

## Biophysics Outreach Manual For Graduate Students

*For more information please see our website:*

*<http://www.life.uiuc.edu/biophysics/ibs/K-12Outreach/Homepage.html>*

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*“...in addition to being competent researchers, STEM graduate students must be able to communicate science and research to a variety of audiences. As the graduate students bring their cutting-edge research and practice into the K-12 classroom, they gain these skills which enable them to explain science to people of all ages, ranging from students to teachers. The graduate students also inspire transformation in the K-12 formal and informal learning environments and stimulate interest in science and engineering among students and teachers.”*

- National Science Foundation, GK-12 Program website, [www.nsfgk12.org](http://www.nsfgk12.org)

## **Introduction**

Scientists have been participating in education outreach since at least 1820, when Michael Faraday began his famous Christmas Lectures. More recently though, due to sobering studies exposing the growing science and math deficiencies among American children, there has been a growing number of scientists participating directly in K-12 classrooms. These outreach programs have often proved successful in significantly improving the level of inquiry and enthusiasm for science among both teachers and students. In 1999, the National Science Foundation created a new graduate fellowship, the NSF GK-12 Program, that pairs science PhD students with K-12 teachers in an effort to improve communication and teaching skills among graduate students while enriching science and math instruction for their K-12 partners. Since its inception, the GK-12 program has funded more than 200 projects at universities across the US, taking graduate student outreach in K-12 classrooms to an all time high.

The UIUC GK-12 program has been particularly successful in bringing UIUC graduate students into K-12 classrooms. Sadly, this program came to an end in 2009, leaving behind a great demand for partnerships between university researchers and local schools. We hope our program will help to continue the fantastic work of the GK-12 program with biophysics graduate students whose interdisciplinary research can be taught in a wide range of K-12 classrooms.

Our outreach program pairs biophysics graduate students with local K-12 teachers to develop lessons that teach middle and high school students about the exciting research happening here at the University of Illinois, Urbana-Champaign. The teachers we work with come from local and suburban Chicago schools where they teach physics, biology or chemistry to students from 7th to 12th grade. The graduate students are PhD candidates doing research on a vast array of topics in biophysics, from single molecule fluorescence microscopy to molecular dynamics simulation of membrane proteins. These students come from diverse academic backgrounds, including physics, biology and computer

science and are eager to give back to the community while improving their ability to teach and communicate their research.

## **How the Program Works**

Students interested in participating in this program should first contact the Center for Biophysics and Computational Biology Director, Bob Clegg (rclegg@illinois.edu), to discuss their lesson ideas and have them approved. This pre-approval will be necessary in order to receive tutorial credit for the outreach. In looking for lesson ideas you can browse through the “Sample Lessons” and “Reading Material” pages on our website. Your research advisor is also a great source of information, we highly encourage research advisors to become involved in this process.

In order to have sufficient time for lesson development, it is a good idea to begin this process at least one month prior to the day(s) you want to teach your lesson. You may need an additional 1-2 weeks afterward to write up your experience for tutorial credit.

Based on your lesson, you will be directed to one or more teachers from the list below (see also the “Participating Teachers” page of our website). It is important that the teacher’s subject



and grade level is appropriate for the topics you would like to teach. When you contact a teacher, briefly describe one or more ideas you have for a lesson and the dates you are available to teach in the classroom. You will get the best results if you are flexible in terms of dates and times since most teachers follow a pretty strict curriculum that may be amenable to your lesson only at certain times of the year. The teacher will respond letting you know if they can or cannot accommodate your lesson and may suggest some initial modifications based on time, space or curricular constraints of the classroom.

Once you have found a partner teacher and have scheduled a date for your lesson, you will need to schedule a time to meet with the teacher by phone or in person as soon as possible. Your initial meeting should be at least 3 weeks before your lesson and you will need to have a rough draft of the lesson plan for you and the teacher to review. The teacher will suggest more changes to improve the accessibility of language and content to the students and to ensure that the lesson is doable. You will want to pay very close attention to ensure your final draft reflects the teacher's suggestions. You will also want to ask the teacher what students will have already learned about your lesson topic, how many students there are per class, how many classes you will be working with (let them know if you only want to work with one or two classes, they can probably accommodate this), how much space is available, what type of equipment, materials, and resources the classroom and school can provide, and how much time is actually allotted for teaching (after roll call, announcements, etc.). It is **VERY IMPORTANT** to ensure you and the teacher are in agreement about what materials and equipment they will provide and what you will need to bring. This includes everything from lab chemicals and glassware, to photocopies, computers, projectors and even chalk. Knowing who is responsible for what will ensure your lesson runs smoothly.

Based on this initial meeting, you will revise your lesson plan and complete a materials list which details who will be providing what equipment or materials and a student handout, if any. Try to make your lesson plan as detailed as possible in case future graduate students or teachers want to use it. Check the link on the website for "Sample Lesson Plans". The most successful outreach lessons are ones that contain a

hands-on activity, lab or an engaging demonstration. Your lesson should not just tell students about scientific discoveries, but allow them to experience the joy of those discoveries for themselves.

Email your revised lesson plan to the teacher at least two weeks prior to the lesson date. The teacher may provide final feedback and you will need to get your final version to them at least one week before the lesson.

### **A Note on Materials and Equipment**

If there are any materials that the school cannot provide for your lesson, first check the inventory of the Illinois Biophysics Society's outreach program. There are also on-campus science outreach programs and teaching labs (see links below and on our website) that often have materials and equipment you can borrow. Many items can also be donated or borrowed from research labs. Liquid nitrogen, for example, is only \$0.2/Liter and often labs have equipment, such as a vacuum pump and dessicator that they can live without for a day. If you are still not able to find the materials you need, contact the Biophysics office, as there is a small budget for purchasing new outreach materials.

### **Summary of Program Structure & Timeline**

1. Read through this manual and reference 1 below. Come up with a couple of ideas for lessons based on your research and make an appointment with the Director, Bob Clegg.

2. Once you're approved, e-mail teachers with your ideas and available dates (dates



- should be at least 3 weeks away).
3. Arrange to meet in person or by phone with your partner teacher at least 3 weeks before your lesson date. Go over all details of your lesson including all time, curricular, material and space constraints of the classroom. Be clear about where all equipment and materials are coming from and what changes the teacher wants you to make to ensure the scope and difficulty level is appropriate.
  4. Revise your lesson plan and email/send to your partner teacher for final comments at least 2 weeks before your lesson date.
  5. Check with IBS outreach, on-campus outreach programs, on-campus teaching labs and research labs for equipment and materials. Contact the Biophysics office ASAP if you need to request purchase of new materials.
  6. Send the final draft of your lesson plan to your partner teacher at least 1 week before the lesson date.
  7. Have fun!

## General Advice

- Remember to promote inquiry whenever possible through the types of questions you ask (open-ended), the design of your labs (not cookbook recipes, but labs with a different result every time). You can also achieve this by using hands-on activities (allow students to experience discovery for themselves) and by ensuring the language and content of your lectures, handouts, or other reading material is accessible to students.
- Be concise in your correspondence with teachers; they don't have a lot of time for email.
- Be responsible with borrowed equipment! If you break something & don't replace or return it, this will jeopardize relationships and resources for future volunteers.
- Allow several weeks for any new software to be installed on school computers. Also, check them in person before the day of your lesson.
- Try not to change dates or cancel once you've already committed with a teacher. Doing this could jeopardize relationships for future volunteers.
- Check the Illinois State Board of Education State Standards (<http://www.isbe.state.il.us/ils/science/standards.htm>) to help you determine whether your lesson ideas will fit into the curriculum and at which age/level.



## **Other Outreach Programs**

The references at the end of this manual (also available on the “Reading Material” page of the website) will help you familiarize yourself with current issues in science education reform, but perhaps the best information sources are the websites of the following K-12 outreach programs:

### **UIUC:**

- Chemistry Outreach (<http://chemistry.illinois.edu/outreach/index.html>)
- The Physics Van (<http://van.physics.illinois.edu/>)
- G.A.M.E.S. (<http://core.igb.uiuc.edu/outreach.php>)
- Engineering Outreach (<http://www.engr.uiuc.edu/outreach/index.php>)

### **Illinois:**

- UIC Weird Science (<http://www.chem.uic.edu/marek/>)
- MSCOPE (<http://mps.uchicago.edu/about.html>)
- Museum of Science & Industry (<http://www.msichicago.org/education/>)
- Orpheum Children’s Science Museum (<http://www.m-crossroads.org/orpheum/>)

### **US:**

- Caltech Precollege Science Initiative (<http://www.capsi.caltech.edu/>)
- NSF GK-12 Programs (<http://www.nsfgk12.org/index.php>)
- SEPAL (<http://sepal.sfsu.edu/>)
- Exploratorium Hands on Activities  
(<http://www.exploratorium.edu/explore/handson.html>)

## **Sample Lessons**

There are several interesting sample lessons in the articles in the references section below, but the best examples will be those provided by previous UIUC biophysics



student volunteers and their partner teachers. These can be downloaded from the program website.

## **Science Education Journals**

Use the following journals to search for sample lessons or for information about current issues in science education reform and best teaching practices for K-20 science and engineering classrooms. Should you decide to publish your outreach lesson(s) and any corresponding assessment results, the first five journals would be the most appropriate places to send your work.

- [The American Biology Teacher](#)
- [The Science Teacher](#)
- [The Journal of Biological Education](#)
- [The Chemical Educator](#)
- [The Physics Teacher](#)
- [The Journal of Chemical Education](#)
- [Chemical Engineering Education](#)
- [Life Sciences Education](#) (*formerly Cell Biology Education*)
- [Electronic Journal of Science Education](#)
- [International Journal of Science Education](#)
- [Journal of Science and Technology Education](#)
- [Journal of Engineering Education](#)
- [Journal of Technology Education](#)
- [Journal of Research in Science Teaching](#)

## **Directory of Participating Schools and Teachers**

Because Biophysics graduate students have very diverse interests and expertise, the partner teachers for our program come from a variety of subject areas and grade levels. Graduate students should choose a classroom that best matches their research

interests. Teachers who have participated in outreach with UIUC science graduate students in the past are marked with an asterisk. They will be the best prepared to help you integrate your research into an age-appropriate lesson.

<b>School/Address</b>	<b>Teacher/Admin &amp; Subject(s)</b>
University Lab High School www.uni.uiuc.edu 1212 W. Springfield Ave. Urbana, IL 61801 (217) 333-2870	David R. Bergandine, dbergand@uni.illinois.edu <i>Chemistry Teacher</i>
Urbana Middle School www.usd116.org/ums 1201 South Vine St. Urbana, IL 61801 (217) 384-3685	*Jan Hari, jhari@usd116.org <i>Science Department Coordinator &amp; 8<sup>th</sup> grade Science Teacher</i>
Edison Middle School www.champaignschools.org/edison 306 W Green St. Champaign, IL 61820 (217) 351-3771	*Kevin Kuppler, kuppleke@champaignschools.org *Bryan Foli, folibr@champaignschools.org <i>7th grade Science Teachers</i>
Danville High School www.danville.k12.il.us/schools/dhs_site 202 East Fairchild St. Danville, IL 61832 (217) 444-1619	*Kathy Hafner, khafner@danville.k12.il.us <i>AP, Honors &amp; Intro Biology Teacher</i> Beth Chamberlain, bchamb@danville.k12.il.us <i>Co-Division Leader &amp; Physics/Engineering Teacher</i>
Neuqua Valley High School http://nvhs.ipedsd.org 2360 95th Street Naperville, IL 60654 (630) 428-6040	Patti Smykal, patti_smykal@ipedsd.org <i>Honors &amp; AP Chemistry Teacher</i> Mark Cummings, mark_cummings@ipedsd.org <i>Honors Biology Teacher</i> Jacqueline Mimnaugh, jacqueline_mimnaugh@ipedsd.org <i>Genetics &amp; Physical Science Teacher</i> Lynn Vlcek, lynne_vlcek@ipedsd.org <i>AP Biology &amp; AP Chemistry Teacher</i> Herb Anderson, herbert_anderson@ipedsd.org <i>Physics Teacher</i>
Metea Valley High School http://mvhs.ipedsd.org 1801 N. Eola Road Aurora, IL (630) 375-5900	*Matt Kirkpatrick, matt_kirkpatrick@ipedsd.org <i>Science Department Chair</i>