Chemistry Seminars
Fall, 2011

Tuesdays at 11:00-12:00

Classroom Building 170
Seminar Program

September 13
Maria Pallavicini
Provost, University of the Pacific
Stem Cells in Cancer? Really?

September 20
Yat Li
Department of Chemistry and Biochemistry, University of California, Santa Cruz
Nanostructured Metal Oxide Materials for Photoelectrochemical Water Splitting

September 27
Dean Tantillo
Department of Chemistry, University of California, Davis
Walking in the Woods with Quantum Chemistry

October 5 (Wednesday)
Eric Kool
Department of Chemistry, Stanford University
Expanded DNA: Synthesis and Function of an Alternative Genetic Set

October 11
Katalin Medzihradszky
Department of Pharmaceutical Chemistry, University of California, San Francisco
Post-translational Modifications – Sweet & Sour

October 18
James Hetrick
Department of Physics, University of the Pacific
An Introduction to Lattice Gauge Theory, or Putting a Neutron in Your Computer’s Memory

October 26 (Wednesday)
Susanne Blum
Department of Chemistry, University of California, Irvine
Lights…Camera… Chemistry! Imaging Tools for Synthetic Chemistry & Dual Catalysis with Gold
November 1  
**Marc d’Alarcao**  
*Department of Chemistry, San Jose State University*  
Sweet Medicine: A New Carbohydrate-based Strategy for Cancer Treatment

November 8  
**Larry McLaughlin**  
*Department of Chemistry, Boston College*  
Studies Toward the Recognition of Double-Stranded DNA by the Janus-Wedge Format

November 15  
**Viktor Zhdankin**  
*Department of Chemistry, University of Minnesota, Duluth*  
Hypervalent Iodine Reagents in Organic Synthesis

November 29  
**Jianhua Ren**  
*Department of Chemistry, University of the Pacific*  
The Ion Chemistry of Peptides and Peptoids
Bio: Maria Pallavicini holds a B.S. in Biochemistry from UC Berkeley, and a Ph.D. in Pharmacology from the University of Utah, Salt Lake City. She has held research positions at the Lawrence Livermore National Laboratory, the Lawrence Berkeley National Laboratory, and the Ontario Cancer Institute in Toronto. She was a professor at UC San Francisco for more than 11 years prior to joining UC Merced as a tenured professor and founding dean in 2002 to establish the School of Natural Sciences for the new research university. In 2011, Pallavicini becameProvost at the University of the Pacific, where she serves as the University's chief academic officer and has overall responsibility for the institution's educational and research programs, library services, enrollment, financial aid, registrar and continuing education. She oversees Pacific's liberal arts college and eight other schools on campuses in Stockton, Sacramento and San Francisco, encompassing 120 academic programs, 839 faculty, 6,700 students, and a $115 million budget.

Pallavicini is an enthusiastic and dedicated teacher who has taught freshman general education courses on stem cell biology, and health and disease, as well as advanced courses in cancer biology and genetics, and trained numerous graduate students and post-doctoral fellows in health sciences. Pallavicini is also renowned for her research in understanding the genetic and functional changes in stem cells in cancer (leukemia and breast cancer) that affect stem cell fate decisions. She has authored or co-authored more than 80 peer-reviewed articles in scientific journals and has presented on stem cells and cancer at scientific conferences around the world. She has held leadership positions in numerous professional societies and served on scientific editorial and advisory boards.
Stem Cells in Cancer? Really?

Maria Pallavicini

September 13, 11:00 AM, Classroom Building 170

What is the cell of origin in cancer? Is it the same in all tumors? Are stem cells involved? Genetic and cell surface markers have been used to define heterogeneity in tumor subpopulations and to lend insight into the types of cells that acquire and display genomic abnormalities, commonly associated with malignancy. Molecular marker analysis coupled with multivariate flow cytometric analyses and sorting of phenotypically defined tumor subpopulations reveals distinct genotype-phenotype relationships in stem and immature populations in primary leukemia and breast cancers. Identifying immature target populations may provide opportunities for early detection of cancer and increase understanding of the tumor subpopulation responsible for metastases and/or relapse.
Bio: Yat Li received his B. S. and Ph. D. degrees in chemistry from the University of Hong Kong. Following a postdoctoral appointment in the group of Prof. Charles Lieber at Harvard University, he joined University of California, Santa Cruz as assistant professor of chemistry in 2007. His researches focus on design and synthesis of semiconductor nanowires and nanowire heterostructures, investigation of their fundamental properties, and exploring their potentials for energy conversion and nanophotonics.
Nanostructured Metal Oxide Materials for Photoelectrochemical Water Splitting

Yat Li

September 20, 11:00 AM, Classroom Building 170

High-density metal oxide nanowire arrays are emerging as a unique class of nanostructured photoanode for photoelectrochemical water splitting. In comparison to bulk materials, they have much larger semiconductor/electrolyte interface, shorter diffusion length for minority carriers, equally good vectorial transport and lower surface reflectivity. To enhance the photoactivity of semiconductor metal oxides, such as TiO$_2$, Fe$_2$O$_3$ and ZnO, we have explored different methods such as, hydrogen treatment, elemental doping and sensitization with small bandgap semiconductor quantum dots (QDs) for improving the overall conversion efficiency of solar light to hydrogen. Synergistic effect has been observed between doping and QD sensitization. In addition, a double-sided device architecture that incorporates both CdS and CdSe QDs on ZnO nanowire arrays has been demonstrated, which showed substantially enhanced photocurrent density. Hydrogen treatment has also been shown to be a unique method for improving the donor density of metal oxides.
Dean Tantillo

Department of Chemistry
University of California, Davis
Davis, CA 95616

September 27, 11:00 AM
Classroom Building 170

Education
University of California, Los Angeles, Organic Chemistry Ph.D. 2000
Harvard University, Chemistry A.B. (Magna Cum Laude) 1995

Appointments:
Associate Professor, University of California, Davis, 2008-present.
Assistant Professor, University of California, Davis 2003-2008
Postdoctoral Associate, Cornell University, 2000-2003

Selected Awards:
Finalist for ASUCD Excellence in Undergraduate Teaching Award, 2009
NSF CAREER Award, 2005

Representative references:


More information on the Tantillo Group: http://blueline.ucdavis.edu
Unusual intermediates and transition state structures encountered in theoretical studies on carbocation cascade polycyclization reactions leading to terpene natural products will be described with an emphasis on the nature of delocalization in these carbocations. The ability of functional groups in enzyme active sites to modulate this delocalization will be highlighted. The use of computed $^1$H and $^{13}$C NMR chemical shifts as a tool to assign the structures of terpene natural products will also be discussed.
Education
Columbia University, Organic Chemistry, Ph.D. 1988
Miami University, Chemistry B.S. (Magna Cum Laude) 1982

Appointments:
George A. and Hilda M. Daubert Professor, Stanford University, 2006-present
Professor, Stanford University, 1999-2006
Professor of Biochemistry and Biophysics (joint appt), University of Rochester School of Medicine, 1996-1999
Professor, University of Rochester, 1997-1999
Associate Professor, University of Rochester, 1995-1997
Assistant Professor, University of Rochester, 1990-1995
Postdoctoral Fellow, Caltech, 1988-1990

Selected Awards and Honors:
Tortellotte Lectureship, Kalamazoo College, 2010
Novartis Lecturer, Massachusetts Institute of Technology, 2003
Mack Award/Lecturer, Ohio State University, 2002
Samuel M. McElvain Lecturer, University of Wisconsin-Madison, 2002
Dean’s Award for Distinguished Teaching, Stanford University 2001
American Chemical Society Arthur C. Cope Scholar 2000
Pfizer Award of the American Chemical Society 2000

Please see http://www.stanford.edu/group/kool/publications.htm for the publication list.
Our natural genetic system functions with four letters of information – the nucleobases A, C, G, and T – allowing the encoding of twenty amino acids in three-base codons. Recently, chemists have been designing new letters for the natural genetic system, by making new base pairs for DNA that hybridize selectively and can be replicated by polymerases. In our laboratory we are trying to go further, by designing a new genetic set wherein all base pairs have a different structure than natural Watson-Crick DNA. One of our long-term goals is to create a functioning genetic system that is orthogonal to the natural one.

Our design is called “xDNA”, short for expanded DNA, and is based on the concept of expanding the sizes of DNA bases by adding a benzene ring. Base pairs of xDNA are built from expanded bases pairing with natural partners, giving eight genetic letters altogether. We have developed syntheses of all four xDNA nucleosides, as well as phosphoramidite and triphosphate derivatives. Studies of xDNA sequences have shown that xDNA helices are antiparallel, with a B-like conformation that is similar to DNA but with widened grooves. Biophysical studies have shown that xDNA helices are much more stable than natural DNA, owing to very strong base stacking of the benzo-bases. Base pairing studies have shown that xDNA retains the same pairing selectivity as natural DNA.

Studies with naturally occurring DNA polymerase enzymes have shown that xDNA is a substrate, albeit a weak one. However, the polymerase Dpo4 was shown to replicate several consecutive base pairs of xDNA in vitro. More interestingly, we have found that xDNA bases can correctly encode protein sequence in E. coli. We expect that xDNA studies will result in useful tools for research and in biomedicine. The fluorescence of xDNA nucleotides and xDNA oligomers may be useful in the study of biological pathways and as genetic probes. The highly stable helix formation makes xDNAs promising as hybridization probes. In addition, the predicted unusual charge transfer characteristics of xDNA may make it useful in nanotechnological applications.
Bio: Katalin F. Medzihradszky is an adjunct professor in the Department of Pharmaceutical Chemistry in the School of Pharmacy of the University of California San Francisco, and also the head of the Proteomics Research Group in the Biology Research Center of the Hungarian Academy of Sciences, in Szeged, Hungary. Her research interests are in protein structure elucidation using advanced mass spectrometric and chromatographic techniques. Her specialty is using different MS/MS techniques such as collision-induced dissociation, electron-capture dissociation and electron-transfer dissociation for peptide sequence determination as well as for studying post-translational modifications, especially O-linked glycosylation. Prof. Medzihradszky has been working at UCSF for 23 years. She previously held an industrial research position at Gedeon Richter LTD, Budapest, Hungary and before that she was a member of the Peptide Synthesis Group in the Chemical Research Center of the Hungarian Academy of Sciences also in Budapest, Hungary. She has contributed more than 100 scientific publications, 17 book chapters and reviews, and holds 2 patents. She is on the editorial board of Molecular & Cellular Proteomics. Dr. Medzihradszky graduated from the Eötvös Löránd University (Budapest, Hungary) in organic chemistry, where she also received her Ph.D.

Prof. Medzihradszky’s work was supported by NIH NCRR P41RR001614 grant and by the Howard Hughes Medical Institute (to the Bio-Organic Biomedical Mass Spectrometry Resource at UCSF, director: A.L. Burlingame), and by a Hungarian Science Foundation Grant, OTKA T60283.)
Protein function is heavily dependent on post-translational modifications (PTMs) and therefore their identification and quantification is an essential part of molecular and cellular proteomic studies. The presence of most PTMs cannot be accurately predicted from the genomic code yet and we are far from being able to define by chemical means a consistent and complete set even of the most widely studied PTMs, e.g. phosphorylation. Both the dynamic and transient nature of most PTMs and their variable stoichiometry further confound their characterization. At the same time, manipulations of samples can introduce spurious modifications, and this causes additional problems with respect to physiological relevance.

Mass spectrometry has become the method of choice for PTM studies: it is unbiased, sensitive and increasingly accurate. When mass spectrometry is linked with modification-specific enrichment methods and powerful search engines that can pore over hundreds of thousands of MS/MS spectra, it can identify peptides, assign modifications and even evaluate assignments with a probability-based confidence score in ever expanding numbers. The presence of covalent modifications is usually detected by matching mass shifts of the precursor ion as well as the peptide fragments containing the modification during MS/MS analysis. Some structures are very stable upon collisional activation and the site of the modification can be established readily from CID data. However, glycosylation and sulfation do not belong to this group. In my presentation, I will show how to tackle these “tricky” PTMs. I will also present some cautionary tales on PTM studies.
James Hetrick
Department of Physics
University of the Pacific
Stockton, CA 95211
October 18, 11:00 AM
Classroom Building 170

Education
U. of Minnesota, Minneapolis, Theoretical Particle Physics, Ph.D. 1990
Case Western Reserve University, Physics, B. S. 1982

Appointments:
Professor and Dept. Chair, University of the Pacific, 2006-present.
Associate Professor and Dept Chair, University of the Pacific, 2001-2006
Assistant Professor, University of the Pacific, 1997-2001
Postdoc, Washington University, St. Louis, 1994-1996
Postdoc, University of Arizona, Tucson, 1994-1996
Postdoc, University of Amsterdam, The Netherlands, 1992-1994
Postdoc, ETH Zürich, Switzerland, 1990-1992

Selected Publications:
C. T. H. Davies, E. Follana, A. Gray, G. P. Lepage, Q. Mason, M. Nobes, J.
Shigemitsu, H.D. Trottier, M. Wingate, C. Aubin, C. Bernard, T. Burch, C.
DeTar, Steven A. Gottlieb, E.B. Gregory, U.M. Heller, J.E. Hetrick, J.
Osborn, R. Sugar, D. Toussaint M. Di Pierro, Aida X. El-Khadra, Andreas
S. Kronfeld, P.B. Mackenzie, D. Menscher, J. Simone, High Precision
Lattice QCD Confronts Experiment, Phys. Rev. Lett. 92, 022001 (2004),
[arXiv:hep-lat/0304004].
C. Aubin, C. Bernard, Steven Gottlieb, E.B. Gregory, Urs M. Heller, J.E.
Hetrick, J. Osborn, R. Sugar, D. Toussaint, Ph. de Forcrand O. Jahn, The
scaling dimension of low lying Diraceigenmodes and of the topological
lat/0410024].
C. Bernard, Ph. de Forcrand Steven Gottlieb, L. Levkova, U.M. Heller, J.E.
Hetrick, O. Jahn, F. Maresca, D.B. Renner, D. Toussaint, R. Sugar, More
evidence of localization in the lowlying Dirac spectrum, PoS LAT2005, 299
(2005), [arXiv:hep-lat/0510025].
An Introduction to Lattice Gauge Theory, or Putting a Neutron in Your Computer's Memory

James Hetrick

October 18, 11:00 AM, Classroom Building 170

Since the 1980's, particle physicists have come to agree on the theory that explains the interactions and behavior of quarks and leptons, called "The Standard Model". Part of this is the description of the force between quarks known as "Quantum Chromodynamics" (QCD) which is a complicated non-linear interaction sharing some general features with electromagnetism, but is far more complex. Thus researchers use numerical means to solve the equations of QCD. This approach goes by the name of "Lattice QCD" since in this method, spacetime is sliced into a discrete set of points (a lattice), and numbers are assigned to links and sites which represent the quantum fields. Using this approach, much has been accomplished over the last 30 years, including ab initio calculations of the mass of the proton and other subatomic particles, finding the temperature and pressure at which neutrons melt, and understanding how quarks are confined inside nucleons. Today lattice gauge theorists are also busy looking for signals of where QCD breaks down and new physics emerges.
Suzanne Blum
Department of Chemistry
University of California, Irvine
Irvine, CA 92697
October 26 (Wed), 3:00 PM
Classroom Building 170

Education
University of California, Berkeley, Chemistry Ph.D. 2004
University of Michigan, Ann Arbor, Chemistry B.S. with highest honors 2000

Appointments:
Assistant Professor, University of California, Irvine, 2006-present
NIH Postdoctoral Fellow, Harvard Medical School, 2004-2006

Selected Awards:
Thieme Synlett/Synthesis Journal Award, 2009
NSF CAREER Award, 2008

Selected Publications:
Gold and Rhodium Transmetalation: Mechanistic Insights and Dual-Metal Reactivity, Organometallics 2011, 30, 1776.
Our group pioneers new mechanisms for dual transition-metal reactivity with synthetic applications and aims to change the way people study chemical reactions by developing single molecule techniques to study mechanisms and catalysis.
Bio: Marc d’Alarcao was born in Lisbon, Portugal on June 11, 1957, but was raised in the United States from an early age. His family eventually settled in Bridgewater, Massachusetts, where he attended high school and subsequently received a B.S. in chemistry from Bridgewater State College. During his last two years of college he began his research career at the University of Massachusetts Medical School in Worcester where he was a research assistant in the microbiology laboratory of Professor Martin Marinus, characterizing bacteria with genetic defects in DNA methylation. From there he moved to the Midwest where he attended graduate school at the University of Illinois at Urbana-Champaign, studying in the laboratory of Professor Nelson J. Leonard. His studies at Illinois were in the area of synthetic organic chemistry aimed at molecules of biological importance, particularly nucleosides. After receiving his Ph.D. in 1983, and a brief postdoctoral stay with Professor Leonard, he returned to the Boston area to undertake postdoctoral studies in the laboratory of future Nobel laureate Professor E. J. Corey at Harvard University. There, he continued in the area of biological chemistry studying several aspects of the prostaglandin family of compounds from the various perspectives of chemical synthesis, biosynthesis, and enzymatic evaluation. In 1986, he moved a few miles north to Tufts University as an assistant professor, and since 1991, an associate professor of chemistry. In 2007, he moved to San José State University in California where he is currently Professor of Chemistry. His research at Tufts and at SJSU involves several aspects of biological and medicinal chemistry including the design and synthesis of potential antitumor agents, and a study of insulin action by synthesis of molecules related to insulin signal transduction with potential utility as treatments for type II diabetes mellitus. He teaches courses in biochemistry, organic, medicinal, and general chemistry and served as the chairman of the Chemistry Department at Tufts from 1996-2000. He has also been involved with two start-up technology companies, Pure Cycle Environmental Technologies, Inc. (Palmer, MA) where he served as Vice President and DC Polymers, Inc. (Melrose, MA), where he serves as Chief Scientific Officer, respectively. DC Polymers was founded in 2007 to commercialize electrochemicallydegradable polymer technology invented in part in Prof. d’Alarcao’s laboratory.
Devising therapeutic strategies to treat cancer is complicated by the fact that cancer cells are fundamentally human cells. Therefore finding methods to kill cancer cells without harming the rest of the cells in the body is very difficult and relies on identifying and understanding properties that are unique to cancer cells. One of these is related to the way cancer cells derive energy from the dietary sugar glucose.

In this seminar, I will give a progress report on our work aimed at developing and synthesizing new compounds that are designed to take advantage of this metabolic difference. Our hope is that these compounds will be selectively toxic to cancer cells and may provide a new strategy for treating this major threat to human health.
Larry McLaughlin

Vice Provost for Research
Department of Chemistry
Boston College
Chestnut Hill, MA 02467

November 8, 11:00 AM
Classroom Building 170

Education
University of Alberta, Canada, Organic Chemistry, Ph.D. 1979
University of California, Riverside, Chemistry, B. S. 1972

Appointments:
Chairman, Dept. of Chemistry, Boston College, 1998-2001
Professor of Chemistry, Boston College, 1991-present
Associate Professor of Chemistry, Boston College, 1989-1991
Assistant Professor of Chemistry, Boston College, 1985-1989

Awards and Honors:
Max-Planck Fellowship, Max-Planck Gesellschaft, FRG1979-1980
Faculty Fellowship, Boston College, 1988
EMBO Short Term Fellowship, European Molecular Biology Assoc., 1982
American Cancer Society Faculty Research Award, American Cancer Society, 1991-1995

Selected Publications:
To control the expression products from unwanted genes including those from oncogenes, transformed cells and viral infections, it would be very valuable to target and inhibit the process of RNA transcription. Gene-specific pharmaceuticals would result. This process begins with the ability to recognize specific double-stranded DNA sequences. The natural processes for such recognition and control relies typically with proteins (suppressors and repressors) binding to DNA and selectively preventing transcription. Our understanding of the recognition processes between proteins and specific DNA sequences is not sufficient to design and prepare a protein product to target a unique double-stranded sequence.

The use of a single strand of DNA to target duplexes is feasible, but to date the one residue to one base pair format (resulting in DNA triplexes) has been limited to polypurine sequences; targets that are not biologically very prevalent, particularly in the DNA sequences of interest. We are developing a fundamentally new type of recognition format in which a third strand of DNA (or the related peptide nucleic acid, PNA) inserts itself between two Watson-Crick faces of the base pairs of the target duplex. The resulting Janus-Wedge (J-W) triplex (Janus after the Roman god often depicted with two faces) can be generalized to any duplex target. The success of this project will lead to a new generation of gene-specific pharmaceuticals.
Viktor Zhdankin

Department of Chemistry
University of Minnesota, Duluth
Duluth, MN 55812

November 15, 11:00 AM
Classroom Building 170

Education

Moscow State University, Russia, Doctor of Chemical Sciences, 1987
Moscow State University, Russia, Chemistry, Ph.D. 1981
Moscow State University, Russia, Chemistry, B. S./M.S. 1978

Appointments:
Professor of Chemistry, U. of Minnesota Duluth, 1999 - present.
Associate Professor of Chemistry, U. of Minnesota Duluth, 1996 -1999.
Assistant Professor of Chemistry, U. of Minnesota Duluth, 1993 - 1996.
Leading Research Fellow - Head of Research Group, Moscow State University, Moscow, Russia, 1989 - 1990.
Research Fellow, Dept. of Chemistry, Moscow State University, 1982-1987

Awards and Honors:
National Award of the American Chemical Society for Creative Research & Applications of Iodine Chemistry, 2011
Sabra S. and Dennis L. Anderson Scholar/Teacher Award, 2009
University of Minnesota Jean G. Blehart Distinguished Teaching Award, 2006
University of Minnesota Duluth Chancellor's Award for Distinguished Research, 2004
Camille and Henry Dreyfus Scholar, 1998-2000
Honorable Diploma from the Russian Academy of Sciences, 1985
Since the beginning of the 21st century, the organic chemistry of hypervalent iodine compounds has experienced an unprecedented, explosive development. Hypervalent iodine reagents are now commonly used in organic synthesis as efficient multipurpose reagents whose chemical properties are similar to derivatives of mercury(II), thallium(III), lead(IV), osmium(VIII) and chromium(VI), but without the toxicity and environmental problems of these heavy metal congeners. The most impressive recent achievements in the field of organohypervalent iodine chemistry include the development of numerous new hypervalent iodine oxidants, the development of enantioselective reactions involving chiral hypervalent iodine reagents, and the discovery of catalytic applications of organoiodine compounds. Our research in the area of organohypervalent iodine chemistry with emphasis on recent advances in the development of new organoiodine(V) oxidants, recyclable polymer-supported or molecular hypervalent iodine reagents, and catalytic systems based on organoiodine compounds will be presented.

Please see http://www.d.umn.edu/~vzhdanki/ for the full publication list.
Bio: Jianhua Ren received her B.S. degree in Chemistry from Beijing Normal University (China). She came to the United States as a graduate student. She received her Master’s degree from Auburn University in 1994, where she learned Organic Synthesis. She received her Ph.D. degree from Purdue University in 1999, where she learned Mass Spectrometry. She was a postdoctoral scholar at Stanford University from 1999 to 2002, where she studied reaction dynamics. Dr. Ren began her academic career at the University of the Pacific in 2002. She is now an associate professor in the Chemistry Department. Dr. Ren and her research group conduct research on peptides, peptoids, magnetic beads, and small organic molecules. Dr. Ren’s favored molecule is cysteine.
Proteins are known to carry charges in their native states through proton addition and abstraction. The extent of charge formation is directly related to the acid-base properties of the amino acid residues. Unusually acidic or basic residues are often found in the active sites of proteins. Our research concentrates on investigating conformational effects on the intrinsic acid-base properties of amino acid residues. We designed a series of model peptides for this investigation. This presentation focuses on the results obtained from cysteine-containing oligopeptides. The acidity of the cysteine residue increased from the C-terminus to the N-terminus and did did the conformation of the peptide changed from a coil to a helix. The helical conformation has a significant influence on the acidities of peptides.

Peptoids are peptide-mimicking polymers. Peptoids can fold into helices and helix bundles, and therefore are an attractive platform for peptide-mimicking nano-materials. The increasingly diverse structures in peptoid libraries require efficient analytical methods to analyze the sequences of peptoids. This presentation focuses on our recent studies of peptoid ion fragmentation under various tandem mass spectrometry conditions. The fragmentation patterns of protonated and alkali metalated model peptoids were examined. The fragmentations induced by protonation and alkali metal cation addition were strikingly different. The possible fragmentation mechanisms were proposed.