Schedule

CHICAGO AREA UNDERGRADUATE RESEARCH SYMPOSIUM

April 1, 2006

8:30 a.m - 4:30 p.m.	**Registration** *First floor, 78 E. Washington Street Entrance*
9:00 a.m.	**Continental Breakfast** *Claudia Cassidy Theater*
9:30 a.m.	**Opening Address** *Claudia Cassidy Theater* Steven J. Sibener, Ph.D. , Carl William Eisendrath Professor of Chemistry at The University of Chicago and head of the James Frank Institute
10:00 a.m.	**Poster Session I** *Preston Bradley Hall*
11:00 a.m.	**Poster Session II** *Preston Bradley Hall*
12:00 noon	**Lunch** *Preston Bradley Hall*
1:00 p.m.	**Research Lecture** *Claudia Cassidy Theater* Milan Mrksich, Ph.D., Department of Chemistry, University of Chicago
1:30 p.m.	**Oral Presentations I** *Claudia Cassidy Theater*
2:30 p.m.	**Coffee Break** *Claudia Cassidy Theater*
3:00 p.m.	**Oral Presentations II** *Claudia Cassidy Theater*
5:00 p.m.	**Banquet Dinner** *Preston Bradley Hall* Keynote Address by Hunter O'Reilly, Ph.D., Loyola University Chicago
6:00 p.m.	**Dessert & Awards Ceremony** *Preston Bradley Hall*

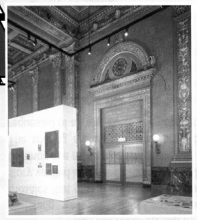
Chicago Cultural Center Map

Garland Court

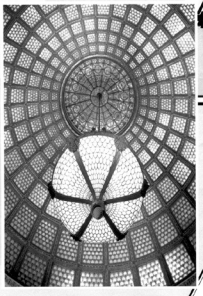
78 E. Washington Street

77 E. Randolph Street

The stairway leading to the 5th floor was inspired by the Bridge of Sighs in Venice, Italy.



Sidney R. Yates Gallery
is a replica of an assembly hall in the 14th century Doge's Palace in Venice, Italy.



Preston Bradley Hall,
home of the world's largest stained glass Tiffany dome.

The coffered ceiling of G.A.R. Memorial Hall

The Grand Staircase
is of white Carrara marble decorated with intricate multicolored mosaics.

The neo-classic architecture of the Randolph Street Entrance is Greek revival.

Elevator · Public Restrooms · Public Telephone · Handicapped Accessible · Welcome Desk · Food Service

Michigan Avenue

Contents

Staff

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Kevin Miklasz
James Waters

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Greg Cvetanovich, Northwestern University
Vivian Ferry, The University of Chicago
Laura Hughes, Northwestern University
Emily Miller, Loyola University Chicago
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Happy Thakkar
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Charles Green
Angela Stathos
Samuel Undine
Christopher Whaley

Advisor Emeritus: Chandler Robinson, Northwestern University

Advisor: Joe Cribari

Acknowledgements

The Chicago Area Undergraduate Research Symposium would not have been developed without the help of numerous people. In particular, we would like to thank the following people for their help and support:

DePaul University
• Lynn Narasimhan of the IST center

Illinois Institute of Technology
• Allan S. Myerson, Provost and Senior Vice President
• Carlo Segre, Professor of Physics and Associate Dean of the Graduate College

Loyola University Chicago
• Professor G. Hunter O'Reilly
• Professor David Slavsky, Dean of the College of Arts and Sciences
• Professor Michael Garanzini, President
• Professor John Frendreis, Provost
• Professor Jeffrey Doering, Department of Biology Chairperson
• Professor David Crumrine, Department of Chemistry Chairperson
• Professor Asim Gangopadhyaya, Department of Physics Chairperson
• Professor R. Scott Tindale, Department of Psychology Chairperson

Northwestern University
• President Henry S. Bienen
• Professor Daniel Linzer – Dean Weinberg College of Arts and Sciences
• Ronald Braeutigam – Associate Dean for Undergraduate Studies
• Dr. Steven T. Rosen, MD, FACP – Northwestern University Feinberg School of Medicine
• Professor SonBinh T. Nguyen
• Professor Teresa K. Woodruff
• Professor Mark Hersam
• Professor Stephen Fisher – Assistant Provost
• Professor Hilary A. Godwin
• Thy Nguyen – Assistant Director Career Services
• Northwestern University Biomedical Engineering Department
• Joe Cribari, Undergraduate Success in Science Program

The University of Chicago
• Professor Steven J. Sibener – Head of the James Frank Institute
• Professor Milan Mrksich
• William Michel - Asst. Vice President for Student Life and Assoc. Dean of the College
• John Boyer - Dean of the College
• Professor Laurie Butler

• Thank you to all of our faculty judges.
• Thanks to all the undergraduate volunteers for all of their help.

To all CAURS Participants,

Welcome to the 2nd Annual Chicago Area Undergraduate Research Symposium! This symposium is a citywide event meant to promote undergraduate research and to foster interaction between all of the Chicago area universities. The organization is entirely student-run, with undergraduates taking time to organize every aspect of the event and to ensure its success. I would like to personally thank all of the CAURS committee members and student volunteers for helping to make this year's event such a success.

The participation in this year's event looks to be nearly double that of last year. For this, we thank all of the student presenters who have taken time to share their research with other members of the Chicago Area scientific community and all of the faculty members from each school who have graciously dedicated their time to this event. I want every student presenter to realize that you will be presenting your research to an excellent audience this year, whether it be the world-renowned expert in your field or a fellow student at the neighboring institution that happens to share your research interests. Take full advantage of this wonderful opportunity!

I am extremely happy to see the growing success of CAURS, and hope that it will become a staple of the Chicago science community for years to come! To all participants, I sincerely hope that you will enjoy all of the presentations at this year's event!

Kevin Miklasz
CAURS Co-director
University of Chicago Student

ILLINOIS INSTITUTE OF TECHNOLOGY

Transforming Lives.Inventing the Future.

Allan S. Myerson, PhD, PE
Provost & Senior VP
Phillip Danforth Armour
Professor of Engineering

Perlstein Hall, Room 223
10 West 33rd Street
Chicago, IL 60616

312-567-3163
312-567-7018 Fax
myerson@iit.edu

April 1, 2006

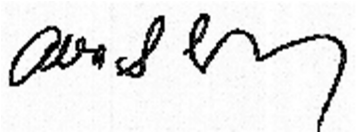
Dear CAURS Participants and Visitors:

On behalf of Illinois Institute of Technology, welcome to the second annual Chicago Area Undergraduate Research Symposium. I am delighted that IIT is one of the sponsors for this event and that IIT students are participants and organizers.

Undergraduate research is a vital part of a university's activity. This event affords an opportunity for students to utilize what they learn in the classroom and make informed decisions about their careers in science and engineering.

Today's events would not be possible without the efforts of the student organizers. Such an inter-institution event is challenging to coordinate and they have all done an outstanding job. Congratulations!

Sincerely,



Allan S. Myerson

April 1, 2006

Dear CAURS Participants, Judges, and Faculty Members,

Welcome to the Second Annual Undergraduate Research Symposium!

Loyola is pleased to collaborate with the University of Chicago, the University of Illinois at Chicago, Illinois Institute of Technology, DePaul University, and Northwestern University this year to offer undergraduate leaders in research the opportunity to present and discuss your research in the sciences. Your participation in the symposium furthers Loyola's commitment to promoting research opportunities for undergraduate students.

Research is fundamental to the life of the academy. As an undergraduate engaging in research, you are enhancing your respective institutions and disciplines. Thank you for these contributions. I hope the time you spend presenting and discussing research with peers and faculty mentors will provide you with new insights into your respective disciplines.

I offer thanks to the organizers of this symposium. Last year's success has set high expectations for this year's program. I hope once again this inter-university collaboration will be another rich experience for all participants.

Sincerley,

Michael J. Garanzini, S.J.
President

Michael J. Garanzini, S.J.
President, Loyola University Chicago

820 N. Michigan Avenue
Chicago, IL 60611
312.915.6400

NORTHWESTERN
UNIVERSITY

Henry S. Bienen, PhD
President
Northwestern University
Rebecca Crown Center
633 Clark Street
Evanston, Illinois 60201

847-491-7456
847-467-3104 Fax
nu-president@northwestern.edu

April 1, 2006

Dear CAURS Participants and Visitors:

On behalf of Northwestern University, I welcome you to the second annual Chicago Area Undergraduate Research Symposium. Northwestern has a deep and sustained commitment to undergraduate research; I am very pleased that many Northwestern students are participants and organizers of today's event.

Research is an integral part of academia and it is my hope that your experience here will broaden and deepen your appreciation of the research process and encourage you to involve yourself in it. By investing yourself in a hands-on research project you gain significant insight into some topic area and valuable experience in creating new knowledge.

I would especially like to thank all the organizers of this symposium. Coordinating a cross-university program like this one involves a great deal of time and effort; their dedication is very much apparent in this exceptional event.

Sincerely,

Henry S. Bienen
President

THE UNIVERSITY OF CHICAGO

April 1, 2006

Dear CAURS Participants,

On behalf of the faculty, staff, and students at the University of Chicago, welcome to the 2nd Annual Chicago Area Undergraduate Research Symposium. The University of Chicago is pleased to host the event this year.

A group of undergraduates from universities around Chicago have been working together all year to create this symposium. As talented undergraduate researchers, I wish you the best of luck as you learn from each other's research and compete for awards. The events of the day are designed to promote beneficial interactions between the students, professional researchers, illustrious speakers, and distinguished faculty in attendance – I hope you will make the most of all today has to offer.

Thank you for taking part in the 2006 Chicago Area Undergraduate Research Symposium (CAURS). I hope you find this event a valuable resource for experiencing first-hand the cooperative endeavors of the Chicago research community.

Sincerely,

John W. Boyer
Dean
Martin A. Ryerson
Distinguished Service Professor of History

John W. Boyer, PhD
Dean
Martin A. Ryerson
Distinguished Service
Professor of History
The University of Chicago

1116 East 59th Street
Chicago, Illinois 60637

773-702-8576
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Awards

FACULTY RESEARCH AWARDS

The Faculty Research Awards are presented to professors who have fostered and developed undergraduate research at their academic institutions.

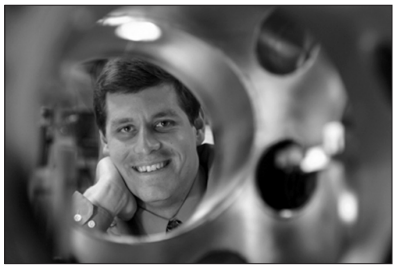
Carlo Segre, Illinois Institute of Technology

Carlo Segre began his scientific career with bachelors degrees in chemistry and physics from the University of Illinois at Urbana-Champaign. He received his Ph.D. in physics from the University of California, San Diego in 1981. After two years as a post-doc, he joined the faculty at the Illinois Institute of Technology, where today he serves as a professor of physics, and Associate Dean of the Graduate College. A member of the American Physical Society and Sigma Xi, he is also a senior staff member of the Center for Synchrotron Radiation Research and Instrumentation at IIT, and the Deputy Director of the Materials Research Collaborative Access Team at the Advanced Photon Source at Argonne National Laboratory. In addition to all of these responsibilities, Professor Segre finds the time to mentor numerous undergraduate students, and has been the instrumental voice of the students working to further IIT's CAURS participation.

John Kelly, Loyola University Chicago

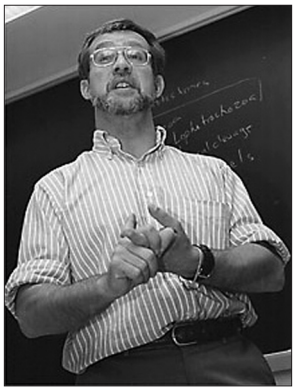
Dr. John Kelly is currently an assistant professor in the Department of Biology at Loyola University Chicago. Dr. Kelly received his Bachelors Degree in Biology from Dartmouth College in 1990. He received his Masters degree in 1995 and his PhD in 1998, both from Rutgers University. From 1998 to 2001 Dr. Kelly worked as a post-doctoral fellow in the Department of Civil and Environmental Engineering at Northwestern University, and in 2001 he joined the faculty at Loyola. Dr. Kelly's teaching responsibilities at Loyola include *General Biology*, *General Microbiology*, and *Microbial Ecology*. Dr. Kelly's research examines the impacts of human induced ecosystem changes on microbial communities, with a special focus on microbes involved in the nitrogen cycle. Dr. Kelly's lab is also involved in the development of new molecular biology tools for the study of these nitrogen cycling microorganisms.

Mark Hersam, Northwestern University



Mark C. Hersam is an Assistant Professor of Materials Science and Engineering in the McCormick School of Engineering and Applied Science at Northwestern University. His research group, which includes numerous undergraduates, develops scanning probe microscopy (SPM) techniques to enable single molecule sensing, characterization, and actuation. Professor Hersam received his B.S. and Ph.D. degrees in Electrical Engineering from the University of Illinois at Urbana-Champaign. He also received a Marshall Scholarship, which he used to complete an M.Phil. degree in Microelectronic Engineering and Semiconductor Physics from the University of Cambridge (UK). He has won numerous awards including an Alfred P. Sloan Research Fellowship, an NSF CAREER Award, and an Arnold and Mabel Beckman Young Investigator Award. Professor Hersam is widely involved in promoting undergraduate education and undergraduate research. His teaching has been honored by Northwestern University's student government, which placed him on the Faculty Honor Roll in 2004, and by the Materials Science and Engineering Department, which gave him the Teacher of the Year Award in 2003. Professor Hersam has promoted undergraduate research by mentoring undergraduates in his laboratory. He also directs the Nanoscale Science and Engineering Center's REU at Northwestern, which annually gives undergraduates the opportunity to experience nanotechnology research. Furthermore, Professor Hersam has served on the faculty review board for the Northwestern Undergraduate Research Journal for all three years of the Journal's existence.

Michael LaBarbera, The University of Chicago

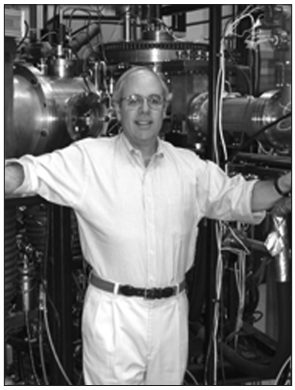


Mike LaBarbera is a profesor in the Department of Organismal Biology and Anatomy and the Department of the Geophysical Sciences. Mike's research interest cover a variety of morphological issues, from the mechanical properties of snail shells, to the evolution of swimming in scallops, to the hydrodynamics of flow past crinoid tube foot arrays. His primary research interest lies in the design of fluid transport systems in invertebrates and vertebrates. Mike teaches several courses a year open to both undergraduates and graduates. His lectures are captivating and enlightening, while his labs are fast-paced and interactive. His students are continually working on a broad variety of problems, usually related to his own research only in that their problems involve biomechanics. Mike has guided his students through investigations into the biomechanics of flying snakes, insect breathing, and fish fins. He is extremely dedicated to helping his students understand biomechanical issues both inside the classroom and in the lab.

Awards for best oral presentation, best poster presentations, best abstract, and project proposal will be announced after dinner at the Dessert and Awards Ceremony.

FACULTY PRESENTERS

Steven J. Sibener, Ph.D., The University of Chicago



Opening Address
9:30 a.m., Claudia Cassidy Theater

Steven J. Sibener, the Carl William Eisendrath Professor and Director of The James Franck Institute at The University of Chicago, has made important contributions to chemical physics, materials chemistry and nanoscience. He has conducted pioneering molecular beam studies of combustion processes, mechanistic studies of interfacial catalytic reactions and precision measurements on the atomic-level dynamics of interfaces. In particular, his innovative use of sophisticated gas-surface scattering instruments and atomic-resolution scanning probe microscopes has led to advances in these areas of research. In addition to the above, his program is now examining molecular self-organization, polymeric nanostructure formation, and nanoscience projects that may lead to the development of novel magnetic, catalytic, electronic and optical materials.

Sibener accepted appointment to the Chicago faculty in 1979 while still a graduate student. He then spent a year at Bell Laboratories conducting his postdoctoral research. He returned to Chicago in autumn 1980. Sibener also spent one year at the University of Colorado as a visiting fellow at the Joint Institute for Laboratory Astrophysics. He served as director of the University's Materials Research Science and Engineering Center from 1997 to 2001. He is also Director of the multi-university Center for Materials Chemistry in the Space Environment. Sibener's honors include the Marlow Medal of the Royal Society of Chemistry, an Alfred P. Sloan Foundation research fellowship, a Camille and Henry Dreyfus Young Faculty Award in Chemistry and an IBM Faculty Development Award. He is an elected fellow of the American Physical Society. Sibener received bachelor's degrees, with honors, in chemistry and physics from the University of Rochester. He earned his M.S. and Ph.D. degrees in chemistry from the University of California, Berkeley.

Milan Mrksich, Ph.D., The University of Chicago

Research Lecture: Living Devices: Integrating Cells with Electronics
1:00 p.m., Claudia Cassidy Theater

Milan Mrksich is an Investigator with the Howard Hughes Medical Institute, and Professor of Chemistry at the University of Chicago. Dr. Mrksich was raised in Chicago, attended the University of Illinois, earned his Ph.D. at Caltech and
served as an American Cancer Society Postdoctoral Fellow at Harvard University prior to joining the faculty at the University of Chicago. Dr. Mrksich directs a laboratory that develops materials for a range of biological applications. One
program develops biochips--these are arrays of proteins, carbohydrates, and drug candidates--that are used to understand the abnormal cellular processes that lead to disease. These same approaches have been used to perform
chemical screens that generate small molecules that may combat infectious diseases, including that caused by anthrax. Another program develops methods to apply biologically active coatings to medical devices and in turn to improve their integration with surrounding tissues. This work is developing coatings that selectively interact with target cells in the body, that prevent clotting responses, and that can perform diagnostic assays on the surrounding tissue. Dr. Mrksich has published more than 100 papers and presented several hundred lectures on his work. He serves on the Board of Governors of Argonne National Laboratory, as Chair of the DARPA Defense Sciences Research Council and as a member of the editorial boards of several scientific journals. He is founder of WMR Biomedical and serves on the scientific advisory boards of ChemoCentryx, Surface Logix, and Helicos.

Hunter O'Reilley, Ph.D., Loyola University Chicago

Keynote Address

5:00 p.m., Preston Bradley Hall

Dr. Hunter O'Reilly is the both an internationally shown artist and also experienced geneticist. She reinterprets science as art through abstractions, digital art and installations. She holds a Ph.D. and Masters degree in Genetics from the University of Wisconsin—Madison, and a bachelors of science from the University of California-Berkeley. Dr. O'Reilly teaches biology and art at the University of Wisconsin-Milwaukee. She created a course, Biology Through Art, where students have the opportunity to create innovative artworks in a biology laboratory.

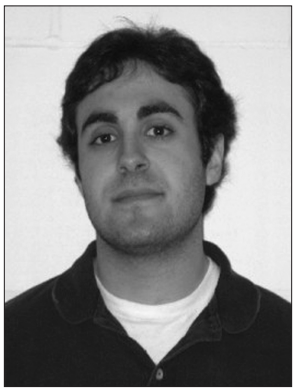
With her extensive laboratory experience, Dr. O'Reilly brings a unique and challenging perspective to the world of biotechnology via her art. When other scientists just see cells, she sees faces and living entities. Dr. O'Reilly sees a person not only as a whole but also as a composite of their DNA and cells.

Dr. O'Reilly has been awarded grants from the Puffin Foundation, the University of Wisconsin-Milwaukee and Fisher Scientific for the creation of Radioactive Biohazard, an exhibit reinterpreting science as art looking at biotechnology from a positive perspective. Radioactive Biohazard was shown at the Walker's Point Center for the Arts in 2001 and at the Warren Robbins Gallery at the University of Michigan in September 2002.

Previously, Dr. O'Reilly's Abstract Faces series of oil paintings showed internationally including New York, San Francisco, England, Italy, Japan and the Czech Republic. Her artwork has been featured in over twenty publications, including ten covers. Further, Dr. O'Reilly has been the subject of more than two dozen newspaper and magazine articles.

UNDERGRADUATE PRESENTERS

Scott Kelber, The University of Chicago



Erosion of Polymers in Low Earth Orbit Conditions

1:30 p.m., Claudia Cassidy Theater

I am a senior at the University of Chicago majoring in Physics and Economics. I have been working in the materials research lab of Dr. Steven Sibener since October, 2004, doing research on polymer erosion in low earth orbit conditions. Previously I worked in the lab of Dr. Bruce Gnade and Dr. Robert Wallace at the University of Texas at Dallas conducting magnetron sputtering deposition and electron-beam deposition studies of organic semiconducting films in a clean room environment. I also conducted Rutherford Back Scattering studies with alpha particles and protons using a particle accelerator in the lab of Dr. Jerome Duggan at the University of North Texas.

I was born in Albuquerque, NM and moved to Plano, TX in 1991 at the age of seven, graduating from Plano Senior High School in 2002. Though science has always been a leading interest, I was on the debate team in high school and in my free time I enjoy sports, reading historical non-fiction, and karaoke. I also currently serve on the executive board of the Lambda chapter of the Alpha Epsilon Pi fraternity at the UofC as a counselor and general troubleshooter.

Jamie Iatropulos, DePaul University

1:50 p.m., Claudia Cassidy Theater

Jamie Iatropulos, a senior at DePaul University, is currently studying to obtain a Bachelor of Science degree in Environmental Science with an emphasis in chemistry. She is a member of the National Society for Collegiate Scholars and the National Society for Women in Chemistry. For the past two years, she has served as a teaching and research assistant for the Environmental Science Program and has had the opportunity to conduct her own research, under the guidance of Dr. Liam Heneghan and Lauren Umek. The research was conducted on the effects of European Buckthorn (Rhamnus cathartica, L) on soil decomposition in Midwestern woodlands using the method of cotton strip assay. Currently, she is working on a project with Lauren Umek, thanks to the generous funding of the McCormick Tribune Foundation, to compile, analyze, and summarize ecosystem oriented research data conducted by Environmental Science Program students over the past 6 years on properties managed by Lake Forest Openlands Association (LFOLA). This document will serve as an invaluable resource for management and for ongoing research activity on land owned by LFOLA.

Manasi Vydyanath, The University of Chicago

2:10 p.m., Claudia Cassidy Theater

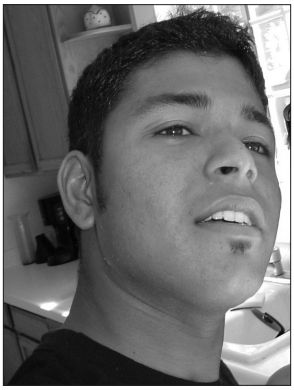
Manasi Vydyanath is a third-year student at the University of Chicago, concentrating in Economics and Statistics. She graduated with six A-levels from the British School of Kuwait in June 2003. Her engagement with economic research is characterized by a keen interest in applying rigorous mathematical and empirical analysis to gain insight into consumer behaviour in unconventional contexts, especially in interdisciplinary fields of inquiry. Manasi's research background includes working as a research assistant with Dr. James Heckman and Dr. Jeremy Fox, as well as independent research in group dynamics and information dynamics. Her current work with Dr. Damon Phillips centers around analyzing the market for classical music in the light of consumer choices when faced with an exogenous as well as endogenous set of information variables, trying to get at the heart of what audiences seem to 'like' and what this might imply for the future of classical music as an art form. She expects this to be the first of a series of explorations into information dispersion for products whose value is based to a large extent upon apperception, such as the broadly defined arts. Manasi is also the Classical Music editor of the University of Chicago Maroon, and enjoys writing poetry, reading extensively and omnivorously, opera, mathematically wicked one-line proofs, and coffee.

Matthew Kolinski, Loyola University Chicago

Analysis of the *Arrested Development 1* expression using Promoter Reporter analysis of the Arabidopsis

3:00 p.m., Claudia Cassidy Theater

Matthew Kolinski is a Senior Biology Major at Loyola University Chicago. He will be graduating with honors in May 2006. He has been involved with Dr. Pickett and his lab since June 2004. He is currently working on his Senior Honor's Thesis in Dr. Pickett's Lab which will include his work with the plant Arabidopsis. Outside of research, he works as a Building Manager in the Fitness Center on Campus and he is involved with Campus Ministry as a leader and supervisor. While at Loyola, Matthew had the opportunity to study abroad
for a semester in Rome, Italy where he was able to study in the eternal city and "Live the Vida Dolce." Learning about other cultures and customs has enriched the education recieved by Matthew while attending Loyola University Chicago.



Anup Shah, Northwestern University

Synthesis and Characterization of Metal-Polymer nanorods with poly((2-terthiophenyl)norbornene)

3:20 p.m., Claudia Cassidy Theater

Anup Shah currently resides in Evanston, Illinois and attends Northwestern University as a junior majoring in Mechanical Engineering and Integrated Science. Anup is far from the warm, welcoming streets of Los Angeles, California, where he spent his formative years.

Anup is currently doing research under Chemistry professor SonBinh Nguyen researching the fluorescent properties of metal-polymer nanorod structures. The research, under the auspice of the Murphy Society Nanotechnology grant, utilizes Scanning Electron Microscopy (SEM) as well as fluorescence microscopy as tools for characterization of the one-dimensional nanostructures.

Interested in collaborative efforts between engineering solutions and scientific discovery, Anup plans to pursue a career in development and research of alternative energy.

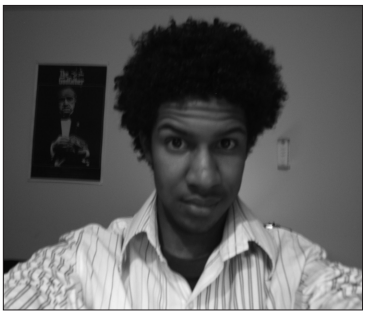
Anup also enjoys architecture, particularly sustainable or 'green' building as well as project-based initiatives. Most recently, Anup founded a website, www.thecabshare.com, which helps Northwestern students find cab-sharing partners in the Northwestern community.

Alison Eckhardt and Rhyan Washington, The University of Chicago

Scaling of Chewing Frequency in Old and New World Primates

3:40 p.m., Claudia Cassidy Theater

Alison studied theatre at Reed College in Portland, Oregon, before transferring to the University of Chicago in the fall of 2004. She is currently working towards a Bachelor's in Anthropology, writing her honors thesis on Mongolian and Siberian shamanism. She became interested in primatology after taking several physical anthropology classes with Russell Tuttle, and in the spring of 2005 began working with Callum Ross and Rhyan Washington on the project being presented today. After graduation in June, she plans to apply for the Peace Corps, and then return to school to pursue a career in physical anthropology.



Rhyan is currently a third year at the University of Chicago, where he is studying Biological Sciences with a specialization in Neuroscience. While he enjoys studying a broad range of biological topics, his primary interests are those of biomechanics and neuromuscular control, anatomy, and how these relate to the development and efficiency in human limb movements. At Chicago, Rhyan works closely with biomechanic and paleontologist, Dr. Callum Ross and undergraduate colleague, Alison Eckhardt. Over the last two years, they have been investigating the mechanics and scaling factors in feeding kinetics in anthropoid and strepsirrhine primates to determine whether there are relationships between the feeding apparatus and similar locomotor systems. This includes experiments and investigations in the regulation of locomotor energetic efficiencies of biting, chewing, and swallowing. Most recently, he worked with Dr. Ross and presented these investigations at two research symposiums, including one at the Society of Integrative Comparative Biology.

Ultimately, Rhyan wishes to gain enough knowledge and experience in the field of biomechanics and pursue a career in developmental prosthetics, particularly those of limb prosthetics. In his free time, he enjoys running, reading, playing computer games, and playing trumpet.

James Pierce, Illinois Institute of Technology

A linear-time algorithm for finding p-centers of trees

4:00 p.m., Claudia Cassidy Theater

Michael Kozminski. Northwestern University

Solution 1H-NMR Reveals Distinctions among Genera within the Family Pinaceae

4:20 p.m., Claudia Cassidy Theater

Michael Kozminski is currently a junior at Northwestern University pursuing a double major in biological sciences and economics. Prior to Northwestern, Michael attended Savannah High School in Savannah, MO. There, he participated in a variety of activities, spending most of his effort on debate and forensics. He is a member of Alpha Lambda Delta and has made the Dean's List every quarter. Outside of class, Michael is a member of Alpha Epsilon Pi, in which he has served as steward and academic coordinator. He is also involved with Unite for Sight (UFS). Back in Missouri, Michael co-established an on-going eyeglass drive in support of UFS. The drive has collected hundreds of glasses that will be sent to needy children and adults across the world. In addition to working with Dr. Joseph Lambert, Michael donates time every week to Dr. Beverly Wright's psychoacoustic laboratory, where he is currently examining the possible correlation between the neural mechanisms of frequency discrimination and pitch shift. After completing his undergraduate studies, Michael plans on attending medical school and becoming a surgeon.

Biology

1

IPRO 302: Synthetic Biology: Engineering Novel Organisms

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Advisor: Nicholas Menhart

We know much about the things life is made up of – the genes, proteins metabolites and other molecular machines - but we still do not really have a good answer to the question, "What is life?". It does seem that there is something intrinsically dynamic about life – a dead person is to a very good approximation identical to a live person in composition and structure on a molecular level. It seems that life is inherently bound up in some way with the system of these components, and their dynamic interactions.

One way to approach the problem of understanding how something as complex as life arises from these comparatively simple molecular machines is to try to build a simple dynamic system from first principles. Our test case is a synchronized version of a three state genetic oscillator developed in unsynchronized form by Elowitz. We have been constructing an implementation of this circuit in a plasmid with a series of genes, the products of which induce three different genes that code for fluorescent proteins. We are also elaborating it to includes intercellular synchronization mediated by quorum sensing, using the lux operon (Vibrio fischeri) so that an entire population of bacteria would produce the same color florescent protein at the same time. We are also developing an implementation of it in a more complex organisms, the zebrafish Danio rerio. The longer this project goes on and the larger the scope, the more will be understood about how genes work together in an organism.

2

Emefa Amartey, Northwestern University
Advisor: Robert Homgren

Cubitus Interruptus (Ci) is a transcription factor in Drosophila, which is regulated by the Hedgehog signaling pathway. In addition to the activation and DNA binding domains in Ci, it also contains many phosphorylation sites. We have identified a conserved domain in the N-terminus of Ci, which we have termed the 'NR' domain, for N-terminal Regulatory domain. This domain contains a number of conserved serines and a single conserved tyrosine, which could potentially serve as sites of phosphorylation. In previous studies, we find that when the NR domain is present Ci is present in the cytoplasm; however, when the NR domain is deleted Ci is present in the nucleus. In this study, we have mutated the potential phosphorylation sites of the NR domain to alanines and crossed flies carrying these mutated constructs with flies containing various CiGal4 drivers in order to determine expression levels of the various potential phosphorylation mutants the NR domain. We expected that in some cases, the progeny, in which the construct was driven by CiGal4 on chromosome III, will die since CiGal4 on III is a stronger driver than CiGal4 on II; and that most lines from CiGal4 will survive. The lines will be crossed with Ac5C/CD2/Gal4 to make clones of the cells expressing the mutant construct. We'll then assay the subcellular

localization of the mutants to find which sites are important for the regulation of Ci, and are perhaps phosphorylated. Mutants that exhibit cytoplasmic staining indicate to us those sites that are not important for subcellular distribution because they exhibit wildtype characteristics, as if the NR domain was not mutated at all. However, mutants that display nuclear staining will tell us which sites are important. This result will be useful in ultimately revealing which potential phosphorylated sites are required for the appropriate subcellular localization in Ci.

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3 Effects of an Invasive Cattail Species on Sediment Microbial Communities in a Wetland Ecosystem

Nicholas L. Angeloni, Loyola University Chicago
Advisor: John J. Kelly

Wetlands protect surface water quality by removing terrestrially-derived nutrients such as carbon and nitrogen from water through the activities of wetland plants and associated microbial communities. We examined sediments in Cheboygan Marsh, a coastal freshwater marsh on the northwestern shore of Lake Huron that has been invaded by an emergent exotic plant, Typha x glauca, to assess the impact of this invasion on wetland microbial communities. Comparison of invaded and un-invaded zones of the marsh indicated that the invaded zone showed significantly lower plant diversity, as well as significantly higher aboveground plant biomass and soil organic matter. The invaded zone also showed dramatic increases in levels of extractable soil nutrients, including a fourteen-fold increase in ammonium, a ten-fold increase in nitrate, and a ten-fold increase in phosphate, which suggests that the Typha x glauca invasion may be impacting the wetland's ability to sequester nutrients. T-RFLP analysis of the sediment bacterial communities based on 16S-rRNA genes revealed significant differences in bacterial community composition between invaded and un-invaded zones, and T-RFLP analysis of denitrifying bacterial communities based on nirS genes revealed significant differences in denitrifier community composition between invaded and un-invaded zones. This shift in denitrifiers may be ecologically significant due to the significant role that denitrifying bacteria play in the removal of nitrogen.

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4 Comparisons of Nutrient Cycling in Soils Dominated by *Rhamnus cathartica* and Un-invaded Soil along a Gradient in Earthworm Density: A Microcosm Study

Melissa Barnhart, DePaul University
Advisor: Liam Heneghan

Earthworms contribute to productive and fertile soils by decomposing organic material, naturally aerating the soil, and depositing nutrient-rich casts. Their activities accelerate nutrient cycling and the mineralization of nutrients within the soil. Consequently, areas of soil heavily populated by earthworms are often the most rich in available nutrients. Soils underneath *Rhamnus cathartica* (European Buckthorn), a prevalent invader of Chicago's woodland, maintain densely populations of earthworms, due to the palatability of its leaf litter. Consequently, these soils are often very high in plant available nutrients, especially nitrogen. I report on an experiment to measure the fluxes of key nutrients from soils where buckthorn grew and from un-invaded soil,

at varying levels of earthworm density. Replicate microcosms were leached every two weeks; using 150 mL of deionized water and the filtrate from each microcosm was measured for nitrate, ammonium and potassium. The experiment is designed in such a way that we can test the hypotheses that nutrient mineralization in the two soils differs, and that there is a greater level of mobility in soils with higher earthworm densities. I will discuss the implication of results for regional ecological restoration projects.

5

Organization of a Specific Satellite III Sequence on Human Chromosome 21

Joubin Bavarian, Loyola University Chicago
Advisor: Jeffrey Doering

The satellite III subfamily consists of a short monomer (5'-GGAAT-3') tandemly repeated up to thousands of times within a heterochromatic region of DNA. The sequencing carried out by the human genome project largely ignored these regions, which are found in the centromeric and short arm regions of all acrocentric chromosomes, since they were thought to be barren of any genes. The research presented investigates one such clone of satellite III DNA found on human chromosome 21, p1-8.1A, estimated to be 4080 base pairs in length. Preliminary sequence data has identified this clone to belong to the Group I subfamily of satellite III DNA, which is characterized by a predominant 5'-GGAAT-3' consensus monomer, and a low percentage of the 5'-GGAGT-3' variant monomer repeats. Mapping techniques using a HC21 hybrid cell mapping panel were used in determining the specific location of this sequence on chromosome 21. The current model of the acrocentric chromosomes indicates that there is very little variation among the sequences of their short arms, and thus no markers have yet been designed that are unique to the short arm of HC21. Discovery of such a marker is important in gaining a better understanding of the causes of chromosome 21-related disorders, such as Down syndrome, by being able to follow specific copies of chromosome 21 between generations, as well as providing a method of rapid diagnosis of Down syndrome.

6

Andrew Chang, Northwestern University
Advisor: Robert Blank

Fractures are an important health problem. The causes of a fracture are dependent on the strength of the bone and the load to which it is subjected. Previous studies show that different strains of inbred mice express distinct bone properties, while also harboring different alleles at many different genetic loci. By breeding mice with differing bone properties we can relate various bone phenotypes to animal genotype. The genotypes of the mice are determined by microsatellites. The phenotypes include measures of biomechanical performance, bone size, bone mineral content, and animal size. Data analysis relies primarily on linear regression. Several loci show statistically significant evidence of linkage and association with bone phenotypes. The next step in this work is to isolate and identify the responsible genes.

7 The Effect of Temperature on the Release of Phosphorus due to the Microbial Decomposition of Wetland Detritus

M. Keegan Delaney, DePaul University
Advisors: J.M. Eames and J.A. Montgomery

Few studies have examined the release of phosphorus (P) to the water column in result to the microbial decomposition of wetland detritus. The current study examines the release of soluble reactive phosphorus (SRP) from wetland detritus into the water column via microbial decomposition and the effect temperature has on the process. Bench-top experiments were used to simulate the decomposition of emergent vegetation during the late fall through early spring. Twelve 10-gallon aquaria were filled with tap water and emergent plant material from the wetland. The treatments consisted of three different temperatures. Water samples were taken weekly and the concentration (mg/L) of SRP was measured using ion chromatography. Nonlinear regression using the Gompertz model was utilized to create empirical models describing the growth trajectories for each treatment. Monte Carlo simulations were used to generate 95% confidence intervals of the parameters, and the parameters are known precisely for each treatment. A one-way ANOVA and Bartlett's test was performed on the models to evaluate the effects of temperature on the process in question. The results show that the means and variance of the experimental groups are not equal, revealing that temperature had an effect on the release and subsequent increase of SRP (mg) in the water column. The final mass SRP and overall growth was positively correlated to temperature. This suggests that the microbial decomposition of wetland detritus and the subsequent release of SRP to the water column would be the greatest during time intervals when warm water temperatures are sustained.

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8 The Phenotypic Analysis of the Sleep/Wake Cycle in Neonatal Inbred Mouse Strains

Magdalena Dumin, Northwestern University
Advisors: Ketema N. Paul and Fred W. Turek

The relationship between poor sleep and poor health underscores the need to identify the components of sleep that are genetically encoded. Studies in adult mice have revealed several sleep traits that are quantitatively driven by chromosomal elements. In the current study, we used a novel protocol to analyze sleep and wakefulness in pups from five inbred mouse strains. Pregnant females (14 days post-pregnancy) from each strain were housed in 14L:10D for the remainder of their gestational period. Food and water were available ad libitum. Newborn pups remained with their respective dams for nine days after delivery (approximately 18-21 days post-pregnancy). On postnatal day 9, pups were implanted with electromyographic (EMG) electrodes and were allowed to acclimate to the recording apparatus for 30 min after which sleep-wake patterns were continuously recorded for 120 min. The EMG waveforms were collected and manually scored. One-way ANOVA revealed that total amounts of wakefulness, active sleep (AS), and quiet sleep (QS) during the recording period, as well as the mean bout duration of each vigilant state were different between the strains. These data suggest that sleep-wake architecture in pups is under a significant degree of genetic regulation. Neonatal sleep-wake patterns are relatively independent of a) circadian regulation and b) the daily homeostatic challenges that

govern sleep-wake architecture. In this respect, they represent sleep-wake regulation in its most fundamental state. In addition, AS and QS are considered precursors to REM and NREM sleep, respectively. Therefore, these results may be predictive of sleep regulation in adults.

9

Scaling of Chewing Frequency in Old and New World Primates

Alison Eckhardt and Rhyan Washington, University of Chicago
Advisor: Callum Ross

An important determinant of the rate at which an animal obtains energy is the rate at which it can intake food. Cropping and masticatory processes determine the rate at which an animal intakes food, therefore chewing frequency is an important determinant of food intake rate. It has been hypothesized that chewing frequency (C_f) scales similar to an oscillating pendulum where C_f α body mass $(M_b)^{-0.17}$. This model was tested in 26 species of anthropoid and strepsirrhine primates whose masses ranged from 1 kg to 130 kg by video recording sequences in which the primates chewed various foods. The recordings were analyzed frame by frame and chewing frequency was measured for each primate and correlated with body mass. It was found that an increase in body mass resulted in a decrease in chewing frequency. Chewing frequency scaled close to body mass$^{-0.17}$ despite differences in the primates' food diets. It was concluded that the process of chewing is more related to jaw mechanics rather than physiological based rhythms such as metabolic rate.

10

Using second-to-fourth digit ratios in rats as a fast and easy method to assay sexual dimorphisms and hormone activity

Daniel Eckroth, Loyola University Chicago
Advisor: Diane Suter

The ratio between the second and fourth digits (2D:4D) is thought to be controlled by *in utero* concentrations of sex steroids, and can be useful as a general indicator of sex differences in mammals. The purpose of this investigation was to test whether the observed ratio in rats is sexually dimorphic. Paws from eight day-old rat pups were exposed to a series of stains and clearing agents to expose the bone and cartilage in the paw. The paws were photographed, and the proximal, middle, and distal phalanges of the second and fourth digits were measured and analyzed. The average digit ratios for male and female rats were 0.94 (S.D. ± 0.05) and 0.96 (S.D. ± 0.05), (P=0.352). The results suggest that there is no measurable difference between the observed 2D:4D ratios in the laboratory rat. Therefore, presently this technique cannot be used as an assay of sexual dimorphisms or hormone activity. It may be of interest to note a pattern which emerged when we examined the relationship between digit ratio and litter number. Pups from each individual litter exhibited similar 2D:4D ratios, and there were significant differences among litters (P<0.005). Investigators may wish to focus on whether this difference can be attributed to genetic differences among litters or differences in the *in utero* environment of each litter.

11 BDNF and NT3 Attract Trigeminal Neurites

Amina Egwiekhor and Philip Vatterott, Loyola University Chicago
Advisor: William Rochlin

Trigeminal and geniculate axons are both attracted to gustatory papillae, but are restricted to non-overlapping areas within the epithelium. We recently found that BDNF is an attractant for geniculate neurites. We therefore investigated which neurotrophins stimulate trigeminal neurite growth by bath application and tested their ability to attract these neurites using slow release beads in collagen gels. Explants were dissected from E15 and E18 rat embryos corresponding to in vivo intralingual pathfinding and target penetration stages, respectively. Bath applied NGF was the most potent and efficacious at eliciting outgrowth at E15 and E18. NT3 was more effective than BDNF at E15, but this reversed at E18. NT3 stimulated finer fascicles than BDNF or NGF. Beads soaked in BDNF, NT3, and BDNF + NT3 did not promote appreciable neurite growth from E15 ganglia, but BDNF- and NT3-soaked beads did attract E18 trigeminal neurites, as reflected by convergence of proximal neurites toward the bead vs radial divergence of distal neurites from the opposite side of the explant. BDNF + NT3 beads elicited the most robust attraction. In preliminary experiments, NGF soaked beads biased outgrowth less than either BDNF or NT3 at E18. Taken together, our observations support the following model: NGF exerts the predominant trophic influence throughout pathfinding and targeting. BDNF and NT3 attract trigeminal axons to the papillae epithelium, and NT3 promotes defasciculation within the epithelium.

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12 Damage Searching Mechanism of Alkylation Repair Proteins

Zishaan A. Farooqui, University of Chicago
Advisors: Chuan He and Erica Duguid

It has been found that a family of DNA repair proteins, O6-alkylguanine-alkyltransferases, repairs methylation of guanine by irreversibly transferring the alkyl group of the damaged guanine onto its own Cys residue. Because it can repair such alkylation, AGTs may confer resistance to tumor cells that are treated by chemotherapeutic alkylating agents. Therefore, a major goal of clinical trials is to inhibit AGT. How do AGT proteins find the alkylation? Previous research shows that the repair function may be "base-flipping" of the damaged lesion. However, the actual search mechanism is unknown. In our research, we employ the fluorescent nucleotide Pyrrolo-c to study how human AGT (hAGT) and c-Ada (a prokaryotic homolog) search for damaged DNA. Preliminary results agree with previous findings, suggesting that c-Ada does not flip out every base pair in DNA to look for damage. hAGT, however, may be able to flip out stable base pairs. Further experiments to elucidate a "sliding" and/or "hopping" mechanism of damage searching include kinetics studies with varying lengths of DNA. If the kinetics of the Protein-DNA interaction varies with the length of DNA substrate, we can better understand the ways in which AGT "gets around" to find alkylation damage.

13 Assessment of Soil Microbial Communities in Surface Applied River Sediment / Biosolids Mixtures

Emmanuel Favila, Loyola University Chicago
Advisor: John Kelly

The accumulation of sediment in the Illinois River over the past century has resulted in a significant decrease in the depth of the river and associated backwater lakes. This sediment accumulation reduces recreational opportunities on the river and lakes, and greatly limits habitats for aquatic organisms. Removal of this sediment should help to improve the quality of the Illinois River and the associated backwater lakes. However, after removal, this dredged sediment must be disposed of or relocated. The Illinois Department of Natural Resources (IL-DNR) is interested in using dredged sediment as a soil amendment to restore damaged soil and encourage the growth of plants. Preliminary greenhouse work by the IL-DNR demonstrated that mixing Illinois River sediment with wastewater treatment plant biosolids (a.k.a. sewage sludge) resulted in improved plant growth as compared to sediment alone. However, no one has yet examined the microbial communities in these land applied sediments. The objective of our study was to assess the microbial communities in mixtures of sediment and biosolids in the field. We determined the relative size, composition, and activity level of the microbial population, as well as the pH, water, and organic content of soil samples collected from field plots consisting of various mixtures of sediment and biosolids. Our results indicate that mixtures of sediment and biosolids produced a better balance between bacteria and fungi as compared to biosolids or sediment alone. Bacteria and fungi both have significant roles in soil ecosystems, and both are important contributors to soil quality. Therefore, a balance between soil bacteria and fungi is a positive soil attribute. Also, the mixed sediment/biosolids plots showed higher levels actinomycetes than either the biosolids or sediment alone. Due to the major role that actinomycetes play in nutrient recycling in soil and due to the beneficial associations actinomycetes can form with plants, high levels of these organisms is also a positive soil attribute.

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14 Use of Medium and Long-chain Cationic Lipid Variations Increases Efficacy of Vesicle-based Transfection

Emnet Gebrehiiwet, Northwestern University
Advisor: Robert MacDonald

Current research indicates that the use of cationic lipids optimize the efficacy of DNA transfection. While cationic lipids containing modifications in their polar head groups have been of particular focus, our research focuses on the use of lipids with hydrophobic tail modifications. Specifically, EPOPC with varying weight or mole ratios of EDOPC or cholesterol have been used to transfect Human Umbilical Artery Endothelial Cells (HUAEC). Hypothetically, these combinations of varying tail lengths should increase DNA stabilize within the vesicle and increase flexibility in fusion with the endosome. Our research continues to explore the effect of varying cationic lipid length mixtures. The mixtures consist of both EDOPC and EPOPC in the formation

of the vesicles. Their effects on the delivery and expression of β-galactosidase DNA to HUAEC cells are be observed in the presence and absence of serum. Detection of transfection efficacy is measured by using β-galactopyranoside fluorescein as a fluorescent marker. Efforts to establish such results are currently underway and will be instrumental in affirming the conclusion of similar previous research.

15

Organization and Characterization of a Satellite III Sequence on Human Chromosome 21

Rachael Hettinger, Loyola University Chicago
Advisor: J.L. Doering

The human genome sequence does not include the heterochromatic regions, although these sequences comprise 10-15% of the genome. We are constructing a detailed physical map of the HC21 centromere and short arm as a model for the organization of these regions. Satellite III (sat III) sequences are found on the p arm of HC21 both proximal and distal to the rDNA. The research done here pertains to a specific sat III clone, p1-7.3A. This clone was first sequenced and yielded a complete sequence of 2577 base pairs (Hettinger et al., 2004), and through the use of an HC21 hybrid cell mapping panel, was found to be located proximal to the rDNA. Sequencing reveals that this sequence is a member of sat III subfamily I, which is characterized by high percentages the typical GGAAT monomer repeat and very low levels of the GGAGT variant repeat. The sequence has a highly heterogeneous organization with no obvious higher order repeats. BLAST comparisons showed that the new sat III sequence has less than 80% identity with any other currently known sat III sequence in the human genome. Thus, it is a candidate for an HC21p-specific probe.

16

Disrupting the GATA-1 and FOG-1 Interaction as a Therapy for Erythroleukemia and Megakaryoblastic Leukemia

Imge Hulur, University of Chicago
Advisor: John Crispino

GATA-1 and FOG-1 are transcription factors important for proper development of erythroid cells, mast cells, eosinophils and megakaryocytes. It has been experimentally shown that the N-finger zinc domain of GATA-1 interacts with the FOG-1 fingers 1,5,6,9 and that this interaction is essential for the differentiation and maturation of megakaryocytes and erythrocytes. Mutations in the GATA-1 gene that alter the FOG-1 binding domain are associated with familial anemias and thrombocytopenias of differing severity. The structure of the GATA-1 N-finger, elucidated by NMR spectroscopy, reveals that the residues [1-37] mutated in patients reside on the FOG-interaction surface. GATA-1 is also mutated in a subset of patients with acute myeloid leukemia. Leukemia occurs when blood cells escape the normal mechanisms of cell cycle regulation and instead proliferate excessively. Since GATA-1 and FOG-1 are essential for the normal development of erythroid cells and megakaryocytes, we hypothesize that molecules that disrupt the GATA-1 and FOG-1 interaction could be used in the treatment of leukemias that involve these two types of blood cells- erythroleukemias and AMKL We are utilizing two approaches to the problem: First, using peptide arrays and Far Western blotting, we will synthesize peptides that mimic the GATA-1 and FOG-1

interaction and use them as a stepping block to choose small molecules which disrupt the protein interaction. Second, we will also visualize the GATA-1 and FOG-1 interaction by ligand blotting and test a library of small molecules to block the interaction.

I7 Jamie Iatropulos, DePaul University
Advisors: Liam Heneghan and Lauren Umek

Studies indicate that successful invader species alter ecosystem properties that are unique and essential to woodland ecosystems. European buckthorn, *Rhamnus cathartica*, a shrub native to Eurasia and North Africa, was imported to North America in the 1880's and since it's introduction has dominated many oak woodlands in the Chicagoland region. Observations by DePaul University's Environmental Science Program indicate that buckthorn invasion is associated with altered soil properties including: increased decomposition, elevated soil moisture and pH, reduced plant available N (NO3- and NH4+), altered soil C:N and. Elevated decomposition in these systems leads to a collapse of the litter layer, a crucial component of woodland soils as well as altered chemical and physical soil properties. This study further investigates properties associated with decomposition under buckthorn through the use of cotton strip assay. This novel method measures decomposition through the loss of tensile strength of cotton strips (a uniform cellulose substrate) over a period of time in soils. Supplementary characteristics associated with decomposition were also measured including: soil temperature, extractable soil nitrogen, soil moisture and microbial community analysis. Results of this research are consistent with previous work in this lab all measured properties are altered as a result buckthorn invasion that may persist after removal. Since the long-term management for woodland systems often calls for restoration to pre-invaded conditions, evidence that this invasive shrub is creating a legacy effect of altered soil properties may call for a more comprehensive approach to management.

I8 Generation of Adenovirus Encoding Bik for Gene Therapy

Heather King, Illinois Institute of Chicago
Advisor: Jialing Xiang

Deregulation of programmed cell death (apoptosis) contributes significantly to the development of cancer. Therefore, pro-apoptotic molecules have been shown a great potential for gene therapy of cancer. Adenoviral vectors are commonly used for gene expression and delivery vehicles in gene therapy. Here, we regenerated a recombinant adenovirus encoding a proapoptotic molecule, Bik (Ad/Bik). The adenoviral vector also contains Green Fluorescent Protein (GFP), which provides an intracellular marker for infected cells. The Ad/Bik/GFP was packaged in 293 cells. Human cervical cancer Hela cells were infected with Ad/Bik/GFP, with the infection efficiency nearly 100% as monitored by GFP expression. Thus, the Ad/Bik/GFP should provide a useful tool for gene therapy study of cancer.

19 Analysis of the Arrested Development 1 expression using Promoter Reporter analysis of the Arabidopsis

Matthew Kolinski, Loyola University Chicago
Advisor: F. Bryan Pickett

Characterization of developmental genes has provided important insights into regulation of embryogenesis and growth. As a unit, the Pickett Lab has focused their research efforts on the ARRESTED DEVELOPMENT 1 and 3 genes of the plant Arabidopsis. My project concerns the analysis of ADD1 gene expression via construction of a promoter::reporter fusion using yellow fluorescent protein (EYFP) to visualize the pattern of expression for this gene during normal development. Using our current findings, we have advanced the understanding of how the gene affects the plant and are able to point to new areas of expression that have otherwise been unnoticed. Of particular import is my discovery that this gene is expressed in leaves. As an aspect of my work I have modified a fluorescent reporter constructs with the GATEWAY rapid cloning system, thus we now have a quick method for generating promoter and gene fusions to EYFP. My understanding of molecular genetics, particularly with respect to the use of restriction sites, reporter genes and ligation of DNA has grown beyond that achieved in the classroom through the hands-on process of working in the Pickett Lab.

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20 Ganglioside GM3 triggers urokinase plasminogen activator receptor (uPAR) signaling to facilitate melanoma growth and metastasis

Viola Koti, Northwestern University
Advisors: Amy S. Paller and Xiao-qi Wang

Overexpression of ganglioside GM3, a sialylated glycosphingolipid, correlates with increased metastasis of melanomas. Anti-GM3 antibody and GM3-related vaccine have been used to treat melanoma, lung cancer and breast cancer at Stage III and IV in clinical trials. However, neither active vaccination nor antibody administration appears to be sufficient to completely clear melanomas or prevent their metastases. Determining the mechanism of elevated GM3 on cancer cell metastasis may offer a rationale to improve GM3-related cancer treatment. GM3 is able to cosegregate with uPAR at the leading edge of migrating cells and GM3 overexpression facilitates squamous carcinoma cell proliferation when uPAR is activated. To address the role of uPAR signaling on GM3 elevated melanoma metastasis, I used a mouse melanoma cell (B16F1). I found that (1) increases in the expression of GM3 facilitated B16F1 cell proliferation without affecting uPAR expression; (2) disruption of the uPAR expression prevents the stimulatory effect of elevated GM3 on cell proliferation; (3) disruption of uPAR expression or treatment of cells with anti-GM3 IgG antibody reduced the stimulatory effect of elevated GM3 on cell spreading, while functional blockade of both uPAR and GM3 eliminated cell spreading. These results suggest therapeutic modalities that target GM3 may require concomitant treatment that suppresses uPAR signaling to control neoplastic cell proliferation.

21

Benjamin LeMoine, Northwestern University
Advisor: Amy Rosenzweig

Copper is an essential micronutrient to all known organisms, but can cause oxidative damage if left unchecked. CopZ, in concert with CopA and Cop B, is crucial chaperone for prokaryotic and archaeal copper homeostasis. Previous research revealed that Archaeoglobus fulgidus possesses a unique member of the CopZ family with a CopZ-like domain located on the C-terminus and a 15 kDa previously uncharacterized N-terminus containing 9 conserved cysteines. In this study, the structure of the N terminus domain of CopZ was determined via x-ray crystallography to 1.8 Å resolution. The novel structure revealed the presence of a [2Fe-2S] cluster and mononuclear zinc site. These additional metal sites were further confirmed through various spectroscopic techniques. A small pocket of approximately 200 Å3 in close proximity to the Fe-S cluster suggests the domain possesses an undetermined catalytic function. The 9th conserved cysteine which is not bound to a metal may be involved in this process. Further study is required to confirm these findings and establish the function of this domain.

22

Plasmodium falciparum: Determining Protein Expression Patterns.

Kimberly Lekwa, Loyola University Chicago
Faculty Mentor: Dr. Kim Williamson

Plasmodium falciparum causes the most severe form of malaria, affecting 100-300 million people a year. Understanding the parasite's development should lead to new approaches to fight this disease. This includes determining when and where proteins are expressed in the parasites life cycle. To do this, recombinant proteins corresponding to selected genes were produced and used to induce specific antibodies. The antibodies were then used to determine the expression pattern of the gene. Three genes of interest are MAL8P1.72, PfL0145c and PF11_0372. MAL8P1.72 and PfL0145c are both predicted to be transcription factors involved in gametocytogenesis. PF11_0372 has homology with a gene, known as *Izumo*, which in mice is only expressed on sperm during the fertilization process. To isolate each gene, polymerase chain reaction (PCR) was used to amplify the coding region with oligonucleotide primers corresponding to specific sites in the parasite's genomic DNA. Expression vector, MPIH902 plasmid was digested with restriction enzymes to open up the polylinker region for insertion of the PCR product. After ligation, DH10B E. coli cells were transformed by electroporation. Plasmid DNA was isolated from the transformed cells and evaluated for proper insertion of the PCR product by sequencing. Following induction of recombinant protein expression, the protein was affinity purified. Protein size was evaluated by SDS-Page and the proteins were injected into mice in order to generate the antibodies. Antibodies against MAL8P1.72 and PfL0145c recognized protein on Western blots of parasite extracts, and are being tested by immunofluorescence assay, while the PF11_0372 antibodies are still being produced.

23 N^6-Furfuryladenine, Phytolacca americana Lectin, Catalase, and Superoxide Dismutase-1 (CuZnSOD), as Agents of DNA Protection or Repair against Ionizing Radiation in Drosophila melanogaster

Parijata D Mackey, University of Chicago
Advisor: Gerhild Packert

The purpose of this study is to evaluate the effectiveness of N^6-Furfuryladenine (kinetin; Kn), *Phytolacca americana* Lectin (Ln), Catalase (CAT), and Superoxide Dismutase (CuZnSOD) as agents of DNA protection or repair against Ultraviolet-C and high energy photon beam radiation in *Drosophila melanogaster*. It was hypothesized that DNA damage would be most greatly reduced in *Drosophila* treated with naturally occurring enzymes (catalase, CuZnSOD), followed by those treated with kinetin (Kn), and lectin (Ln), when compared to a control.

To test the hypothesis, this study monitored the viability, male-to-female ratio, and mutation rates of Canton-S (wild-type) *Drosophila* test populations. Healthy populations were determined to be those with a male-to-female ratio closest to 1:1, and mutation rates closest to zero. The *Drosophila* were split into 19 groups, so that each protective agent (Kn, Ln, CAT, CuZnSOD, in concentrations of 25ppm) was paired with either high energy photon beam or UV-C radiation. Five controls were also performed. The experiment was repeated three times.

The results partially supported the hypothesis; 25ppm Kn was the most effective at procuring a healthy *Drosophila* population exposed to high energy photon beams, while 25ppm CuZnSOD was the most effective for UV-C exposed *Drosophila*, when compared to a control. The average mutation rate for untreated, non-irradiated *Drosophila* was 0.76%, while the male-to-female ratio was 0.915:1. When exposed to radiation, the mutation rate rose to 11.96% for UV-C, and 10.33% for photon beams. The male-to-female ratio was 0.540:1 for photon beams, and 0.617:1 for UV-C.

When photon beam-exposed *Drosophila* were treated with Kn, the mutation rates dropped to 1.24% (additional mutation rates: 5.56% for Ln, 7.16% for CAT, 7.10% for CuZnSOD). When UV-C exposed *Drosophila* were treated with CuZnSOD, the mutation rates dropped to 0.549% (1.66% for Ln, 8.44% for CAT, 1.71% for Kn). The male-to-female ratios were, on average, 0.951:1 for Kn treated photon beam *Drosophila*, and 1.002:1 for CuZnSOD UV-C. The data suggests that it is possible to shield organisms from the effects of ionizing radiation through ingestion of certain biochemical agents.

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24 The Search for the Siderophore Degradation Gene

Patrick McGill, Loyola University Chicago
Advisor: Dr. Castignettie

Some pathogenic bacteria are able to obtain iron from their host in order to sustain their growth. "The competition for iron between a host and bacteria is one of the most important factors determining the course of a bacterial infection" (2). Some hosts respond by going into an iron-withholding mode in order to attempt to kill the invaders. Select bacteria will respond by producing what are called siderophores (1). Siderophores are "compounds produced by microorganisms for scavenging iron from the environment" (3). Siderophores, such as Deferrioxamine B (DFB), obtain iron from

the environment for the bacterial metabolic processes which require iron and which allow the bacteria to grow and reproduce.

In today's world of antibiotic resistant bacteria, the knowledge of these siderophores becomes increasingly important. There are siderophore-degrading organisms, such as the bacterium Mesorhizobium loti. M. loti has been the focus of our study because of it's unique ability to degrade the siderophore DFB and use it as a source of carbon. When we isolate the gene(s) that encodes for the one, or multiple enzymes, that is responsible for the degradation of DFB within M. loti, it will be a step toward controlling iron-uptake due to siderophore use. If one knows how siderophore degradation occurs, then one may be able to limit iron access, thereby limiting bacterial growth by promoting strategies to destroy the pathogen's siderophores. This knowledge is also important to the scientific community because little is actually known about the degradation of siderophores, the enzymatic pathways, or the gene(s) that are involved in the process.

Transposon mutagenesis, via conjugation of E. coli pOT182with M. loti, the siderophore degrading bacterium, was used to generate M. loti mutants incapable of using DFB. The use of antibiotic screens (tetracycline-resistant and polymixin B resistant) as well as replica plating experiments has determined the mutants that can no longer use DFB as a carbon source. M. loti is naturally resistant to the antibiotic polymixin B and the transposon acquired from the E. coli pOT182 carries antibiotic resistance genes to tetracycline. This allows us to use antibiotic screening to determine which colonies are M. loti with the transposon inserted somewhere in the genome. If the transposon is inserted in the siderophore degradation gene a knockout mutation will occur and the M. loti will not be capable to survive with siderophores as it's sole source of carbon. Testing with PCR is used to test for the presence of the 16S rRNA gene of M. loti as well as the transposon to further our screening process. The combinational use of these two screens, along with the proper antibiotic and DFB usage profiles, will establish the mutants as M. loti cells that have acquired the transposon in such a manner as to inactivate DFB usage. Successful implementation of this strategy will have tagged M. loti's DFB utilization gene(s) with the transposon. We are presently in the PCR screening phase of sixteen possible mutants. Our goal is to verify as many mutants as possible that test positive for both the 16S rRNA and the transposon. We will follow these investigations with cloning and sequencing of the gene(s).

25

Emily Miller, Loyola University Chicago
Advisor: Jeffrey Doering

While 10-15% of the human genome is composed of heterochromatic DNAs, these regions are not included in the completed sequence. We are creating a detailed physical map of the centromere and p arm of HC21 as a model for the organization of such regions. Our previous work identified a number of low copy number (LCNR) sequences in the centromere of HCY and on the proximal short arm of HC21p. These sequences have a very similar linear order on both HC21 and HCY, except that the

order on HC21 is inverted relative to that on HCY. BLAST analysis indicates that at least 5 of these LCNRs are part of the larger chAB4 duplicon. The chAB4 duplicon is ~86kb in length and is composed of a chAB4 DNA segment adjacent to a 48bp satellite array of variable length, followed by an NF1-related pseudogene. While others' work suggested that chAB4 has a palindromic organization, sequence analysis of a number of loci containing the chAB4 duplicon and adjacent LCNRs shows no evidence that it is part of a palindrome on HC21 or HCY. This data clarifies the organization in a previously uncharacterized region of the centromere on HCY. On HC21 a full copy of the chAB4 duplicon and adjacent LCNRs is found on the proximal p arm near the q21-II region. Using BLAST, we identified BACs containing chAB4 duplicon sequences that had not been placed in the genome map. By comparing these BAC sequences, copies of chAB4 on HC21, Y, 17, and 22 showed at least 90% similarity. This work indicates that chAB4 may actually be part of a larger duplicon ~200kb in size. Heterogeneity in the duplicon structure is indicated by a ~25kb insertion into the sequence on HCY and HC17. BACs containing chAB4 and adjacent LCNRs located in the proximal p arm of HC21, as well as BACs found at the distal end of the D21Z1 region containing monomeric alphoid DNA and satellite III will allow closing the gap between the two regions. This will create a contiguous map of ~5Mb that links the q21-II and D21Z1 regions, joining the p arm to the q arm.

Regulation of chondrogenesis by GPI-linked proteins

Stephanie R. Mui, Northwestern University
Advisor: Andrew T. Dudley

The growth of cartilage is regulated by the growth plate chondrocytes. The growth plate consists of distinct zones of differentiated chondrocytes. During bone growth, cells from the resting zone are progressively recruited to the proliferative zone. In the proliferative zone, the cell cycle is upregulated, resulting in a rapid increase in the number of chondrocytes. As the cartilage grows, cells progressively exit the proliferative zone, hypertrophy and die (hypertrophy zone), and are subsequently replaced by bone. To understand the regulation of bone growth, we analyzed the *Piga* mutant mouse, in which all GPI-linked cell surface proteins were knocked out, resulting in short-limbed mice. Histological analysis failed to detect organized cells consistent with proliferative chondrocytes in *Piga* mutant mice. However, studies of cell proliferation and gene expression suggest that the disordered cells are proliferative chondrocytes. These data suggest that GPI-linked proteins are important determinants of chondrocyte morphology.

Simulation of the structure of the putative Rubisco-Carbonic Anhydrase and Rubisco-Phosphoribulokinase Complexes

Shivangi Pandya, University of Illinois at Chicago
Advisors: Fred Stevens and Louise Anderson

Ribulose 1,5-bisphosphate carboxylase/oxygenase (Rubisco) is involved in the catalytic attachment of CO2 to ribulose 1,5-bisphosphate and the formation of two molecules of 3-phosphoglycerate. Rubisco thus plays an important role in photosynthetic CO2 fixation (the Calvin cycle), along with other enzymes. Previous studies have suggested

that there exists an interaction between Rubisco and Carbonic Anhydrase. Interactions between Rubisco and Phosphoribulokinase have also been indicated. However, the amino acids potentially involved in these associations have not been defined. In this study, we compared the amino acid sequences of these three proteins from various species and identified the conserved regions. A conserved segment indicates the importance of that segment in the function of the protein. Hence, there is a possibility that the segment is either a part of the active site of the protein, or is involved in an interaction with another protein. Active site residues tend to reside towards the interior of the protein quaternary structure, whereas the residues involved in interactions with other proteins reside towards the exterior. We examined the structures of the proteins on Protein Data Bank and determined which of the amino acid residues in the conserved regions resided on the exterior of the proteins. We docked the two enzymes with Rubisco computationally using Insight II. Consistent with the experimental data, we were able to predict association between the enzymes and the structures of the Rubisco-Carbonic Anhydrase complex and of the Rubisco-Phosphoribulokinase complex.

28

Stem Cell Markers: ABCG2 and MCM2 Expression in Retinoblastoma

Hema L. Ramkumar, Northwestern University
Advisor: S. Krishnakumar

Minichromosome maintenance protein 2 (MCM2), a component of the prereplicative complex, is essential for eukaryotic DNA replication and is only expressed in proliferating cells. MCM2 is also a proven marker for detecting neural stem cells. ABCG2, the half ATP-binding cassette transporter, has also been shown to be expressed in small subpopulations of cancer stem cells. There is no information on the expression of cancer stem cell marker ABCG2 and neural stem cell marker MCM2 in retinoblastoma (RB) and its correlation with tumor invasiveness and postoperative or preoperative chemotherapy. MCM2 and ABCG2 reactivity was evaluated by immunohistochemistry in 39 archival retinoblastoma specimens. Of the 39 RBs, 18 tumors were not subject to any preoperative or postoperative chemotherapy, 15 tumors underwent postoperative chemotherapy, and 6 tumors had preoperative chemotherapy. Twenty tumors had no invasion, and 19 tumors had invasion of the choroid and/or optic nerve. ABCG2 was positive in 15/19 tumors with invasion, and MCM2 was positive in 16/19 tumors with invasion. Invasive tumors showed higher expression of ABCG2 ($p<0.01$) and MCM2 ($p<0.01$) proteins compared to non-invasive tumors. There was no correlation with the differentiation or laterality of the tumors. Interestingly, the non-neoplastic retina expressed MCM2 immunoreactivity to a small extent. ABCG2 and MCM2 were expressed more in invasive tumors, and this positivity might indicate the presence of a cancer stem cell sub-population in retinoblastoma. Further studies are needed to understand the role of neural stem cells in retinoblastoma and their contribution to drug resistance and tumor progression.

29

Pim3's role as a negative regulator of the insulin signaling pathway
Kavitha Selvaraj, University of Chicago
Advisor: Gene Webb

The goal of this study is to elucidate the role of Pim3 in the insulin signaling pathway. Pim3 is a novel kinase that was cloned by our lab and found to be highly active in pancreatic β-cells. Previous work suggests that Pim3 functions to regulate signal transduction in the β-cell, although the specific function of the kinase is unknown. To define the effect of Pim3 on cell signaling, we reduced the function of the long form isoform of Pim3 by constructing a dominant negative allele (Pim3 DN long). We cloned Pim3 DN long into an adenoviral vector, infected MIN-6 cells with varying concentrations of the adenovirus, and used Western blotting to test for alterations in the activation of known components of the insulin pathway. Our data suggested that reduced activity of Pim3 long suppresses expression of Protein Kinase B (Akt), which, in the context of previous experiments in our lab, may indicate that Pim3 long is a member of a protein complex. Experiments currently underway are examining the effects of Pim3 long on the physiological function of the pancreatic β-cell, specifically insulin transcript production and insulin secretion.

30

Merina Thomas, Northwestern University
Advisor: Neil Jaffe

Protein degradation is an integral step in several cellular processes, including cell cycle control, gene expression, antigen presentation, and signal transduction. Faulty degradation can lead to such diseases as Alzheimer's disease, prion disease, and Huntington's disease. We are focusing on characterizing selectivity in protein unfolding and destruction by ATP-dependent proteases, and one method of characterizing the proteases is to determine whether proteases differ in their ability to degrade proteins. A biochemical protein degradation assay used to measure protease unfolding strength was translated to high throughput automation. The results indicate that the developed methodology decreases experimental error that accrues by pipetting of individual timepoints during the biochemical assay, increases the general ease of experimental operation, and allows an increased throughput, thereby facilitating large scale proteomic studies. High-throughput degradation assay techniques will be further developed for future experiments involving the characterization of ATP-dependent proteases.

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Retrogene movement within- and between-chromosomes in evolution of Drosophila genomes
Toshio F. Yoshimatsu, University of Chicago
Advisor: Manyuan Long

A key aspect to understanding evolution at molecular level is the locality of the genes. Discerning the evolutionary force that leads to particular distribution of genes could provide a hint on the mechanism that plays a critical role in evolution. Previous genomic studies on *Drosophila* and mammals have concluded that genes retrotransposing between chromosomes demonstrate a strong tendency to migrate

out of X-chromosome, suggesting a possible evolutionary process that contributed to the over-representation of male-biased genes on autosomes. Previous works were incomplete, however, for it used small sample of data by which analyses on within-chromosome retrotransposition was inconclusive. In this study, we reexamined and further extended the genomic study of *D.melanogaster* by observing a larger and updated genomic dataset to complete the analyses of retroposition within- and between-chromosomes. Strategies similar to the previous works were employed, where retrogenes were identified computationally by observing loss of intronic region compared to its parental gene. Even though our data incorporated evolutionarily ancient genes in addition to relatively young retroposed genes, our findings on between-chromosome gene movement agreed with the pattern previously reported, which suggests origin of retroposition to root back early in the history. Furthermore, we found within-chromosome movement to be scarce within X but excess in autosomes. These observations support the hypothesis that natural selection is likely the evolutionary force against retroposed genes on the X chromosome. Analyses on gene expression also revealed that majority of the X-derived autosomal retroposed genes had evolved testis expression functions, consistent with previous genomic analyses.

Chemistry

32 On the Anisotropy of the Cl Radical Following the Photodissociation of Methylchloroformate

Marie-Justine Bell, University of Chicago
Advisor: Laurie Butler

This study investigated the angular distribution of Cl fragments following the photodissociation of methychloroformate. Earlier studies have used methylchloroformate as a photolytic precursor for the CH3OCO, methyl formate, radical which is an intermediate in many reactions that are relevant to combustion and environmental atmospheric chemistry. Prior research has suggested that photodissociation of methychloroformate may produce nascent methyl formate radicals in both the ground and low lying first excited state. In this study, the ground state and the first excited state of the methyl formate radicals (both produced via photodissociation of methylchloroformate) exhibited very different angular product distributions and translational energy distributions. The ground state of the methyl formate radicals was found to have an anisotropy parameter, β, of 0.65, while the excited state was found to have a β of -0.7, suggesting very different dissociation mechanisms for the ground and excited state. Moreover, with this experiment we were able to refine the product branching ratios for the production of σ = 0.52 for the ground state radicals and σ = 0.48 for the excited state radicals.

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33 The Attempted Creation of a Graphite Nanocomposite using Ring-Opening Metathesis Polymerization

Valerie M. Casey, Northwestern University
Advisor: SonBinh Nguyen

In an effort to create a homogenous graphite/polymer nanocomposite, ring-opening metathesis polymerization was attempted from both graphite oxide (GO) and thermally expanded graphite oxide (TEGO). Ammonium salts were synthesized and attached to the GO surface, most likely via a reaction with epoxy groups on the surface of GO. Evidence of intercalation of ammonium salts can be seen through IR spectroscopy, X-ray diffraction, and elemental analysis. Once the GO had been intercalated with an ammonium salt, it was attempted to attach Grubbs catalyst to the ammonium salt. Initiation of the binding of Grubbs catalyst to the ammonium salt was evidence by 1H NMR data. However, attempts of initiation of Grubbs catalyst to the ammonium salt attached to GO is doubtful. Subsequent attempts to perform ROMP failed. Believing that the distance between the GO layers was not large enough to promote incorporation of the bulky Grubbs catalyst into the GO matrix, TEGO was substituted to provide a source of graphene nanoplatelets. A pyrene derivative was electrostatically attached to the surface of GO, Grubbs catalyst was attached to the pyrene derivative, and ROMP was attempted. While polymerization was noted, the creation of a suitable nanocomposite was unsuccessful. Preparation of a suitable nanocomposite will be useful in the creation of strong materials for aerospace technologies.

34 Drug Toxicity and Adverse Side Effects in Gastroesophageal Reflux Disease (GERD): Effect of Proton Pump Inhibitors (PPIs) on Gastrointestinal Flora

Vina Chhaya, Northwestern University
Advsior: James Radosevich

Objectives: Gastroesophageal reflux disease (GERD) is a condition in which acid and pepsin from the stomach is thought to be refluxed into the esophagus. Proton pump inhibitors (PPIs), such as Protonix, are given to patients in order to raise the pH of the stomach. However, recent studies have shown that acid-producing cells also exist in the upper gastrointestinal tract and oral cavity, suggesting that PPIs may have other target cells outside the stomach. Human and bacterial DNA homology suggested that PPIs may affect the activity of both eukaryotic and prokaryotic proton pumps.
Methods: Nineteen different strains of Lactobacilli were inoculated in microtiter plates in media at a pH of 4.5 and two-fold dilutions of Protonix at a range of 2.5 mg/mL to 2.5 µg/mL. If no growth was observed at pH 4.5, the strains were inoculated in media at pH 5.0 and 5.5 to determine the level of sensitivity to the drug. Bacterial growth was monitored under these conditions, and the minimal inhibitory concentration (MIC) of the drug was determined for the strains most sensitive to Protonix. In the cases where growth was inhibited, Gram-staining was carried out to visualize any potential morphological changes in the bacteria.
Results: Eight of the nineteen Lactobacilli strains were found to have an MIC below 313 µg/mL, with L. plantarum 14917 being the most sensitive (MIC=20 µg/mL). Additionally, in some strains, such as L. s. salivarius 11741, Gram-staining revealed conformational changes in the bacteria when grown in the presence of Protonix.
Conclusions: The sensitivity and conformational changes observed in a number of strains in the presence of Protonix suggests that taking PPIs could cause a disturbance in the normal balance of flora found in the oral cavity and gastrointestinal tract, possibly leading to the long-term complications seen in some patients.

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35 Photophysics of Multi-Metallic Tungsten-Alkylidyne Complexes

Vivian Ferry, University of Chicago
Advisor: Michael D. Hopkins

Organic phenyleneethynylenes have many potential applications in molecular electronics as sensors. The analogous organometallic complexes, with a metal center substituted for one of the carbon atoms in the phenyleneethynylene chain, are attractive systems because they should exhibit tunable electronic properties. We investigated the photophysical properties of tungsten-alkylidyne compounds of the type C_6H_6-n-{CWL_4Cl}n (L=phosphine, n = 1,2). Characterization was done by absorption, emission, and excitation spectroscopy. Emission quantum yields and lifetimes were measured. Low-temperature and solid-state emission studies were also performed to elucidate the nature of the electronic transitions. The properties of the 1,3-disubstituted (n=2) compound were found to be very similar to that of the single-metal (n=1) complex. The conjugated 1,4-disubstituted complex, however, exhibits markedly different behavior, indicating that the tungsten centers are in communication with each other.

36 A Novel Synthesis of Oxazolidines Using [3 + 2] Coupling of Aziridines and Carbonyls

Sandra Goyal, Northwestern University
Faculty Advisor: SonBinh Nguyen

An outstanding challenge in organic and medicinal chemistry is the rapid and efficient generation of nitrogen-containing heterocycles such as oxazolidines, 5-membered cyclic rings with two heteroatoms, nitrogen and oxygen, flanking a carbonyl group. These compounds have been shown to be present in many biologically active natural products and can be used as pro-drugs in drug delivery applications. Their biological activity is derived from a structure that straddles two biologically important structural motifs: β-amino alcohol and β-amino acid. Their ability to function as pro-drug is facilitated by masking the β-amino alcohol functionality within the ring, which also allows for increased lipophilicity and ease of entry through the lipid bi-layer in cells.. As such, oxazolidines are very attractive targets in synthesis.

Traditionally, oxazolidines have been synthesized through the coupling of a β-amino alcohol to either diethylcarbonate or phosgene. Such procedures are often atom-uneconomic and inefficient, in addition to being hazardous (as in the case of phosgene). In contrast, the [3+2] catalytic coupling of aziridines and organic carbonyls could provide a safe and highly efficient alternative to oxazolidines in one step. The high reactivity of the aziridine ring would allow it to undergo an efficient coupling with carbonyl electrophiles in a one-pot reaction under mild reaction conditions. In addition, the ready availability of a variety of aziridines and carbonyl substrates will allow for facile extension of this coupling methodology into a diverse range of oxazolidines. We have demonstrated that a variety of aldehydes can readily be coupled to aziridines, yielding 4 and 5 substituted oxazoldines in the presence of a scandium triflate catalyst. We have also extended this [3+2] coupling to a wide range of ketones.

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37 Protein Crystallization in Micron-Sized Wells

Laura Hughes, Northwestern University
Advisor: Teri W. Odom

Despite the importance of protein crystallization in molecular biology, biochemistry, and pharmaceutical development, protein crystallization still requires screening a large number of conditions to find the optimal ones. As a result, a large quantity of protein must be used to screen for conditions. This research presents a method for crystallizing proteins within micron-sized wells using a small amount of protein. Discontinuous dewetting provides a simple way to fill these small wells with protein solution; these filled wells are then allowed to crystallize over a buffer reservoir. In two model systems, this method successful forms crystals within the microwells; the use of a fluorescence dye confirms that the observed crystals are protein. Additionally, a variation on discontinuous dewetting is being investigated to attempt to create multiple crystallization conditions in a single experiment.

38 Isothermal Titration Calorimetric Study of Tetracycline Metal Ion Interactions – Evidence of Conformational Changes

Elissa Johnson, Depaul University
Advisor: Lihua Jin

Tetracycline has diverse biological functions, including both antibiotic and non-antibiotic nature. Tetracycline binds a number of divalent metal ions with high affinity, a property that is important for its diverse biological functions. Although tetracycline metal ion interactions have been studied extensively, controversies remain concerning binding stoichiometry and binding mode. We chose to use isothermal titration calorimetry to determine binding stoichiometry and thermodynamic profiles of Ca^{2+} and Mg^{2+} binding at several different pH. Stoichiometry for Ca^{2+} binding was 1:1 at all four pH values tested between 8.5 and 11.7. Unlike Ca^{2+}, Mg^{2+} was found to bind in a 1:2 (tetracycline:Mg^{2+}) ratio, suggesting one Mg^{2+} coordinating to two tetracycline molecules, differing from the 1:1 ratio reported in the literature. The 1:2 ratio is consistent with the binding mode found for tetracycline complexes with tetracycline repressor (TetRD) and the 30S ribosomal RNA. The Mg^{2+} ion bound to the tetracycline in these complexes is also bound to the TetRD and the RNA. We also observed a slow endothermic tailing at the exothermic binding peak in the first few injection peaks of Ca^{2+} binding and the tailing is dependent on pH as well as the concentrations and the ratio of tetracycline and metal ion. This coupled nonstoichiometric endothermic process distored the otherwise normal binding isotherm, complicating curve fitting and thus determination of thermodynamic parameters. Although deprotonation of tetracycline was found to be coupled to metal ion binding, our data showed that deprotonation was not responsible for the coupled endothermic process. We propose that the endothermic process was likely due to conformational change in tetracycline upon metal ion binding.

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39 Comparison of nitrate and nitrite levels in perfusates of different regions in rat brain using in vivo low flow push-pull perfusion sampling to determine nitric oxide synthase (NOS) activity in cerebral tissues

Hwan Keun Kim, University of Illinois at Chicago
Advisor: Scott Shippy

The recent discoveries about the nitric oxide (NO) revealed that it participates in neuro-signaling and regulation of endothelium in vasodilation. Since NO that was generated either by neuronal NO synthase (nNOS) or endothelial NO synthase (eNOS) oxidizes to nitrate and nitrite within a very short time, in vivo sampling methods, a low flow push pull perfusion method was therefore used to sample the rat brain perfusates in order to estimate the neuronal NO (nNO) concentration from nitrate and nitrite using the capillary electrophoresis detection method. Two in vivo sampling methods, cannulated and acute sampling were investigated to determine the effect of tissue disturbance near the sampling area to the nNO concentration. Current result seems to support the idea that high concentration of endothelial NO (eNO) in the blood interferes the estimation toward the nNO due to the tissue damages near the sampling site for the

first few perfusates in acute sampling methods while the concentration level gradually comes down to nNO level as vasoconstriction occurs. On the other hand, relatively higher standard deviations and concentrations in cannulated samples could be caused by the intact sampling area environment where both nNOS and eNOS were activated simultaneously. Furthermore, we are currently investigating the NO metabolites' levels in striatum and thalamus to determine whether different number of NOS in these areas makes different yield of NO since thalamus is known to have lower number of NOS than striatum. The preliminary results showed that the recovered concentrations seemed to be similar in both areas. Therefore, further study is necessary to confirm whether our result solely corresponds to the nNO by infusing selective eNOS inhibitors.

40

Carbon Nanotube Manipulation

Taeyoung Kim, Illinois Institute of Technology
Advisor: Rong Wang

The unique nano-wire structure of carbon nanotubes (CNT) makes it a potential material for high sensitivity chemical/bio sensors. This is derived from its extremely high one-dimensional conductivity. A typical single wall carbon nanotube(SWCNT) has a dimension of 1.2 nm in diameter and 1 to 20μm in length. Thus application of CNT in fabrication of various devices relies on the capability of CNT nano-manipulation. In this work, we demonstrate the application of the atomic force microscope (AFM) in displacement and dissection of CNTs under controllable conditions. Tapping mode AFM combined with interleave mode was used to image and manipulate the CNTs. While the tapping mode allows CNTs to be imaged in a non-destructive manner, interleave mode permits the application of local high force at the desired location to displace or dissect the CNTs. With a relatively low loading force and high scan rate, we were able to parallely displace a CNT bundle(6.2nm in diameter, 1.2μm long) for 463nm. When a higher loading force and lower scan rate were applied, cutting of a CNT bundle with a minimum dimension of 6nm was achieved. With the capability of moving a CNT to a desired location, we expect to make CNT circuit with designed structure. With the capability of cutting CNT with desired gap, we expect to construct capacitor based nano-device toward sensor application. As an undergraduate student, I have learned the usage of CNT in many ways as well as the operation of AFM for nanoscale imaging and nanoscale manipulation.

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A Thermodynamic Study of the Interaction of Cholesterol with Lipid Membranes

Mark Kittisopikul, University of Chicago
Advisor: Ka Yee C. Lee

Using Isothermal Titration Calorimetry (ITC), we used microcalorimetry techniques to study the binding affinities between cholesterol and phospholipids in order to gain insight into the physiological regulation of cholesterol in cellular membranes. By perturbing the system with methyl-beta-cyclodextrin (mBCD) and 1-octanol, we observed certain stoichiometric ratios at which cholesterol preferentially partitions into lipid vesicles, which are used to model lipid membranes. ITC allows for the measurements of small binding energy between loosely bound molecules such as lipid

and cholesterol. mBCD is used to solubilize cholesterol into the surrounding solution in order to study the effects of removing or inserting cholesterol into pure lipid vesicles. 1-octanol was discovered to displace cholesterol from lipid complexes and is used to disrupt specific binding of cholesterol from our simulated lipid membranes. By using ITC to observe the molar heats created when cholesterol-lipid interactions are perturbed by either mBCD or 1-octanol, we determined the strength of their low affinity non-covalent binding in lipid vesicles. Our results provide evidence for the existence of lipid-cholesterol complexes in the phospholipids membranes and quantitatively assess the strength of the low affinity binding between lipids and cholesterol. Using these results we developed a model of how these lipid-cholesterol complexes exist and how these may relate to cholesterol-induced rigidity changes. This bottom up approach informs the biological membrane picture by developing a physical understanding of cholesterol interactions in lipid membranes, giving insight into why cholesterol amounts may vary across different cell types, and how the mechanism of cholesterol regulation may occur.

42

Solution ^{1}H-NMR Reveals Distinctions among Genera within the Family Pinaceae

Michael A. Kozminski, Northwestern University
Advisor: Joseph B. Lambert

Recent studies have used spectral distinctions among exudate-producing plant species to classify samples between families but have failed to distinguish below this mark, particularly at the levels of genus and species. Such work examined taxonomic relationships throughout the Kingdom Plantae via solid-state carbon-13 (^{13}C) nuclear magnetic resonance (NMR) spectroscopy. The present study utilizes solution proton (^{1}H) NMR in order to determine if intrafamilial differences are detectable. Previous examinations have dealt with a wide variety of exudates, many of which were insoluble in any type of deuterated solvent. Since high-resolution ^{1}H-NMR is limited to solutions, this study focuses on the family Pinaceae, which produces resins that are highly soluble in deuterated chloroform ($CDCl_3$), a common NMR solvent. Representing seven of the eleven genera of the family, the Pinaceae test samples were shown to display distinctiveness in their one- and two-dimensional proton spectra. The ^{1}H-NMR technique was found to be a sufficient means of identification at the familial and generic levels. Moreover, a particular set of one-dimensional traits and eleven, two-dimensional cross-peaks were found to typify the family Pinaceae, setting it apart from other families within Plantae. Thus, both one- and two-dimensional proton spectra can distinguish among test samples at the generic level. These results highlight the power of the ^{1}H-NMR technique and offer many practical applications in archaeology and botany, such as creating a more complete description of primitive economic activity from resins at dig sites or confirming the taxonomy of a contested plant species.

43 Montmorillonite K10 Clay-Catalyzed Hetero-Diels-Alder Reaction of Dienes with Aldehydes

Andrew J. Little, DePaul University
Advisor: Matthew R. Dintzner

The hetero-Diels-Alder reaction of simple dienes with aldehydes was carried out in the presence of activated Montmorillonite K10 clay to afford 5,6-dihydro-2H-pyran products in good yields. The reactions were carried out under solvent free conditions and proceeded quickly at room temperature.

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44 Creating patterns of ZnO nanostructures using photolithography templates

Thomas McDonald, Northwestern University
Advisor: Teri W. Odom

Patterns of ZnO nanostructures were created on templated silicon substrates under hydrothermal growth conditions. Controlling the morphology, nucleation location, and size of ZnO nanostructures is a critical step in functionalizing these materials. It has been shown that thin layers of silver metal upon single-crystal silicon make preferential nucleation sites over bare single-crystal silicon. To create large areas of preferential nucleation sites in a consistent pattern, phase-shift photolithography was first used to create holes in photoresist. A thin layer of silver metal was deposited upon the photoresist and holes, which upon further treatment ultimately created wafers with patterns of consistently spaced and uniformly sized silver dots. These patterned wafers were directly added to a heated aqueous solution of zinc nitrate and methenamine. Following these reactions, ZnO nanostructures were characterized by scanning electron microscopy. It was seen that ZnO was synthesized in a variety of morphologies, including well-aligned nanorods. Temperature, reaction time, reactant concentration, and wafer pretreatment have proven to be important variables in controlling ZnO morphology, quality, and size.

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45 Metal-Induced Reactions of O-Nitroso Aldol Product

Marvin Morales, University of Chicago
Advisor: Hisashi Yamamoto

We recently established a new method for the introduction of oxygen at the α-position of carbonyl compounds using nitrosobenzene as an oxy electrophile: the O-nitroso aldol (O-NA) reaction. The asymmetric version of this transformation has been widely developed by our and other laboratories. The produced O-NA product is expected to be a good ligand for metal ions and a potentially useful compound for accessing oxygen and/or nitrogen containing molecules. We describe herein different reactions of the O-NA product promoted by metal ions.

46 Conjugated Ditungsten Dialkylidyne Complexes with Various Ligand Systems

Jeffrey S. Mugridge, University of Chicago
Advisor: Michael D. Hopkins

Linear, conjugated molecules of the form XL_4WCCWL_4X show great potential as building blocks in the area of molecular electronics due to their rigid-rod structures and controllable electronic properties. Variation of the ligands (L) on each metal center changes the electronic properties in predictable ways. This flexibility can be readily applied to molecular wire design. Here we report the synthesis and characterization of ClL_4WCCWL_4Cl where L = $P(OMe)_3$ and early attempts to prepare analogous complexes with amine, halophosphine and mixed phosphine / carbonyl ligand systems. These compounds are in principle synthesized via similar routes. However, the synthetic scheme that affords the trimethyl phosphite substituted complex results in the formation of unexpected and/or decomposed products, when applied to the other attempted ligand systems. The compounds were characterized via NMR and electronic spectroscopy, X-ray crystallography and electrochemical measurements. The electronic and physical effects induced by variation of the ligands will also be discussed.

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47 Montmorillonite K10 Clay-Catalyzed Hetero-Diels-Alder Reaction of Dienes with Aldehydes

Zachary R. Osner, DePaul University
Advisor: Matthew R. Dintzner

Activated Montmorillonite K10 clay was found to catalyze the hetero-Diels-Alder reaction of simple dienes with benzaldehydes to give the corresponding 5,6-dihydro-2H-pyran products in good yields under mild, environmentally friendly conditions.

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48 Synthesis of Novel Cationic Phosphatidylcholine And Their Role in Gene Delivery

Harsh Parikh, Northwestern University
Advisor: Robert MacDonald

The cationic derivatives of phsophatidylcholine [PC] compounds hold a significant interest in the area of gene therapy due to their great potential in the clinical applications of gene therapy. The goal of this research is to synthesize such cationic transfection agents that are not commercially available today. These phospholipoids are derived from naturally occurring phosphatidylcholine, and provide an alternative to the viral vector in gene transfection. Alkylation addition at the free phosphate oxygen of phosphatidylcholine confers upon the lipoids a positive charge, which would interact with the negatively charged DNA to form lipoplexes. The properties of this additional side-chain are hypothesized to be influential factors in DNA delivery applications.

Presumably different sizes and polarities of side-chain on lipoids would give different lipoplex structures. Several different types of these cationic transfection agents have been synthesized, namely phospholipoids with haloalkyl and polyethyleneglycol [PEG] or polypropyleneglycol [PPG] side-chains. Furthermore, further modifications at this haloalkyl and polyalkyleneglycol chain may give some additional innovative compounds. In addition, alkylation of phospholipoids with unusual alkyl chains have been performed, and reagents are available for synthesis of even more. These novel families of phospholipoids can be tested for their potential role in the gene delivery, as well as for the formation of large vesicles, which may prove to be useful in the membrane fusion research. The results from this experiment could be groundbreaking, if a superior transfection agent is obtained than those commercially available today.

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Hard Wall Induced Stratified Liquid Formation

Ream Qato, University of Chicago
Advisor: Dr. Binhua Lin

We are investigating several hard-sphere fluids constrained by hard-wall grooves of varying widths in order to study the effects of changes in width on the properties of the hard-sphere fluid. We have been using these systems to investigating the transition between quasi-one- and quasi-two-dimensional diffusion. Our observations of density profiles in the fluids have provided interesting experimental confirmation to situations that have only been previously tested and studied in computer simulation. Our density profiles agree well with computer simulations published by Goetzelmann and Dietrich utilizing linear weighted density approximation (LDWA) and molecular dynamics (MD) simulations. We have also found initial evidence of the formation of a stratified liquid as the density of spheres in the system is increased.

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Gold(I)-Catalyzed Synthesis of Dihydrobenzofurans from Aryl Allyl Ethers

Nicholas W. Reich, University of Chicago
Advisor: Dr. Chuan He

Once thought to be of little use catalytically, cationic gold species have only just recently been explored as useful catalysts for several organic transformations. In particular, the addition of nucleophiles to alkynes, and more recently alkenes, have been shown to be effectively catalyzed by gold. This research describes the formation of dihydrobenzofurans, a common moiety found in natural products, from aryl allyl ethers using in-situ formation of PPh_3AuOTf as the active catalyst. This reaction proceeds through a Claisen rearrangement followed by intramolecular addition of the resulting phenol to the allyl group. While both gold(I) and gold(III) can be used to catalyze this transformation, the rate at which each of the two steps in this reaction occur varies markedly and highlights the different properties of gold's two common oxidation states. The scope of this reaction is explored along with investigation into the mechanism by which it proceeds. This research demonstrates the usefulness of this one-pot synthesis of dihydrobenzofurans and is the first reported example of a Claisen rearrangement catalyzed by gold.

51 Analysis of Coffee Composition by GC/MS and EPR

Sharla Rent, Northwestern University
Advisor: Shelby Hatch

Coffee is among the most widely consumed beverages in the world. Modern coffee is available in a variety of roasts and flavors, each unique in taste and chemical makeup. Despite the long history of coffee brewing and production, the complete composition of coffee remains unknown. Additionally, the composition of coffee is not stable with time. The molecular compounds that make up fresh brewed coffee differ from those in old coffee. Analyzing the time dependence of coffee composition therefore will yield information pertinent to flavor, taste, quality, and nutrition. Our research addresses this issue by using GC/MS and EPR to analyze coffee composition at various stages. There are over 800 volatile compounds in coffee, not all of which have a known function. By using Gas Chromatography / Mass Spectrometry to examine how the composition of coffee and coffee headspace changes with time we hope to gain insight into what makes a "good" cup of coffee as well as chemically how coffee changes with time. Electron Paramagnetic Resonance techniques are being used to examine how the concentration of free radicals, as well as which compounds they are associated with, differs between stages in the brewing process. Research has been done by others in this area, but EPR spectra results obtained in our lab indicate that some of the previously examined compounds have been falsely identified. We hope to properly determine how the nature of free radicals in coffee is affected by coffee roast, quality, and time.

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52 Tetrathiomolybdate and its Interaction with Cu(I)-Proteins: Fighting Cancer by Disrupting the Angiogenic Process

Chandler D. Robinson, Northwestern University
Advisor: Thomas O'Halloran

Angiogenesis is the process of blood vessel growth and proliferation. In order for a tumor to exceed a critical size of 2mm, angiogenesis must be stimulated to divert nutrients to feed a tumor's rapid growth. Thus, angiogenesis is an important target in cancer treatment. It is mediated by many different angiogenic promoters that influence the migration, proliferation, and differentiation of cells, such as vascular endothelial growth factor (VEGF) and basic fibroblast growth factor (bFGF). Many of these angiogenic factors appear to be dependent on normal levels of copper (Cu). Lowering copper levels moderately with a drug called tetrathiomolybdate (TM) produces strong antiangiogenesis and potential anticancer effects. Our goal is to discover the precise mechanism by which TM binds copper in the body. To study this unknown mechanism, we are using coordination model studies of Cu chaperones, such as Cu(I)Atx1 and Wilson's Domain 5, with TM. These TM-Cu-chaperone complexes could provide a model for the possible Cu-TM interactions in angiogenic promoters. Our studies will also show if TM is binding to intra or extracellular copper proteins, or both, and how strong of an affinity it has for copper.
Our data from EXAFS and FPLC gel filtration, as well as the shapes of the faces of

the crystals we have formed of TM reacted with Cu(I)Atx1 all suggest that the TM is forming a trimer complex with Cu(I)Atx1. We will only know for certain once we have resolved the crystal structure. To date, we have obtained diffraction resolutions of up to 1.8 Å on the crystals we have formed, but have not been able to resolve this data.

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53 A "Greener" Solution to Asymmetric Sulfoxidation: Catalysis by [Fe(salen*)]2O Complexes

Claire M. Schmerberg, Northwestern University
Advisors: So-Hye Cho and SonBinh T. Nguyen

An increased awareness of environmental issues has lead to the development of green chemistry, a branch of chemistry with the goal of reducing the amount and toxicity of chemical waste. In this sense, environmentally friendly methods for asymmetric sulfoxidation have gained much attention recently, as drugs such as esomeprazole (a chiral sulfoxide found in several acid-reflux drugs) gain popularity. Unfortunately, the current protocols used in the asymmetric oxidation of organic sulfides are far from being environmentally friendly, employing toxic transition metals, corrosive and atom-inefficient oxidants, and volatile organic compound (VOC)-releasing solvents. Our research attempts to integrate the increasing need for asymmetric sulfoxides in the pharmaceutical industry with increasing interest in green chemical methods to produce a catalytic system that is optimized for high enantioselectivity and low environmental impact. In this project, we test the green [Fe(salen*)]2O catalyst with several environmentally friendly oxidants (such as hydrogen peroxide) and solvents (including ionic liquids) in the asymmetric sulfoxidation reaction.

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54 Flushed with Concern: DePaul University's Contribution to Urban Stormwater Runoff and Pollution

Amber Winter, DePaul University
Advisor: James Montgomery

Abstract: To address the pervasive problem of polluted runoff in urban areas, I examined DePaul University's pollutant contribution to urban stormwater runoff. I sought to determine the types and concentrations of pollutants present in local runoff as well as to compare first flush samples (those collected after a prolonged period without precipitation) to standard samples. Over a period of eight months (June-December 2005), I collected stormwater runoff from 8 storm drains located at various points on DePaul's Lincoln Park campus as well as 2 control samples collected from rainwater samplers. Samples from impervious (impenetrable), lawn based, and control sites were then analyzed for pH, phosphates, nitrates, bacteria, and sediments. Initial data analysis indicates that there are significantly higher levels of phosphates, nitrates, and sediments in runoff samples than those found in control samples. Furthermore, first flush samples suggest that pollutant concentrations are higher than those found in standard samples. A study of best management practices tailored to the DePaul Lincoln Park campus may be conducted to alleviate possible deleterious effects of pollution in local runoff.

55 Development of a Highly Efficient and Selective Catalytic Oppenauer Oxidation System

Bi-Shun Zeng, Northwestern University

The oxidation of alcohols to their corresponding carbonyl containing compounds constitutes one of the most fundamental transformations in organic chemistry. While several oxidation protocols are currently available in the literature, they are plagued by the use of stiochiometric amounts of heavy metals, selectivity issues (tendency of the reagent to react with functional groups besides the alcohol), specificity issues (the inability of the oxidizing reagent to react with only a specific type of alcohol in the presence of another), waste issues, and the employment of highly toxic reagents. Given the rise in attention afforded to the development of environmentally friendly chemical processes over recent years, efficient, clean, and inexpensive oxidation methods that address these aforementioned problems are of utmost importance. One such oxidation method is the Oppenauer reaction, a highly selective synthetic tool for alcohol oxidation to corresponding carbonyl, utilizing aluminum, an inexpensive and innocuous metal, as a key reactant. Although discovered in the mid-1930's,[Oppenauer, 1937 #6] only recently have Oppenauer oxidation systems implementing catalytic amounts of aluminum been realized.[Ooi, 1998 #25; Ooi, 2002 #23] In all cases, the authors attribute the activity of the catalysts to the complex ligand frameworks surrounding the active aluminum center, and it has been reported that simple organoaluminum complexes are inefficient catalytic precursors for analogous oxidations.[Ooi, 2002 #21]
Our research is geared towards developing catalytic Oppenauer oxidation method that employed catalytic amounts of simple and inexpensive aluminum reagents. Specifically, we investigated the reactivity of trimethylaluminum (AlMe3) and trisaluminum isopropoxide (Al(OiPr)3) as potential catalysts in the Oppenauer oxidation of a variety of alcohols, using 3-nitrobenzaldehyde as a readily available and inexpensive, oxidizing agent. We are also interested in the variation in catalyst loading (the amount of catalytic species added to the reaction), type of aluminum catalyst used in the oxidation of various alcohol substrates.

Gratifyingly, we have shown that a highly active catalytic Oppenauer oxidation manifold was developed. Both $AlMe_3$ and $Al(OiPr)_3$ could be used as catalysts for the oxidation of a variety of alcohols. While quantitative oxidation of alcohol was generally achieved in less than 0.5 h using $AlMe_3$ as the catalyst, extended reaction times were generally needed for analogous quantitative conversion when implementing $Al(OiPr)_3$. The catalyst loading also affected the success of alcohol oxidation. A higher quantity of catalyst used resulted in a more active system. The structure of the alcohol was another determinant of the reaction time. The bulkier substrates that underwent oxidation via the aluminum isopropoxide equated to longer reaction times.

Engineering

56 Active Flow Control of Vortex formation and circulation of NACA 0012 airfoil

Jesse Collins, Illinois Institute of Technology
Advisor: David R. Williams

Insects and small birds use unconventional methods such as vortex stabilization to develop high amounts of lift at low Reynolds' numbers and high angles of attack. It is the purpose of this study to investigate the application of active flow control techniques over a NACA 0012 airfoil for the purpose of leading edge vortex stabilization in separated flows with applications in unmanned/micro air vehicles (UAV/MAV) wings. This enhancement in lifting characteristics and control stabilization will yield increases in performance of UAV/MAV in the areas of maneuverability, range, payload and endurance. Closed-loop active flow control will be realized using micro valves fabricated by the Lee Company inside the wing. Through slots on the leading edge and wing tips, pressurized air will be forced out of the wing to control the circulatory 3d effects near the tips and the position of leading edge vortices. To collect quantitative data of these effects, a Scanivalve Digital Sensor Array pressure transducer will measure pressures at various pressure tap locations across the wing, and an ATI Industrial Automations force transducer will measure the forces on the airfoil. To provide a qualitative description of the flow field, smoke wire visualization techniques will be employed as well as Particle Image Velocimetry. PIV will be integrated to provide another visualization of the flow and allow the measurement of circulation at span-wise sections on the airfoil.

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57 Effects of Hypoglycemia on Oscillatory Potential Sensitivity to Hypoxia in Cat Electroretinograms

Rebecca Hannah and Grace Lin, Illinois Institute of Technology
Advisor: Jennifer Kang Derwent

The effects of hypoxia and hypoglycemia on inner retinal cell function were studied through the electroretinogram (ERG) oscillatory potentials (OPs). Vitreal ERG responses to bright flashes of diffuse white light were recorded during hypoxic episodes lasting from 15 minutes to 2 hours in dark-adapted anesthized cats. Hypoxia was induced by inspiration of a mixture of N_2 and air. Three levels of hypoglycemia, achieved by lowering arterial blood glucose with intravenous infusions of glucose and insulin, were examined. The oscillatory potentials (OP_1-OP_4) were then extracted from the raw ERG data using a Chebyshev1 filter (bandpass, 75-300 Hz) via Matlab. Under normoglycemia and 2 log intensity light level, a 20% decrease of amplitude corresponded to a PaO2 level (mmHg) of 25.7 for OP_1, 27.3 for OP_2, 28.5 for OP_3, and 24.2 for OP_4. During moderate hypoglycemia a 20% decrease corresponded to a P_aO_2 level (mmHg) of 34.3 for OP_1, 30.7 for OP_2, 35.3 for OP_3, and 31.0 for OP_4. During severe hypoglycemia, a 20% decrease corresponded to a PaO2 level (mmHg) of 53.3 for OP_1, 27.4 for OP_2, 53.2 for OP_3, and 31.3 for OP_4. The data suggest that the effects of hypoxic and hypoglycemic conditions on OP_1- OP_4 are similar to the ERG b-wave response in that they resist changes to a certain level and then suddenly decrease rapidly. The data also suggest that the OP components may originate from

different retinal cells due to the variation in the nature of the response to oxygen and glucose changes of each OP. In general, the OPs appear more sensitive to changes in blood oxygen as the severity of hypoglycemia increases.

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Maxwell's Equations Modeling of Biological Tissue Optics for Improving Early-Stage Cancer Detection in Epithelial Tissues

Kevin Huang, Northwestern University
Advisor: Allen Taflove

Colorectal cancer is the nation's second most lethal cancer, the cause of more than 56,000 deaths in the U.S. every year. Although early detection of colon cancer dramatically increases patient survival rate, current screening technologies require colonoscopy. Colonoscopy is uncomfortable, expensive, and can present safety issues. Therefore, it is generally considered to be unsuitable for mass screening.

The recent development of the four-dimensional elastic light fingerprinting (4D-ELF) technique by Prof. Vadim Backman is extremely promising in revolutionizing cancer screening1. Coherent backscattering spectroscopy utilizes the backscattering of light to obtain micro- and nanoarchitecture of the subject tissue. This technique combines low spatial coherence, broadband illumination with low temporal coherence detection. As shown in Fig.1, analysis of the wavelength dependence of the angle and polarization of scattered light from epithelial tissues such as the rat colon reveals a vivid "fingerprint" of a precancerous condition. Note that the precancerous tissue revealed in Fig. 1 would appear completely normal under a conventional optical microscope. In fact, Prof. Backman has shown that the 4D-ELF "fingerprint" appears much earlier than any previously known biomarker for the precancerous condition. In experiments initially on rat models and later with as many as 200 human patients, the 4D-ELF technique has proven to be nearly 100% accurate.

The underlying physics governing the backscattering of light from precancerous tissues is not well known. My research is aimed at investigating this physics basis from the fundamental perspective of Maxwell's equations. To this end, I am responsible for supercomputing simulations which solve Maxwell's equations for the complex geometries represented by epithelial tissues. My work is directly supervised by Professors Backman, Taflove, and Li, who are collaborating in this research. We hope that our work will lead to the design of clinical instruments for ultra-early-stage detection of colorectal cancer and possibly other epithelial malignancies such as pancreatic and lung cancers.

Specifically, my research involves the simulation of light scattering from epithelial tissues using the finite difference time-domain (FDTD) and pseudospectral time-domain (PSTD) computational solutions of Maxwell's equations2. My first goal is to determine the scattering path of plane waves as they propagate through epithelial tissues modeled as random distributions of dielectric media in two dimensions. The exact trajectory of photons after they enter a random medium with a particular transport

mean free path is important in addressing the inverse problem of characterizing tissue nanostructures using depth-resolved CBS measurements. The use of FDTD and PSTD simulations allows the calculation and visualization of the instantaneous Poynting vectors of the scattered light both within and immediately adjacent to the random biological media. This study is important in that it will allow us to correlate the width of the CBS peak to the photon path since it is known that the angular width of the CBS peak is inversely related to the length of the scattering path3.

Enhancing DNA Detection: Small Molecule DNA Hybrid Model Studies
Dorthea Koh, Northwestern University
Advisor: Professor SonBinh Nguyen

The synthesis and characterization of a series of model compounds designed to simulate the core structure of small-molecule DNA hybrids (SMDHs) are described. Two different model compounds were synthesized using solid-phase technique: either a benzyl alcohol or a diphenylacetylene alcohol was first coupled to phosphoramidite and then oxidized to the corresponding phosphates. These two model compounds were subjected to a series of timed simulations designed to mimic the ammonium hydroxide deprotection step involved in the coupling of DNA to a small molecule and the exposure to UV irradiation that occurs during the subsequent purification process. With this strategy, we were able to demonstrate their robustness in the presence of concentrated ammonium hydroxide and under strong UV irradiation. Significantly, their stability as monomers underscores the stability of polymer-DNA hybrids that have been used in a highly sensitive method of electrochemical DNA detection.

Classification and Identification of Heart Murmurs Characteristics
Tenille Medley, University of Illinois at Chicago
Advisor: Roland Priemer

Early detection of heart murmurs is a critical step in the potential decrease of death due to heart failure which claims the lives of approximately 2000 Americans per day (one American every 44 seconds). This research proposes a method that will investigate characteristics of normal and abnormal phonocardiogram signals (PCG signals) in order to develop a stethoscope that will detect common characteristics such as murmur duration, dominant frequency, period (systolic, diastolic), magnitude, etc. A database of about 150 various PCG signals was used in this research. The murmurs were extracted from each PCG signal, and two transform functions (Power Spectral Density and Short Time Fourier Transform) were used to convert these murmurs into the frequency domain for further investigation. This examination suggests two implications: In many cases, multiple occurrences of dominant frequencies in the systolic murmurs were more prevalent than the innocent murmurs. The intensities of the dominant frequencies are proportional to the grade level of the murmurs. These findings allow applications of an artificial neural network to classify the input signals based on these common characteristics. Research currently classifies separation of heart murmurs into the four dominant shapes: (crescendo, decrescendo, crescendo-decrescendo (diamond shaped), plateau (uniform magnitude)). These results will be applied to develop artificial neural networks, which can classify PCG signals into those with and without murmurs based on the aforementioned characteristics.

61 Fluorescence-imaging of Oxygen Consumption as a Test of Islet Function

Shravani Pasupneti, Illinois Institute of Technology
Advisor: Emmanuel Opara

The standard test for islet cell function is the response of islets to changes in glucose concentrations. This test is not suitable for routine use in islet transplantation because it usually requires many hours or even days for completion. The purpose of this study is to develop a rapid and valid metabolic test based on a reliable index of the function of islets. Such a test would be suitable to test the function of both naked and encapsulated islets, immediately prior to transplantation. Method: Islets were isolated from the rat pancreas using the procedure of collagenase digestion, and were handpicked into microplates with fluorescence sensors (BD Biosensor) at the bottom of the wells in a Krebs-Ringer bicarbonate buffer, pH 7.4, medium with or without glucose at room temperature. Blank microplates containing medium, but no islets, were set up and used to correct for any background oxygen consumption in the assay system. Results: In preliminary experiments, we have observed a dynamic change in oxygen consumption that is glucose concentration dependent. Conclusion: This is a procedure in which oxygen becomes depleted, and the biosensor fluoresces, providing a linear signal that can be directly correlated to cell function. This system is more favorable than current methods used to test islet cell viability and functionality due to its rapidity. (Supported in part by funds from the Whitaker Foundation).

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62 Model catalytic oxide surfaces: a study of LaAlO3($11\bar{1}$) surface

James Rondinelli, Northwestern University
Advisor: Laurence D. Marks

Insight into the nature of surfaces and the processes which occur on them is of great importance in the study of catalysis. For example, approximately 50% of the total municipal solid waste generated annually in the United States is attributed to the chemical industry in the form of by-product waste. This amounts to more than 100 million tons annually. The goal of this research is to improve the activity and selectivity of catalytic oxidation by identifying catalytically active sites and reaction pathways through atomic scale structure analysis. It is these important prerequisites that will make the engineering of new and more efficient materials possible. The ramifications of this research may result in positive environmental impacts on various industrial activities, including chemical production and fossil fuel consumption for energy generation. While much work has been done on understanding the atomic structure of surfaces on metals, knowledge of transition metal oxide surfaces is minimal. In this poster, we report the discovery of the ($\sqrt{5}\times\sqrt{5}$)R26.6° reconstruction on the $LaAlO_3$ ($11\bar{1}$) surface. The approach we take is to stabilize the reconstruction through air anneal treatments and characterize the surface with transmission electron microscopy. Structure solution analysis is performed with Electron Direct Methods on this model perovskite material. We show that the surface exhibits flat <$11\bar{1}$> facets

and subsurface voids. Our results indicate that simple structural ordering is responsible for the two observed reconstruction domains. We also discuss possible mechanisms for surface stabilization that may be extended to other perovskite materials.

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Determining tumor grade using quantification of cerebral blood volume through contrast enhanced MRI

Rahul Sawlani, Northwestern University
Advisor: Timothy J. Carroll

Central nervous system (CNS) tumor aggressiveness leads to neovascularity and a subsequent increase in cerebral blood volume (CBV) in the tumor region. Currently, relative CBV (rCBV) found using MRI can differentiate between stable and progressive tumors, but with high variability and overlap. The standard practice for tumor grading is resection, which is very invasive and is limited by tissue sampling error and the lack of a specific tumor marker. We are the first to develop a technique that can quantify CBV and thus vascular proliferation using MRI. We hypothesize that using this technique will lead to a more clear separation in tumor grading. A series of 18 patients scheduled for MRI before surgical resection of CNS tumors were studied. Dynamic susceptibility-weighted contrast-enhanced (DSC) MRI was used to quantify CBV. We compared two complementary quantification techniques: Gradient Recalled Echo (GRE) and Spin Echo (SE) MRI acquisitions. A Region of Interest (ROI) analysis was performed to compare qCBV within enhancing regions of the lesion with normal tissue. Vascular proliferation was quantified based on local changes in qCBV, while normal WM served as a control. Statistically significant differences on CBV were observed for both acquisitions. GRE MRI pulse sequences showed better separation between normal and cancerous tissue than SE, but were more prone to artifact and field inhomogeneity induced signal dropout near frontal sinuses and auditory canals. While more patients are needed for this study, current results are promising and patient accrual continues. This technique could be a great tool for CNS tumor treatment.

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Synthesis and Characterization of Metal-Polymer nanorods with poly((2-terthiophenyl)norbornene)

Anup Shah, Northwestern University
Advisor: Sonbinh Nguyen

The introduction of the fabrication of metallic meso or nano-scaled rods in 1997 by Martin and Hulteen ushered in the creation of metal-polymer nanoscaled rods. Moreover, metal-polymer rods have been studied, and the potential applications of these rods have renewed interest in the investigation of the one-dimensional nanostructures. In our experiment, we continue the investigation of the metal-polymer rods by introducing a novel polymer with fluorescent properties - poly((2-terthiophenyl)norbornene).

In our research, we intended to fabricate metal-polymer rods using the literature precedent of the metal-polymer synthesis by Martin and Hulteen, replacing a non-fluorescent polymer with the fluorescent poly((2-terthiophenyl)norbornene) as the polymer domain in the rods. We also resolved to characterize the rod morphologies

through high-resolution SEM (scanning electron microscopes), optical microscopy, and fluorescence microscopy.

All these goals have been realized, producing interesting images and data which pose fundamental physical questions of energy transfer between conjugated polymers and coinage metals. The precedent of energy transfer by Nobel Laureate Alan Heeger et. al. clearly warrants more detailed inquiry into the mechanism of this phenomena.

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Monocyte Derived Microparticles And Their Role In Thrombosis On Biomaterials

Michael Turturro, Illinois Institute of Technology
Advisor: Connie Hall

Microparticles (MP) are membrane vesicles that are released from various blood and vascular cells upon activation or during apoptosis. In healthy individuals, MP are typically found in relatively low numbers but have been shown to increase in certain disease states. MP populations have been shown to contain various active membrane-bound proteins, such as tissue factor (TF) the principle initiator of blood coagulation and perhaps its inhibitor, tissue factor pathway inhibitor (TFPI). The TF and TFPI activities of MP and their adherence to biomaterials were studied using MP derived from monocytes. Monocyte MP were artificially created *in vitro* using a sample of monocytes isolated from whole blood. The monocytes were then activated using a calcium ionophore or lipopolysaccharide and the MP collected by ultracentrifugation. The MP were tested using standard factor Xa generation assays and fluorescent microscopy to determine if either TF or TFPI was present. Adherence of MP to artificial surfaces was observed under both static and flow conditions to determine the *in vivo* effects of the introduction of a biomaterial. Early results indicate that the majority of monocyte derived MP express varying concentrations of TF, with minimal TFPI. When introduced to an artificial surface, MP tend to not only adhere to the surface, but to other MP forming aggregates. The degree to which the MP adhere to the surface appears to be related to both the shear rate and the type of material used.

Mathematics and Economics

66 **A linear-time algorithm for finding p-centers of trees**
Pierce James, Illinois Institute of Technology
Advisor: Michael Pelsmajer

The general facilities location problem is an optimization problem which involves finding a set of central facilities which "best" serves the customers. "Best" can be described in various ways depending on our notion of distance as well as other constraints. We present a fast algorithm for solving a version of this general facilities location problem. We then show how the algorithm can be modified to find other types of centers.

Physics

67 **SPR dispersion compensation for a gold-coated corrugated surface**
Marsela Jorgolli, University of Chicago
Advisor: Mike T. Reilly Sr.

The objective of this effort is to improve upon a microarray-based system for label-free, high-throughput proteomic analysis. The system operation is based on a novel grating-coupled surface plasmon resonance imaging (GCSPRI) technology that enables measurement of hundreds to thousands of binding events simultaneously without the limitations of reporter molecules. We expect that this technology will provide a powerful new tool for highly multiplexed analysis of an organism's global protein profile, reflecting metabolic and physiologic activity in relation to time, development and interaction with the environment. It will be applicable to the detection of a broad range of metabolic products, signaling molecules, hormones, enzymes, receptors and other proteins. Our intention is to introduce a SPR-compensation grating which will allow for smaller sample volumes by reducing the effects of thin-film interference as well as providing more interrogation light by eliminating an interference filter. I determined the particular orientation of the SPR-compensation gration to improve the instrument's efficiency. Furthermore, I successfully assembled the optical system and managed to improve the light through-output by 20X, leading to 20X more images per unit time and the subsequent $\sqrt{20}$ gain signal to noise.

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68 **Testing CsI Photocathodes' Efficiencies in Liquid Xenon**
Marsela Jorgolli, University of Chicago
Advisor: Elena Aprile

Several cosmological observations have converged on the ΛCDM concordance model. From this model it is known that only 5% of the Universe can be seen, 73% is in form of dark energy, and 22% is dark matter. The proposed XENON experiment is among the new generation direct searches for dark matter weakly-interacting-massive-particles (WIMPs). XENON's ultimate goal is to achieve sensitivity of the order of $\sim 10^{-46}$ cm^2. In the detector, a CsI-photocathode will efficiently detect the fraction of direct light (scintillation signal produced in LXe by WIMP recoil events) heading

downward. The CsI-photocathode in place of a common cathode can significantly improve light collection and lower the minimum energy threshold. The purpose of this experiment was to optimize preparation and test CsI-photocathodes for maximum performance in LXe. We produced and tested photocathodes of different thicknesses – 500nm and 600nm – and of different sizes – 6cm and 12cm in diameter. CsI-photocathodes were prepared in a High Vacuum Deposition Chamber and tested in a LXe parallel plate ionisation chamber. We analyzed the experimental data with a ROOT program. The Quantum Efficiencies (QEs) of the photocathodes significantly improved – from ~13% to ~21% – as we better understood the experimental techniques. We observed that QEs are directly proportional to the applied electric field. Furthermore, we concluded that the rate of deposition, vacuum of the chamber, and evaporation temperature significanlty effect CsI-photocathode efficiencies. A better understanding of the different factors that determine the performance of the photocathode will allow the achievement of higher QEs.

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Theoretical Radial Velocity Distributions of Double Neutron Star Systems

Jeff Kaplan, Northwestern University
Advisor: Professor Vicky Kalogera

The radial velocity component of binary pulsars, such as PSR J037-3039, is an important statistic in determining the properties and formation history of binary pulsar systems. However, the radial component of a binary pulsar's velocity is not something which can be determined from observation. Although we cannot determine the radial velocity of double neutron stars (DNS) observationally, population synthesis calculations can provide us with reasonable guidance on the expected radial velocity distribution of DNS. By using the *StarTrack* population synthesis code in conjunction with the observed density function of massive binaries in the galaxy we were able to generate a theoretical population of DNS. By then evolving the motion of these systems in the galactic potential to the current era and calculating the radial velocity of the DNS relative to the sun, we are able to construct theoretical radial velocity distributions for double neutron star systems. We find that the derived radial velocity distributions are very well approximated by a Gaussian distribution centered at zero with standard deviations ranging from 60 to 200 km s^{-1}. In addition, the standard deviation of the distribution is dependant on the parameters used in the nascent kick velocity imparted to the DNS system upon birth of the neutron stars. This analysis was part of a larger study conducted on the formation and progenitors of PSR J0373-3039. Our paper can be found on astro-ph at astro-ph/0602024.

70 Erosion of Polymers in Low Earth Orbit Conditions

Scott Kelber, University of Chicago
Advisor: Dr. Sibener

Objects in low earth orbit (LEO) experience not the vacuum of outer space but rather an atomic oxygen environment that significantly reacts with and degrades a variety of materials used in spacecraft and satellites. Of particular interest amongst the materials used in space are polymers. This then motivates the examination of how a variety of polymers behave during exposure to atomic oxygen. Additionally, since these materials would also experience ultra-violet radiation from the sun, simulations of polymer erosion from atomic oxygen must also include exposure to UV light.

A polymer of principle interest is poly(methyl methacrylate) (PMMA). The behavior of PMMA under exposure to atomic oxygen and vacuum ultra-violet (VUV) light is of interest for two main reasons. First, the properties and structure of PMMA are well understood by the scientific community; this lends PMMA as a good initial choice to elucidate the effects of atomic oxygen and VUV light. Second, PMMA is commonly used in a variety of applications; as both an insulator and in wafer bonding applications as both an adhesive and protective layer. Finally, PMMA has never before been exposed to a supersonic molecular oxygen beam; its behavior under such conditions thus merits exploration.

This project seeks to use a quartz crystal microbalance (QCM) to measure the mass erosion of PMMA that has been spin-coated on two quartz crystals. The atomic oxygen arrives from a molecular oxygen beam that is incident on the crystal surface. A deuterium lamp provides a beam of UV light. One particular goal is two determine whether the reaction that occurs in the presence of UV light and atomic oxygen is just the superposition of the individual reactions or if a synergistic reaction occurs that requires the presence of both VUV light and atomic oxygen on PMMA. After testing PMMA, other polymers will be examined.

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71 Diffusion in Patterned Narrow Channels

Alessandro Lauro, University of Chicago
Advisor: Binhua Lin

Using digital video microscopy we are investigating the behavior of diffusion of micron-sized colloidal suspension that are confined to narrow channels in various arrangements (e.g. circular, sinusoidal, with corners) and also in varying channel width. This system was chosen so that we could investigate the effect of the spatial confinement and varying patterns on the long time single-file diffusion. Our observation of diffusion patterns has resulted in interesting experimental confirmations that until now have only been predicted theoretically. In particular, we have observed that the long-time mean squared displacement is not linear, as predicted by theory.

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Robert Lucero, University of Chicago
Advisor: Dr. Yau Wah

This is the first search for the long-lived neutral kaon decaying into a neutral pion, photon, neutrino and anti-neutrino using the E391a experiment located at KEK (High Energy Physics Laboratory) in Japan. Currently, there is no theoretical prediction for the branching ratio of this decay mode and could be a significant background to the Golden Mode: K_L to $\pi^0\gamma\nu\nu$. Current results have produced a Branching Ratio for K_L to $\pi^0\gamma\nu\nu$ to be less than or equal to $2.097 * 10^{-6}$ with a 90% Confidence Level.

73

Spectroscopic studies of Pb corrosion of reactor materials

Daniel Olive, Illinois Institute of Technology
Advisor: Dr. Carlo Segre

The U.S. Department of Energy has identified lead-cooled fast neutron reactors as a promising technology for small, modular, non-refuelable reactors. These pre-fabricated reactors are designed to be placed in remote regions for power generation and then transported back to the factory for disposal. However, the corrosive nature of high temperature lead mandates the careful selection of materials to be used in the primary cooling loop. In order to determine the kinds of corrosion likely to be found in these new reactors this experiment attempts to determine the change in molecular structure that occurs at the lead-structural material interface. The materials (316L stainless steel, molybdenum, and spinel,) all having been exposed to lead and heated in an inert atmosphere were studied using synchrotron radiation from the Advanced Photon Source at Argonne National Laboratory in both in situ and ex situ EXAFS experiments.

74

Two pion interference studies with the MIPP experiment

Dmitry Ratnikov, Illinois Institute of Technology
Advisor: Nick Solomey

The Fermilab Main Injector Particle Production (MIPP) experiment, E907, has collected data from 2004 through 2006 using pion, kaon and proton beams from 10 to 120 GeV/c momentum on various targets from Hydrogen to Uranium. This experiment has the ability to use K- beam on hydrogen target to produce a fireball of secondary particles, which allows to derive the radius of original interaction. This is done by using the quantum mechanics effect of two bosons to be more likely in identical final states. Our data supports the effect and permits to measure the diameter of the Kaon interactions that can be compared to the known results from protons and pions.

75 The Search for the $\Sigma^+ \to \pi^+ \pi^- \mu^+$ Decay

Nil Valls, Illinois Institute of Technology
Advisor: Dr. Daniel M. Kaplan

While the current Standard Model of particle physics describes the strong, weak and electromagnetic interactions, it fails to explain the gravitational interaction and experimental facts of neutrino oscillation. Grand Unified Theories (GUTs) attempt to unify the electroweak interaction and quantum chromodynamics, and can accommodate neutrino oscillation. GUTs would allow decays conserving baryon number minus lepton number (B–L) but violating lepton and baryon number individually. However, such modes would be greatly suppressed. The search for one of these modes, such as the $\Sigma^+ \to \pi^+ \pi^- \mu^+$, might provide additional experimental evidence for GUTs. The HyperCP experiment, run at Fermi National Accelerator Laboratory between 1997 and 1999, accumulated large amounts of data, particularly hyperon and kaon decays, suitable for searching the $\Sigma^+ \to \pi^+ \pi^- \mu^+$ decay. Work is still in progress; however, thus far evidence of our decay of interest has not yet been observed.

76

Tony Zitek, University of Chicago
Advisors: Binhua Lin and Stuart Rice

We have previously studied the hydrodyanimc coupling between Brownian colloidal particles diffusing along a linear channel. We found that the quasi-one-dimensional confinement leads to a sharply screened interaction, and that particles move in concert only when their mutual distance is smaller than the channel width. While the study of diffusion along narrow, straight channels leads to many applications in itself, we seek to develop a better understanding of how the geometry of a narrow channel affects the diffusion mechanism. Hence, we will compare the hydrodynamic coupling of particles in a linear channel to that in a bent channel by evaluating the relative and collective diffusion in the two cases.

Social Sciences and Psychology

77 Academic Stress, Positive Cognitive Reframing Coping, and Internalizing Symptoms

Christine M. (Alyx) Kesselring
Advisor: Noni K. Gaylord-Harden

Despite trends indicating that many undergraduate students experience potentially troublesome emotional difficulties related to high academic stress levels, little research assessing the emotional effects of academic stress levels on undergraduate students has been conducted. The link between increases in general life stress and increases in anxiety and depression (internalizing) symptoms is well-established, and recent research indicates that academic pressures are the most significant source of general life stress for college students. Furthermore, past research indicates that positive cognitive reframing, a cognitive coping strategy, helps individuals reduce the negative emotional impact of stressful situations by changing their thoughts and beliefs about the stressful situation. The current study examined positive cognitive reframing coping as a moderator of academic stress and internalizing symptoms in a sample of 95 college students. It was predicted that (1) internalizing symptoms would increase as academic stress levels increased, and that (2) positive cognitive reframing coping would moderate the relation between academic stress and internalizing symptoms. Participants completed measures of anxiety and depression symptoms, academic stress levels, and coping responses. Results indicated that academic stress and positive cognitive reframing coping predicted internalizing symptoms; however, positive cognitive reframing coping did not moderate the relation between academic stress and internalizing symptoms. Although the results of this study did not support the hypothesis that students who engage in positive cognitive reframing coping would show stable levels of internalizing symptoms as levels of academic stress increase, the results do suggest that positive cognitive reframing minimizes students' negative emotional reactions to academic stress.

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78 Molecular Genetic Study of Sexual Orientation

Rachael M. Kim, Yuliya (Julia) Gerasimchuk, Rebecca Harris, Nicholas Infusino, Yogesh Khanal, Chu-li (Jules) Lai, Tiffany Chao, Jaclyn Janoski, Robert Loman, Megan Ryan, Sven Sommers, Kristin Bartelme, DeMarus Allen-Batieste, Alexander Brown, Katherine Hahn, Debbie Kim, Peter Luckow, Evgeni (Gene) Schwartz, Laneshia Thomas, Northwestern University
Advisors: Alan R. Sanders, Khytam Dawood, Ritesha Krishnappa, Alana Kolundzija, Timothy F. Murphy, J. Michael Bailey

Family and twin studies support a significant genetic component in the trait of male sexual orientation, one of the most fundamental variations in normal human sexuality, though its development appears to be complex with a number of genetic and environmental contributions. We describe our ongoing linkage (gene mapping) study, the first portion focusing upon recruiting a large number of affected sibling pairs comprised of gay brothers, to help increase the understanding of the genetic contributions to this trait (http://www.gaybros.com/). Briefly, participants complete a

questionnaire about sexual orientation, demographics, size and structure of the family, and gender related behaviors, as well as provide a blood sample for a source of DNA. Our study utilizes the Kinsey scale for assessment of sexual orientation, focusing upon the psychological aspects (i.e., attraction and fantasy). The research currently focuses upon the various recruitment strategies currently being used to collect the sample, and an initial description of the composition of the current family collection. A main finding is that we identify larger numbers of potential participants through festivals than other settings, but the latter scenarios (e.g., via advertisements and through organizations) attract potential participants who are much more likely to complete the study protocol. Future study years will be dedicated to completing a genome-wide linkage scan, fine-mapping, association analyses, and the secondary analyses for the fraternal birth order effect and the quantitative trait of childhood gender nonconformity. To date, we have obtained questionnaires and blood samples from many families, but do not yet have genetic data to report since the laboratory portion of the study will be done after collecting the full sample (target of 1,000 sibling pairs), using lab methods optimized for large scale work.

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79 Social Network Composition's Impact on Individuals' Attitude Strength: How is Our Attitude Strength Affected as We Jump from One Network to Another?

Jasmine Kwong, University of Chicago
Advisor: Penny S. Visser

People form and maintain their attitudes within social environments. Previous findings indicate that individuals embedded in congruent social networks (made up of others with similar views) hold stronger attitudes compared to those who are embedded in heterogeneous social networks (made up of others with a range of views): individuals in congruent networks are more resistant to attitude change and hold more stable attitudes. The current project explored the implications of immediate social contexts for individual-level attitude strength, examining the consequences of two different branches of a social network (one made of school friends and another made of family members) that may differ in attitudinal composition. Is an individual's attitude strength so malleable that it changes as the individual jumps from one social network to another? To get at two branches of a social network, participants were given two surveys while they were on Campus and another while they were away on Thanksgiving break. The surveys asked participants to report their political attitudes, their intentions to act in support of their views (stronger attitudes increase attitude-expressive behavior), and their network members' political views. Some results suggest that changes in immediate social networks result in changes in attitude strength, such that more change in social network compositions lead to less attitude-expressive behavior and a less stable attitude. These results depend on factors including how the individual holds the particular attitude, for instance, individuals who hold an attitude with a lot of certainty are less sensitive to changes in social network composition.

80 Melissa Liebert, Northwestern University
Advisor: Dan Molden

This study examined how individual differences in BIS/BAS sensitivity and sexual differences in mate preference moderated the effects of social proof on the perceived value of a potential partner and the motivation to engage in a relationship. It was predicted that females and individuals with high BAS levels would be more sensitive to social proof when making value judgments of potential partners whereas males and individuals with high BIS levels would be unaffected. Through the assessments of 99 university students, BIS/BAS sensitivity did not moderate the effects of social proof. Sexual differences remained a moderating variable, as females were influenced by social proof when making value judgments regarding willingness to date and talk to a potential partner. Results suggest that females utilize implicit, socially reinforced cues to assess the value of mates.

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81 Leptin, energy status, and child growth among the Tsimane' of lowland Bolivia

Katherine C. Sharrock, Northwestern University
Advisors: Thomas McDade and Bill Leonard

Leptin, a hormone derived mainly from adipose tissue, is an important regulator of energy status, growth, metabolism, fat storage, reproductive function, and immune function. Although leptin has mainly been studied in Western populations, it is important to examine variation in leptin levels in diverse populations around the world to gain a better understanding of leptin's functions, regulation, and the role it played in human evolution. My objectives are to 1) describe the distribution of leptin in children and adolescents by age and gender in the Tsimane', a remote population; 2) compare leptin levels in this population with pre-determined leptin levels in populations from industrialized countries; and 3) compare leptin concentrations to anthropometric measures of growth and nutritional status. The study was conducted among the Tsimane', a highly autarkic population in lowland Bolivia that subsists through a combination of horticulture, hunting, and foraging. Anthropometric data and blood spot samples were collected during the dry season of 2002 from 493 Tsimane' between the ages of 2 and 15 years. Leptin was assayed using an ELISA protocol validated for use with blood spot samples. Analyses indicate that Tsimane' children have very low leptin levels (mean 0.287 ng/mL in males, 0.704 in females), a finding consistent with the high degree of energy stress and growth faltering observed in this group. Significant correlations exist between leptin and WAZ, BMI, mid-arm circumference, skinfolds, arm muscle area, and percent body fat in females and mid-arm circumference and percent body fat in males. Investigating variation in leptin provides insight into an important mechanism through which energetic factors affect growth and health.

82 Manasi Vydyanath, University of Chicago
Advisor: Damon Phillips

While many observers note that programming decisions made by arts organizations such as operas and symphonies as well as recording companies appear to hinge around a synthesis between artistic criteria and generalized characterizations of audience preferences, perhaps less is understood about the economics of such preferences and the relationship between the consumption of the arts as a function of its production. This paper attempts to quantitatively explore these dynamics, in relation to both live performance and recordings, parsing the preference weights that characterize classical music audiences' utility functions to get at the reasons behind the popularity of some concerts or recordings over others. We analyze an original dataset compiled from a variety of sources like Opera America, the American Symphony Orchestra League, and IRS tax filings for non-profit organizations, which captures data on audience behavior from both the perspective of live performance and online record sales. We estimate a series of models to delve into the specification of consumer tastes; to get at the assumed preference for Bach over Bartók, for instance, we utilize a variety of coding mechanisms – based on criteria like the year of the composer's birth, number of performances/recordings made by the performers, and the financial size of the orchestras – to pin down conditional distribution functions for its direction, magnitude and components. In addition to providing an intriguing interdisciplinary application of econometric techniques, the paper presents interesting preliminary implications for both concert design and cultural policy, in terms of informing the ongoing dialogue about the market for and the future of classical music.

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Chandler Robinson
President and Founder of AURS