| **MENTOR**  ***Department*** | **RESEARCH TITLES & ABSTRACTS** |
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| Dr Jacob J. D. Egge  *Biology* | **Cryptic speciation in a miniature catfish**  Cryptic species are morphologically indistinguishable (i.e. you can’t tell them apart based on physical appearance), or nearly so, from their close relatives, yet represent distinct evolutionary lineages. The goal of this collaborative research project is to use a combination of morphological and molecular data to test for potentially cryptic species within the brown madtom, a miniature catfish from the southeastern United States. |
| Dr Eric E. Finney  *Chemistry* | **Approaches to carbon dioxide activation**  The activation of carbon dioxide by organic substrates and organometallic complexes will be studied. The overall goal of this research is the conversion of carbon dioxide to potential fuel sources (formic acid, methanol, etc.) or its incorporation into organic molecules as a way to use CO2 as a useful synthetic building block. |
| Dr Jon O. Freeman  *Chemistry* | **Understanding the Structure-Function Relationship of Triterpene Synthases**  My group is currently exploring two projects that investigate the structure-function relationship of triterpene synthases. The first project will investigate the importance of a conserved flexible region located near the active site of triterpene synthases by developing single-stranded DNA (ssDNA) aptamers that target this flexible region. If a dynamic range of motion is required for catalysis, then a bound ligand should limit the conformational freedom and inhibit the enzyme’s function. Alternatively, if the enzyme remains active with ligand bound, then this may suggest that the inherent flexibility is not essential for enzyme activity.  The second project will investigate evolving triterpene synthases for biofuel production. However, before we can begin evolving terpene synthases, we must develop a screen for detecting terpene biofuel production. We will do this by developing a screen which fluoresces in the presence of the biofuel botryococcene. |
| Dr Neva L. Laurie-Berry  *Biology* | **Phenotypic and Molecular Characterization of Two Jasmonate-Insensitive Mutants of Arabidopsis**  Jasmonate is a plant hormone that controls many aspects of plant development and defense. Our research seeks to understand the signal transduction pathways that mediate these responses by studying jasmonate-insensitive mutants in the model plant Arabidopsis. By understanding how plant defenses are controlled, we can lay the foundation for producing overall healthier plants better able to withstand infections and stress. We will analyze plant growth, carry out infection assays, assay gene expression through rtPCR, and sequence candidate genes. |
| Dr Alex R. Lechler  *Geosciences* | **Palouse loess clumped isotope record of Last Glacial Maximum climate cooling**  The Last Glacial Maximum (LGM) marks a period of significant global climate cooling during which continental glaciers and ice sheets expanded and covered much of the Pacific Northwest. Despite copious research into the causes and impacts of LGM cooling, fundamental questions remain on the quantitative magnitudes of climate change and degree of regional variability. This study will use carbonate clumped isotope thermometry study of Palouse loess soil carbonate to provide new, quantitative, and direct measures of LGM-to-modern surface temperature change in the Palouse region of eastern Washington state. These quantitative constraints will inform understanding of the mechanisms and outcomes of global and regional climate change in the past, in turn, enhancing capabilities to predict and simulate future climate change and associated climate change impacts. |

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| Dr Andrea M. Munro  *Chemistry* | **Investigating the Interactions Between CdSe Nanocrystals and Dithiocarbamate Ligands**  Colloidal nanocrystals are used in light-emitting diodes and next-generation photovoltaics due to their size-tunable optoelectronic properties and photostability. The surface chemistry of colloidal nanocrystals affects charge transfer to and from nanocrystals and also influences the efficiency of nanocrystal-based electronic devices. Recently, there have been reports that exchanging the native surface ligands on CdSe nanocrystal spheres with phenyldithiocarbamate ligands can increase the nanocrystal band gap energy and increase the conductivity of nanocrystal films. Both affects are caused by the alignment of the HOMO level of the nanocrystal and ligand, which allows photogenerated holes to be delocalized over the nanocrystal and ligand; increasing the effective size of the nanocrystal.  Most groups that study the interactions between nanocrystals and phenyldithiocarbamate ligands employ ammonium phenyldithiocarbamate ligands. However, ammonium phenyldithiocarbamates cause nanocrystals to precipitate, thus it is challenging to work with these systems in solution. The Munro research group has developed an alternate synthesis using 1,1,3,3-tetramethylguanadinium (TMG+) phenyldithiocarbamate ligands that are soluble in organic solvents and allow for the interactions between CdSe nanocrystals and phenyldithiocarbmates to be studied in solution. Our research will focus on characterizing the effects of TMG+ phenylidthiocarbamate ligands on the optical and electronic properties of CdSe nanocrystal spheres, rods, and belts and will investigate how these ligands bind to the different shapes. |
| Dr Tina T. Saxowsky  *Chemistry* | **Retromutagenesis: A novel route to adaptive mutagenesis**  In recent years, cells have been shown to have some ability to accumulate adaptive mutations in response to selective pressure that induces prolonged growth arrest. While multiple mechanisms related to DNA damage and genome maintenance have been shown contribute, the specific role of DNA base damage and base excision repair in the process has not been explored. Base damage can be bypassed by RNA polymerase, resulting in a pool of mutant mRNAs through transcriptional mutagenesis (TM), and potentially a population of mutant proteins that could alter the phenotype of the cell. In non-dividing cells, such as those subject to drug pressure, the influence of persistent DNA damage on transcription could affect cellular outcomes. We hypothesize that TM could be an important first step in acquiring drug resistance, as the mutant protein generated could allow cells to resume DNA replication and convert this damage to a permanent advantageous mutation, a process we call retromutagenesis. Using *Saccharomyces cerevisiae* as a model organism, we have established an experimental system that examines adaptive mutagenesis in response to canavanine exposure. The research proposed here aims to further characterize this experimental system to elucidate the role that TM specifically might play in these adaptive processes. |
| Dr Heidi Schutz  *Biology* | **Effects of selection and a mini-muscle mutation on sex differences in pelvic bone density of mice**  The evolution of organismal morphology is a complex suite of processes acting in concert to produce an integrated whole. This synergistic evolution of integrated parts has given rise to the rich study of trade-offs (or the sacrifice in performance of one characteristic, so that performance of another may improve) in biology. The pelvis of vertebrates is a complex skeletal structure that is involved in two critical functions that are potentially in functional conflict, moving about the environment (locomotion) and reproduction (specifically, the passage of offspring). The objective of the proposed project is to assess whether selection for high voluntary wheel running, which results in a two-fold increase in locomotor performance and the occurrence of a Mendelian recessive gene causing a 50% reduction in muscle mass, cause changes in patterns of pelvic density between male and female mice. By examining correlations between changes in bone density and data on performance (wheel running) and the occurrence of the mini-muscle phenotype we hope to understand how functional constraints and potential conflicts drive male-female morphological differences in a fundamental vertebrate structure. |

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| Dr Julie W. Smith  *Biology* | **Song Divergence in North American Red Crossbills (*Loxia curvirostra* complex)**  Red crossbills provide a unique opportunity to study how niche-based divergent natural selection promotes the evolution of reproductive isolation and hence speciation. Red crossbills are an incipient bird species for which we know much about the ecological conditions favoring morphological divergence and specialization on alternative resources. Behavioral data indicates that reproductive isolation is evolving between red crossbill call types; however, the factors promoting reproductive isolation are not fully understood. I propose to examine the role of song divergence as a potential isolating barrier. I will use combined field and lab methods to compare the songs of different call types to examine the extent and nature of song divergence between call types. |
| Dr Claire E. Todd  *Geosciences / Environmental Studies* | **Investigating Glacial Erosion on Mount Rainier**  Glacial erosion has global and regional impacts ranging from a significant role in biogeochemical cycling, to increasing flood hazards in rivers supplied by glacial melt. This project will investigate glacial erosion processes in Mount Rainier National Park by quantifying geochemical weathering fluxes and the amount of sediment transported by glacial melt, and by mapping sediment deposition in the area immediately downstream of glacier termini (known as the proglacial area). Previous work by student-faculty research teams suggests that the proglacial environment is shaped by infrequent but dramatic outburst floods, but that the daily transport of fine-grained sediments by glacial melt is a significant component of sediment transport on Mount Rainier. Previous work also indicates that geochemical weathering fluxes vary significantly in space and time. Preliminary estimates of erosion rates based on existing data suggest that selected glaciers on Mount Rainier erode at rates comparable to some of the most erosive alpine glacial environments in the world. Funding from the Division of Natural Sciences for summer 2015 student-faculty research will enable me to finalize these results and prepare them for publication. |
| Dr Dean A. Waldow  *Chemistry* | **Ring Opening Metathesis Polymerization and Characterization of Oxanorbornene Polymers Towards Improved Energy Related Battery and Fuel Cell Electrolyte Membranes**  Ring opening metathesis polymerization (ROMP) will be used to synthesize two broad classes of diblock copolymers and homopolymers with applications in battery membrane technology and in fuel cell membrane technology. The diblock copolymer structures synthesized will develop nanometer morphologies potentially allowing these materials to improve performance of lithium ion batteries and in the hydrogen or reformation based fuel cells. The nano-morphology of these materials will be studied as a function of block molecular weight allowing lamellar, cylinder, sphere, and gyroid morphologies to be produced on a sub 100 nanometer length scale. Subsequently, the influence of the nano-morphology on ionic motion will be investigated. One block in each material will allow for both thermal and structural support while the second block will provide ion mobility. The materials will be characterized using many instruments (e.g., NMR, GPC, AFM, and electrochemistry) at PLU, dielectric spectroscopy at the University of Tennessee – Knoxville, X-ray scattering at the University of Washington, and possible analysis using Neutron Scattering at the Oak Ridge National Laboratory or National Institute of Standards and Technology user facilities. |
| Dr Neal A. Yakelis  *Chemistry* | **Heat-Activated Molecular Triggers used to Initiate Sustained Release of Drugs**  The controlled release of drugs in the body is a key way to improve the efficacy of pharmaceuticals. Through a collaboration with a lab at the University of Washington, we have worked to develop a prototype of a polymer that will release drugs slowly over time by the slow degradation of a self-immolating (or self-destructing) polymer (SIPs) in the blood stream. This release will be triggered by the thermally-induced reaction of a molecular trigger unit: the Diels-Alder product of an oxidized hydroxyurea. This trigger undergoes a retro-Diels-Alder reaction followed by reaction with water to release nitric oxide (NO) and initiate the slow release of the drug units. Our work this summer will look at building non-toxic molecular triggers that will degrade at different temperatures. We can then study the rates of their decomposition by monitoring color-changes by UV-visible spectroscopy. |