FACULTY RESEARCH INTERESTS

DEPARTMENT OF CHEMISTRY
Illinois State University

2017-18

JOHN E. BAUR
PROFESSOR, ANALYTICAL CHEMISTRY
B.S. 1986, Iowa State University; Ph.D. 1990, Indiana University

The Baur group uses microscale and nanoscale electrochemical sensors to probe dynamic biological and chemical systems with high spatial resolution. Areas of interest are development of instrumentation and techniques for the simultaneous chemical and topographical imaging of model neurons and mammalian taste buds.

SARAH B. BOESDORFER
ASSISTANT PROFESSOR, CHEMICAL EDUCATION
B.S. 2002, University of Illinois; M.S. 2003, University of Wisconsin; Ed.D. 2012, Illinois State University

The Boesdorfer group's research interests involve chemistry teachers at all levels; how they alter and improve their practice, and what we can do to help and encourage improvements to their practice. Generally speaking, we research different learning experiences' impacts on chemistry teachers' classroom practices. Currently, the release of Next Generation Science Standards (NGSS) and their adoption as state teaching standards have provided learning opportunities for teachers. Chemistry teachers' responses to these standards, their interpretation, implementation, and impact has been the focus of some studies. In addition, we are interested in curricular developments for teaching chemistry, both to improve students' understanding of chemistry but also in terms of its impact on chemistry teachers' general classroom practices.

JEREMY D. DRISKELL
ASSOCIATE PROFESSOR, ANALYTICAL CHEMISTRY
B.S. 2001, Truman State University; Ph.D. 2006, Iowa State University

Research in the Driskell group focuses on the development of novel diagnostic and biological assays by integrating chemistry, nanomaterials, and biology. Our laboratory aims to exploit the unique size-dependent properties of nanomaterials to develop biosensing applications based on surface-enhanced Raman spectroscopy (SERS) and dynamic light scattering (DLS). Work includes both applied research to develop innovative bioanalytical tools, as well as fundamental research to investigate the mechanism of SERS, antibody-antigen binding kinetics, and attachment of proteins onto gold nanoparticles.

GREGORY M. FERRENCE, FRSC, ACS Fellow
PROFESSOR, INORGANIC CHEMISTRY
B.S. 1991, Indiana University of Pennsylvania; Ph.D. 1996, Purdue University

Single-crystal small molecule X-ray crystallography is central to the research and scholarship in the Ferrence group. Projects range from 'routine' crystallography to examination of the structure of novel organic, metalorganic and organometallic compounds. Some projects focus on the unique structures of discrete molecules; other projects focus upon better understanding solid state intermolecular interactions; still others focus on utilization of crystallographic data in chemical education. We have examined structures of compounds containing main group, transition metal, lanthanide, and even actinide elements. We are actively investigating crystallographic aspects of quasiracemic mixtures of compounds. We are particularly interested in utilizing chemical information contained in the Cambridge Crystallographic Database to enhance students' learning in chemistry coursework.

JON A. FRIESEN
PROFESSOR, BIOCHEMISTRY
B.A. 1991, Bluffton University; Ph.D. 1996, Purdue University

Research in the Friesen lab focuses on enzymes involved in biosynthesis of phosphatidylcholine. Recombinant DNA technology is utilized to produce the enzymes choline kinase and CTP: phosphocholine cytidylyltransferase. Following purification, enzyme kinetic studies are conducted to elucidate the mechanism of catalysis.

ISABEL X. GREEN
ASSISTANT PROFESSOR, PHYSICAL CHEMISTRY
B.S. 2007, Peking University; Ph.D. 2012, University of Virginia

The Green Lab probes the surface chemistry of novel nanoparticle catalysts. Surface chemistry is involved in the production of almost all synthetic materials in our lives through heterogeneous catalytic reactions. It is also a dominant factor in environmental remediation such as the catalytic exhaust systems used in automobiles. Our lab employs low temperature in situ transmission infrared (TIR) spectroscopy to study chemical reactions in real-time over novel nanoparticle catalyst surfaces. One current project studies a group of gold-core-oxide-shell (Au@TiO2) nano-catalysts showing promise as efficient thermo- and photo- catalysts for oxidation reactions. By comparing catalytic performances of similar Au@TiO2 nanoparticles with subtle design differences such as gold loading, shell thickness, and nanoparticle size, we can provide crucial insights into future catalyst design and optimization.

CHRISTOPHER G. HAMAKER
ASSOCIATE PROFESSOR, INORGANIC CHEMISTRY
B.S. 1993, E. Michigan University; Ph.D. 1999, Iowa State University

Research in the Hamaker group is focused on coordination chemistry, catalysis, and crystal engineering. Our work bridges the traditional areas of organic and inorganic chemistry, with exposure to analytical techniques. Our first project is the development of novel ligands for coordination chemistry with possible environmental and catalytic applications. Our second project is the investigation of sulfonamides and their intermolecular interactions in the solid state using X-ray crystallography.

SHAWN R. HITCHCOCK
PROFESSOR, ORGANIC CHEMISTRY
B.S. 1990, Wayne State University; Ph.D. 1995, University of California, Davis

Our research is focused on the development of heterocyclic compounds known as oxadiazinones in asymmetric organic synthesis. These compounds are hydrazino-homologs of the well-known oxazolidinone auxiliaries that have been successfully applied in reactions such as the aldol addition reaction, the Diels-Alder reaction, and conjugate addition. The presence of the additional nitrogen in the oxadiazinones allows for synthetic flexibility in designing these compounds as chiral auxiliaries or organocatalysts. We have employed these compounds as chiral auxiliaries in the asymmetric aldol addition reaction and the glycolate aldol addition reaction. Current targets in this work are arundic acid and a key fragment of hapalosin. In addition to these goals, our current efforts are focused on designing the oxadiazinones so that they can be used as organocatalysts. To this end, we are interested in pursuing organocatalytic transformations such as Friedel-Crafts alkylations, alpha-fluorination, and cycloaddition reactions to form isoxazolidines. We are also interested in extending the use of these compounds in the asymmetric Michael addition reaction to synthesized targets such rolipram, baclofen, and lyrica.

WILLIAM J. F. HUNTER
PROFESSOR, CHEMICAL EDUCATION
B.S. 1988, Mount Allison University; B.Ed. 1989, Dalhousie University; M.A. 1994, Dalhousie University; Ph.D. 1998, Purdue University

In general the Hunter group is interested in understanding the conditions under which beginning teachers of chemistry flourish when they enter the profession. Studies have focused on preservice secondary school science teachers as they prepare to enter the profession. We are also interested in how technology may be effectively used to teach chemistry. We are studying how curricular modifications are implemented by faculty in the University, and team-teaching in a secondary chemistry classroom.

MARJORIE A. JONES
PROFESSOR, BIOCHEMISTRY
B.S. 1970, Central Michigan University; Ph.D. 1982, University of Texas Health Science Center at San Antonio

Leishmania parasitic protozoans infect more than 20-25 million people worldwide and some 350 million people are at risk since they live in areas where Leishmania are human pathogens. Such diseases can be expressed as skin infections, infections in the mucus membranes of mouth and throat, as well as infections in the internal organs. There are very few good therapies currently being used to treat human Leishmania diseases in part because the treatments are expensive, have severe side effects, and drug resistance is also developing. Thus a major area of research in the Jones Lab is the use of unique compounds as potential cytotoxic agents for Leishmania diseases and we test various compounds for their ability to affect the growth of these protozoans in culture. We specifically use the Leishmania *tarentolae* species which is not pathogenic for humans but is for reptiles and is, thus, a safe and easily cultured model system. Microscopic changes in cell shape, size, and motility as well as analysis for cell viability are done following addition of compounds at various concentrations. We are working to determine the mechanism of cytotoxicity of the effective compounds by analyzing proteins, enzymes, and lipids affected. The long term goal is to develop these various classes of materials as selective pharmaceutical drugs to treat human Leishmania diseases.

JUN-HYUN KIM

ASSOCIATE PROFESSOR, ANALYTICAL/NANOMATERIALS CHEMISTRY

B.S. 1995 and M.S. 2000, Keimyung University; Ph.D. 2005, University of Houston

The research interests in the Kim group involve the development of various nano/micro-scale materials for two important applications: catalysis and drug delivery. In the area of catalysis, we are interested in the systematical synthesis of stable metal nanoparticles possessing tunable absorption properties and the examination of their photothermal heating efficiency as well as catalytic chemical reactions upon irradiation of a solar simulated light. In the area of drug delivery, we are developing a stimuli-responsive smart drug-delivery vehicle, which consists of multiple metal nanoparticles possessing a strong optical property and pH/temperature-sensitive polymer particles containing a high dose of drug molecules, for controlled delivery and release to avoid side-effects.

TIMOTHY D. LASH

DISTINGUISHED PROFESSOR, ORGANIC CHEMISTRY

B.S. 1975, University of Exeter; M.Sc. 1977, University College, Cardiff, Wales; Ph.D. 1979, University College, Cardiff, Wales

The Lash laboratory is investigating the synthesis of porphyrins and related aromatic macrocycles. This work currently emphasizes the synthesis, characterization and reactivity of carbaporphyrins and structural analogues including azuliporphyrins, benziporphyrins, N-confused porphyrins and dicarbaporphyrinoids. These unique macrocyclic structures exhibit a broad range of characteristics and vary from nonaromatic to fully aromatic systems. Carbaporphyrinoids readily form stable organometallic complexes with Ni(II), Pd(II), Pt(II), Cu(III), Ag(III), Au(III), Rh(III) and Ir(III) and have the potential for applications in catalysis. Furthermore, novel regioselective oxidation reactions are being investigated and the resulting carbaporphyrin derivatives have been shown to exhibit valuable biological activity.

CRAIG C. MCLAUCHLAN

PROFESSOR AND CHAIR, BIOINORGANIC CHEMISTRY

A.B. 1996, Harvard University; M.S. 1997, and Ph.D. 2000, Northwestern University

Vanadium coordination chemistry is the main research interest in the McLauchlan lab, with projects focused on materials and bio-mimetic complexes. One goal is to produce new vanadium-organophosphate or -organophosphonate complexes that possess open frameworks and to study their catalytic properties. Another project involves biomimetic activity of a series of V(III), V(IV), and V(V) species with well understood ligands for bio-mimetic insulin-enhancing and/or anti-leishmanial properties, often through phosphatase models.

ANDY MITCHELL

ASSOCIATE PROFESSOR, ORGANIC CHEMISTRY

B.S., 2001, Grove City College (PA); Ph.D., 2008, Texas A&M University

The Mitchell research group is focused on the development of novel synthetic methods and the total synthesis of biologically active natural products. The methods focus of our group is cycloadditions, more specifically oxidopyrylium-alkene [5+2] cycloadditions toward bridged polycyclic ethers. Many fascinating natural products such as polygalolide, toxicodenane, and hedyosumin contain a bridged ether and are uniquely accessible via oxidopyrylium-alkene [5+2] cycloadditions. As we continue to develop synthetic methodology, we will apply these methods toward the total synthesis of natural products. Finally, both natural and unnatural molecules synthesized in our lab will be tested for biological activity.

CHRISTOPHER C. MULLIGAN

ASSOCIATE PROFESSOR, ANALYTICAL CHEMISTRY

B.S. 2003, Northern Illinois University; Ph.D. 2008, Purdue University

Research in the Mulligan group is focused on developing rapid, accurate chemical detection methods using mass spectrometry. Our group is investigating "ambient" mass spectrometric analysis, or the ability to directly ionize and detect chemical species from unprepared samples in their native environment. These novel ionization methods can be coupled with portable mass spectrometric instruments to allow on-site chemical analysis. Areas of interest include environmental monitoring, forensics, and security applications.

RICHARD W. NAGORSKI

PROFESSOR, ORGANIC CHEMISTRY

B.S. 1988, Brandon University; Ph.D. 1994, University of Alberta

Carbinolamides are a functional group that are of increasing importance due to their critical presence in a growing number of compounds having interesting biological function. Little is known about the reactivity of this functionality and our studies are designed to probe both the mechanism of reaction and reaction catalysis for these compounds as a function of pH, [buffer], and [metal-ion]. The goal of the studies is to elucidate the reaction pathways of carbinolamides and carbinolamide derivatives with the outcome being a better understanding of their potential roles in bioactive compounds. A second area of interest is in the rates of enolate production as a function of ring-strain and antiaromaticity. A focus of these studies is to provide a better understanding of how enzymes are capable of so effectively catalyzing enolate formation relative to chemical catalysts.

STEVEN J. PETERS

PROFESSOR, BIOCHEMISTRY/PHYSICAL/ ORGANIC CHEMISTRY

B.S. 1989 and M.S. 1990, Illinois State University; Ph.D. 1997, Indiana University

Research interests in the Peters group involve the chemistry of free radicals and radical anions. We employ magnetic resonance techniques to explore the chemistry of these systems. My students and I have been looking at the electron-initiated addition of heteroallenes that result in the formation of stable trimer anion radicals. Two examples of heteroallenes investigated are isocyanates and isocyanurates; both are important in polymer chemistry.

JEAN M. STANDARD

PROFESSOR, PHYSICAL CHEMISTRY

B.S. 1982, Bradley University; Ph.D. 1987, University of Wisconsin–Madison

Research in the Standard group is in the area of computational chemistry. The major themes of our research include investigations of weakly bound intermolecular complexes, studies of atmospherically significant chemical reactions, and development of molecular potential energy surfaces. One research project involves studies of the structure, properties, and reactivity of sulfur ylides, compounds that are important in the synthetic production of epoxides. Another project involves elucidation of the mechanisms of acid rain formation, with particular focus on the formation of sulfuric acid from sulfur dioxide.

EIRIN C. SULLIVAN

ASSISTANT PROFESSOR, INORGANIC/MATERIALS CHEMISTRY

B.Sc. 2004, University of Birmingham; Ph.D. 2009, University of Birmingham

The solid state chemistry group investigates the intricate relationships between the crystal structure and physical properties exhibited by inorganic non-molecular compounds. Our research seeks to understand the subtle influence of dopants and defects on crystal structure and thereby tailor the optical or electromagnetic behavior of novel materials for existing or new applications. In particular, we are examining the potential of oxyfluorides with anti-perovskite structure as phosphors for innovative energy efficient phosphor conversion LED lamps. These devices use photoluminescent coatings to absorb the blue light emitted by a high brightness LED and then re-emit light of different wavelengths such that the overall combination yields useful white light.

LISA F. SZCZEPURA

PROFESSOR, INORGANIC CHEMISTRY

B.S. 1989, State University of New York at Buffalo; Ph.D. 1994, State University of New York at Buffalo

Research in the Szczepura lab focuses on the chemistry of transition metal cluster complexes. We focus on coordinating new types of ligands to clusters of six metal atoms and subsequently study the reactivity and physical properties of the product complexes. All new complexes are fully characterized using various spectroscopic techniques (NMR, IR, UV-vis), as well as electrochemical and crystallographic techniques when suitable. Such fundamental studies on these supraoctahedral complexes are aimed at providing a better understanding of their chemistry in the hopes of one day designing new cluster complexes for specific applications, such as catalysis.

MICHAEL I. WEBB

ASSISTANT PROFESSOR, INORGANIC CHEMISTRY

B.S. 2008, Mt. Allison University; Ph.D. 2013, Simon Fraser University

Research within the Webb group focuses on the occurrence of metals in medicine, as either the therapeutic agent or the target for therapy. Specifically, protein interactions have been observed to be central in either the pathology of several diseases following an interaction with endogenous metal ions, thereby becoming the target for therapy, or in the transportation of metallotherapeutics to their site of action. We are currently investigating several protein-metal interactions, with the ultimate goal of providing new leads for therapeutic development. Currently, we are studying ruthenium-based therapeutics for the treatment of cancer and Alzheimers disease. One significant advantage of metal-based therapeutics compared with more common chelation therapy is that the chemical environment around the metal can be tailored to target specific biomolecules or disease hallmarks. Lastly, we are also interested in studying the interactions between metal ions and the Parkinsons disease protein alpha-synuclein, as a potential target for therapy.

CHRISTOPHER S. WEITZEL

ASSISTANT PROFESSOR, BIOCHEMISTRY

B.S. 2002, Wabash College; Ph.D. 2009, Indiana University

Currently, research in the Weitzel lab focuses on understanding adaptations of the aminoacyl-tRNA synthetase (aaRS) scaffold to facilitate the acquisition of new, and potentially essential, functions. This family of ancient enzymes catalyzes the first step of protein translation. Remarkably, while it is exceptionally rare for any organism to retain two copies of any aaRS, there are several examples within the Archaea where a second gene encoding a protein product with homology to leucyl-tRNA synthetase (LeuRS) has been maintained. Currently, the physiological implication of this duplication remains unknown. The short-term goal of our research is to understand the functional significance of maintaining a second LeuRS-like protein within the Archaea domain. We are addressing this topic using a multidisciplinary approach utilizing techniques that span biochemistry, genetics, microbiology, and molecular biology.