

# DEPARTMENT OF CHEMISTRY & BIOCHEMISTRY

## LIST OF FACULTY RESEARCH INTERESTS

Zahra Alghoul

1. Separation and analysis of complex samples with liquid chromatography
2. Sample preparation using liquid-liquid extraction and solid phase extraction
3. Developing simulations for use in chemistry education

Seth Bush

1. Studying the emergence of Science Faculty with Education Specialties
2. Developing and studying teacher professional development process
3. Improving teacher recruitment and training
4. Building and testing inquiry-based science toys, games and manipulatives

Tammy Campbell

Jennifer Carroll

1. Marine natural product isolation and characterization
  - a. Rational collection of marine invertebrates and algae by SCUBA
  - b. Screening of samples for biological activity
  - c. Isolation of active components by chromatography (Flash and HPLC)
  - d. Dereplication of known compounds by mass spectroscopy and literature review
  - e. Elucidation of novel compounds by high field ID and 2D NMR techniques
2. Development of o-chem experiments in natural products

Phil Costanzo

1. Tailored polymer synthesis
  - a. Preparing polymers via controlled radical, free radical and step-growth polymerization techniques
  - b. Impart functionality utilizing functional initiators and monomers and by post-polymerization functionalization
  - c. Develop structure-property relationships
2. Characterization of stimuli-responsive materials in solution and solid state
3. Evaluation of materials for commercial applications, such as fuel-cell membranes, propellant binders, surfactants, and self-healing composite materials
4. Development of polymer synthesis experiments that probe structure-property relationships

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### Scott Eagon

1. Development small, potent biomolecules that are rationally designed to selectively target critical proteins associated with lethal diseases. Specifically, diseases which affect large numbers of people in underdeveloped countries will be targeted, such as malaria and HIV. A variety of methods will be used to develop these novel therapeutics, including:
  - Synthetic Organic Chemistry
  - Biological Studies & Screening
  - Computational Docking

### Ray Fernando

1. Polymeric coatings
2. Polymer-surfactant interactions and rheology
3. Blended BS + MS in Polymers and Coatings Science
4. Industrial internships

### Emily Fogle

Mechanistic Enzymology. My research seeks to better understand the detailed chemical mechanisms that enzymes use. In particular I am interested in pyridoxal phosphate dependent enzymes as well as oxidoreductases.

1. Methods used to gain insight into these enzymes include:
  - a. steady state kinetics
  - b. pH rate profiles
  - c. kinetic isotope effects
  - d. site-directed mutagenesis
2. Other skills involved in these studies include:
  - a. overexpression of proteins
  - b. protein purification
  - c. basic molecular biology techniques

### Derik Frantz

Molecular Architecture. Design and synthesis of non-natural molecular constructs with unusual structures

1. Highly symmetric molecules and supramolecular systems with static and dynamic components
2. Conjugated oligomers and polymers with unusual geometry
3. Organic stable radicals

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### Anya Goodman

1. Development of a new pyrosequencing-based method (pyroprinting) for identifying contaminants in plant products, such as herbal supplements and rare spices (collaboration with A. Dekhtyar in the Computer Science department). PRE-REQ: Mol bio lab (CHEM/BIO475)
2. Pyroprint assay design and modeling (dispensation order, primer selection and specificity, dispensation order, pyroprint matching) and testing/trouble shooting the method in the lab
3. Comparative genomics, genome structure and evolution: fruit fly genomes (collaboration with GEP <http://gep.wustl.edu>) PRE-REQ: Bioinformatics Applications (BIO/CHEM441)
4. Genome annotation of recently sequenced Drosophila genomes. Comparative analysis of heterochromatic Dot chromosome and other genome regions
5. Curriculum development for biochemistry courses: develop new experiments for CHEM371 and create video tutorials for labs and activities. PRE-REQ: Biochemical Principles (CHEM371)

### Derek Gragson

1. Polymer adsorption at solid/liquid and liquid/liquid interfaces
  - a. kinetic studies using second harmonic generation, ATR-FTIR, and interfacial tensiometry
  - b. equilibrium measurements using interfacial tensiometry and AFM
2. Protein adsorption at liquid/liquid interfaces in the presence of interfacial polymeric films
  - a. effects of pH, ionic strength, and surface charge density on the adsorption of simple proteins to interfaces with polymeric films present
3. Adsorption of polysoaps to liquid/liquid, liquid/air, and liquid/solid interfaces
4. Development of p-chem experiments that explore interfacial phenomena

### John P. Hagen

1. Determination of standard energies of surface adsorption and micellization in mixed surfactant systems
2. Lipid monolayers at the air-water interface
3. Development and testing of experiments for general and physical chemistry lab

### Taylor Haynes

#### Organometallics method development

1. Investigating the use of copper catalysis with the use of environmentally friendly oxidants (such as O<sub>2</sub>), and developing subsequent tandem reactions with newly formed oxidation products through *in situ* generation of various cuprate formation
2. Utilizing copper-catalyzed fragmentation pathways in the synthesis of various heterocyclic targets
3. Expanding upon the class of N-Heterocyclic Carbene ligands through incorporation of amino acid scaffolds to provide a readily available source of chirality into the ligand framework

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### Mike Heying

1. Improving theoretical descriptions of the thermodynamic properties (pressure, density, chemical potential, etc.) and structures (pair distribution functions) of model fluids
  - a. Utilizing these improvements to better understand and predict phenomena like phase changes in these systems
  - b. Building (theoretically) more non-idealities into these "ideal" fluids to better mimic more realistic and more interesting systems
  - c. Simulating model fluids (hard particles, soft potentials, etc.) in various ensembles as a way of providing comparative experimental data.
2. Studying the kinetics of single or multiple chemical as a function of process inputs as a way of developing fluency in numerical techniques and fundamental equations

### Chad Immoos

1. Fluorescence detection of Reactive Carbonyl Species
  - a. Synthesis of pre-fluorescent probes
  - b. Investigation of fundamental reaction chemistry
2. Copper Complexes for Fluorescence Detection of Nitric Oxide
  - a. Synthesis of pre-fluorescent probes
  - b. Fluorescence bio-imaging in biological systems
3. Merging metallo-biomimetics and hydrophilic polymers
  - a. Synthesis of transition metal catalysts to mimic biological reactivity
  - b. Covalent attachment of catalysts in block co-polymers
  - c. Investigation of reactions in polymers and at polymer surfaces

### Dane R. Jones

1. VOC Analysis

### Eric M. Jones

Biophysical chemistry of proteins and peptides:

1. Amyloid proteins and peptides
  - a. Development of nanoparticle-based diagnostic assays for amyloids
  - b. Structural characterization of polymorphic amyloids (serum amyloid A, glucagon, and others) using spectroscopy and microscopy
2. Effects of methionine oxidation on protein folding and stability
3. Applications of vibrational spectroscopy in biochemistry and food science

### Eric J. Kantorowski

1. Mechanistic organic chemistry, synthetic methodology, organic synthesis
2. Electrophilic- and radical-induced ring opening of cyclopropanes and other strained systems
3. Synthesis and synthetic methodology aimed at the preparation of bioactive natural products and analogs
4. Pedagogical innovation using modern technology  
PRE-REQ: CHEM 217/317.

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Kevin B. Kingsbury

1. Polymer Chemistry
  - a. Novel Hydrogels with controlled architectures using RAFT and 'Click' Chemistry
  - b. Semiconducting polymers for Polymer LED's
2. Organometallic and Organic Chemistry
  - a. Polymerization catalysts
  - b. Transition metal carbynes
3. Development of 'Green' Laboratory Experiments for Inorganic and Polymer Chemistry

Alan Kiste

1. Development of new methods for analyzing chemistry students' learning and production of chemistry symbolism and representations, and the analysis of student representations using these new methods
2. Development, assessment and evaluation of new pedagogical interventions
3. Examination of how students utilize learning resources in large lecture classes

Corinne Lehr

Biogeochemistry of the toxic metalloids arsenic, antimony, selenium, and tellurium

1. Development of trace analytical methods such as HPLC-AAS to measure organometalloid species
2. Field measurements of organometalloid compounds in environments such as oceanic phytoplankton mats, hypersaline lakes, and hot springs
3. Isolation and investigation of microbes which can methylate metalloids

Andres Martinez

Analytical chemistry: development of portable assays on devices made out of paper for qualitative and quantitative analysis

Our current work is focused in three main areas:

1. Studying the shelf life of reagents stored on the devices
2. Developing methods for solvent-free deposition of reagents onto the devices
3. Developing methods for quantifying the signal from assays that produce a color change.

PRE\_REQ: Creativity, curiosity and a strong work ethic. No specific coursework is required.

Ashley McDonald

1. Using computational chemistry to study noncovalent interactions in complex biophysical systems, particularly nucleic acids
  - a. Studying the effects of pi stacking between bases in nucleic acids
  - b. Developing computational tools (computer programming) to examine the effects of geometry on pi stacking in nucleic acids
2. Computational analysis of naphthalquinoline geometries to understand their binding affinity and specificity for triplex DNA
3. Calculating interaction energies between DNA aptamers and ligands, to understand mechanisms for riboswitches and potential nucleic acid therapeutics
4. Broad interest in computational drug design

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Kristen Meisenheimer

1. Reactivity profiling of relevant natural products
  - a. Involves synthetic modifications to biologically active natural products
  - b. Purification and characterization of the synthetically modified natural products
2. Development of organic chemistry experiments using flash chromatography

Grace Ann Neff

1. Chemical Education
  - a. Development of hands-on-inquiry-based chemistry activities and lesson plans for K-12 classrooms using easily attainable materials
  - b. Outreach to area K-12 science teachers through the Central Coast Science Project
  - c. Outreach to the general public
2. Course Development
  - a. Development of new course materials (experiments, activities, worksheets, etc.) for General Chemistry courses
3. Assessment
  - a. Assessment of the Integrated General Chemistry course (with Dr. Tina Bailey)
  - b. Development of new assessment tools for General Chemistry courses

Hasan Palandoken

1. Broad field of Organic Synthesis
2. Medicinal chemistry
  - a. Investigation of cell surface ion exchanged as expedient molecular targets for new brain cancer therapy
  - b. Synthesis of cell surface ion exchange inhibitors and their prodrug forms
3. Polymer chemistry
  - a. Study of the alkoxyamine (RONH<sub>2</sub>) functional group in new materials as versatile ligating sites for carbonyl (i.e., aldehyde/ketone) substrates
  - b. Synthesis and characterization of alkoxyamine polymers
  - c. Testing the alkoxyamine polymers for the selective immobilization, molecular presentation and controlled release of various carbonyl compounds (e.g., pharmaceuticals, biomolecules)

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Erik Sapper

1. Organic coatings and polymeric materials
  - a. Lifetime prediction of coatings in service environments
  - b. Color and appearance of coatings
  - c. Coatings for corrosive and extreme environments
  - d. Coating failure modes and test method development
  - e. Electrochemistry, sensors, and *in situ* measurement
2. Computational design of materials
  - a. Multiscale modeling of material performance
  - b. Quantitative structure-activity relationships
  - c. Materials informatics and chemometrics
  - d. Bayesian networks and probabilistic graphical models
  - e. Autonomous science and evolutionary algorithms

Gregory Scott

1. Characterization of nanomaterials via scanning probe microscopies (scanning tunneling microscopy and atomic force microscopy)
2. Identification of the relationships between morphological, electrical, and optical properties of nanomaterials

Sandra Ward

Katharine Watts

1. Connecting natural products to biosynthetic pathways in soil bacteria
  - a. Cloning and analysis of natural product biosynthetic gene clusters
  - b. Expression of biosynthetic gene clusters in heterologous hosts
  - c. Isolation and structure elucidation of pathway intermediates and products
  - d. Elucidation on enzyme function in biosynthetic pathways
2. Microbial diversity and biosynthetic potential in environmental samples
  - a. Isolation of unique microbes from environmental samples
  - b. PCR-screening of genomic DNA for biosynthetic genes
  - c. Gene sequencing and analysis

Steven Wilkinson

1. Protein stabilization mediated by compatible solutes (osmolytes)
  - a. Development of structure- and activity- based biochemical assays of protein stability
  - b. Characterization of osmolyte-dependent protein stability for multiple protein models
  - c. Investigation of stabilization mechanisms
2. Biochemical characterization of transcriptional regulators from the radiation-resistant bacterium *Deinococcus radiodurans*
  - a. Cloning, overexpression and purification of putative gene regulatory proteins
  - b. Characterization of DNA- and ligand-binding properties
  - c. Analysis of molecular mechanisms and gene regulatory functions

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Shanju Zhang

1. Optoelectronic Macromolecules: synthesis, microstructure and optoelectronic properties of conjugated polymers with applications in photovoltaic cells, light-emitting diodes, transistors and biosensors.
2. Anisotropic Nanomaterials: synthesis, surface modification and self-assembly of 1D and 2D nanoparticles including nanowires, nanorods, nanotubes, and grapheme for various emerging applications.
3. Polymer Nanocomposites: preparation, processing, and properties of functional nanocomposites with applications in smart coatings and energy conversions.

David Zigler

Matt Zoerb

1. Trace gas measurement
  - a. Marine and terrestrial biogenic volatile organic compounds
  - b. Sources, concentrations and reactivity of trace gases relevant to aerosol particle and cloud formation
2. Chemical composition of ambient aerosol particles
3. Instrument/method development
  - a. Mass spectrometry techniques for in site measurement of trace gases
  - b. Laboratory analysis and field sampling techniques