2013 Gustavus Adolphus College FYRE Program
Opportunity book and application form for students

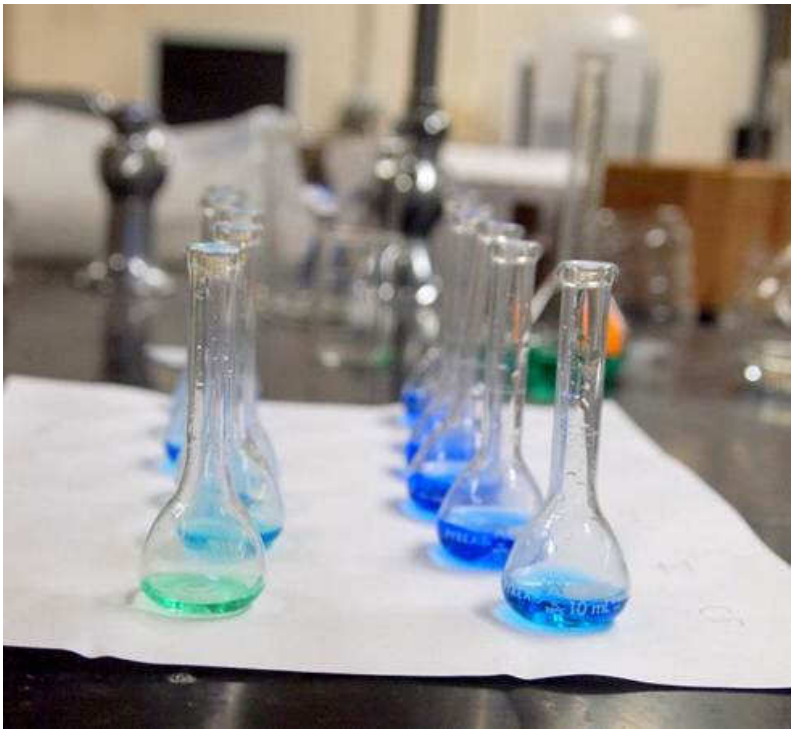
First-year science students: if you are interested in a Gustavus research experience this summer, this is the program for you! The First Year Research Experience (FYRE) Program, the successor to the Howard Hughes Medical Institute Summer Science Research Program, allows us to offer several first-year students the opportunity to conduct scientific research with members of the Gustavus faculty during the summer of 2013 (in addition to other research opportunities open to students of all years).

In this booklet, you will find

- Information about the FYRE Program
- A timetable for the application, selection, and notification process
- Research project descriptions
- Application instructions and forms (due to Dr. Steve Miller no later than 4:30 pm on March 6)

Program information

Students in this program will conduct research with Gustavus professors for 10 weeks during the summer of 2013. The research projects are full-time commitments, typically beginning in early June and ending in early to mid August.



Besides lab and field work, summer programming on the Gustavus campus includes:

- Weekly meetings for students to present research plans and progress.
- Weekly social breaks in Nobel Hall.
- Occasional group outings. Past trips have included science museums, tours of local companies, canoe trips, and picnics.
- A symposium in September for summer science researchers to present their results.

For more information about Gustavus summer research in general, visit http://gustavus.edu/academics/research/

Program Timeline

NOW: start filling out applications and selecting potential research projects. Plan ahead; you will need to meet with faculty members before the application deadline.
February 19: information session in Nobel 201, 8-9 pm (optional).
March 6: submit complete applications to Dr. Steve Miller by 4:30 pm.
March 20: you will be notified whether your application was accepted, wait-listed, or declined. Each accepted student will be informed of the project to which s/he was matched.
March 28: deadline for accepted students to return signed forms indicating their commitment to participate in the program.
March 29: wait-listed students are notified of their updated status.

Common questions

Do I get paid?
Yes; you will receive a stipend of $4000 for the 10-week program, and on-campus housing will also be provided. Research students are generally housed together, typically in Campus View (yes, it has A/C). You are responsible for your own food expenses (the Caf is open most of the time, and you have a kitchenette).

Do I have to be a first-year student to apply?
Yes; students beyond their first year should speak to a faculty advisor or other trusted faculty member about research opportunities at Gustavus and elsewhere.

Is this the only summer research opportunity for first-year students?
No; Gustavus professors may be happy to work with first-year students outside of this program. Talk to a professor in your department of interest for more information.

Do I know enough to do research?
These projects are designed with first-year students in mind. The faculty advisors have thought about what background knowledge a student would need in order to contribute to his/her research, and have listed appropriate course prerequisites. They are prepared to work with you to help you learn!

Is this opportunity only for students with the top grades?
No; the qualities that make someone a good researcher can be very different than those that help someone earn a lot of "A" grades. Many students with "B" or "C" records are very good research students. If you are applying to this program, but are concerned about weak grades on your transcript, do your best to highlight your strengths in the rest of your application.

Do I have to think up my own research ideas?
No; it takes many years and much training to learn the skills required to develop valid scientific research questions and appropriate experimental plans to address those questions. Scientific research at the undergraduate level typically engages students in projects designed by professors, and that is the model used for this program.

I don't know any of the professors with projects listed here. How do I get up the nerve to talk to them?
Striking up a conversation is probably much easier than you imagine—faculty generally *love* talking about their research! The best thing to do is to call or send them an email to let them know you are interested in their research, and to ask if/when they have time to talk with you about it. Mention your interest in this program (FYRE) in particular and be ready with some times that you are available for a meeting.

2013 FYRE Program
Research Project Descriptions

The following are descriptions of available research projects. The faculty member and his/her department or program, office location, and email address are included; you should contact faculty members for further information about projects in which you might be interested.

Dr. Jeff Jeremiason, Chemistry and Environmental Studies (NHS 206C, jjeremia@gustavus.edu)

Open pit iron mining activities in northern Minnesota exposes sulfur-containing minerals to oxygen and leads to the accumulation of sulfate in the waters of the pits and in iron tailings basins. Water from these pits and basins either seeps out or is pumped out to area water bodies. Sulfate is a key component in the cycling of mercury in the environment as sulfate-reducing bacteria are key producers of the more toxic form of mercury, methylmercury, which is the form that accumulates in fish. Beginning in 2012, Dr. Jeremiason's lab began a cooperative project with the Minnesota Department of Natural Resources and the US Geological Survey to collect water and biota from several water bodies to begin examining the relationship between sulfate releases and potential formation of excess methylmercury in the receiving waters. Laboratory studies are also ongoing investigating the detailed photochemistry and binding of methylmercury to dissolved organic matter which has been isolated from several of the water bodies. Students working on this project would participate in rugged field work, learn field sampling and quantification techniques for mercury while processing many samples, and learn to operate and maintain several scientific instruments for the analysis of mercury.

Prerequisites: CHE 141

Dr. Pamela Kittelson, Biology and Environmental Studies (NHS 335, pkittels@gustavus.edu)

I am a plant ecologist interested in how variation in a population is shaped by animals and inherited traits. My research project this summer will focus on the native prairie perennial, *Echinacea angustifolia* (purple coneflower) growing in remnants of tallgrass prairie near Alexandria, Minnesota. My research team will examine how insect herbivory is affected by plant traits, and how genetic variation affects both. Herbivory and plant traits are likely to influence survival and reproduction of individual plants. Consequently, variability in how individuals express their traits and react to insect herbivores will influence *Echinacea* population growth and fitness. For example, traits that might lead to insect resistance could result in a trade-off where these plants also express low reproduction while plants that support high herbivory have more offspring. Insights from this research will enhance our understanding of how plant traits, insects and genetic diversity interact to affect demography (population growth). In this project students will learn how to collect and maintain field data, operate simple physiological instruments, design experiments examining genetic factors, identify important insect herbivores and plants, and learn basic statistical and demographic methods.

Prerequisites: Bio 102 and a desire to be in the field: rain, shine, heat, humidity and during lovely days too.

Dr. Karla Marz, Biology (NHS 221A, kmarz@gustavus.edu)

I am interested in how the structures of proteins determine their ability to regulate behavior and other biological functions, particularly with regard to circadian rhythms. Circadian rhythms are internally driven 24-hour cycles that allow anticipation of regular daily environmental changes. In humans, circadian rhythms of body temperature, digestive system workings, and ability to concentrate are a handful of functions that vary with time of day in ways suitable for animals who are active during the day and inactive at night. Genetic studies with humans and other animals have motivated the cell and molecular biology research in my lab, which attempts to answer the question, "How do the clocks driving these rhythms work?"

The molecular gears of circadian clocks reside within cells, and one, the protein Cryptochrome (CRY), is the focus of research in my lab. In my lab you will use molecular biology and cell biology techniques to probe CRY interactions with other circadian clock components. You will learn how to work with bacterial and mammalian cells in culture, DNA, and proteins; interests in protein structure and protein-protein interactions, and/or molecular neurobiology, are a plus.

Prerequisites: BIO 101 and/or CHE 107

Dr. Steve Miller, Chemistry (NHS 107A/B, smiller3@gustavus.edu)

I am interested in the structures of transition metal-based molecules. I try to understand them through spectroscopic and/or computational characterization of various systems. The work we do in my group is fundamental research—we carefully plan experiments, but we never truly know what an experiment will tell us until we perform it. We are therefore always willing to follow a project wherever it might lead, even if it is in an unexpected direction. We are currently using UV-visible spectroscopy to study aqueous systems of transition metal ions (e.g. Cu^{2+}) in the presence of small, aromatic, N-containing molecules in an effort to better understand what species are actually present in complicated chemical mixtures. Students working in my group can expect to gain experience in some combination of: quantitative laboratory techniques; use of a variety of standard spectroscopic instruments, including UV-visible, infrared, and/or fluorescence; laser-based characterization methods, such as resonance-enhanced Raman and/or laser-induced fluorescence; and the fundamentals of computational (i.e. computer-based) chemistry.

Prerequisites: CHE 107

Dr. Amanda Nienow, Chemistry (NHS 106A, anienow@gustavus.edu)

The overarching objective of the research is to evaluate the effect epicuticlar wax (i.e., wax from crop leaves) and other components of crop foliage have on the photochemistry of pesticides. In particular, we are interested in fundamentally understanding changes in the kinetics (rate of change) and mechanisms

of the photodecomposition of imidazolinones pesticides when sorbed to waxes or intact crop leaves relative to imidazolinones in aqueous solution. (The imidazolinone compounds are a class of pesticides commonly applied to soybeans and corn in the Midwestern U.S.) The photochemical transformation of these herbicides has been examined in water samples, but the mechanisms, kinetics and photoproducts of photochemical transformation of these herbicides sorbed to soybean or corn epicuticular wax or on intact crop plants have not been examined.
The project will address three main research questions:

1. What are the kinetics and photodegradation mechanism for the photolysis of pesticides on the surface of epicuticular wax extracted from crops at early growth stages and how do the data compare to results from aqueous solution systems?
2. How does the growing temperature, humidity, age of plants, and light conditions in the greenhouse alter extracted epicuticular waxes from crops at early growth stages and, therefore, the photodegradation rates and mechanisms of sorbed pesticides?
3. What are the kinetics and photodegradation mechanism for the photolysis of pesticides on the surface of crops at early growth stages and how do the data compare to the results from the wax and aqueous solution systems?

Prerequisites: CHE 107 required; CHE 141 and BIO 101 recommended

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Dr. Jessie Petricka, Physics (Olin 213, jpetrick@gustavus.edu)

PROJECT 1: This project is an effort to construct a molecular ion trap. Research on molecular ions is important in many different fields. Some examples include: spectroscopy for comparing to astronomical data, chemical reaction rate measurements, precision studies of quantum mechanics, and tests of the time-variation of fundamental constants like the mass of the electron.

Previous work on this project has explored the production of ions with high power lasers. The development of a trap using simple methods and equipment is the ongoing focus. Specifically, we wish to optimize the parameters for trapping and detection technique to produce a repeatable and reliable source for a variety of different ions. Students working on this project will become familiar with laser, vacuum, control electronics and data acquisition systems. Students will also be exposed to computer design, control, and simulation programs.

PROJECT 2: This project is a study of the electric and magnetic fields used for wireless power transfer. Such a device could revolutionize a number of every-day areas, from transportation to mobile computing to health care.

In this project students will make extensive use of CAD, numerical modeling, and computer simulation software in order to explore different designs' efficiency and feasibility. Students may also gain hands-on experience in the building and testing of certain designs. Students working on this project will also become familiar with electronics and data acquisition systems.

Prerequisites: None

Dr. Dwight Stoll, Chemistry (NHS 202, dstoll@gustavus.edu)

Liquid Chromatography is a separation technique with applications in areas ranging from drug discovery and environmental analysis, to neuroscience. Despite the fact that Liquid Chromatography was invented over 40 years ago in its modern form, it remains a very vibrant and exciting area of research. One particularly active area is the development of new materials that are used in the actual separation device where compounds of interest interact with the separation media to different degrees, which in turn leads to their physical separation. The separated compounds are then detected and quantified and/or characterized using a variety of different technologies. We are interested in characterization of new materials using the so-called Hydrophobic Subtraction Model (HSM) of retention in reversed-phase HPLC.

Currently there are over 700 commercially available materials designed for reversed-phase HPLC. The HSM does a very good job of describing the chemical characteristics of these materials, and the model is invaluable for scientists looking to choose one or more of these materials for a particular application. However, there is a small family of materials based on graphite-like carbon that are radically different from all of the other materials, and there is currently no model that explains how these graphite-like materials differ from or are similar to the other materials. In this project we will collect interaction data for 100 carefully chosen probe compounds on the graphite-like phases as well as other more conventional materials, as a means of a constructing a model that is sufficiently accurate to help us understand the extent to which the graphite-like phases are truly unique materials (or not).

Prerequisites: CHE 107

Dr. Laura Triplett, Geology and Environmental Studies (NHS 124B, ltriplet@gustavus.edu)

I am seeking a first-year student to join me in conducting biogeochemical research during the summer of 2013. Specifically, I am studying how rivers transport silicon to the oceans. Rivers are the primary source of silicon to coastal ocean ecosystems, where it is often a limiting nutrient for important groups of phytoplankton like diatoms and radiolaria. An array of human activities have decreased the delivery of bioavailable Si (Si) from land to sea, which is a significant concern for marine ecosystems already under pressure from a variety of environmental changes. In this project, we are evaluating the role of riparian (riverbank) vegetation in the transport of Si in rivers. Plants absorb dissolved silica (DSi) from water and transform it into amorphous particles (ASi) that accumulate in soils. Therefore, one factor that can alter the flux of Si in rivers is a change in vegetation cover in the active riverbed.

This is the second year of a three-year project to determine how vegetation, and an invasive species of grass in particular, affect the transport of silica in rivers. This work is interdisciplinary, involving aspects of geology, chemistry and ecosystem science. During the first part of the summer, the students will assist with laboratory method development and testing in the geochemistry labs at Gustavus. In July, our group will be joined by researchers from Utah State University for a one-week field excursion to the Platte River in Nebraska. There, we will collect sediment and vegetation samples, measure in situ chemical conditions, and map the current extent of the invasive species. The remainder of the summer will be

spent back at Gustavus analyzing samples and determining how silica cycling has changed since samples were collected in 2010 and 2012.

Prerequisites: At least two courses <u>with labs</u> in geology, biology, and/or chemistry

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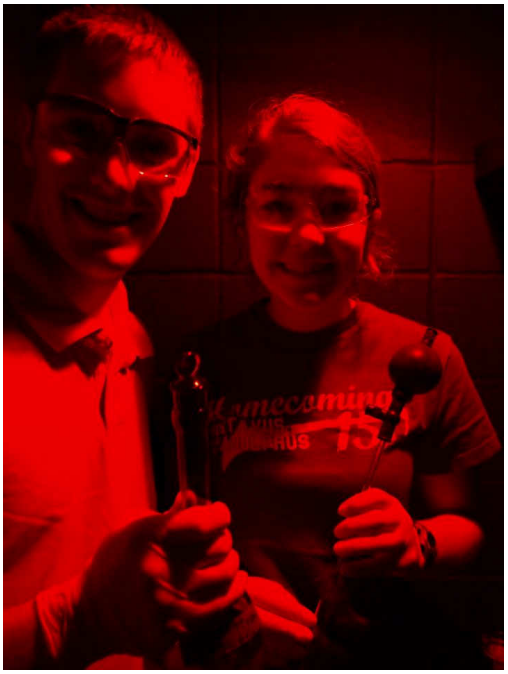
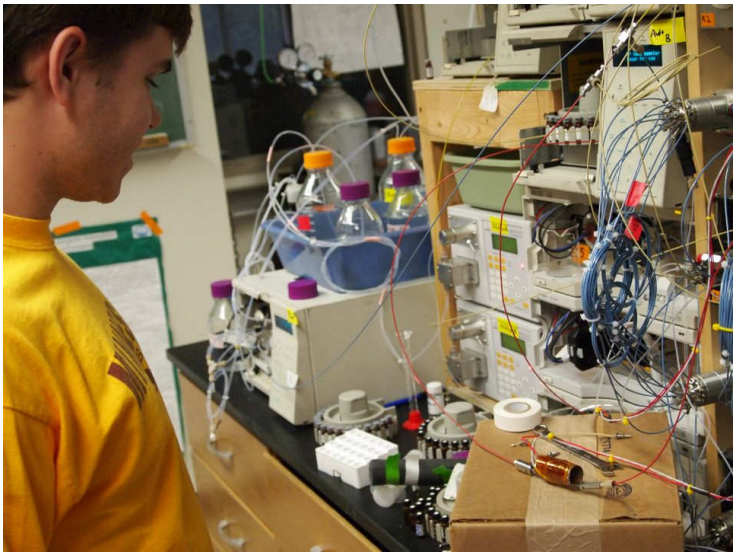
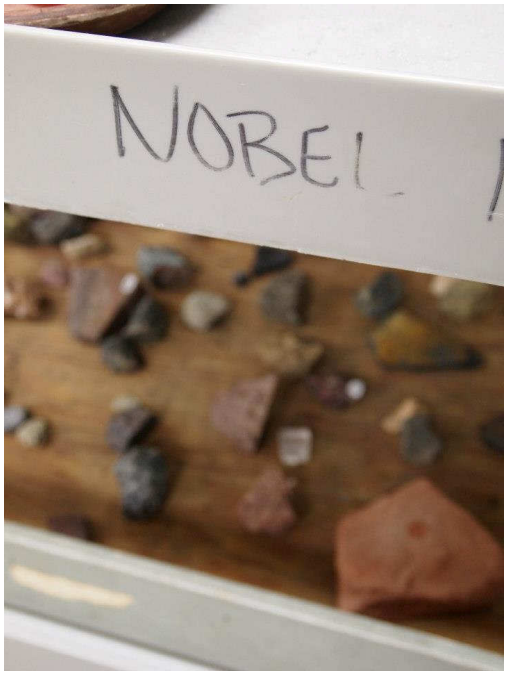


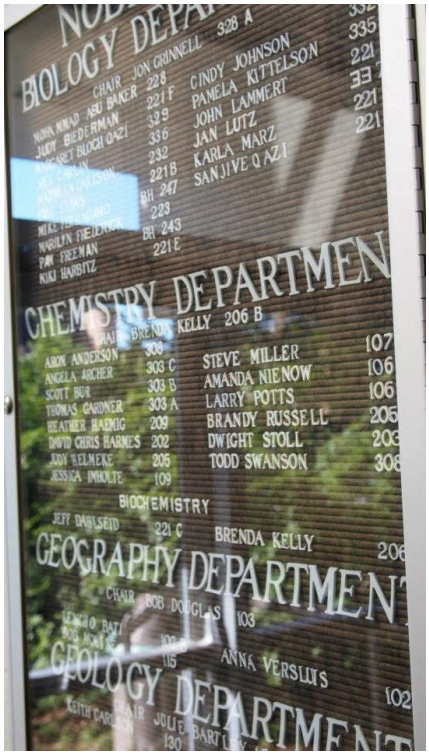




2013 FYRE Program
Application instructions for first-year students

Eligibility requirements

- You must be currently be a first-year student at Gustavus
- You must be planning to continue your education at Gustavus during the 2013-2014 school year
- You must agree to meet all program expectations (see below)



Expectations of participants

- Commit full-time to the 10-week research program. The exact dates of research will be agreed upon by the faculty member and student, but typically run from early June to mid-August.
- Participate in summer programming, particularly the weekly student research presentations. (Students whose research keeps them off campus during the summer are exempt.)
- Complete Responsible Conduct of Research training and any appropriate safety training during the summer.
- Submit a final written research report, reviewed and approved by the research advisor.
- Present research results at the Summer Research Symposium held on campus in September.

Application checklist:

Please submit all of the following items to Dr. Miller by 4:30 pm on Wednesday, March 6.

- ❑ Application cover sheet (next page)
- ❑ Ranked project choices and professor signatures form (last page)
- ❑ Printout of Undergraduate Web Transcript (available on WebAdvisor)
- ❑ Personal statement (1 page or less, double spaced), in which you should describe your motivations and interest in participating in the FYRE program

When completing your application, please:

- Submit original paper copies of all materials (i.e. no photocopies or electronic versions).
- Ensure that your name is included on every sheet of paper in your application.
- Submit all pieces of your application at once.
- Do not staple papers; bind them with a paper clip, or enclose them in a folder or large manila envelope.
- Submit your application to Dr. Miller no later than 4:30 pm on Wednesday, March 6. Drop it off in his office (NHS 107A/B); you may wish to the consult the schedule posted by his door or contact him to find an appropriate time.

If you have any questions about the application process, please contact Dr. Miller at x7321, smiller3@gustavus.edu, or in person at NHS 107A/B.

2013 FYRE Program
Student Application Form
Cover Sheet

_____

(applicant full name) (email address)

Program eligibility	yes	no	maybe
Are you currently in your first year of college?			
Are you currently enrolled at Gustavus Adolphus College?			
Do you plan to return to Gustavus next year?			

List all Gustavus science and math courses, and the instructor of each lecture or lab section.

Course number	Name of Course	Lecture instructor(s)	Lab instructor(s)
Example: CHE 107	*Principles of Chemistry*	*Dr. Russell*	*Dr. Kelly*

May we contact the instructors of your Gustavus classes to discuss your performance in class/lab this year (this is highly recommended, but not required)? Please circle your response. Yes No

If you wish, you may list the names and phone numbers of up to two people (Gustavus faculty and/or others, excluding family members) who can comment on your lab skills, independence, maturity, and/or responsibility (please check with them before listing them). You are not required to list anyone; we may or may not contact these references.

_____

(name and how they know you) (phone #)

_____

(name and how they know you) (phone #)

2013 FYRE Program
Student Application Form
Project choices and professor signatures form

_____

(applicant name)

You are required to gather the signatures of **three** faculty members as evidence that you have met potential research advisors face-to-face before submitting your application (you may meet with more, but only three signatures are necessary). Please read the project descriptions provided, and contact the faculty advisors for the projects you find most interesting. Faculty members will likely wish to speak with you about their research projects and your interests, but may have limited availability due to teaching or other commitments. (They may also be willing to simply sign your form upon request.) Note that it is *your* responsibility as the applicant to collect all three required signatures before the application deadline, so be sure to leave yourself adequate time to gather them!

_____

(faculty signature) (printed faculty name) (date)

_____

(faculty signature) (printed faculty name) (date)

_____

(faculty signature) (printed faculty name) (date)

Once you have met with at least three faculty members, please indicate your **top three** project choices in ranked order (i.e. "1" is your top choice, etc.). Please only rank the projects of faculty members with whom you have met (e.g. do not rank Jeremiason's project if you did not meet with him about it).

	Jeremiason
	Kittelson
	Marz
	Miller
	Nienow
	Petricka, Project 1
	Petricka, Project 2
	Stoll
	Triplett