2015 Gustavus Adolphus College FYRE Program Opportunity book and application form for students

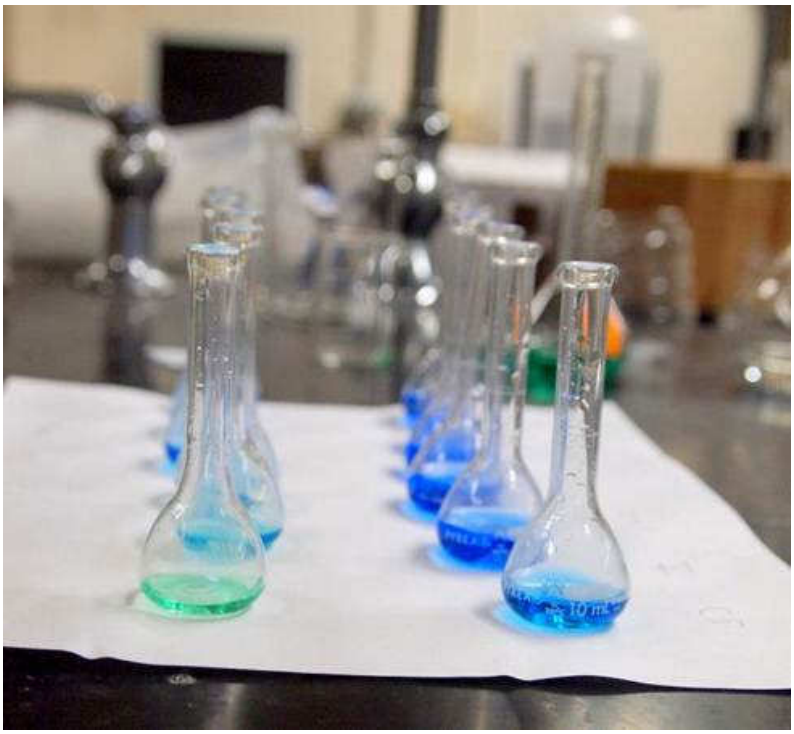
First-year science students: if you are interested in a Gustavus research experience this summer, this is the program for you! The First Year Research Experience (FYRE) Program, the successor to the Howard Hughes Medical Institute Summer Science Research Program, allows us to offer several first-year students the opportunity to conduct scientific research with members of the Gustavus faculty during the summer of 2015 (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 Thursday, 3/6)

Program information

Students in this program will conduct research with Gustavus professors for 10 weeks during the summer of 2015. 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.
Tuesday, 2/17: information session in Nobel 201, 8-9 pm (optional).
Thursday, 3/5: submit complete applications to Dr. Steve Miller by 4:30 pm.
Monday, 3/23: 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.
Wednesday, 4/8: deadline for accepted students to return signed forms indicating their commitment to participate in the program.
Thursday, 4/9: 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 will 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.

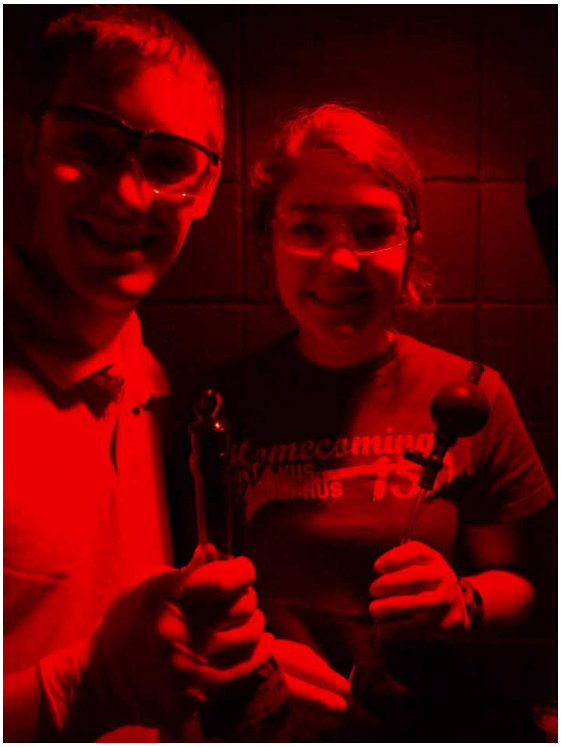
Is this the only summer research opportunity for first-year students?
No; Gustavus professors may be happy to work with first-year students outside of this program. Talk to a professor in your department of interest for more information.

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. Also, plan ahead—faculty often have busy schedules, and may not be available for last minute meetings.



2015 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. Julie Bartley, Geology and Environmental Studies (NHS 131, jbartley@gustavus.edu)

Project 1: Stromatolites and Microbialites are fossil structures built by the interaction of microbes and mineral precipitation. This summer, we will investigate how microbes influence the growth of these structures. There are three project threads: (1) to use microscopy to catalog the kinds of mineral textures present in stromatolites; (2) to investigate the relationship between the overall form of the stromatolite and its mineral texture; and (3) to do fieldwork in Utah and Montana to examine field relationships between stromatolites and the environments in which they grew. This project might appeal to a student who enjoys geology, biology, and chemistry and is excited about doing some work outdoors too.

Project 2: Understanding Ancient Fossils is sometimes tricky, because it is hard to match extinct forms with microbes that are alive today. A colleague of mine has found several fossil forms with strange features. Our job will be to identify possible modern relatives and explore how those organisms could get preserved in the fossil record. In a related thread, we'll use some advanced microscopy techniques to image very old (1.9 billion years) microfossils. This project might appeal to a student who enjoys biological mysteries and is interested in the evolution of early life.

Prerequisites: At least one science course (in any discipline)

Dr. Margaret Bloch-Qazi, Biology (NHS 329, mqazi@gustavus.edu)

My research explores how increasing female age affects her reproductive fitness as well as her offspring's fitness (i.e., transgenerational effects). The fruit fly, Drosophila melanogaster, is used as a model system for studying female reproductive senescence because it is both an amenable laboratory organism and it shares many similarities with other animals, including humans, at the cellular level. We have learned that aging females respond differently to males during courtship, have lower reproductive fitness, and that fitness costs of increasing maternal age carry over to the next generation. Work in my laboratory is now focused on further characterizing these fitness effects and understanding their developmental and physiological basis. Ongoing projects in my laboratory that you would be able to contribute to include:

1) documenting the specific components of male and female courtship affected by increasing female age,
2) characterizing the stages of oogenesis (egg development) affected the most by increasing female age, and
3) quantifying the magnitude of trangenerational effects of female age on offspring viability.

Students working in my lab learn about female reproductive senescence in human and non-human animals, develop skills in experimental design, and experience the joys and limits of research with fruit flies.

Prerequisites: BIO 101

Dr. Scott Bur, Chemistry (NHS 303B, sbur@gustavus.edu)

The Bur research lab investigates ways to synthesize organic molecules that are potentially interesting in biological systems. The current project of involves making molecules that show promise for disrupting weak protein-protein interactions, such as those between transcription factors. Three classes of compounds have been identified by initial screening assays. Research this summer will involve designing syntheses for these classes of molecules, and then making as many analogues as we can.

This project is a cooperative effort between Dr. Bur's lab and Dr. Will Pomerantz at the University of Minnesota. The Pomerantz lab will screen the molecules we make for activity.

Prerequisites: CHE 141 (must be completed at GAC; no transfer Organic I credit)

Dr. Jon Grinnell, Biology (NHS 328A, grinnell@gustavus.edu)

Although once a keystone herbivore numbering in the millions on the Great Plains, most American bison now are kept and intensively managed on small reserves. Managers are often aware of the need to conserve genetic diversity, but less often are they aware of the value of maintaining behavioral diversity as well. This project will take place on one such reserve, the 8000 acre Ordway Prairie reserve of the Nature Conservancy in South Dakota, and seeks to characterize the value of bison behavior to genetic diversity. You will work as part of a team of three to five student researchers, contributing to the overall project goals as well as undertaking your own research project. The project runs from June to mid-August for 10 weeks, and includes 6-7 weeks of intense bison behavioral observation that will require learning to identify 15 or so individual bulls from natural markings, then recording their interaction, bellowing and mating behaviors over the course of the summer breeding season. In addition, you may be asked to help out with reserve management duties as well (e.g. fence repair, weed control, maintenance activities). You will be supervised by both myself and the reserve manager at Ordway. Ordway Prairie is in the rolling prairie pothole region of South Dakota, 10 miles west of Leola (popln 300) and 45 minutes NW of Aberdeen (the nearest city). Successful applicants will have interests in animals and conservation, be in good physical condition, and be able to tolerate living in an isolated setting with few companions. Skills at using audio and video recorders, taking good notes, and some mechanical aptitude are pluses. Housing provided on site.

Prerequisites: None

Drs. Ian Hill and Dwight Stoll, Chemistry (Dr. Hill: NHS 203, ihill@gustavus.edu; Dr. Stoll: dstoll@gustavus.edu, on leave—contact for appointment)

Background: Adulteration of numerous products, ranging from currency to street drugs is a pervasive problem that is as old as the emergence of commerce in social structures. One example of such adulteration that has become increasingly important in recent years is the adulteration of olive oil. Recent years have seen a prevalence of low-cost virgin olive oils, particularly after a reclassification of USDA standards for olive oils in 2010. Cost reduction can come from optimization in processing, prevalence of a cheap olive supply, or through blending high quality oils with cheap-to-produce oils (e.g., hazelnut oil). The most direct method of determining olive oil purity is determining the specific lipid content of the oil. Currently this is accomplished using Liquid Chromatography coupled to Mass Spectrometry (LC-MS). This type of approach first separates the complex mixture of lipids that comprise plant oils, and then determines their molecular masses as a means of identifying each of the compounds. However, even this sophisticated approach is limited because the mixture of lipids in most plants oils is very diverse, and contains a number of isomers that are difficult to distinguish by molecular mass. Two-Dimensional Liquid Chromatography (2D-LC) is emerging as a very powerful, yet increasingly practical tool for the analysis of such complex mixtures as plant oils. A critical factor contributing to the success or failure of 2D-LC is the ability to separate the mixture according to variations in at least two different molecular properties. In this project we will induce such differences in molecular properties by hydrogenating the lipids over a platinum catalyst in real time, and build this functionality into a 2D-LC instrument at Gustavus.

Proposal: This work will involve a proof-of-concept combination of two well-studied techniques: 1) Separation and analysis of complex reaction mixtures with 2D-LC; and 2) The liquid-phase hydrogenation of unsaturated organic compounds with a platinum catalyst supported on alumina. The student working on this project will work with benchtop hydrogenations using platinum catalysts under a variety of reaction conditions (temperatures, concentrations, adding hydrogen-transfer reagents, pH, etc.) to optimize reaction conditions to achieve rapid and complete hydrogenations. The student will also have the opportunity to transfer this knowledge in setting up an in-line reactor between the first and second columns of a state-of-the-art 2D-LC instrument. We will use the resulting instrument to try to differentiate between pure olive oils and oils that have been adulterated with varying levels of cheaper oils. The experience of optimizing a reaction system on a bench-scale and applying that knowledge in achieving better analytical separations will be a valuable experience for a student looking at a future in a chemistry-related field. This project is a collaboration between Gustavus chemistry Professors Ian Hill and Dwight Stoll, and food scientists at the U.S. Food and Drug Administration, and the student will have opportunities to interact with these scientists as well.

Prerequisites: CHE 107 and CHE 141

Dr. Yuta Kawarasaki, Biology (NHS 221F, ykawaras@gustavus.edu)

My research in environmental physiology focuses on the adaptations of insects for winter survival. Characteristics of the winter environment such as low temperature and decrease in water availability

impose manifold constraints on survival of cold-blooded, or ectothermic, animals. These stresses have, in turn, collectively shaped diverse strategies of these animals – evasion or tolerance of freezing temperatures, mechanisms of energy conservation, and resistance or tolerance to dehydration – through the process of natural selection. In order to better understand the basis for these adaptations, my research lab employs a broad range of approaches from cutting-edge molecular techniques to classical, whole-organism studies.

This summer, we will be examining the effects of fluctuating subzero-temperature exposures on the physiology of insects. Traditionally, studies in insect cold hardiness have employed fixed-temperature experiments, in which samples are maintained at a certain temperature (e.g. -10°C) for a specific duration (e.g. 3 d). However, as you should already know, temperatures fluctuate regularly and often drastically during a season and even during a day. How do the effects differ when insects are exposed to fixed versus fluctuating temperature conditions? Does it make a difference if we had made an observation in freeze-tolerant (yes, there are some organisms that can tolerate internal ice formation!) versus freeze-intolerant insects? These are some of the basic questions underlying this project; students will become familiar with the fundamentals of experimental design, some physiological and biochemical laboratory techniques, and potentially the use of a fluorescent microscope.

Prerequisites: BIO 101

Dr. Brenda Kelly, Chemistry and Biology (NHS 206B, bkelly@gustavus.edu)

Research in my lab centers upon the structure and function of the enzyme, gamma-glutamylcysteine ligase (gamma-GCL). Gamma-GCL is the enzyme that catalyzes the rate-limiting step in the synthesis of glutathione. Glutathione is necessary for the survival of most organisms, as it functions to detoxify cells. We have recently discovered that E. coli gamma-GCL transitions between two or three different oligomeric forms: monomer, dimer, and higher-order oligomer in different environmental conditions. The transitions can be induced through the addition of the reducing agents, Tris(2-carboxyethyl)phosphine (TCEP) and dithiothreitol (DTT), and the oxidizing agent ascorbic acid. We are currently trying to determine if there are major structural differences in the individual monomeric units of these forms and the impact of structural changes on function using UV/Vis and fluorescence spectroscopic techniques. Students working on this project will gain experience in protein purification techniques, UV/Vis spectroscopy, and fluorescence spectroscopy.

Prerequisites: BIO 101 and CHE 141

Dr. Jeff Jeremiason, Chemistry and Environmental Studies (jjeremia@gustavus.edu; currently off-campus—email for further contact information)

Minnesota has a statewide fish consumption advisory due to mercury contamination. A new research study is commencing with the goal of identifying why some of the rivers in Minnesota have particularly high levels of Hg in fish. Five rivers in northeastern and northwestern have been chosen as study sites and sampling will begin in May 2015. The Jeremiason Lab will be in charge of analyzing water and

sediment samples for mercury. We will also be collecting samples at some point during the summer months. Understanding the mercury cycle in these complex systems requires landscape and food web characterization, knowledge of hydrology, soil and water chemistry, photochemistry, etc. Students will have the opportunity to interface with graduate students, other professors, and state scientists working on the project. Students working on this interdisciplinary 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 the different forms of mercury.

Prerequisites: CHE 107

Dr. Steve Mellema, Physics (Olin 210, mellama@gustavus.edu)

This project is designed to modernize my optical scattering lab. This will involve the use of several major pieces of equipment already on hand (the optical table and components, an IR diode laser and controller, acousto-optic modulator, stepper motors and controllers, photodiode detectors, high-frequency lock-in amplifier, etc.) and the implementation of LabView software to control experiments. The eventual goal is to construct an optical reflectometer to isolate unscattered photons from the background of a highly-scattering medium. The work will involve hardware, software and computer interfacing. The student will learn some electronics, optics, and computer programming.

Prerequisites: PHY 195/196 and PHY 205/206

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

When pesticides (a broad category of chemical compounds including herbicides, insecticides, and fungicides) are applied to fields, they can be dispersed into the environment in a variety of ways such as volatilization, run-off into water systems, or sorption by soil or plants. In addition, the compounds can be chemically transformed through chemical reactions or photodegradation. In our lab, we explore the photochemistry of pesticides in aqueous solution and sorbed to the crop/plant surfaces to which they are applied. For the past three years, we have been examining the photochemistry of the imidazolinone herbicides through the degradation kinetics and identification of photoproducts. This work will continue in the summer of 2015, with focus given to examining the photochemistry of the compounds when sorbed directly to corn and soybean leaves. In addition, we plan to begin examining the photochemistry of some halogenated pesticides. Students in this lab are trained in methods used in experimental chemistry including experimental design, data acquisition, data analysis, and the presentation of the results. Specifically, students learn how to use a high pressure liquid chromatograph (HPLC), a UV-Vis spectrophotometer, a fluorimeter, and mass spectrometer, and how to analyze the data from each of these systems. In addition, students may work in the Gustavus greenhouse or outside growing corn and soy crops.

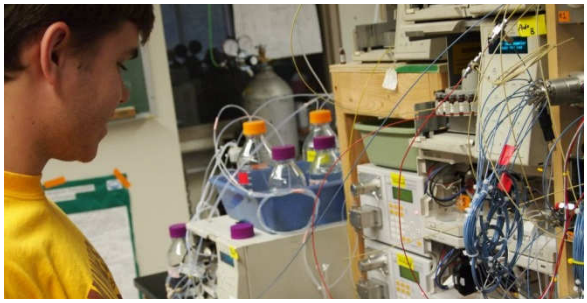
Prerequisites: CHE 107; CHE 141 recommended

Dr. Dwight Stoll, Chemistry (dstoll@gustavus.edu, on leave—contact for appointment)

Background: High Performance Liquid Chromatography (HPLC) is a very powerful technique for separating complex mixtures so that individual chemical compounds can be identified (as in Medicine Man), and/or quantified (as in detection of Performance Enhancing Drugs in athletes). A HPLC system consists of a liquid pump, an injection device (for introducing the sample into the column), a column (where the separation happens), and a detection device (for detecting when compounds exit the column), all of which are connected by very small metal capillaries (e.g., 100 micron inner diameter) on the order of 10 to 50 cm long. Since the invention of liquid chromatography just over 100 years ago, the technique has been used under conditions where the flowing liquid is under "laminar flow". This means that the flow is very homogeneous, and all of the velocity vectors of the liquid point in the same direction. In the past five years, however, technology has been introduced that allows us to operate HPLC instruments under conditions where the liquid is likely flowing under "turbulent flow". In the Stoll Laboratory we are finding that this transition from Laminar to Turbulent flow has dramatic effects on the behavior of the HPLC system, and potentially profound implications for the ways that these systems are designed and used. Specifically, we are finding that the pressures needed to push liquids through these tubes are much higher than those expected for laminar flow conditions. Furthermore, we have evidence that these tubes behave as 'dispersion-less' connectors, as a result of the turbulent flow conditions.

Proposal: In this research project we will collect pressure and dispersion data as a function of liquid flow rate using a suite of stainless steel capillaries made specifically for this study. We will vary the solvent type, flow rate, tubing diameter and length, and temperature, and develop a model to predict pressure as a function of these parameters. We will also design and build a highly customized HPLC instrument specifically for the purpose of making very accurate dispersion measurements (widening of chromatographic peaks in these tubes) using the same suite of capillaries, and the same set of operating variables. We will also attempt to develop a model for the degree of peak dispersion as a function of these variables. Taken together, these two models (for pressure and dispersion) will provide unprecedented insights and guidance for the design and implementation of future HPLC instruments. The student working on this project will work with state-of-the-art HPLC equipment, and have the opportunity to interact with engineers and scientists at a major international instrument manufacturer as part of this collaborative project.

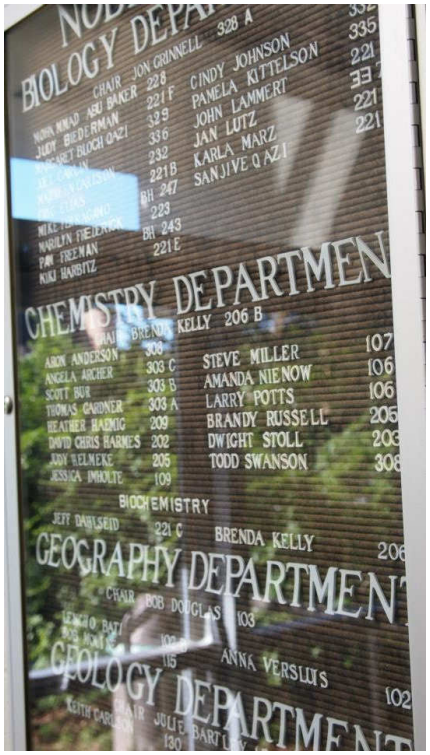
Prerequisites: CHE 107 and CHE 141



2015 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 2015-2016 school year
- You must agree to meet all program expectations (see below)



Expectations of participants

- Full-time commitment to the 10-week research program. Exact start and end dates will be agreed upon by the faculty member and student (typically early June to mid-August).
- Participation in summer programming, especially weekly student research presentations. (Students are exempt from this requirement while conducting research off campus.)
- Completion of Responsible Conduct of Research training and any appropriate safety training during the summer.
- Submission of a final written research report, reviewed and approved by the research advisor.
- Presentation of 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 Thursday, 3/6.

- ❑ Application cover sheet (next page)
- ❑ Ranked project choices and professor signatures form (last page)
- ❑ Printout of Undergraduate Web Transcript (available on WebAdvisor)
- ❑ Personal statement (500 word maximum), in which you should describe your motivations for 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 Thursday, 3/6. 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.

2015 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. Anderson*

Name of your FTS instructor: _____

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 laboratory 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 #)

2015 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 rank only 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).

	Bartley, Project 1
	Bartley, Project 2
	Bloch-Qazi
	Bur
	Grinnell
	Hill/Stoll

	Kawarasaki
	Kelly
	Jeremiason
	Mellema
	Nienow
	Stoll