Laser Immunotherapy for Treatment of Metastatic Tumors  
Dr. Wei R. Chen, Department of Engineering & Physics  

Metastatic tumors (cancer spread) are the major cause of cancer patient death. So far, there is no effective treatment method for metastatic tumors. We have developed laser immunotherapy, a novel approach using the combination of laser treatment and immunological stimulation to induce anti-tumor immunity to fight metastatic tumors. Our previous pre-clinical studies have shown that laser immunotherapy is effective in curing metastatic tumors. This new therapy includes two major components: laser photothermal interaction and immunological stimulation. The former is to achieve acute tumor destruction and the latter is for long-term cancer control. The student participating in the STEP@UCO program will focus on the laser thermal interaction to improve the effectiveness of tumor cell destruction. The student will also have an opportunity to observe and to participate in immunological studies using animals. The student may have a possibility of long-term participation of this research for the next several years at UCO.

Lysine Biosynthesis in Fungi  
Dr. Lilian Chooback, Department of Chemistry  

A recent decrease in effectiveness of many antibiotic agents against bacterial infections provides a serious need for development of new antibacterial drugs. One area of research has been focused on the inhibition of lysine biosynthetic pathways in bacteria. Inhibitors of lysine biosynthesis have been of interest because they are toxic to microorganisms but have little or no toxicity to mammals. Human cells do not synthesize lysine; and are therefore immune to toxic effects of these drugs. So far there are no commercially available antibacterial agents that target lysine biosynthesis. The goal of our research project is to identify enzyme inhibitors that may serve as lead compounds for the development of new antibacterial drugs.

Population Genetics  
Dr. Michelle Haynie and Dr. Allyson Fenwick, Department of Biology  

Population genetic tools can be used to answer a variety of interesting questions, including how individuals reached their current ranges, how they are related to nearby groups, or how they are currently changing. The same tools can be used for very different organisms – Dr. Fenwick’s lab investigates invasions of Mediterranean geckos and fire ants on the UCO campus, and Dr. Haynie’s lab focuses on natural populations of small mammals. This summer, Dr. Haynie’s work will focus on pocket gophers in central Oklahoma and the Oklahoma panhandle. Participating students will have the opportunity to do field sampling and will learn the lab techniques of DNA extraction, PCR, and sequencing/genotyping in both labs to understand the evolution of populations changing over local and regional scales. Interested students will have the chance to focus on one of these biological systems during their time at UCO.
Fire History and Disturbance Dynamics in Cross Timbers Forests
Dr. Chad King, Department of Biology

The development and maintenance of forests are driven by disturbances. The frequency and magnitude of disturbances can be affected by natural as well as human factors. However, there have been few studies in Oklahoma that have quantified the history of fire and other disturbances that shaped the Cross Timbers forest. Secondly, little is known about the association between the driving factors (climate, land-use history) and disturbance type, frequency, and magnitude. Using the study of tree-rings (dendrochronology), students participating in the STEP@UCO program will be engaged in collecting and analyzing wood samples from a Cross Timbers forest at Lake Arcadia to understand forest structure, tree age, and disturbances that have previously affected the forest. In the laboratory, students will be engaged in the preparation and analysis of tree-rings. Students will learn the techniques of sampling tree-rings in a forest, preparing samples for analysis, crossdating procedures, and statistical analysis of tree-rings. The goal of this research is to understand historic factors that affected the development of forests and how changes to those factors can lead to alternative successional trajectories.

Operations Research
Dr. Bradley Paynter, Department of Mathematics & Statistics

Operations research is the science of using mathematics to make good decisions. Situations in which operations research has been successfully implemented include:

- Scheduling of airline flight crews in a way that minimizes cost while complying with union and federal work regulations;
- Finding shorter routes for package delivery drivers;
- Ensuring the fast and efficient resupply of military personnel deployed around the world;
- Finding an effective mix between different media in an advertising campaign; and
- Determining how to stock goods on a grocery store’s shelves to generate more sales.

Often, finding the best solution to these problems is functionally impossible. As a result, this kind of research involves using a number of advanced techniques to find good solutions in a reasonable amount of time. Chief amongst these techniques are metaheuristics such as Genetic Algorithms or Ant-Colony Optimization.

In the STEP program, students will learn how to apply these and many other techniques as they solve a real-world problem of their choosing. Some possible ideas for research problems are:

1. Finding the cheapest tour to see a game in every Major League Baseball stadium this summer;
2. Establish a final exam schedule that reduces the possible number of exams a student has to take on a single day; and
3. Find optimal strategies for board games (Pandemic, Settlers of Catan, etc).

Cell Biology of Aging
Dr. Melville Vaughan, Department of Biology

If you are asked about aging, you might think of wrinkled skin, gray hair, heart attacks, and cancer. But how does aging affect single cells? Do cellular changes result in some of these consequences? My laboratory’s interest is to study the cell biology of aging and how it affects skin. Aging at the cellular level may be caused by senescence or oxidative damage. We have recently identified an interesting cellular change associated with antioxidant treatments. Our goal is to test many antioxidants to see whether they have the same effect. At the same time, we will ‘age’ cells by inducing oxidative damage. STEP@UCO students will learn human cell culture techniques and use protein-staining assays combined with fluorescent microscopy to find answers that may someday help our understanding of aging processes and how anti-aging therapies like antioxidant treatments work. The lessons we learn from cellular studies can then be applied to our understanding of aging in humans as well as other mammals, for the ultimate goal of increasing the quality of life during aging.