Florida State University
Young Scholars Program
Independent Research Project Examples

Below are some examples of the general descriptions of research projects. Keep in mind these are *general* descriptions provided by the researchers themselves, so the degree of detail may vary somewhat.

_____ 1. **Dr. Hongchang Cui, Department of Biological Science -- 2 students**
Lab Website: www.bio.fsu.edu/faculty-cui.php
Recommended Computer Skills: N/A
Project Description: Stem cells are important for medicine because of their ability to produce various cell types. Unlike animals which use up their stem cells during embryogenesis, plants keep two populations of stem cells throughout their lifespan - one at the tip of the shoot and the other at the tip of root, which produce organs continuously. The purpose of this project is to identify genes that control stem cell renewal in plant. Students will use microscope to examine the expression pattern of a green fluorescent protein (GFP) under the control of the promoter of a gene that is expressed in the stem cells in the root of Arabidopsis, a model plant species. The seeds have been treated with mutagen. So, if the GFP expression pattern is altered, a gene that control the expression of this stem cell factor must be mutated and the gene can be identified by molecular and genomics methods.

_____ 2. **Dr. Karen McGinnis, Department of Biological Science -- 2 students**
Lab Website: http://www.bio.fsu.edu/mcginnislab/
Recommended Computer Skills: Basic competency in Microsoft office and personal computer usage
Project Description: Students will be involved in studies of plant mutants defective in the regulation of gene expression. This includes working with whole plants in the field and greenhouse, and performing some basic molecular biology experiments. Students can select a specific project from a couple options. For example, a student could choose to participate in our genetic screening process, where new mutants are identified by observing plant characteristics in the field. Students could also participate in characterization of some of our currently studied mutants, by characterizing defects or abnormalities in these plants. For most projects, students will have the opportunity to learn about and attempt experiments with polymerase chain reaction (PCR), DNA extraction, and plant genetics.

_____ 3. **Dr. Kimberly Hughes, Department of Biological Science -- 1 student**
Lab Website: http://www.bio.fsu.edu/kahughes/Hughes_Lab_Home_Page.html
Recommended Computer Skills: Organization skills are critical, student must absolutely be able to keep track of data sets and the details in the experimental design in spreadsheets. Back-up files of data sets should be stored in a 'cloud' or spare hard drive.
Project Description: With global climate change occurring, environmental stress on populations of organisms is expected to increase. To understand the physiology behind starvation stress, which will certainly increase under climate change, we have created several populations of starvation resistant fruit flies (Drosophila melanogaster). These populations of flies survive starvation stress in part by being extremely obese. These flies also have reduced reproduction. We are looking for a student who is interested in working on a project revolving around the trade-off between obesity and reproduction in an evolutionary context.

Student will learn basic care and keep of Drosophila melanogaster as well as physiological experimental assays, which could potentially include starvation assay, fecundity assay, viability assay, lipid extraction, ovary dissections etc… Student will also learn basic experimental design and statistics involved in analysis and interpretation of their results.

_____ 4. **Dr. Kimberly Hughes, Department of Biological Science -- 1 student**
Lab Website: http://www.bio.fsu.edu/kahughes/Hughes_Lab_Home_Page.html
Recommended Computer Skills: The student will be using a program called JWatcher to record female mosquitofish behavior. The student does not need prior experience with this program, and will learn how to use the program with minimal computer skills. The student will need minimal prior experience with Excel, because they will enter data with this program.

Project Description: The eastern mosquitofish is a small, highly aggressive, live-bearing freshwater fish native to the Tallahassee area. Male eastern mosquitofish have two different color patterns: a shiny silver pattern which is common, and a black and white spotted pattern which is rare. These males behave differently: spotted males are more aggressive and mate more often with females than silver males do. We are interested in explaining these differences in behavior by investigating how these fish interact in a social group, and how their genes affect their behavior. To watch a video showing my research in the fish room, follow this link: http://news.fsu.edu/Non-Feature-Videos/Research-In-Action!-Aggressive-Mosquitofish.

The goal of the student's Individual Research Project will be to characterize how female eastern mosquitofish behave towards spotted and silver males within different social groups and across generations. The student will not only learn all about rearing and caring for mosquitofish in the lab, but will also design, run and analyze their own experiment. The experiment will involve learning how to use a simple computer program that actual Animal Behaviorists use, observing female mosquitofish in the lab and measuring their behavior. The student will learn how to identify many mosquitofish behaviors, will witness aggressive and mating interactions of females, and will have the opportunity to explore their findings and interpret what the behaviors mean. "The student will be using a program called JWatcher to record female mosquitofish behavior. The student does not need prior experience with this program, and will learn how to use the program with minimal computer skills. The student will need minimal prior experience with Excel, because they will enter data with this program.

____ 5. **Dr. Darin Rokyta, Department of Biological Science -- 4 students**
Lab Website: http://www.bio.fsu.edu/~drokyta/
Recommended Computer Skills: None required, but familiarity with Python or R would be useful.
Project Description: My lab studies the evolution of snake venoms, and we are seeking students interested in studying how venom proteins evolve and vary within and between species. Research projects will include the identification and characterization of venom proteins from rattlesnakes native to the U. S., examination of patterns of variation in those venom proteins within species, and analyses of evolutionary patterns within the broader context of venomous snake species.

Specific techniques to be learned include: assembly and analysis of genome-scale sequence data, basic proteomics, PCR and sequencing, phylogenetics, and detection of signals of natural selection in molecular data.

Note that students will not be allowed to interact with live venomous snakes, although they will have opportunities for observing us doing so if desired.

____ 6. **Dr. Beth Stroupe, Department of Biological Science -- 2 students**
Lab Website: http://www.bio.fsu.edu/faculty-stroupe.php
Recommended Computer Skills: Will all be learned here.
Project Description: We want to characterize a key enzyme in the sulfur cycle, sulfite reductase, which is encoded by Escherichia coli's cysJ gene. One approach to studying this environmentally and biochemically critical molecule is to reverse engineer the protein through a series of mutations in the protein's gene, and then measure how the protein activity changes when that altered gene is expressed. We have prepared a collection of cysJ genes carrying random mutations in its DNA sequence. Your mission will be to integrate those mutant genes into a special strain of E. coli, which does not encode the cysJ gene, and then select those bacteria that have recovered altered sulfite reductase activity. Once you identify novel sulfite reductase activities, you will isolate the genomic DNA, determine the gene sequence, and compared the sequences to the known sequence and structure so we can understand the molecular basis of the altered activity. Some of the experiments that you will perform are: Sterile technique, including media preparation for bacterial growth and bacterial culture; bacterial transformation; recombinant DNA techniques, including DNA isolation; mutant bacterial selection, genomic analysis of DNA sequences using Vector NTI, basic protein structure visualization using the Coot and Chimera software programs.

____ 7. **Dr. Deng Wu-Min, Department of Biological Science -- 2 students**
Lab Website: http://www.bio.fsu.edu/faculty-wumin.php
Recommended Computer Skills: Basic computer skills are required.

Project Description: Genetic and bioinformatic analysis of genes involved in growth control and tumorigenesis

This research laboratory is interested in how important cellular decisions such as proliferation, growth and polarization are made during animal development. Dysregulation of these cellular processes are tightly associated with tumorigenesis and cancer formation. My laboratory mainly uses *Drosophila* as a model organism to study the molecular and cellular mechanisms underlying these cellular behaviors.
The current research in my lab has three major foci (described in detail below):

1. temporal regulation of cell proliferation, growth, and differentiation in the follicle cells,
2. the cellular mechanisms the oocyte uses to establish asymmetric maternal-determinant positioning and therefore its polarity, and
3. the molecular mechanisms underlying cell competition in epithelial cells.

____ 8. **Dr. Hong-Guo Yu, Department of Biological Science -- 2 students**
Lab Website: http://www.bio.fsu.edu/faculty-yu.php
Recommended Computer Skills: N/A
Project Description: Research in my lab is focused on how chromosomes are folded and separate during cell divisions. In mitosis the cell replicates itself by equally partitioning duplicated chromosomes. In contrast, during the first division of meiosis, homologous chromosomes pair, recombine, then separate; meanwhile, sister chromatids are joined together until the second division of meiosis. Understanding the dynamics of chromosome organization and segregation during cell division can provide insights into the causes of birth defects, aneuploidy, and developmental abnormalities in human.

We have been studying two highly conserved protein complexes called cohesin and condensin to determine their roles in chromosome organization and segregation. Both cohesin and condensin mediate regulated and reversible chromosome assembly that is necessary for safeguarding genome integrity. My laboratory has played an important role in elucidating the meiotic functions of cohesin and condensin in DNA double-strand break repair and chromosome segregation. Using budding yeast as a genetic model organism, we have established two research projects.

1. Mechanism of chromosome organization and genome integrity during meiosis. We have developed novel tools to investigate local chromatin structural changes at the point of chromosome break occurrence.
2. Coordination of chromosome segregation with centrosome dynamics during cell divisionWe use fluorescence microscopy techniques to investigate centrosome duplication and separation during the cell cycle.

Understanding how chromosomes fold and segregate in model organisms will shed light on the mechanism of chromosome metabolism in genomic instability and carcinogenesis in human.

____ 9. **Dr. Yanchang Wang, Department of Biomedical Sciences -- 2 students**
Lab Website: http://med.fsu.edu/index.cfm?page=biomedicalSciences.wangLab
Recommended Computer Skills: N/A
Project Description: Accurate chromosome segregation is essential for cell survival. Chromosome mis-segregation causes gain or loss of chromosomes, resulting aneuploidy, a cause of cancer development. This research project will use budding yeast as a model system to identify genes required to prevent the formation of aneuploid cells.

____ 10. **Dr. Akash Gunjan, Department of Biomedical Sciences -- 2 students**
Lab Website: http://med.fsu.edu/index.cfm?page=biomedicalSciences.gunjanLab
Recommended Computer Skills: Microsoft Word, PowerPoint, Publisher (but none of these are an absolute requirement)

Project Description: Our DNA is fragile and constantly under attack by various physical and chemical agents from both outside and within the cells. Agents from outside the cell include ultraviolet (UV) light in the sunlight, X-rays, toxic chemicals in the environment, etc. These agents cause a variety of damage to the DNA that the cell needs to repair efficiently. All cells have evolved a variety of mechanisms that detect and repair many different kinds of DNA damage very efficiently. DNA damage is detected by sensor proteins that trigger the recruitment of repair proteins to the sites of DNA damage. If the DNA is left unrepaired or improperly repaired, this can lead to harmful mutations. If the cell carrying the damaged DNA divides, it can pass on the damage and/ or mutations to the daughter cells. Eventually, these mutations could lead to cancer.

In eukaryotes, the DNA is wrapped around positively charged histone proteins to form nucleoprotein filaments called chromatin. Histones help package the DNA to fit it inside the nucleus of each cell, which in turn regulates access to the genetic information contained within the DNA. Hence, all aspects of DNA metabolism, including DNA damage and repair, as well as diseases such as cancer are likely to be affected by chromatin structure. To study the contribution of chromatin structure and components in carcinogenesis, we are carrying out a systematic analysis of chromatin dynamics at DNA repair sites in real time following laser induced DNA damage in live human cancer cells using cutting edge microscopy. A typical experiment is depicted below. The student will be involved in collecting the images on the microscope using live human cells and then processing the images and analyzing the data.

____ 11. **Dr. Wei Yang, Institute of Molecular Biophysics -- 2 students**
Lab Website: http://www.chem.fsu.edu/bio.php?id=56
Recommended Computer Skills: N/A
Project Description: Computer Simulation of Drug Delivery: In this project, we will employ state-of-the-art computer simulation techniques to understand how drug molecules permeate into the intracellular environment.

____ 12. **Dr. Thayumanas Somasundaram, Department of Physics/Institution of the Molecular Biophysics -- 2 students**
Lab Website: http://www.sb.fsu.edu/~soma/Proj/YSP/index.html
Recommended Computer Skills: Proficiency with Microsoft Windows environment with Word, Excel, Power Point is sufficient for major part of the project's goal. Basic Linux/UNIX environment skills will be introduced and is helpful in the last part of the project.
Project Description: The aim of the project is to crystallize a protein with and without nucleation helpers and study the effect of them on crystal symmetry and dimensions. It will involve the following steps:

1. Specific laboratory skills in handling liquids, biological samples and liquid nitrogen.
2. Setting-up and observing (optically) crystal trays of protein samples.
3. Flash cooling of crystals using gaseous/liquid nitrogen at cryo temperatures.
4. Collecting x-ray diffraction pattern and obtaining crystal dimensions and space group.
5. Drawing conclusions based on the observations

Steps 1-3 can be completed during the first three weeks, Steps 4 and 5 can be completed during the 4 and 5th weeks, leaving the last week for final analysis and presentation of the results. The correlation between crystal symmetry and cell dimensions in presence of various nucleation agents will be the part that the student(s) will research and learn.

____ 13. **Dr. Kun Yang, Department of Physics -- 1 student**
Lab Website: http://fs.magnet.fsu.edu/~kunyang/
Recommended Computer Skills: N/A
Project Description: Entanglement is the most counter-intuitive aspect of quantum mechanics. Einstein, who called it "spooky action at long distance", was so annoyed by it that he refused to accept the standard interpretation of quantum mechanics. Yet it is at the heart of many fascinating physical systems and phenomena, ranging from electrons in solids to black holes. In this theoretical physics project we will study how to use entanglement to characterize various quantum systems. It is part of a larger research program on entanglement in my group, which involves a couple of graduate students whom the YSP participant will be able interact with.

____ 14. **Dr. Robert Hart, Department of Earth, Ocean, and Atmospheric Science -- 2 students**
Lab Website: moe.met.fsu.edu

Recommended Computer Skills: Familiarity with a Unix environment would be helpful but not necessary. The student will be working with a data analysis program (Matlab) but all necessary training will be provided.

Project Description: Want to discover a hurricane? This project is part of an ongoing research effort to improve and expand the historical record of tropical cyclones. You will be working with an experimental dataset of cases where a hurricane could possibly be added to the official record and using historical weather observations to determine whether or not a tropical cyclone actually existed at that place and time. You'll learn the basics of meteorology and the science of studying hurricanes, and apply that knowledge to expand what we know about the most energetic weather features on Earth!

____ 15. **Dr. Sungmoon Jung, Department of Civil and Environmental Engineering -- 2 students**

Lab Website: http://www.eng.fsu.edu/~sjung

Recommended Computer Skills: Basic knowledge on computer programming and data acquisition system will be helpful, but not required.

Project Description: Tall structures such as high-rise buildings or wind turbine towers experience strong forces due to the wind. The magnitude of the wind force depends on the cross-sectional shape of the structure, because the air flow (hence the force) changes when we change the cross-sectional shape. The goal of this summer project is to reduce the magnitude of the wind force by trying different cross sections. The students can expect the following research and learning activities:

1. To learn how to use a computerized data acquisition system (LabView)
2. To make a force sensor work (to connect it to the computer, and to create a LabView module)
3. To construct specimens and to conduct wind tunnel tests

____ 16. **Dr. Chiwoo Park, Department of Industrial and Manufacturing Engineering -- 2 students**

Lab Website: http://www.eng.fsu.edu/~chiwoo.park

Recommended Computer Skills: Applicants should be proficient in MS Windows and Office software. Prior experience in any programming language is preferred but not required.

Project Description: The goal of this individual research project (IRP) is to analyze microscopic pictures of nanoparticles to study the relationship between nanoparticle shapes and their properties. The students will be involved in the following activities to achieve the goal:

1. Attend a general introduction session on nanoparticles and their promising applications
2. Attend a lab tour for watching how nanoparticles are produced
3. Attend a lab tour for watching how nanoparticles are imaged by electron microscopes
4. Study general image analysis techniques and software for extracting several outlines of nanoparticles from microscopic pictures
5. Apply the image analysis techniques and software to real electron microscopic pictures, and discuss how nanoparticle shapes are different and how nanoparticle shapes are related to their material properties.

____ 17. **Dr. Emmanuel Collins, Department of Mechanical Engineering -- 2 students**

Lab Website: www.eng.fsu.edu/ciscor/

Recommended Computer Skills: Computer programming will not be required. However, familiarity with C or C++ is useful since they are the primary languages used to program the robots.

Project Description: Selected high school students will be involved in the development of curvilinear motion models for some of our mobile robotic platforms such as the XRL hexapedal (legged) robot and the FAMU-FSU Bot skid-steered platform. The students will be given responsibility for some of the vital data collection that is involved with determining the parameters of the vehicle models. The project will familiarize the students with various robot sensors and the external Vicon motion capture system that is used for accurate tracking of the vehicle motion. This program will provide students with the skills to safely operate the sensors and motion capture system, perform experiments, and extract and analyze data.

____ 18. **Dr. Jonathan Clark, Department of Mechanical Engineering -- 2 students**

Lab Website: http://www.eng.fsu.edu/stride/

Recommended Computer Skills: Computer skills will be helpful. Any sort or programming, CAD, or Matlab
Project Description: Design of novel legs/climbing feet for a small dynamic climbing robot. These legs and feet will be applied to a small (200g) dynamic climbing robot and be capable of greater flexibility in climbing real world surfaces such as trees. The project may involve design, fabrication, and testing of the robot.

19. **Dr. Hui Li, The Center for Advanced Power Systems -- 1 student**
Lab Website: http://www.eng.fsu.edu/~li/
Recommended Computer Skills: Matlab
Project Description: The student will learn the basic operational principles of solar panel and variable applications of solar energy. Then he/she will get further knowledge about the existing issues in the solar energy market. Finally, the student can investigate one possible solution to solve a practical problem and evaluate the solution.

List of specific activities:
1. Study solar panel and modeling
2. Discuss solar energy market
3. Study issues of solar energy for residential applications
4. Study issues of solar energy for power system applications
5. Investigate possible solutions for the issues
6. Evaluate one solution to solve a practical issue

20. **Dr. Tomasz Plewa, Department of Scientific Computing -- 3 students**
Lab Website: http://people.sc.fsu.edu/~tplewa/
Recommended Computer Skills: Practical programming experience with Fortran, C, or C++ is required.
Project Description: We invite interested summer students to work in a research group investigating problems in computational astrophysics and plasma physics. Applications include computer modeling of stellar interiors, supernova explosions, evolution of the interstellar medium, and design of laser plasma experiments. These problems are rich in physics and involve a combination of hydrodynamics or magnetohydrodynamics, thermal transport, thermonuclear combustion, gravity, and realistic equation of state.

Students will work to develop computer software required for interactive analysis of computer simulations accessible online through a web-based interface. This project requires students to have interest in astronomy, physics, computer science, good background in mathematics, and fluency in at least one programming language (Fortran, C, and/or C++; knowledge of symbolic languages such as Matlab is a plus).

21. **Dr. Zhenghao Zhang, Department of Computer Science -- 1 student**
Lab Website: http://www.cs.fsu.edu/~zzhang/
Recommended Computer Skills: This project will require computer skills. The student should be able to write programs to analyze log files and plot figures to represent the results. Matlab is the best language for this purpose but other languages will also work.
Project Description: Understanding Wi-Fi.

As wireless networks such as Wi-Fi and LTE are becoming more and more widely deployed, understanding the fundamentals of the wireless technology is important. In this project, the student will be involved in measuring the Wi-Fi signal to advance the understanding of how Wi-Fi works in various aspects. We will use the Software Defined Radios (SDR) in our lab to carry out the measurements. The student will be able to use the SDRs to see the wireless signal in the air with the standard tools. In addition, the student can also write customized programs to extract the parts of the signal of interest and analyze the signals. Of particular interest is to learn how signal changes as people move in the indoor environments and how to extract information from such changes. This project will be ideally suited for students who are interested in wireless networks and like experimental research.

22. **Dr. Mark Powell & Shawn Smith, Center for Oceanic & Atmospheric Prediction Center -- 2 students**

Lab Website: http://coaps.fsu.edu/
Recommended Computer Skills: We seek students that are comfortable working on personal computers and using software like Word and Excel. Familiarity with Linux or Unix operating system or a programming language (Fortran, C, Visual Basic) will be helpful. We generally teach any essential computer skills to the students.
Project Description: The IRP will center around examining the accuracy of forecasts of hurricane intensity at landfall. The students will compare measured hurricane intensity at landfall with forecast intensity values from National Hurricane Center (NHC) forecast products. Intensity will be examined using maximum wind speed. The analysis will focus on hurricanes making landfall primarily in the United States, but may be expanded to all landfalls in the North Atlantic basin. Students will be working with the official NHC database of hurricane landfalls and will be extracting forecast intensities for different temporal periods prior to landfall (12, 24, 36, 48 hr) from the NHC forecast products. The students will be trained to calculate statistical measures of accuracy, uncertainty, and/or bias for the forecast versus actual landfall intensity measures. Students will have read and manipulate landfall data on the computer to create tables, charts, and graphs displaying their calculated statistics. The project will offer the opportunity for the students to work with Dr. Mark Powell, a hurricane research scientist from NOAA's Atlantic Oceanic and Atmospheric Laboratory (stationed at FSU).

____ 23. **Dr. Sourav Saha, Department of Department of Chemistry and Biochemistry -- 2 students**
Lab Website: http://www.chem.fsu.edu/~Sourav/Saha/Home.html
Recommended Computer Skills: -
Project Description:

1. Anion recognition and sensing through electronic interactions.
2. Convert light to electricity using multichromophoric (dyes that absorb light) self-assembled solar cells
3. Controlled drug-delivery systems based on pH (acid/base) responsive self-assembled vesicles and nanotubes

____ 24. **Dr. Naresh Dalal, Department of Department of Chemistry and Biochemistry -- 2 students**
Lab Website: - http://www.chem.fsu.edu/bio.php?id=10
Recommended Computer Skills: -
Project Description: The project will involve chemical synthesis of a compound involving the chemistry of chromium or copper or Molybdenum and its characterization by x-ray diffraction and spectroscopic techniques. The goal is to see if we can make a new compound that can serve as a component of a memory storage device.