# Students and Teachers As Research Scientists

## 2012 MENTOR SELECTION FORM

**Applicant**

Name: _____ High School: _____

**Research Interest Areas Available**

Please look at the entire list of research topics and **rank your top seven choices** (1 = high, 7 = low). Put an **X** on the areas you absolutely would **NOT** consider.

**ANTHROPOLOGY**

1. _____ **Dr. Patti Wright:**
Join us in researching materials excavated from archaeological sites and contributing to the public's knowledge of the early-mid 19th century lifeways of urban and rural Missourians. Participants will analyze artifacts and research historic records. Several projects are available. One includes researching the game of marbles and other aspects of child's play based on artifacts recovered from historic neighborhoods in north St. Louis City. Other projects involve researching the social and economic relationships that characterized the lives of Daniel Boone Hays, his wife and children, his slaves, and his famous grandfather, Daniel Boone, based on artifacts recovered from excavations at the Hays' 1830s farmstead located in St. Charles County.

**BIOLOGICAL SCIENCE**

2. _____ **Dr. Robert Aldridge**:
My lab studies the reproductive anatomy and physiology of snakes and lizards. Currently, we are interested in determining the role of sexual secretions of the kidney on sperm movement and fertilizing capacity in these organisms. We use the African Brown House Snake as our model organism because these organisms have two separate reproductive tracts that act independently. Experimental snakes will have either the right or left kidney removed. By comparing matings of snakes that use the intact tract versus tract with the kidney missing, we will be able to compare mating that have and do not have kidney secretions. The ultimate measure of fertility will be the percent success in fertilizing the clutch of eggs laid by the female. We also plan to measure the morphological and physiological characteristics of sperm as they progress through the male reproductive tract, and later, as they travel through the female tract. Morphological changes include differences in subcellular ultramicroscopic and the ability of sperm to swim and fertilize eggs. Participants will assist in the daily care and feeding of the snakes as well as in the behavioral experiments. Participants will learn to collect, preserve and analyze the ultramicroscopic anatomy of sperm.

3. _____ **Dr. Mariana Beltcheva:** GPCR regulation of Human Embryonic Stem Cell Differentiation.

4. _____ **Dr. Mikhail Berezin**:
Our laboratory is focusing on synthesis of optically active fluorescent compounds for optical imaging. The student will participate in fundamental photophysical studies of novel small molecules and nanoparticles and application of the new probes to diagnostics of diseases.

5. _____ **Dr. Godfrey Bourne**:
Competition and species diversity in two butterfly pollinator assemblages in Guyana. In behavioral ecology and evolutionary biology there is little payoff in repeating other researcher's experiments, and, unlike molecular biology, these disciplines are not self-correcting because few studies depend on the accuracy of earlier ones. [Why might this be so?] However, when relatively inexpensive opportunities present themselves to us we should exploit them. At CEIBA Biological Center in Guyana, South America, the butterfly community is well known, and pollination studies are underway for two common butterfly bushes, the forest daisy, *Wulffia baccata* (L.) Kuntze, synonym, *Tilesia baccata* (L.) Pruski (Asteraceae), and sweet sage, *Lantana camara* (L.; Verbenaceae). Preliminary observations have also been made on a different pair

of vine producing plants also frequented by butterflies. This second project will involve studying competition by pollinators of two trailing vines, a forest cucumber, *Gurania subumbella* (Miquel; Cucurbiaceae) and white aster, *Chromolaena odorata* (L; King et Rob.; Asteraceae). The majority of ecological communities examined to date exhibit skewed species abundance distributions, with few numerically dominant species, and several rare species (Kunte 2008 and citations therein). This pattern is posited to be caused by the extent and nature of niche apportionment and competitive dominance in communities (MacArthur 1957, Hutchinson 1959, Tokeshi 1999). The effects of dominance and competition on species abundance relationships have only been studied within a trophic level by one researcher (Kunte 2008). The aim of these two STARS discovery experiences are to reexamine Kunte's (2008) study in Guyana at CEIBA by answering the question—does removal of dominant species in Guyanaian butterfly pollinator assemblages increase butterfly diversity?

6. _____ **Dr. James Carrington:**
Research in the Carrington lab focuses on RNA-mediated regulation and silencing of genomes, genes and viruses. This lab focuses on the biogenesis, functions, and evolution of small RNA-directed silencing pathways in multicellular eukaryotes.

7. _____ **Dr. Brian Downes:**
Two projects are planned for the summer of 2012. We will be characterizing protein degradation adapters (i) for the plasma membrane, and (ii) for the cytoskeleton. The working hypothesis in the Downes Lab is that protein destruction uses scaffolds, adaptors, and subcellular surfaces to achieve maximum resolution. We are working to map such specificity onto the major protein degradation system, which is called ubiquitylation. Ubiquitylation is a critical regulatory system for degrading key control proteins, directing genome expression, sorting proteins, and repairing DNA; when aberrant, diseases including Alzheimer's, Parkinson's, Huntington's, and various cancers, among others result. Representative components of the core ubiquitylation system have been examined carefully, yet their subcellular distribution and coordinated activity are poorly understood. Conveniently, ubiquitylation is a highly conserved process giving us the opportunity to examine the system using large numbers of inexpensive organisms, like the model genetic plant Arabidopsis thaliana, to dissect the activity of currently un-described adaptors. As a part of protein characterization, we typically test whether the Arabidopsis and Human adaptors have conserved function.

8. _____ **Dr. Joel Eissenberg**: Genetics and Molecular Biology.

9. _____ **Dr. Decha Enkvetchakul**:
Ion channels are proteins that control the passage of ions into and out of the cell, which in turn is important in a vast array of physiological phenomena, e.g. the electrical activity of neurons and muscles that allow us to think and move. My lab is interested in the structure of ion channels (i.e. how ion channels are built, what is the shape of an ion channel) and how their structure allows them to control the flow of ions. Students will also have opportunities to learn about and to assist in purifying proteins and manipulating DNA using PCR to make mutant ion channels.

10. _____ **Dr. Jonathan Fisher:**
The focus of the lab is on regulation of glucose transport into skeletal muscle.

11. _____ **Dr. Blythe Janowiak:**
Our area of research interest is the biochemistry of microbes. Specifically, we are interested in better understanding why Group B Streptococcus survives in human immune cells.

12. _____ **Dr. Jack Kennell:**
Project 1: The identification and characterization of cellular pathways involved in communication between mitochondria and the nucleus. Project 2: The study of the mechanism of replication of a small genetic element that replicates by reverse transcription and is considered to be a "molecular fossil."

13. _____ **Dr. Sergey Korolev:**
Biochemical studies of: 1.) DNA repair proteins 2.) signaling phosphiolipases.

14. _____ **Colleen Conley, Kimberly Hogan, and Tina Miller:**
The area of research interest we would like to have students participate in is the sensory project development for protein-based food products. The student will learn the principles of sensory testing methodologies, including descriptive analysis, discrimination testing, and consumer acceptance across a wide range of food applications. This is a hands-on learning opportunity for someone interested in food perception and evaluation.

15. _____ **Dr. Toni Kutchan:**
Our laboratory research aims at elucidating the biosynthetic pathways of selected medicinal compounds in plants and developing improved sources of these chemicals. We investigate how plants make special chemicals called natural products. These chemicals frequently are used as medicines, either as pure compounds by pharmaceutical industry, or as mixtures in traditional medicines. Selected natural products are currently being investigated in the laboratory in mature plants and in tissue and cell culture. We participate in three national and international projects that involve deep transcriptome sequencing of medicinal plants using next generation sequencing technologies. In general, in our research, we strive to understand the formation of medicinal compounds in selected plants at the enzyme and gene levels and then to use this information to improve upon production of pharmaceuticals either in planta or in a heterologous host such as yeast or bacteria.

16. _____ **Dr. Robert Marquis:**
My lab studies the ecology of tritrophic interactions, that is, interactions among plants, herbivores, and the carnivores that eat herbivores. These interactions have been found to be important in a wide variety of ecosystems, from open ocean, marine tide pools, and freshwater streams, to savannas and forest. We focus on the herbivores and carnivores associated with oak trees in the St. Louis region. We combine lab and field work to determine which natural enemies influence the abundance of insect herbivores, and how their impact varies with oak species. We also study the impact of invasive insects, particularly the Asiatic oak weevil, and plants, particularly the Amur honeysuckle, on native species.

17. _____ **Dr. Amit Mathur and Dr. Terrie Inder:**
We are investigating novel magnetic resonance imaging techniques as markers for assessing brain development and brain injury in newborn infants.

18. _____ **Dr. Todd Mockler:**
Development of algorithms and bioinformatics tools for assembly and analysis of plant genomes.

18. _____ **Dr. Steven Mumm and Dr. Michael Whyte:**
We study molecular genetics of rare inherited bone diseases, such as hypophosphatasia, juvenile Paget's disease, X-linked Hypophosphatemic rickets, and many others. The major goal is to identify specific gene mutations in patients' DNA as the cause of their bone disease.

20. _____ **Dr. Wendi Neckameyer:**
Behavioral genetics using *Drosophila melanogaster* to understand neural substrates for mental illness and autism.

21._____ **Dr. Daniel Ory**: Mechanisms of regulation of cellular cholesterol homeostasis.

22. _____ **Dr. Vijay Sharma:**

My research interests are at the interface of radiopharmaceutical chemistry, medicinal chemistry, and biology, to discover and develop molecular probes, for addressing important biological questions across multiple disciplines. Specific emphasis is towards the design of small organic molecules, peptides, and metalloprobes, including their radiolabeled counterparts for diagnosis of diseases, such as Alzheimer's disease and coronary artery disease (Myocardial Perfusion Imaging), tumor imaging, to understand protein-protein interactions via imaging of reporter gene expression *in vivo*, and to investigate biological mechanism(s), using agents designed and developed within the group for rapidly emerging fields of molecular imaging.

23. _____ **Dr. Laurie Shornick:**
Infants are very susceptible to infection. My laboratory is interested in understanding the differences between the neonatal and adult immune response to respiratory viral infections.

24. _____ **Dr. Dorota Skowyra:**
1) Principles of protein structure-function analysis (biotechnology); or 2) regulation of the cell division cycle in yeast *S. cerevisiae* (cell biology); or 3) characterization of new pharmacological regulators of the 26S proteasome (drug discovery); or 4) role of immunoproteasome in autoimmune destruction of pancreatic β-cells (type 1 diabetes); or 5) proteasomal proteolysis in alpha1 AT-Z liver disease (protein misfolding disease).

25. _____ **Dr. Thomas Smith:**
The project will deal with protein purification, cloning, mutagenesis, characterization, and crystallization of one of several proteins we are working with in the laboratory.

26. _____ **Dr. Susan Spencer**:
Our lab works on regulation of Epidermal Growth Factor receptor (EGFR), a signaling protein important for nervous system differentiation and cancer. We do our work in the fruit fly eye, a great model system for studying cell communication and development.

27. _____ **Dr. Michael Tomasson**: Cancer genetics and multiple myeloma.

28. _____ **Dr. Mark Voigt:**
Cell, molecular and genetic investigations into the development and function of the sensory nervous system using Zebrafish.

29. _____ **Dr. Xuemin (Sam) Wang:**
Plant biochemistry, biotechnology, plant response to environmental stress, increase vegetable oil production.

30. _____ **Dr. Jessica Wagenseil:**
Our lab studies vascular mechanics in mouse models of cardiovascular disease. The student will perform mechanical tests on mouse arteries, analyze the data and fit mechanical models to quantify the results and make comparisons between genotypes.

31. _____ **Dr. Daniel Warren:**
We are a comparative physiology lab whose primary goal is to understand how painted turtles are able to survive and recover from extended periods of oxygen deprivation, such as occurs during overwintering. The student will work on a project related to how turtles metabolize lactate acid and other end-products of anaerobic metabolism.

32. _____ **Dr. Wenyan Xiao:**
Genetics and plant biology. His laboratory studies the mechanisms underlying DNA methylation and demethylation in regulating imprinting and reproduction in plants.

33. _____ **Dr. Oliver Yu:**
We are a synthetic biology lab. We engineer metabolic pathways to produce high-value natural compounds. We like to know the limiting factors of an engineered pathway in a different species and how to increase the biosynthesis in transgenic organisms. I am interested in having a student to engineer a pathway related to flavor and fragrance this summer.

## CHEMISTRY

34. _____ **Dr. Samuel Achilefu:**
Novel self-hybridizing molecules for drug delivery and molecular imaging of cancer.

35. _____ **Dr. James Bashkin:** Organic chemistry and biochemistry for human health care applications.

36. _____ **Dr. Eike Bauer:**
Our research is directed towards the development of new catalyst systems based on ruthenium and iron and students will be involved in investigating catalytic activities using gas chromatography. The catalysts speed up chemical reactions and may find applications in pharmaceutical production.

37. _____ **Dr. Dana Baum**:

We are interested in using DNA as a catalyst in a variety of applications. DNA is known for its coding role in cells, but DNA also has properties that make it a useful tool outside of the cell. Possible projects involve using DNA as a catalyst in biofuel cells and using DNA in sensors for pollutants in the environment.

38. _____ **Dr. Steven Buckner:**
We are developing synthetic methods for nanostructured materials with applications in energy and fuels. Participants will learn and apply new synthesis methods and analyze their new materials with a variety of physical and analytical chemical methods.

39. _____ **Dr. James Chickos:**
The projects center around the measurement of physical properties of interest to chemical engineers, environmentalists and those working in the thermochemical community using gas chromatography and differential scanning calorimetry. The projects involve measurements of phase change enthalpies and vapor pressures of materials that often cannot be measured by other means. Current efforts are associated with evaluating some physical properties of prescription drugs.

40. _____ **Dr. Peter Gaspar:**
Our student will participate in determining whether a reaction expected to produce a highly reactive intermediate by extrusion from a bicyclic precursor is promoted by ring-strain. This is physical organic chemistry and includes both laboratory work and quantum chemical calculations. The student will be encouraged to shape his or her blend of experimental and computational research, depending on his or her individual interest.

41. _____ **Dr. Sophia Hayes:**
The Hayes Group conducts basic research studies on materials useful for electronics, solar cells, photodetectors, and other applications. Projects include sample preparation for single-crystal studies, thin-film studies, and measurements, such as photoluminescence, nuclear magnetic resonance (similar to MRI's used in medicine.) Students who are ideal for this type of research generally have a strong interest in physics or engineering, and in physical chemistry. In the past, students have engaged in single-crystal growth, photoluminescence measurements on nanoclusters, and fitting of data using mathematical tools.

42. _____ **Dr. Stephen Holmes:** Synthesis, spectroscopy, materials, and magnetism.

43. _____ **Dr. Istvan Kiss:**
Complex Electrochemical Dynamics: Synchronization and Chaos. Current generating chemical reactions produce a variety of dynamical responses that exhibit striking similarities to living systems. These abiotic systems can produce, for example, synchronization similar to those observed with flashing fireflies and chirping crickets. Our research group investigates self-organization in electrochemical systems and how such critical behavior could affect our present and future fuel cell and battery technologies.

44. _____ **Dr. Michael Lewis:**
How aromatic molecules bind certain molecules is important in a wide range of biological and chemical environments. Our research lab explores the binding properties of aromatic molecules. We are interested in a student researcher performing computational modeling studies to investigate novel binding of aromatics with biological significance.

45. _____ **Dr. Richard Mabbs:**
Using mass spectrometry, ultrahigh vacuum equipment and pulsed lasers, we image photoelectrons to probe molecular electronic structure. STARS participants will experience state of the art physical chemistry research techniques and develop simple qualitative models to explain experimental results. These will serve to provide better understanding of the fundamentals of chemistry. Participants will also explore methods of incorporating this material into pedagogical tools aimed at illustrating and clarifying essential basic concepts of quantum chemistry.

46. _____ **Dr. James O'Brien and Dr. Leah O'Brien**:
High Resolution & High Sensitivity Molecular Spectroscopy with Spectral Observations being Made in Absorption by Intracavity Laser Spectroscopy and in Emission by Fourier Transform Spectroscopy (FTS). Diatomic Free Radicals such Gold Oxide, Platinum Fluoride, Copper Nitride, and Nickel Hydride are Created for Spectral Observations in Hollow Cathode Discharge Plasmas. Over the past several summers, STARS students engaging in such work have been co-authors of papers published in top journals in this field, such as the *Journal of Molecular Spectroscopy*. The recently acquired high-resolution, state of the art FTS instrument will be implemented over the summer 2012.

47. _____ **Dr. Nigam Rath:**
Single crystal and powder X-ray diffraction techniques for solid state structure determination.

48. _____ **Dr. Keith Stine:**
The research project will involve aspects of nanomaterials chemistry and biochemistry. The goal of developing Immunoassays for disease biomarkers will be pursued using nanoporous gold as a support for immobilized antibodies or carbohydrate binding proteins. These new materials will be used to detect disease related antigens using electrochemical methods in solution. Students involved in this project will learn some basic aspects of nanomaterials chemistry, electron microscopy, biochemical interactions, and chemical analysis using instrumentation such as a uv-visible spectrometer or fluorescence spectrometer. Some of the particular antigens of interest include those related to detection of different forms of cancer.

49. _____ **Dr. Brent Znosko:**
There is a need for reliable, rapid methods to predict secondary (hydrogen bonding pattern) and tertiary (3D) structures of RNA, which would provide a foundation for determining structure-function relationships and for targeting RNA with therapeutics. Research in the Znosko lab focuses on the thermodynamics (stability) and structural features of RNA motifs. Currently, the primary focus is on two projects. The first attempts to understand the thermodynamics and structure of RNA secondary structure motifs. The second investigates the role of substituent interactions in DNA/RNA base stacking intercalator stacking. We utilize chemical, biochemical, and computational techniques, in addition to various nucleic acid-specific software, computer programming, and website design.

## ENGINEERING / EARTH & ATMOSPHERIC SCIENCE

50. _____ **Dr. Ramesh Agarwal:**
A student interested in Aerospace Engineering may work on the "Analysis and Design of Airfoils for Micro-Air Vehicles or Unmanned Air-Vehicles". A student interested in Renewable Energy may work in the areas of energy from Wind, Solar or Biomass. They can also work in the energy efficiency of buildings and appliances.

51._____ **Dr. Pratim Biswas**:
Nanoparticle aerosol technology enabling energy applications. Solar energy, biohybrid and biomimetic solar PV systems.

52. _____ **Dr. Jeffrey Catalano:**
My group investigates chemical processes that control how contaminants and nutrients migrate and distribute in the environment.

53. _____ **Dr. John Encarnacion:** Relationships between stratovolcanoes and cinder cones.

54._____ **Dr. Dan Hanes:** Sea floor mapping and sandwave dynamics.

55. _____ **Dr. Young-Shin Jun:**
The Environmental Nanochemistry lab (PI: Young-Shin Jun) is conducting highly interdisciplinary researches which aim to explore the environmental impact of human activities through improved understanding of the fate and transport of contaminants and nanoparticles. In addition, our group is performing comprehensive investigations of $CO_2$ sequestration (green house gas) and managed aquifer recharge (clean water supply) to mitigate the impacts of climate change.

56. _____ **Dr. Srikanth Singamaneni:**
Soft Nanomaterials Laboratory at Washington University focuses on the development of chemical and biological sensors based on metal nanostructures and smart polymers. The ultimate goal of the research effort is to develop an inexpensive, point of care diagnostic method for early and rapid detection of kidney cancer. The student working with us will be involved in the synthesis, surface modification and assembly of metal nanostructures at polymer surfaces and interfaces. The surface modified metal nanostructures will be employed in the detection of biomolecules (kidney and prostate cancer biomarkers) in physiological liquids (saliva, urine, blood). Over the course of the project, the student will be exposed to a wide variety of microscopic and spectroscopic tools.

57. _____ **Dr. Michael Swartwout:**
Project 1: Integration and Testing of Space Vehicles. Large satellites have large lists of rules governing their safe design, assembly, test and operation. Small satellites -- such as those being built in our lab -- are often smaller than a single part that goes into a large satellite, and yet the small satellites are still subject to the long list of rules. This summer, we will research the reasons behind the rules for the assembly and testing of large satellite and simplify them for small satellites. We will put this research in practice as we prepare Saint Louis University's first satellite, COPPER, for launch.
Project 2: History and Future of Space Mission Failures. We are building a specialized database detailing every space mission ever flown. We are particularly interested in studying the ways that some missions fail, in order to develop new approaches for future missions.
The STARS student will assist in the development and maintenance of the database, as well as developing hypotheses about the success and failure of missions and testing them via the database

58. _____ **Dr. Abuduwasiti Wulamu**:
Remote sensing, GIS and applications of geospatial technologies in monitoring of environmental issues, e.g. earthquake destruction and deformation. This summer, I will be involved in the following projects: 1) monitoring the health and status of critically endangered lowland rainforest habitat in Madagascar using integrated remote sensing and GIS in which

satellite data including synthetic aperture radar (SAR) data will be used to measure tree height and health; 2) 3D campus GIS project that involves generating 3D virtual city using LiDAR, RADAR and GIS; 3) Monitoring land subsidence due to mining and groundwater extraction using satellite based InSAR.

59. _____ **Dr. Grigoriy Yablonsky:**
1) Mathematical modeling of chemical reactions of hydrocarbon oxidation.
2) Mathematical model of aviation safety, in particular mathematical model of the flight delay.

## MATHEMATICS / COMPUTER SCIENCE

60. _____ **Dr. Martin Pelikan:**
Evolutionary computation, artificial intelligence, machine learning, artificial life.

## PSYCHOLOGY / PUBLIC HEALTH

61. _____ **Dr. Michael Anch:**
Parkinson's Disease is a disorder most famous for its dramatic motor deficits. However, the disease is also associated with lesser-known pathological phenomena, such as cognitive impairment and sleep disturbance. By administering a drug that restores activity to areas damaged in Parkinson's-like conditions, we hope to ameliorate, not only the classic motor symptoms but also the profound sleep disturbances associated with similar neurological processes. Using a rat model of Parkinson's Disease, the student will learn surgical techniques, rat handling, rat sleep stage scoring, electrode construction, and histological procedures.

62. _____ **Dr. David Balota:**
Experimental psychology, learning, memory and aging. He works on issues related to visual word recognition, semantic memory, priming on implicit memory tests, and attention systems that modulate performance within each of these domains. He investigates these phenomena within young adults, older adults, and individuals who have dementing illnesses such as senile dementia of the Alzheimer's type.

63. _____ **Dr. Terri Rebmann:**
The Institute for Biosecurity in the School of Public Health studies bioterrorism and pandemic preparedness. Research projects include examining pandemic preparedness of local businesses, schools, healthcare providers, and response agencies in the St Louis region and across the United States. Current research projects involve: a) the assessment of physiological and psychological effects of wearing N95 respirators (i.e., masks) by healthcare workers in a hospital intensive care unit for long periods of time, b) examining the infection prevention practices of emergency first responders, and c) determining the infection prevention competencies of public health professionals. A variety of research practices are used: focus groups, surveys, interviews, physiological and psychological monitoring, etc.

64. _____ **Dr. Jeff Zacks:**

The Zacks lab studies perception, memory, and their neural basis. STARS students will assist with behavioral testing, stimulus preparation, and data analysis.

## PLEASE RETURN THIS MENTOR SELECTION FORM WITH ALL OF THE FOLLOWING:

**1) application form (preferably not handwritten); 2) complete transcript;**
**3) scores of all tests taken; 4) essay; 5) one letter of recommendation;**
**6) financial aid application (if needed) and**
**(7) your $75.00 non-refundable, application fee check made out to UMSL.**
**ALL TO BE RECEIVED NO LATER THAN WED. MARCH 28, 2012. Send to:**

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