UROP Project List

1. Research Assistant

Cats and rodent botflies
Research Description:

> Cats in the Twin Cities Metropolitan Area occasionally develop respiratory and other problems from what veterinarians believe are rodent bot fly larvae. The larvae are immature forms of bot flies that normally develop as internal parasites of mice, chipmunks, squirrels and cotton tail rabbits. A working hypothesis is that "hunters" are accidentally infected through exposure to the maggots that reside near their normal hosts' burrow entrances. Disease develops as the small maggots burrow outward from a cat's respiratory system. Dogs are also infected. We do not know what kind of bot flies are involved in the metro area cases, and when infections are acquired. That knowledge could help attending veterinarians and cat owners avoid infections.

UROP Project:

> Opportunities for undergraduate research would revolve around development of a databased library of botfly specimens obtained from veterinarians, rescue shelters and wildlife rehabilitation centers. The specimens need to be curated and photographed to develop an illustrated digital library, which will help identify the types of botflies that occur in wildlife and companion animals in the area. A student working on this project would learn how to find and compile research literature on botflies, curate insect specimens for storage and future reference, barcode specimens and manage collection information in a database, create microscope slides of diagnostic body parts, photograph specimens for digital analysis, and create an illustrated reference manual to aid in identification of future specimens.

Contact Person:

> Roger Moon, Professor, Entomology, rdmoon@umn.edu 612-624-2209

Web: http://www.entomology.umn.edu/People/GradFaculty/Moon/index.htm

2. Undergrad Research Assistant

Below are three projects ideas from my lab:

a. Research description:

Our working hypothesis is that diet can modulate the expression of taste receptors and chemosensory molecules in the gastrointestinal tract. It is believed that taste and other chemosensory receptors regulate hormone production and release from the endocrine cells of the intestine and stomach. We have collected gastric and intestinal tissues from pigs on different diets to evaluate the changes on taste and chemosensory receptors and gut hormone expression associated to diet.

UROP Project 1:
   The project involves RNA extraction and quantitation of gene expression using qRT-PCR. In some cases, the design of probes and primers specific for the gene of interest is necessary. Data analysis and figure generation is also included in the development of the project.

   b.   Research description:
In previous studies, we identified the presence of primary cilia in the gastric endocrine cells that secrete gastrin, a hormone important for acid secretion and other metabolic functions. In the mouse gastrointestinal tract, we found that endocrine cells of the gastric antrum and corpus have primary cilia. When we analyzed the pig stomach for the presence of primary cilia, we found that the gastrin-expressing cells in the pig antrum had primary cilia in a lower frequency than in the mouse antrum. More importantly, in contrast to the mouse, cells presenting primary cilia in the corpus of the pig do not belong to the endocrine lineage. To evaluate the significance of primary cilia in the pig's stomach, we need to identify those cells of the corpus.

UROP Project 2:
   This project is based on histological and immunohistochemical identification of specific cell types in the gastric stomach. The student will prepare slides from paraffin-embedded tissue blocks and perform immunofluorescent and immunohistochemistry detection of markers co-labeling with primary cilia markers. Morphometric evaluation of positive and co-labeling cells will be done. The student will also perform data analysis and figure preparation.

   c.   Research description:
Gastrin is a hormone produced in the stomach that is important for acid secretion, cell differentiation and metabolic control. In previous studies we found that mice that secrete more gastrin (hypergastrinemic) than controls develop obesity and insulin resistance. To test if gastrin is important for weight control, we fed gastrin-deficient mice with control and high-caloric diets. The gastrin-deficient mice gained less weight than the control mice when fed the high-caloric diet, suggesting that gastrin may play a pro-obesity role in metabolism. To decipher how gastrin may affect metabolism, we start with testing in vitro the effect of gastrin on liver cells function.

UROP project 3:
   The student will prepare cell cultures and treat them with different concentrations of gastrin. Cells will be collected for protein and RNA extraction. Cell extracts will be used for enzymatic activity determinations, western blot and gene expression analysis. The student is expected to be able to calculate and prepare solutions, concentrations and treatments and have previous laboratory skills (pipetting, cell culture, etc.) Data analysis and figure preparation are included in the project.

Contact Person: Milena Saqui-Salces, Assistant Professor
(612) 624-4277 office, (612) 624-4265 lab, msaquisa@umn.edu

3. Research Assistant

Endoparasitoids are insects which devour other insects from the inside out, eventually killing the host. One problem with this feeding strategy, however, is that the parasitoid cannot flee when predators or hyperparasitoids (i.e. parasitoids of parasitoids) attack. To deal with this threat, some parasitoids have evolved the ability to manipulate their host's behavior, making the host like a zombie that acts against its own self-interest. For example, some parasitized caterpillars will kick and thrash about to protect pupae of the very parasitoid that attacked it. In other cases, parasitoids may cause their hosts to seek out protected areas before they die, carrying the parasitoid to a safe place to complete its development. Anecdotal evidence suggests that such phenomenon may be occurring between the soybean aphid and one of its parasitoids, *Aphelinus certus*.

A UROP project idea:
> Examine in the lab whether *A. certus* is able to "hijack" the soybean aphid and cause it to move to areas that benefit the parasitoid but are harmful to the aphid. Comparisons could be made between different parasitoid and aphid species.

Contact person**:** Joe M. Kaser, Kaser008@umn.edu (312) 437-5390

4. Research Assistant

Ecology and Genetics of Parasitic Wasps
> An independent research opportunity is available to address the ecology and evolution of parasitoid wasps that are commonly used as biological control agents in agricultural ecosystems. The undergraduate researcher will work as a member of Professor George Heimpel's lab on a research program addressing the ecological consequences of sex determination and sex ratio of parasitoid populations. There will be some freedom to help design and conduct an independent research project related to population dynamics or mating behavior of parasitoids. Potential projects include assessing the sex ratio of parasitoid populations in or around Saint Paul campus, or conducting an inbreeding study in the lab to assess the consequences of small population sizes on sex ratio.

Desired Qualifications:
> Candidates should have strong organizational skills and the ability to work independently.

Contact person: Interested candidates can contact Jerome Weis, weis0550@umn.edu

5. Research Assistant

Genetic analysis of intermediate wheatgrass using Genotyping-by-sequencing

Intermediate wheatgrass (Thinopyrum intermedium) is genetically related to wheat and has been grown worldwide as a perennial forage species. We aim to develop IWG as a grain producing crop with a perennial habit and associated environmental benefits. Compared with annuals, this perennial species retains higher soil fertility, prevents loss of nitrogen and phosphorus through surface runoff, protects against soil erosion, and is more resilient to pathogens and abiotic stresses. However, IWG is hexaploid and an outcrosser, and little genetic analysis of IWG has been done. Recently, next-generation sequencing has dramatically reduced the cost of DNA markers. These marker technologies can be used with any species, even those like IWG without previous genomic resources. Genotyping-by-sequencing (GBS) method will be used to genotype a F1 mapping population, with 170 genotypes. Combined with the data from the other populations, an integrated genetic map with 5,000 GBS markers will be produced.

Opportunities for undergraduate research include:
1) work on the promising perennial grain crop, intermediate wheatgrass;
2) perform basic molecular biological experiments, including DNA isolation, PCR, GBS library development;
3) access next-generation sequencing data, and discover GBS markers; 4) develop a genetic map using JoinMap.

Contact person: James A. Anderson, Professor, ander319@umn.edu 612-625-9763

6. Research Assistant

Genes related to wheat quality improvement
Bread-making quality improvement is one of the major breeding objectives. The unique viscoelastic properties of bread wheat are the basis of bread-making quality, which were conferred by gluten proteins. Gluten proteins are classically divided into gliadins and glutenins. High-molecular-weight glutenin subunits (HMW-GS) were widely studies and is being used in wheat breeding program by marker assisted selection (MAS), while low-molecular-weight glutenin subunits (LMW-GS), accounting for 2/3 of glutenins, were complicated and had not yet been used for MAS in wheat breeding. Recently, an accurate and efficient method was developed to dissect the composition and diversity of LMW-GS genes in bread wheat, and several superior LMW-GS alleles were reported. In this project, a LMW-GS molecular marker system will be used to detect the composition of LMW-GS in advanced breeding lines. The diversity of LMW-GS genes in our breeding program will be uncovered. Moreover, the quality of the advanced breeding lines have been tested in the past several years. Correlation analysis will be performed to identify superior alleles for wheat quality improvement.

Opportunities for undergraduate research include:
1) work on wheat quality;
2) carry out basic molecular biological experiments, including high throughput DNA isolation, PCR, 3730 DNA analyzer;
3) analyze the composition and diversity of LMW-GS genes in bread wheat.
4) conduct correlation analysis and know about the process of MAS.

Contact person: James A. Anderson, Professor, ander319@umn.edu 612-625-9763

7. Research Assistant

Potential UROP projects with the Figueroa Lab (Plant Pathology Department)
Molecular and Genetic determinants of wheat stem rust resistance

Research Description:

Puccinia graminis f. sp. tritici (Pg-tr), the causal agent of wheat stem rust is an airborne fungus which threatens the production of wheat; and therefore, the world's food supply. Recent epidemics of stem rust due the emergence of hypervirulent strains urge us to further our understanding of the underlying basis that control stem rust disease susceptibility or resistance. Consider this disease as one coin with the pathogen representing one side of the coin and the host (plant) another. Our studies seek to answer questions that involve both sides of the coin …what are the weapons that P. graminis f.sp. tritici employs as a pathogen? How does the plant fight back? What are the plant defense responses that are effective against such a devastating pathogen? Why do some interactions result in disease, whereas other don't?

Relevant websites:
http://rusttracker.cimmyt.org
http://www.globalrust.org

UROP Projects:

1. Characterization of the cellular defenses activated in resistant wheat. Plants employ distinct mechanisms to detect the presence of a pathogen. The transmission of these signals throughout the cell results in an array of responses such as cell wall modifications, production of compounds toxic to the pathogen, alterations in gene expression, etc. Using microscopy and techniques in molecular biology we compare how certain plant genes that determine stem rust resistance affect the pathogen's development and onset of infection. The student working in this project will learn how to perform infection assays in greenhouses and growth chambers, evaluate symptoms, prepare solutions, apply histological techniques, extract DNA & RNA, and conduct standard PCR and qRT-PCR.

2. Exploiting Brachypodium distachyon as a resource of genetic resistance against stem rust
Brachypodium distachyon is a small grass that is regarded as an experimental model to study cereals such as wheat and barley. B. distachyon exhibits resistance to stem rust. A genome-wide survey of genes in B. distachyon that change in expression upon infection with Puccinia graminis f. sp. tritici allowed us to identify potential genes or pathways that may mediate defense responses. To confirm the role of those candidate genes in stem rust resistance we analyze whether mutations in those genes result in an increase of infection by Puccinia graminis f. sp. tritici. The student working in this project will learn how to perform infection assays in

greenhouses and growth chambers, evaluate symptoms, and will use microscopy to monitor and compare the pathogen growth. Additionally, the student will become proficient in DNA isolation, gene sequencing and PCR.
Contact person: Dr. Melania Figueroa, figue031@umn.edu 612-624-2291

8. Biofuel cell Research Assistant

Research Description:
Biofuel cell is a promising technology that provides a potential solution for electricity generation from biomass using enzyme or bacteria. Biofuel cell or microbial fuel cell (MFC) catalyzes substrate undergoing a redox reaction to generate power by using enzyme or bacteria as catalyst. In this study, we developed Carbon nanotubes (CNTs) for the anode design and a novel design of a consortium system is applied as the cell reaction system. These studies aim to increase the power generation of the fuel cell, including the cell performance and the duration of power output.

UROP Projects:
Opportunities for undergraduate research include:
(1) culture of bacteria (Saint Paul),
(2) making carbon nanotubes for the anode (Saint Paul),
(3) fuel cell device set-up (Saint Paul),
(4) monitoring the fuel cell performance (Saint Paul).

Contact person: Ping Wang, PhD, ping@umn.edu (612) 624-4792; (612)624-3264
http://pingwang.cfans.umn.edu

9. Research Project: "Quantifying rhizobial-strain benefits to soybean or alfalfa"

Problem Description:
Rhizobia are soil bacteria, best-known as root-nodule symbionts of legume crops, which they provide with nitrogen. Nitrogen fixation is metabolically costly, however, and its cost to the plant may be increased by conflicts of interest with their rhizobial symbionts. For example, some rhizobial strains divert more resources from nitrogen fixation to their own current or future reproduction. How much more benefit would soybean and alfalfa get from rhizobia, if fewer nodules were occupied by these less-efficient strains? You could help answer this question.
See also: http://micropop.cbs.umn.edu/projects/rhizobia.html

UROP Research Opportunities:
One or two UROP students are sought to work with me in designing your own research project on legume-rhizobium interactions relevant to agriculture. For example, the usual method for assessing strain benefits – comparing early growth of

plants inoculated with a single strain – may over-emphasize speed of nodulation. In the field, where each plant hosts several strains, differences in efficiency may be more important. You could use our fixation-efficiency apparatus to measure nitrogenase activity divided by nitrogenase-linked respiration and compare that to various methods based on plant growth. A summer UROP could include field sampling.

Prior experience with growing bacteria and plants would be helpful.

Contact person: Please contact R. Ford Denison, Adjunct Professor in Ecology and Evolution Fellow in CFANS, if you are interested denis036@umn.edu
Website: http://micropop.cbs.umn.edu/projects/rhizobia.html

10. Position Title: Assistant

Environmental Geochemistry and Mineralogy
> The Toner group has UROP projects in a variety of research areas: arsenic contamination of Minnesota groundwater, iron mobility in marine and terrestrial systems, and microbial alteration of iron-bearing minerals. For each of these projects, mineralogical characterization of samples by X-ray diffraction (XRD) is required, and there are opportunities for collecting new data and/or analyzing existing datasets using the software program JADE. The data collection and analysis will be conducted at the University of Minnesota's Characterization Facility on the Minneapolis campus, and in the Toner laboratories on the St. Paul campus. Results will be published in peer reviewed geochemistry journals. These research projects require good computer skills, basic geochemistry and mineralogy knowledge, and most importantly, a motivated individual. The UROP student will be invited to participate in group and collaborator meetings.

Contact person: Contact professor Toner, toner@umn.edu with subject line: Mineralogy UROP
> 612-624-1362
http://www.tc.umn.edu/~toner/

11. Research Assistant

Quantitative Population Ecology
Potential UROP Projects:
> Work with an existing wildlife data set to estimate population size or other key demographic parameters (e.g. survey data, banding data), or use simulation modeling to address an important assumption in currently used analytical methods. I'll provide data and any necessary statistical guidance. You'll provide enthusiasm and a willingness

to improve your analysis and writing skills while producing a potentially publishable independent research project.

Contact person: Todd Arnold, arnol065@umn.edu

12. Research Assistant

Dairy Cow Heat Stress and Ventilating System Modeling

Project Description
Heat stress in lactating cows leads to increased lameness, increased mortality, increased disease incidence, decreased reproductive performance, decreased milk quality because of increased somatic cell count, decreased feed intake, decreased milk production, and decreased calf health. Highly productive dairy cows begin to experience heat stress when the temperatures are above 68 F. Dairy producers are using tunnel ventilation, cross-ventilation, mixing fans, sprinklers and misters to reduce the heat stress that dairy cows experience. Research is needed to better understand how these ventilating systems perform. One method is to develop spreadsheet models and compare the model results to data from real barns.

UROP Opportunities
> Opportunities for undergraduate research include:
> (1) Using spreadsheet models to assess ventilating system performance in tunnel and cross-ventilated barns and compare the model results to temperature and relative humidity data from existing barns,
> (2) Develop a dairy cow heat stress model using published equations that account for convective, respiratory, evaporative, radiant and conductive heat exchange between dairy cows and their surrounding environment, and
> (3) Investigate alternative techniques for mitigating heat stress for dairy cows. Undergraduate students that are proficient using spreadsheets and interested in learning more about spreadsheets are encouraged to apply.

Contact person: Kevin Janni, Ph.D., P.E. Professor and Extension Engineer, kjanni@umn.edu
> 612-625-3108

13. Research Assistant

Who Will Teach Effectively?
Linking Applicant Pre-hire Characteristics to Teacher Productivity and Retention
This research project aims to identify predictors of teacher effectiveness using data from Minneapolis Public Schools. Teacher labor markets are of great interest to economists, human resource scholars, and policy makers due to several unique features. Most people would agree that effective teaching should be reflected in higher student learning, but measuring and valuation of such in practice has not proven to be easy. Only recently, a few

districts (including Minneapolis) have started to produce measures of teacher effectiveness that rely on student outcomes and peer reviews. Absent good measures of teacher effectiveness, most personnel decisions regarding teachers were, and continue to be made based on teacher credentials, such as education (highest degree), certification and years of experience. The problem remains that these commonly used measures are poorly correlated with productivity (as measured by student outcome-based measures).

UROP project:
    This project will use novel data collection techniques and theory in personnel economics and industrial psychology to generate and test pre-hire predictors of future effective teaching. If successful, the project stands to generate significant social gains, as the economic stakes associated with identifying effective teachers early on are huge. Having a one-standard deviation better teacher in a kindergarten class is conservatively estimated to generate over $200,000 in net present value of social returns each year.

Contact person: Elton Mykerezi, Associate Professor, Applied Economics, myker001@umn.edu
    (612) 625 2749

14. CFANS Project Ideas – Forester Lab

Project 1: Analysis of land cover and plant communities in the Greater Cloquet Forestry Center and Itasca State Park landscapes
    One student/technician is needed to assist with the creation of a detailed and comprehensive land-cover classification layer for the landscapes associated with the Cloquet Forestry Center and the Itasca Biological Station/Itasca State Park. After creating the data layers, the student will test whether using the updated layers change the ecological conclusions about resource selection by black bears in the Cloquet area. The final deliverables of this project will be: 1) completed and up to date land-cover classification GIS vector layers for the landscapes around Cloquet Forestry Station (20,000 acres) and the Itasca Biological Station / Itasca State Park (33,250 acres); and 2) a quantitative analysis of the impact of land-cover classification on the interpretation of space use by American black bears. These land-cover data will be consistent with Minnesota Land Cover Classification System (MLCCS) methodologies and will include the most recent MN DNR natural community classification system. These data are currently lacking, and will be an essential resource to students and researchers conducting ecological and biological field research within these landscapes associated with two University of Minnesota research stations.
Contact person: James D. Forester, jdforest@umn.edu
http://fwcb.cfans.umn.edu/forester/index.html

Project 2: Stable isotope analysis of moose hair

In order to gain a better understanding of moose foraging behavior from late spring to early fall in northeastern Minnesota, we hope to have a CFANS UROP student prepare and conduct stable isotopes analysis (carbon and nitrogen) on moose hair from more than 100 individual, radio-collared moose. This analysis, which requires no prior experience with stable isotopes, will allow us to gain a better understanding of how the diet of moose varies as a function of both space and time. Our ultimate goal with this study is to determine how moose diets vary as a function of ambient temperature, and how this, in turn, might be impacting winter survival of moose in Minnesota.

Contact person: James D. Forester, jdforest@umn.edu
http://fwcb.cfans.umn.edu/forester/index.html

Project 3: Stable isotope analysis of moose scat

In order to gain a better understanding of moose foraging behavior during late spring in northeastern Minnesota, we hope to have a CFANS UROP student prepare and conduct stable isotopes analysis (carbon and nitrogen) on moose pellets from more than 50 individual animals. This analysis, which requires no prior experience with stable isotopes, will allow us to gain a better understanding of how moose diets vary throughout northeastern Minnesota, during early spring — one of the most critical feeding periods for moose. Our ultimate goal with this study is to determine how diet composition during early spring changes as a function of location and habitat setting in northeastern Minnesota.

Contact: James D. Forester, jdforest@umn.edu
http://fwcb.cfans.umn.edu/forester/index.html

Project 4: Spatial variation in stable isotopes of C and N in paper birch

Paper birch is one of the most widespread and abundant tree species in North America. In order to gain a better understanding of how the stable isotope composition (carbon and nitrogen) of this ecologically and financially important species varies, we hope to have a CFANS UROP student prepare and analyze tissue samples from more than 100 paper birch specimens collected from throughout northeastern Minnesota. This analysis, which requires no prior experience with stable isotopes, will allow us to gain a better understanding of how ambient temperature, habitat setting, and location work together to impact the isotopic composition of paper birch. Our ultimate goal with this study is to determine how paper birch responds to different environmental variables in a way that might impact herbivore populations in northeastern Minnesota.

Contact person: James D. Forester, jdforest@umn.edu
http://fwcb.cfans.umn.edu/forester/index.html

15. Undergraduate Research Assistant

Calculation the Amax of different kinds of cellulose
Research Description:
> Cellulose binding domain (CBD) is part of the cellulose which is from Clostridium thermocellum DSM 2360. The CBD tag was fused with enhanced green fluorescent protein (EGFP) and expressed in Escherichia coli to demonstrate its ability to function as an affinity tag. This project aims to calculate the maximum cellulase adsorption capacity (Amax) of some cellulosic materials, such as nano-fiber, kraft pulp fiber, filter paper, cotton fabric and medical cotton. Then we will find the most efficient CBD binding cellulose which will be used as the immobilized material for other CBD fused enzymes.

UROP Projects:
> Opportunities for undergraduate research include: (1) learn how to culture the E. coli cells. (2) Purification of the EGFP-CBD, SDS-PAGE and quantify the protein. (3) Calculation the Amax of difference kinds of cellulose. (4) Some other basic lab skills about molecular experiments.

Contact person: Ping Wang, Professor, ping@umn.edu 612-624-3264

16. Undergraduate Research Assistant

Number of positions: 2

The Biosensors and Bionanotechnology Laboratory in the Department of Bioproducts and Biosystems Engineering is looking for two enthusiastic and creative undergraduate students to work on one of the following projects:
> 1- Development of a biosensor based on liquid crystals for the detection of food pathogens. The research involves preparation and functionalization of liquid crystals and characterization using UV-visible spectroscopy, optical microscopy and other techniques
> 2- Development of a portable biosensor for real-time detection of nitrite and nitrate in soils. The project involves the fabrication and use of ion-selective electrodes to make electrochemical sensors specific to nitrite and nitrate. This portable sensor will allow farmers and agricultural engineers to rapidly evaluate the nitrate/nitrite content in the soil before applying the adequate amount of fertilizers.
> These projects are a great learning and training experience in nanotechnology and biosensing techniques for food safety, agricultural and environmental applications. This is also the opportunity to learn how to plan and execute experiments, analyze results, write scientific reports and publish your first paper in international journals.

Desired qualifications:
> Prior work in nanotechnology or biosensors is NOT required.

Students with basic training in chemistry, biology, biotechnology or chemical engineering are preferred, but all candidates will be considered.

Contact person: Prof. Abdennour Abbas, aabbas@umn.edu
Website: www.abbaslab.com