successor organization. The “popularizing” of the communist appeal to the masses was also ensured by the secret police and counter-intelligence units, who conducted the suppression of “anti-Soviet” elements during a transitional period between the end of the Red Army’s military operations and the establishment of the new government.
Cannabinoid Modulation of Cognition in a Rat Model of Schizophrenia

Cammie Curtin and Mark Stefani
Department Psychology, Middlebury College, Middlebury VT 05753

Cognitive abnormalities are among the most frequent and severe deficits caused by schizophrenia. These deficits include impaired working memory and behavioral flexibility, both of which are regulated by the medial prefrontal cortex (mPFC). Past studies have indicated that the endocannabinoid system may be involved impairing cognitive function in schizophrenia. Composed of CB1 and CB2 receptors that are found throughout the CNS, the endocannabinoid system affects a variety of physiological processes, including neurotransmitter release, motor learning, synaptic plasticity, and pain sensation. Drugs that activate cannabinoid receptors have been shown to exacerbate the development of psychosis. However, antagonists, which block the receptors, have been shown to improve cognition. This study investigated the effect of CB1 receptor antagonist AM251 on spatial working memory and behavioral flexibility in rats. The study also explored the interaction between MK801, a drug that models schizophrenia in animals, and AM251. We expected that if cannabinoid receptors are important to cognitive functioning in the mPFC then injections of AM251 should improve cognition. Furthermore, if activity in the endocannabinoid system reduces cognition in schizophrenia, AM251 should block the cognitive effects of MK801. Over a period of 1.5 weeks, male Sprague Dawley rats completed two maze-based behavioral tasks. Before each task, rats were given bilateral intercranial injections into the mPFC of a control solution, AM251, MK801, or a mixture of the two drugs. In Spontaneous Alternation, an assessment of spatial working memory, the rats explored an unbaited four-arm maze. In Set Shift, which measured the animals’ behavioral flexibility, the rats first learned a stimulus discrimination rule through reinforcement. One day after learning the first rule, they were required to learn a new rule based on qualitatively different stimuli in order to be rewarded. Preliminary Spontaneous Alternation data suggest that MK801 induces cognitive deficits in rats, while AM251 may block the negative effects of MK801 on cognition.

Enantiocontrol by PHOX Ligands in Pd-Catalyzed Allylic Substitution Reactions

Department Chemistry & Biochemistry, Middlebury College, Middlebury VT 05753

In order to study the mechanism of enantioselection in palladium-catalyzed allylic amination reactions, electronically modified phosphinooxazoline (PHOX) ligands (3a-f) were prepared. The enantiomeric ratios produced by nucleophilic substitution of 1 by benzylamine were determined by HPLC. It is predicted that the electronic properties of the substituent ligand on PHOX can determine the asymmetry of the products in a predictable way, thereby supporting electronic control of enantioselectivity induced by these ligands.
Chemical Relationships between Maple Sap and Underlying Soil

Bianca Dragone, Eleanor Horowitz and Molly Costanza-Robinson
Department of Chemistry and Biochemistry and Program for Environmental Studies, Middlebury College, Middlebury VT 05753

Chemical relationships between sugar maple sap (Acer saccharum) and the underlying soil could be used to establish scientific support for maple syrup terroir, the concept of “a taste of place,” as well as allow maple sap chemistry to be used as an indicator of soil fertility and the general health of a sugarbush. To examine such relationships soil and sap samples were collected from 23 maple syrup producers throughout the state of Vermont. Sap samples from the years 2009 and 2010 were analyzed for electrical conductivity, sugar content (°Brix), and pH. Trace and minor inorganic analysis was performed using inductively coupled plasma-atomic emission spectrometry and graphite furnace atomic absorbance spectrometry. No correlation (p > 0.10) was observed between the 2009 and 2010 sap samples with regards to Ca, Mg, K, and P concentrations, while a positive and negative correlation was observed for Mn (p < 0.10) and Na (p < 0.02), respectively. GPS and NRCS Soil Survey (SSURGO) data were collected for each site and used to determine soil sampling locations. Samples were collected and soil analysis included pH, concentrations of Ca, Mg, and Mn, and molar ratios of Ca:Mn and Ca:Al, although 2010 soil analysis is not yet complete. Soil and sap data from 2009 will be compared to 2010 sap data to evaluate whether trends and relationships between soil and sap chemistry remained consistent between years.

The Non-Enzymatic Glycation of Ubiquitin: A Structural and Functional Study

Mark Esposito and Roger Sandwick
Department of Chemistry and Biochemistry, Middlebury College, Middlebury VT 05753

The glycation of ubiquitin with ribose 5-phosphate (R5P) and glucose was studied to determine the effect of post-translationally modified ubiquitin on intracellular proteolysis. Intracellular proteolysis is initiated by the conjugation of ubiquitin to protein substrates via an ensemble of enzymes to 1) form a thiol ester bond to the C-terminus of ubiquitin, 2) transport conjugated ubiquitin to target protein substrates and 3) attach ubiquitin to surface ε-amino groups of a target protein substrate. Polyubiquitination then can occur in a processive manner through ε-amino groups on ubiquitin. Our investigations focused on identifying the location of glycation sites on the ubiquitin surface and on developing a method for assessing the effect that glycation has on ubiquitin activity. R5P-glycated and Glucose-glycated ubiquitin isolated by boronate and anion exchange chromatography showed up to three glycation events within a 72 h period. Trypsin digestion studies suggest glycation occurs preferentially at certain ε-amino groups. A novel method which employs yeast cytochrome c as a ubiquitination target substrate and LC-MS for subsequent analysis is under development for use in assessing the functionality of modified ubiquitin. Preliminary results suggest that this is a robust method for the detection of ubiquitination. Further refinement of this method is necessary before the effects of glycation on ubiquitination can be analyzed.
Catalytic Chromium Complexes Facilitating Radical Reactions with Benzene

Peter J. Georgakas and Jeff Byers
Department of Chemistry & Biochemistry, Middlebury College, Middlebury VT 05753

The primary goal of this study was to synthesize organometallic chromium complex (2). It was hypothesized that the organometallic chromium complex (2) could be used to initiate the catalytic activation of benzene in radical reactions. Throughout the course of this study, success has been found in the synthesis of a similar, but catalytically inactive organometallic chromium complex (1). The synthesis of this complex was pursued as a means to develop the needed synthetic techniques to generate organometallic chromium complex (2). The primary methods of analysis for this study include 1H-NMR, 31P-NMR, 13C-NMR, TLC, and GC-MS.
Investigating SloR-repression of the sloABCR Operon in the Oral Pathogen Streptococcus mutans: a DNA and Protein Perspective

Jeff Haswell, Frank Sweeney, and Grace Spatafora
Department of Biology, Middlebury College, Middlebury VT 05753

Streptococcus mutans is the principal causative agent of human dental caries, an infectious disease that continues to affect populations of both developed and underdeveloped countries. SloR, a 25-kDa protein, acts as a bifunctional metalloregulator by repressing and activating the transcription of certain S. mutans genes on the UA159 chromosome. Previous work in the Spatafora Research Laboratory identified a consensus palindrome or “SRE” to which SloR presumably binds. However, the results of preliminary DNA footprinting experiments implicate a sequence that localizes 18bp further upstream of the predicted SRE (called an “SBS”) in SloR binding. Nevertheless, we hypothesize that SloR represses sloABCR gene expression upon direct metal ion-dependent binding to a promoter-proximal SRE and/or SBS. To reveal whether SloR-SRE or SloR:SBS binding interactions are responsible for the observed repression of sloABCR by SloR, we are generating mutant variants of the sloABCR promoter region using progressive deletion and site-directed mutagenesis approaches. The mutations we have generated thus far have been successfully cloned into a pJL84 integration vector that harbors a promoterless chloramphenicol acetyltransferase (CAT) gene. We have since introduced wild-type and mutant promoter constructs into the S. mutans UA159 chromosome by allelic exchange and are currently confirming the double crossover event by PCR and DNA sequencing. Once these fusion strains have been confirmed we will perform CAT reporter gene assays and so reveal the nucleotides that are paramount for promoter activity. From these experiments we may define whether SloR regulation of the sloABCR operon is sequence- and/or secondary structure-specific. To complement these investigations, we are also generating SloR protein variants to reveal their potential impact on wild-type sloABCR promoter activity. To this end, the wild-type sloR coding sequence was successfully cloned into a pDL277 shuttle vector. This construct will be used as a template for site-specific mutagenesis using a QuikChange II site directed mutagenesis kit from Stratagene. The confirmed constructs expressing SloR mutant variants will be transformed into a SloR-deficient background that harbors a chromosomal fusion of the sloABCR promoter region to CAT. This fusion strain, called GMS153, has already been generated and awaits confirmation by PCR and nucleotide sequencing. The end result of these experiments will be the identification of amino acid residues in the SloR protein that are absolutely required for SloR-DNA binding and that could therefore serve as target sites for the development of an anticaries therapeutic agent.
Lipid Hydroperoxide Levels in Follicular Fluid and Oocytes of Developing Bovine Antral Follicles

Margo Hennet and Catherine Combelles
Department of Biology, Middlebury College, Middlebury VT 05753

In an era when many women forego having children until their thirties, artificial reproductive technologies (ART) such as in-vitro fertilization (IVF) and in-vitro maturation (IVM) are becoming an increasing focus of reproductive research. As the fate of an embryo is intimately tied to the quality of the oocyte it came from, the factors that affect oocyte quality are important to identify and explore. In this study, oxidative stress was investigated as one such factor in bovine oocytes. Oxidative stress can result in, among many things, cell membrane lipid damage, or lipid peroxidation (LPO). This study measured LPO levels in both follicular fluid and live oocytes in order to better understand the dynamics of oocyte development, provide suggestions to improve techniques for in-vitro manipulation, and to validate or reject LPO levels as a reliable marker of oocyte quality. To do so, LPO levels were compared to additional parameters such as oocyte quality (based on morphology) and apoptosis of follicular cells. We hypothesized that LPO levels would increase with low oocyte quality and high apoptosis. LPO in follicular fluid and live oocytes was measured using spectrophotometry and the live fluorescent probe BODIPY C-11, respectively. Quality of oocytes was assessed, and somatic cells from each follicle collected for apoptosis analysis, at the time of collection. The percent of each oocyte membrane with oxidative damage (as reported by BODIPY-C11) varied with factors such as follicle size and oocyte quality. LPO levels in follicular fluid varied according to follicle size and follicle dominance (from apoptosis data) as well. Further research will continue to investigate the impact of oxidative stress on oocyte quality by experimentally increasing or decreasing LPO levels in live oocytes in vitro and monitoring their maturation, fertilization and developmental progress compared with those of controls.

Superoxide and Dicarbonyls Generation through the Maillard Reaction of Ribose 5-Phosphate Determined by Bovine Heart Cytochrome C Reduction

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Cytochrome c (cyt c), a heme protein found on the mitochondrial membrane, functions to shuttle electrons between cytochrome C reductase and cytochrome C oxidase in the respiratory chain. Cyt c also acts as an initiation factor for apoptosis. The Maillard reaction of cyt c and ribose 5-phosphate (R5P) occurs quickly as R5P binds to lysine residues on the cyt c surface. We have observed that this reaction also reduces the protein from the ferri-cytochrome C (Fe3+) to the ferro-cytochrome C (Fe2+) state. The presence of superoxide dismutase (SOD) decreases the rate of cyt c reduction by 50-60%, implying that O2- is generated through the glycation reaction, and that it plays a major role in cyt c reduction. The addition of free lysine to the system increased reduction rates 4-fold. The reaction between excess lysine and 10 mM R5P generates O2- at a rate of 1.0 µM min-1. Although O2- plays a clear role in cyt c reduction, it is not the sole reductant. SOD does not completely inhibit cyt c reduction, and increasing the pre-incubation time of lysine and R5P speeds the rate of cyt c reduction. Together these data suggest that there is a second reductant in solution, potentially a cross linked Schiff base capable of passing electrons directly to cyt c. ATP, a known inhibitor of cyt c reduction by R5P, has no effect in decreasing reduction in the lysine-R5P system. This suggests that ATP can block R5P from reacting with critical lysine residues, but that both O2- and the cross linked Schiff base can access the heme group directly. The findings of this study have important implications to the functioning of cytochrome c in the cell and to the production of reactive oxygen species in biological systems.
The Non-enzymatic Glycation of Bovine Hemoglobin Using Ribose-5-Phosphate

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Hemoglobin is a long-lived, oxygen-transporting protein found in all red blood cells. Its long half-life subjects it to reactions with sugars, causing modification of the protein by a process known as glycation. Elevated levels of glycated hemoglobin are associated with excess blood glucose (hyperglycemia) and, in effect, diabetes. Although glucose is more prevalent in the bloodstream, the sugar ribose-5-phosphate reacts faster than most other sugars due both to the negative charge of its phosphate group and its tendency to remain in the acyclic form. In this study, bovine hemoglobin was incubated with ribose-5-phosphate at 37°C for several days. Analysis by SDS-PAGE showed increased formation of hemoglobin dimers and complexes with increased glycation time. This may result from amino acid cross-linking between proteins, or by the reaction of hemoglobin with hydrogen peroxide formed during early stages of glycation. Both gel electrophoresis and UV-absorption results showed that the heme group was removed from the protein, another known effect of peroxide reaction with hemoglobin.

An Investigation of Visual Features for Location Recognition

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For effective visual navigation, both humans and robots rely on distinctive visual landmarks. The long-term goal of this research is to develop algorithms for accurate and fast image-based localization, given a database of panoramic reference images such as Google Streetview, a problem also known as location recognition. Our work this summer focused on evaluating different visual feature detectors and descriptors for this purpose. We tested corner feature detectors such as SIFT (shift invariant feature transform) and SURF (speeded up robust features), as well as “blob” detectors such as MSER (maximally stable extremal regions). We also investigated different feature descriptors that allow the matching of features between images. We integrated public implementations of these methods into a common framework using Python, C++, and different image libraries such as OpenCV. Our research culminated in a matching program integrating an MSER detector with SURF descriptors using OpenCV. We tested this application, along with pure SIFT and SURF implementations, using urban panoramic images provided by Microsoft.
Role of Orexin Signaling in Rat Model of Selective Attention

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A fundamental aspect of cognitive function is the ability to filter and extract, through focused attention, useful information from the vast array of incoming stimuli at any given moment. Impairments in selective attention performance are associated with disorders such as Parkinson’s disease, obsessive-compulsive disorder, and schizophrenia. The orexins are two neuropeptides produced in the lateral hypothalamus and adjacent perifornical area that project to many locations in the brain, including those that are involved with selective attention. Orexins have been found to play a significant role in energy homeostasis, sleep, arousal, reward, feeding, stress, and substance abuse. To further investigate the role of orexins in selective attention, male Sprague-Dawley rats were trained on a selective attention task paradigm designed to measure their ability to focus on external stimuli and perform appropriate response actions. Through positive reinforcement, the subjects learned to attend simultaneously to three locations in an operant chamber and to respond to the presentation of brief light stimulus (3 or 5 second duration) randomly presented at one location. Twenty minutes prior to the start of the test session, each rat received an intraperitoneal injection of either the orexin receptor antagonist SB334867 (1 mg/kg) or a sterile saline control solution. Based on the available literature we expect orexin to cause a dose-dependent impairment on performance of the selective attention task.

Enterprise Land use in the Post-Soviet, Privatized Russian Federation: Economic Implications

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This study explores the land-use rights of Russian enterprises and land market conditions, both nationally and as varied across regions. It finds statistical relationships between land-use rights and economic performance at the enterprise level. The timeliness of this study corresponds with current land reform legislation in Russia. Enterprise land tenure in the Russian Federation (RF) is formulated under three categories of land use: 1) rights of ownership (private ownership), 2) lease tenure from the government, and 3) “permanent (perpetual) use,” a pseudo-lease contract from the state. Under permanent use tenure, the renter cannot sell the land, and the state maintains the right to seize the land at any time for fair compensation. We hypothesize that this category of land use threatens business security and credit access for Russian enterprises with permanent use tenure, and accordingly, that recent amendments to the 2001 RF Land Code could impose an unnecessary economic burden on the Russian economy. The possible cost of incomplete land reform to the Russian economy underscores the urgency of evaluating land reform in Russia. Possible costs take on the forms of 1) loss of potential foreign investment, 2) loss of potential domestic enterprise investment and reinvestment, 3) lack of credit access at the enterprise level, and/or 4) inefficient land use within Russia at the firm and macro levels. Regional variations in land markets, tax rates, rent rates, and property legislation illustrate complicating factors in formulating a national approach to efficient land use that minimizes federal-municipality competition. Existing bureaucratic controls over land rights, taxes, land transactions, seizures, and so forth further suggest that the state currently lacks both the economic and political incentive to cede controllership of enterprise land out from permanent use tenure. Using data from a survey designed by Middlebury College Professor of Economics William Pyle and administered to 359 Russian industrial enterprises in 2009, our initial analysis uncovers statistically significant relationships between land tenure rights and indicators of enterprise performance and security. We measure investment levels, credit access, subletting trends, and level of corporate restructuring after privatization against the three types of land tenure in order to assess the effect of land use rights on enterprise economic health. Although no claims of causality can be made thus far, trends in the Russian media and in tangential scholarly work on Russian enterprise privatization support our results, encouraging further research within this dataset.
Effect of the Neurosteroid Allopregnanolone on Cognitive Flexibility in a Rat Model of Schizophrenia

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Schizophrenia is a mental disorder characterized by cognitive impairment, dampened emotional responses and false sense of reality. The most difficult to treat of these symptoms are the cognitive impairments, such as poor cognitive flexibility and working memory. Cognitive flexibility refers to the ability to shift behavioral strategies in response to environmental changes. Working memory is a system for short term storage and manipulation of information. Both abilities depend on the prefrontal cortex (PFC). Cognitive deficits represent the most significant hurdle to schizophrenics integrating into society. Neurosteroids present a therapeutic approach to the cognitive deficiencies of schizophrenia. Allopregnanolone (ALLO) is a neurosteroid that enhances the action of the inhibitory neurotransmitter GABA. A theory regarding the causal mechanisms schizophrenia proposes a deficiency in synaptic GABA transmission within the PFC is a fundamental cause of schizophrenia. Thus, we used male Sprague-Dawley rats to determine if ALLO would block the impairments of cognitive flexibility and working memory induced by the NMDA receptor antagonist MK-801, which produces a schizophrenic state. Cognitive performance after treatment was tested with set-shift and spontaneous alternation tasks. The set-shift task measured the rats’ ability to shift from one rule to another in response to environmental feedback. The rats were given bilateral microinjections of MK-801 alone or in combination with two concentrations of ALLO (0.25 and 0.5 micrograms/hemisphere) into the medial PFC 20 minutes before training on the second rule. In spontaneous alternation the rats received microinjections 20 minutes before freely exploring a four armed maze for 15 minutes. In the set-shift task, co-administration of ALLO and MK-801 has produced results indistinguishable from control animals, indicating a possible reversal of the behavioral impairments produced by MK-801. Current spontaneous alternation results suggest administration of ALLO improves working memory. Data from co-administration of ALLO and MK-801 do not indicate the same reversal of working memory deficits previously observed in the set-shift task.
Using DNA Footprinting to Characterize the SloR:DNA Interaction in Streptococcus mutans

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Streptococcus mutans is the principal causative agent of dental caries, a common infectious disease throughout the world despite overall advances in water fluoridation and oral healthcare. S. mutans facilitates the formation of dental caries by forming a complex biofilm on the tooth enamel, allowing it to reside on the dentition where food sources are transiently available with intermittent mealtimes. Through fermentation, S. mutans metabolizes dietary carbohydrates and produces acid byproducts which accumulate at the tooth surface owing to a diffusion barrier that is established by the plaque biofilm. This acid build-up lowers the pH of the local plaque environment, demineralizing the tooth enamel and initiating the process of dental decay. Previous reports in the literature combined with work deriving from the Spatafora Research Laboratory identified a bifunctional manganese-dependent regulatory protein, called SloR that regulates many of S. mutans’ virulence genes. Computer analysis revealed a SloR recognition element (SRE) in the promoter regions of many virulence genes including the sloABCR operon whose gene products modulate essential metal ion uptake by S. mutans. DNA footprinting experiments previously undertaken in our laboratory by Mitchell Pesesky (MBBC,’10) support SloR binding to a region that is located 18 bp upstream of the predicted SRE. As a 2010-11 Beckman Scholar, I am applying the DNA footprinting approach to validate these preliminary findings and to reveal the specific nucleotides to which SloR binds in the sloABCR upstream regulatory region. DNA footprinting experiments will be extended to include analysis of both DNA strands to determine whether SloR homodimeric binding to the sloABCR promoter region is symmetrical. DNA footprinting of other Class I (SloR-repressed) virulence gene promoters in S. mutans is also planned as is the analysis of Class II (SloR-activated) gene promoters. Taken collectively, this research will advance our understanding of SloR’s role in mediating S. mutans induced caries development, and in particular it can elucidate the precise nucleotides to which SloR binds so they may be targeted in the future by an anti-caries therapeutic.

Picking up the Bones: An Examination of Why So Many Well-intentioned Sub-Saharan NGO Projects Fail

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In recent years, NGOs (Non Governmental Organizations) have grown in vastness and vigor of influence, size and in representation worldwide. However, in terms of impact, their successes vary widely. Studies reveal a number of external and internal factors as having hindered the successes of many NGO development projects, such as the limited sustainability measures (financial and non financial), poor monitoring and evaluation, rigid local political systems and cultural differences. The evolution of NGOs has resulted in improvements in many of these areas. For example, sustainability is included among the main objectives of many NGOs today. Despite these advances, one issue that continues to be ignored is a flawed process of problem identification. The failure to address the ‘real’ problem of a particular society has an obvious and significant potential to limit the positive impact of an NGO on the particular community in question. Yet today, the failure to identify the ‘real’ problem remains a major reason as to why the paths of NGOs are littered with the bones of failed projects. This paper is an in-depth investigation of the implications of particular processes within an NGO especially during the project development stage, which catalyze the deliverance of services geared towards supplementary problems rather than the ‘real’ problem as identified by the locals. Even though there has been an increase in local participation in development initiatives, a grassroots approach to problem identification is still hindered by certain processes within the NGOs themselves. Our focus on environment and conservation NGOs in Sub Saharan Africa in this paper will lead the way for future research on this issue.
Inverse Gas Chromatography for the Determination of the Air-water Interfacial Area of Unsaturated Porous Media

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The air-water interfacial area (AI) influences retention and transport of contaminants in unsaturated porous media (e.g. soil) and its magnitude determines its relative importance. Several methods for measuring AI have been developed. While inverse gas chromatography (IGC) methods are believed to provide accurate measurements of AI within a system, previous use of IGC-measure AI values to predict the gas-phase transport of trichloroethylene (TCE), a suspected carcinogen, have not matched experimental TCE transport. Poor temperature control and temperature effects on equilibrium partition constants may have been responsible for this inaccuracy. This project seeks to improve on the gas-phase tracer method by incorporating additional temperature controls. The IGC method uses methane as a nonreactive tracer and decane as an interfacial tracer, and the ratio of their retention time in a soil column can be used to calculate R, the retardation factor, and AI. Initial trials of the improved method have yielded reproducible results for methane, decane, and TCE (travel time % rsd 4.1, 3.8 and 2.3%, respectively). Retardation factors and AI will be calculated from these data, and the values for decane will be used to predict the retardation factor for TCE, which will then be compared with experimental TCE results.

Gametogenic Failure: An Analysis and Study of the Mei2.5 Mutation in Females

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Please contact Jeremy Ward for abstract.
Neurosteroid Modulation of Selective Attention in a Rat Model of Schizophrenia

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Schizophrenia is a mental illness characterized by abnormalities of perception, emotion, and cognition. Of these abnormalities, the cognitive impairments are proposed to contribute most to poor prognosis and recovery. One such aspect of cognitive impairment is deterioration of selective (or “top-down”) attention, which is the ability to maintain a behavioral or cognitive goal in the face of distracting stimuli. One of the neurotransmitters thought to influence selective attention behavior is GABA, an amino acid that functions as the primary inhibitory neurotransmitter in mammalian brains, and when bound to a GABA receptor, opens ion channels and allows Cl- ions to flow across the neuron cell membrane. GABAAergic neurons play an important role in regulating the activity of neural networks that ultimately influence behavior. In this study, we investigated whether a GABA receptor modulator, allopregnanolone, was capable of reversing impairments in cognitive flexibility induced by treatment with another drug, the NMDA glutamate receptor antagonist MK-801. Male Sprague-Dawley rats were first trained on a selective attention task requiring rats to orient toward and divide attention between three locations at which brief light stimuli (5 or 2 second duration) were randomly presented. On the test day, each rat was given an intraperitoneal injection consisting of a control solution, MK-801, or allopregnanolone, alone or in combination 20 minutes before the start of a behavior session. We hypothesize that administration of MK-801 will impair cognitive flexibility relative to that of control animals. We further hypothesize that injection of allopregnanolone alone will improve selective attention task performance and, when coadministered with MK-801, would block the cognitive impairment initially induced by MK-801.

Generation and Trapping of the Benzylic Chromium Tricarbonyl Radical

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Benzylic radicals are known to be unreactive molecules due to the resonance stability provided by the benzene ring. However, evidence exists that when a chromium tricarbonyl is complexed to a benzylic radical, it becomes somewhat reactive, and useful for organic synthesis. Alkenes, the general trapping reagents used for radicals, were modified to better suit the trapping of benzylic chromium tricarbonyl radicals. In the reaction of a benzene chromium tricarbonyl with a phenylseleno group in the beta position, and 2-(carboxyethyl)allyltributyltin, a radical was successfully trapped.
Initial Study of Gene Expression of the N-acetylglucosamine Assimilation and Isoprene Pathways in Borrelia burgdorferi

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Borrelia burgdorferi, the bacterium that causes Lyme disease, is transmitted by the Ixodes ticks and cycles through mammalian hosts such as deer and mice. Infected humans show a variety of signs, including a bulls-eye rash, fever and fatigue. Long-term problems include inflammation of the joints and problems with the heart and nervous system. The fully sequenced genome of B. burgdorferi codes for a comparatively limited number of metabolic enzymes. The organism relies on its host for important compounds, including fatty acids, amino acids, and various cofactors. Two of the biochemical pathways vital to the function of B. burgdorferi are the assimilation of acetyl-CoA to produce isoprene and the metabolism of N-acetylglucosamine. Our research focuses on the important enzymes in these pathways, with the larger goal of understanding how the metabolic processes of B. burgdorferi are connected. In previous work in the Cluss group, differential gene expression was used to confirm the coordinate expression of the isoprene operon in B. burgdorferi (Alramini, 2009). This technique can also be used to study gene expression in various conditions which imitate the mammalian or tick host. We focused on two chromosomal genes in this study. bb0685 codes for HMG-CoA reductase, one of the central enzymes in the isoprene pathway, and bb0151 coding for N-acetylglucosamine-6-phosphate deacetylase, an important part of the N-acetylglucosamine assimilation pathway. Using qT-PCR, we monitored the expression of these two genes in both adaptive and immediate response conditions. We have also cloned these genes in various E. coli hosts to produce recombinant protein for further biochemical characterization.

Investigating Small Regulatory RNAs as Potential Mediators of Streptococcus mutans Virulence Gene Expression

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Dental caries is a bacterially-derived infection that poses an acute global health risk. Streptococcus mutans, a gram-positive oral bacterium, is the primary causative agent of this infection. The pathogenicity of S. mutans is a product of a complex regulatory network of virulence factors including, but not limited to, the organism’s ability to adhere to the tooth surface, to assume a biofilm lifestyle, and to tolerate the acid it generates upon metabolizing carbohydrates consumed in the diet. SloR is a 25kDa global, bifunctional, metalloregulatory protein that we determined regulates a range of S. mutans virulence genes. Preliminary evidence in the Spatafora Research Laboratory suggests that RNA transcripts deriving from each of three intergenic regions on the S. mutans UA159 chromosome—IGR48, IGR55, and IGR174—are subject to SloR metalloregulation. We hypothesize that SloR represses the activity of these putative small, noncoding RNAs (sRNAs) through direct binding to SloR recognition elements (SREs) that localize to the 5’ regions of the transcripts. We predict that such SloR binding may prevent complementary base pairing of these sRNAs with their predicted downstream target genes, rpl, luxS, and yabB, at least two of which are likely contributors to the S. mutans-induced cariogenic process. The SloR-mediated upregulation of these virulence attributes would therefore be expected to exacerbate tooth decay. The present study sets out to characterize these IGRs, their potential regulation by SloR, and their putative impact on downstream target genes. To this end we performed 5’-RACE experiments to define the +1 transcription start sites for each IGR and their respective target genes. The small size of these intergenic regions has proved to be problematic for various stages of 5’-RACE. Gel mobility shift assays are also planned to determine whether SloR:sRNA binding is direct. This work could be the first to elucidate sRNA-mediated gene regulation in S. mutans. Moreover, an improved understanding of sRNA-mediated gene expression that is subject to SloR control could reveal novel targets for the development of a therapeutic aimed at alleviating and/or preventing S. mutans-induced dental caries.
Synthesis of Conjugated Polyalkenes from Organometallic Chromium Complexes for use as Molecular Wires

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Organometallic chromium complexes, notably η6-styrene chromium tricarbonyl, catalyzed by Hoveyda-Grubbs 2nd Generation catalyst in olefin metathesis reactions were investigated to determine their effectiveness as monomers in conjugated conducting polymers. Emphasis was focused on forming the dimer, which was successfully synthesized using varying solvent conditions – primarily diethyl carbonate – and verified by TLC, GC-MS, and 1H/13C NMR. Both the synthesis of benzocyclobutadiene chromium tricarbonyl and divinylbenzene chromium tricarbonyl, to be used as monomers in ring-opening metathesis polymerization (ROMP) and acyclic diene metathesis (ADMET) respectively, are in progress.
Characterizing the Promoter Regions of SloR-dependent Class I and Class II Genes in Streptococcus mutans

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Dental caries, the second most common health disorder in the US, principally result from the colonization of the dentition by the facultative anaerobe Streptococcus mutans. S. mutans’ success as an oral colonizer in humans is largely due to its ability to adhere to hard surfaces, produce biofilms, and survive in the ensuing acidic environment. Each of these virulence processes involves the activation and regulation of complex genetic pathways deriving from the S. mutans genome. Previous work in the Spatafora Laboratory has implicated the metalloregulatory protein, SloR, as a manganese-dependent regulator of genes involved in these virulence pathways. Gel shift assays and in silico approaches have identified a 22 base pair conserved palindromic SloR recognition element (SRE) to which SloR presumably binds. The results of a microarray and qRT-PCR experiments revealed the manganese- and SloR-dependent transcription of at least 14 genes that contain a predicted SRE in their promoter region. Class I genes are repressed by SloR whereas Class II genes are up-regulated by SloR. We noted an interesting relationship between Class I and Class II genes with respect to the positioning of the predicted SRES and the downstream translation start sites: namely, Class I genes harbor predicted SREs that localize promoter region-proximal while Class II genes harbor predicted SREs that localize promoter region-distal. To confirm whether SRE-promoter positioning is important for bifunctional gene regulation by the SloR metalloregulator, we set out to define the +1 transcription start site for Class I (i.e. glgB, sloA) and Class II (tpx, spaP, and fabM) virulence genes in S. mutans using a 5’RACE approach (invitrogen). To identify the -10 and -35 promoter sequences for these genes, we cloned cDNA that we generated for each gene into the pGEMT-EZ cloning vector (Promega) for subsequent DNA sequencing. In addition, the glgB, sloA, tpx, spaP and fabM promoter regions will be subcloned into the integration vector pJL84 that harbors a promoter-less chloramphenical acetyltransferase (CAT) reporter gene for subsequent site-directed mutagenesis using the QuikChange II Site directed mutagenesis kit (Stratagene). These constructs will be returned to the S. mutans chromosome by allelic exchange and the resulting fusion strains used to monitor promoter activity in spectrophotometric CAT assays. In this way, we will be able to define a potential role for functional promoters and their corresponding SREs in S. mutans virulence gene regulation and reveal a putative role for regulatory element position in SloR-mediated metalloregulation in this important oral pathogen.
Two Electron Oxidation of Deoxyguanosine without Oxygen Molecules by a Ru(III) Complex through Disproportionation

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Among the many mechanisms for the oxidation of guanine derivatives (G) assisted by transition metals, RuIII and PtIV metal ions share basically the same principle in the oxidation of G. Both RuIII and PtIV-bound G have highly positively polarized C8-H that is susceptible to deprotonation by OH−, and both undergo two-electron redox reaction. The main difference is that because RuIII can accept only one electron from G to become RuII, it requires O2 to undergo two-electron transfer. However, because PtIV accepts two electrons to become PtII, this redox reaction does not require O2. In this study we report that [RuIII(NH3)5(dGuo)]Cl ([RuIII-dGuo]; dGuo = deoxyguanosine) yields both [RuIII-8-oxo-dGuo] and cyclic-5′-O-C8-dGuo a two electron oxidized G species, namely, cyclic-5′-O-C8-dGuo (major product) independent of O2. The UV-vis spectroscopic analysis showed the production of [RuII-dGuo] from [RuIII(NH3)5(dGuo)] follows the rate law : d[RuII]/dt = ko[RuIII] + k1[OH−][RuIII], ko = (6.0 ± 3.2) x 10−4 s−1 and k1 = 1.9 ± 0.2 M−1s−1 at 25 oC. Since there was no reductant in the solution, RuIII must be disproportionated to [RuII-dGuo] and [RuIV-dGuo]). We propose the 5′-OH in [RuIV-dGuo] in solution attacks C8-dGuo-RuIV to initiate the two-electron transfer from dGuo to RuIV generating cyclic-5′-O-C8-dGuo and RuII without involving O2. The kinetic curve of the major product cyclic-5′-O-C8-dGuo under Ar atmosphere follows the same trend as that of the disproportionation. This further supports our proposed mechanism that the oxidation products were originated from the putative [RuIV-dGuo]. In the presence of O2, both [RuIII-8-oxo-dGuo] and cyclic-5′-O-C8-dGuo were produced.

Scalar Field Oscillons in the Early Universe

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Immediately after the Big Bang, the universe was hot, chaotic, and filled with energetic, rapidly changing fields—for example, electric and magnetic fields, and an important but still theoretical scalar field called the Higgs field. The universe eventually expanded and cooled, losing energy to its expansion in the process, and left the fields as we see them today. It is likely, however, that the fields were subjected to some unusual potential energies immediately after the Bang, which would have led to surprising, interesting non-linear solutions to their equations of motion. One possible result of these nonlinearities is the presence of oscillons, stable, long-lived waving particles that do not disperse or spread out over time and could have important implications for baryogenesis, the process of creating matter. Building on the work of previous Middlebury physics majors, we created computer models of two-dimensional scalar fields and let them evolve from random thermal initial conditions at the universe expanded and cooled. Previous work found that specifically chosen nonlinear potentials could produce copious oscillons. Recently, we began using statistical methods to compare the results of models with and without oscillon-forming potentials. We defined a quantity called the Correlation Differential to be a measure of how random or ordered a field is at a given time. We found that fields with oscillon-forming potentials have order established in them before the oscillons actually form, which may shed light on the oscillon formation process. Work continues to improve our simulations and run them in three dimensions.
Relating Hydrogen Peroxide Levels in Follicular Fluid to Dominance and Health Status of Individual Bovine Antral Follicles

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The antral follicle provides an environment that supports the development of the oocyte. Producing an oocyte with the potential to yield a healthy embryo requires maintaining a delicate balance between reactive oxygen species (ROS) and antioxidants. Without this balance, oxidative stress occurs and can lead to damage in many cellular components such as DNA, lipids, and proteins. Especially in assisted reproductive technologies such as in vitro fertilization and in vitro maturation, it is crucial to understand this balance to optimize the quality of the oocytes and embryos used in these procedures. This study aimed to identify a relationship between the ROS hydrogen peroxide and the dominance status of the follicle. Follicular fluid was examined for hydrogen peroxide levels while the dominance of the follicle was determined using follicular diameter and membranosa granulosa health as determined by a combination of atretic markers (TUNEL, caspase-3, DAPI). Through analysis of the three largest follicles in an ovary pair, the largest follicle is identified as fully or partially dominant while the next two largest follicles are identified as healthy or atretic subordinate. First, hydrogen peroxide concentrations were examined in follicles of varying diameter. No correlation was initially found between hydrogen peroxide levels and follicular diameter. However, when ovarian stage was controlled for, there was a negative correlation between hydrogen peroxide concentration and follicular diameters of stage IV ovaries. When follicular health and dominance was accounted for, the data suggest that atretic subordinate follicles have lower concentrations of hydrogen peroxide than healthy subordinate follicles. In the future, other ROS need to be measured in not only follicular fluid, but in other compartments of the developing bovine antral follicle such as the membrana granulosa and the cumulus-oocyte complex.

Surfactant effects on water retention and the air-water interface

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The transport of hazardous contaminants in the vadose zone is influenced by the air-water interface (AWI). A common method of determining the areal extent of the AWI, inverse liquid chromatography (ILC), measures the AWI via the ratio of nonreactive tracer vs. interfacial tracer travel times through a soil column at a specified water content. Although this method has shown promise, complications related to surface tension decreases induced by dodecylbenzene (SDBS), the surfactant interfacial tracer used in this investigation, may limit the accuracy of the method. Changes in surface tension alter capillarity thereby inducing drainage in the soil column and changing the AWI being measured. While other studies have dismissed this concern, our investigation examined this phenomenon by monitoring water content in real-time during ILC. ILC experiments conducted at SDBS tracer concentrations of 0.1 and 0.2 mM resulted in 27.5% and 41.3% loss of water content respectively from the system and also caused asymmetry in the input and elution of the tracer from the column.
Experimental Analysis of POI Distribution and Shortest Tour Voronoi Diagrams on Geographic Networks

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The round-trip distance function on a geographic network (such as a road network, flight network, or utility distribution grid) defines the “distance” from a single vertex to a pair of vertices as the minimum length tour visiting all three vertices and ending at the starting vertex. Given a geographic network and a subset of its vertices called sites (for example a road network with a list of grocery stores), a two-site round-trip Voronoi diagram labels each vertex in the network with the pair of sites that minimizes the round-trip distance from that vertex. Alternatively, given a geographic network and two sets of sites of different types (for example grocery stores and coffee shops), a two-color round-trip Voronoi diagram labels each vertex with the pair of sites of different types minimizing the round-trip distance. The asymptotical efficiency of the algorithms we used to compute round-trip Voronoi diagrams depends on the relationship between doubling density of sites and an upper bound on the number of non-empty Voronoi regions. In this research project, we create Java applets to implement the algorithm and allow the user to see the algorithm animated step by step. In addition, we collect experimental data of doubling density from all states and different types of sites to show that empirical road data distribution also allows the algorithms to be asymptotically more efficient than previous known algorithms, same as the results obtained using theoretically reasonable distribution.

Petrologic and Spatial Analysis of Volcanic Ballistics from the 1790 Explosive Eruption of Kilauea, Hawaii

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Kilauea volcano on the island of Hawaii is well known for its effusive, fountain-style eruptions. However, its eruptive history is punctuated by explosive eruptions that would today be a serious hazard to local human populations. Explosive eruptions induced by contact between water and magma are known as phreatomagmatic, and such an eruption in 1790 was responsible for the deaths of roughly 80 Hawaiian warriors (Swanson and Christiansen 1973). Explosive eruptions deposit a suite of products, among which are volcanic ballistics. Ballistic samples from the 1790 events range in density from 1.88g/cm3 to 3.47g/cm3. Spatial distribution ranges from ≤ 1 to 10 ballistics/ha. The array contains juvenile bombs, or material sourced from young magma, and lithic blocks composed of lava flows erupted prior to 1790. Composition varies from fine-grained, plagioclase feldspar-rich to Mg-rich with abundant olivine phenocrysts. SiO2 (44.04 – 52.13%) and Na2O (1.02 – 3.04%) values are typical of tholeiitic basalts. Petrology and spatial distribution suggests the 1790 ballistics were emplaced by 7 or 8 blasts from ~4 vent regions.
Reaction of G-containing Oligomer with trans-d,l-1,2-diaminocyclohexanetetrachloroplatinum

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Many transition-metal complexes mediate DNA oxidation. DNA oxidation products depend on the nature of the metal complex and the structure of the DNA. High-valent oxometal (MnV=O, RuIv=O, OsIV=O, CrV=O) complexes oxidize DNA at both sugar and base sites. Complexes including CrVI, MnII, FeIII, CoII, NiII, and CuII mediate oxidation in the presence of oxidants such as O2, H2O2, or SO32-. Preliminary results show that for the reaction between trans-d,l-1,2-diaminocyclohexanetetrachloroplatinum (trans-Pt(d,l)(1,2-(NH2)2C6H10)Cl4, [PtIVCl4(dach)]; dach = diaminocyclohexane) and a guanine (G) containing oligomer, PtIV binds to every G but, only G at the 5’end can be oxidized to cyclic 5’O-C8-G by an intramolecular attack. If an external hydroxyl or phosphate is present, however, PtIV-bound G can be oxidized to 8-oxo-G by an intermolecular attack. The mechanism involves PtIV binding to N7 of G followed by nucleophilic attack of the external hydroxide or phosphate oxygen to the C8 of G, accompanied by an inner-sphere, 2ē transfer to produce 8-oxoguanosine for hydroxide, or 8-(hydrogen phosphate) for phosphate. The latter converts to 8-oxo-G by reacting with solvent H2O. This study monitored the reaction between [PtIVCl4(dach)] and 5’-dTTTTG-3’ by high-performance liquid chromatography and 1H NMR spectroscopy. The resulting 8-oxoG product confirms proposed mechanism initiated by intermolecular attack.