preparedness for the challenges in Biology related fields in the 21st century. However, training in developing those skills is not typically available to students until graduate school. In this courses-imbedded research project, students were exposed to a semester long series of realistic problems related to acceleration, force, torque and energy. Students are required to self-develop activities for formulating protocols of collecting data, analyzing, and making conclusions about these problems. The purpose to use this new method of student laboratory engagement is to train students in being able to be creative, critical, and trouble shoot simple problems during experimentation. Additionally, technical writing is emphasized as this is important for students to be successful as graduates in biology major in today's world. Throughout the semester students learn how to present scientific results. Instructors organize the discussion on the validation of experimental plan, grade reports and provide detailed one-on-one feedback to students. At the end of semester students are required to write a comprehensive report summarizing all their experimental procedures, data collection approaches, and presentation of results. Students' performance are assessed by carefully developed rubrics based on accepted standards used in conducting scientific research and reporting, a point-based scale is used to track student's skills of critical thinking, quantitative data analysis, and their technical communication. Additionally, students' feedback through pre-and post-survey questions is assessed to determine effective of this new lab format in their learning process.

**1101-Pos Board B856**
**Exciting Minds to Make them Shine: An Undergraduate Hands-On Training Program in Biophysics**
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The limited application of luminescence spectroscopy in directly monitoring foods and pharmaceuticals can be attributed to two causes: a) most useful fluorophores are either toxic, expensive, have limited availability or selective solubility, and b) detailed photophysical characterization of edible fluorophores is limited.
We have attempted to fill this void with an educational program that involves student-led research by undergraduates. This hands-on training program focuses on photophysically characterizing and cataloging generally-recognized-as-safe (GRAS) chromophores normally present in or routinely added to foods. This program creates a database of edible fluorescent and/or phosphorescent probes while also identifying potential applications of the probes as intrinsic sensors of quality and safety in foods and pharmaceuticals. These objectives require a full integration and understanding of biophysical concepts from formation of excited electronic states and transfer of excitation energy within biophysical systems to the effect of physical state of biological materials on photophysical responses.
Within this program ~15 compounds have been tested and characterized in the last few years by a team of >15 undergraduates working individually and collaboratively. The involvement of such a large pool of undergraduate students enables the testing of a broad set of potential chromophores while also providing training in biophysical research methods and techniques to a group of potential scientists. This project additionally promotes mentoring skills among the collaborating graduate students and senior undergraduates. The results of this project have been used to inform and successfully obtain federal grant funding. We believe this program serves as a useful platform for introducing biophysics research to undergraduates. The strategies that have been developed during its implementation can be extrapolated to teach biophysical concepts in other areas.

**1102-Pos Board B857**
**Biophysics in Order: An Interdisciplinary Approach to Undergraduate Student Engagement in Research**
**Diane M. Wiener**[1], Fernando Esquivel-Suarez[2], Bentley Gibson[2], Laura A.G. Gray[2], Victoria L. Templer[2], Leslie Taylor[2], David G. Lynn[2].
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There is a growing recognition among university educators that early exposure to research facilitates student engagement, reinforces learned material, and provides critical training that is otherwise not provided in a traditional class setting. Unfortunately, by the nature of graduate education, undergraduates are rarely afforded opportunities to formally interact with university researchers. The ORDER (On Recent Discoveries by Emory Researchers) program is taught by graduate students and postdoctoral researchers under the guidance of faculty and aims to provide an interdisciplinary, research-based course to undergraduate freshmen and upperclassmen. During the freshmen seminar course, students propose a research question and actively conduct experiments to address their hypotheses. The capstone of the course is a research report and formal presentation of their results, specifically intended for a broad audience. The course was adapted for upperclassmen to focus on students creating and presenting a research proposal which they can use to guide the transition after their baccalaureate education.
Here, we discuss the integration of a single-molecule biophysics module into the ORDER curriculum taught in the 2012-2013 academic year at Emory University. ''iSearch: Illuminating Identity'' was a course designed by teacher-scholars from disciplines ranging from Neuroscience and Physics to Psychology and Spanish. Each teacher-scholar exposed undergraduate students to his/her specific research pursuits and mentored undergraduate students through the research process. The undergraduate students came from a broad assortment of academic programs offered at the university. Further, we present the layout of the course, the active methods used to engage students, the lessons learned from collaboratively teaching a research-based course, and the educational benefits for the teacher-scholars. In particular, we detail the single-molecule biophysics module and present pre- and post-survey results from students probing their interest and understanding of the biophysics research field.

**1103-Pos Board B858**
**An Integrated, Instrument Intensive Project-Based Biochemistry Laboratory for Enhanced Student Learning and Research**
**Todd P. Silverstein**, Sarah R. Kirk.
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We have designed and implemented a two-semester instrument-intensive experimental biochemistry course. In the early part of the course, student training is focused on experimental design, calibration curves, and statistical analysis. Students study biologically significant small molecules using HPLC, UV-Vis Spectroscopy, and electrochemical biosensors. In the last half of the first semester, experiments grow in complexity and students become more independent as they use multiple spectroscopic techniques to study lipid membrane dynamics, protein structure, and enzyme activity. In the second semester, students study the impact of structure on protein function, use qPCR to quantitate relative gene expression in plants, and study the dynamics of tRNA structure upon ligand binding using fluorescence, absorbance, and electrophoresis. Throughout the course, students are trained in both formal and informal scientific writing. The culmination of both semesters is a student-designed inquiry-based independent project. We will describe the structure of the course, how learning outcomes are addressed, and report on initial student responses to this integrative instrument-based biochemistry experience. *The authors gratefully acknowledge the NSF (DUE award # 1044737) for support of this project.*

**1104-Pos Board B859**
**Sustained Crystallography Skills through Multimedia-Supported Active Learning**
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Structure solution skills in x-ray crystallography are critical capabilities for students and postdoctoral trainees in biophysics, biochemistry and structural biology. While many institutions have incorporated classes on theoretical crystallography into their curricula, practical structure solution skills are rarely imparted through coursework.
We thus developed an enabling, hands-on crystallography sub-curriculum, which can be added to existing biophysics curricula that focus on the theoretical foundations. Taking place in an encouraging, collaborative learning environment, our educational intervention sets out to provide learners from diverse backgrounds with sustainable skills to tackle real-world, protein structure solution problems independently.
Our curriculum is designed in a multimedia-enhanced, blended classroom format: Reading resources as well as short, narrated and pre-recorded slide presentations provide course participants ahead of class with the necessary background to work on problem sets during face-to-face sessions. Part of an evolving case study, the problem sets contain real-world diffraction datasets in various degrees of difficulty. Throughout the curriculum, learners are sequentially guided through all essential structure solution steps, from remote diffraction data collection and processing, various structure solution strategies, to structure quality evaluation. By the end of the curriculum, every student shares their experiences in an audio-supported slide-presentation over the web, while classmates provide feedback.
We evaluate learners' confidence, academic performance and sustained skill level through a multi-facetted set of assessments, including quizzes, problem

set solutions, final presentations, peer feedback, pre- and post course surveys, as well as a comprehensive structure solution set to be solved in a longterm post-test. Participants showed good problem solving- and very good crystallographic communication and feedback skills. Their confidence level applying x-ray crystallography techniques increased during the course. Most importantly, three months after the course, >80% of participants were able to solve and refine unknown diffraction datasets to publication quality level.

**1105-Pos Board B860**

**An Open-Source Lipid Bilayer Setup for Hands-On Learning of Biophysics**

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Although people are generally interested in how the brain functions, neuroscience education is hampered by a lack of low cost and engaging teaching materials. To address this, we developed an open-source lipid bilayer amplifier which is appropriate for use in introductory courses in biophysics or neurosciences. The amplifier is designed using the common lithographic printed circuit board fabrication process and off-the-shelf electronic components. In addition, we propose a specific design for experimental chambers allowing the insertion of a commercially available polytetrafluoroethylene film. This device can be used in simple experiments in which students monitor the bilayer formation by capacitance measurement and record unitary currents produced by ionophores like gramicidin A. Used in combination with a low-cost data acquisition board this system provides a complete solution for hands-on lessons, therefore improving the effectiveness in teaching basic neurosciences or biophysics.

**1106-Pos Board B861**

**Utility of Synechocystis sp. PCC 6803 Glutaredoxin a as a Platform to Study High-Resolution Mutagenesis of Proteins**

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Glutaredoxin from the cyanobacterium Synechocystis sp PCC 6803 is a small protein, containing only 88 amino acids, that participates in a large number of redox reactions, serving both as an electron donor for enzyme-catalyzed reductions and as a regulator of diverse metabolic pathways. The crystal structures of glutaredoxins from several species have been solved, including the glutaredoxin A isoform from the cyanobacterium Synechocystis sp. PCC 6803. We have utilized the small size of Synechocystis glutaredoxin A and its propensity to form protein crystals that diffract to high resolution to explore a long-standing question in biochemistry; i.e., what are the effects of mutations on protein structure and function? Consequently, we have initiated a long-term educational project that would examine the structural and biochemical changes in glutaredoxin as a function of single-point mutational replacements.

**1107-Pos Board B862**

**Tethered Particle Motion for Undergraduates**

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We have developed a simplified method for observing and measuring the Brownian motion of microbeads tethered to surfaces by individual DNAs. The method is suitable for integration into upper division undergraduate physics or biology labs. Modified Lambda DNAs are attached to functionalized glass coverslips and tethered to commercially available microbeads. The instrumentation is inexpensive and simple: capillary action is used to load samples into a simple flow cell and data is collected using a webcam mounted on an upright microscope. Video data can be tracked manually using freely available software and analyzed in a number of ways. Sample lab protocols and material lists will be made available.

**1108-Pos Board B863**

**Undergraduate Laboratory on DNA Folding using AFM**

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Atomic Force Microscopy (AFM) is an exciting biophysical technique capable of imaging biological molecules at near atomic resolution, measuring precise force dynamics of protein unfolding, or applying mechanical stress to cells and measuring their response. Yet, despite its ubiquity in biophysical research, AFM has been almost nonexistent in the undergraduate laboratory. Fortunately, with newer AFM systems becoming more affordable and user-friendly, the possibility of AFM in undergraduate courses is now a reality. Our goal is to design an AFM laboratory for students with an introductory background in physics. In this laboratory, students will (1) image the structure of DNA adhered to a mica cover slip in the absence and presence of a condensing agent (protamine), (2) model the DNA as a worm-like chain or a series of toroids, respectively, and (3) use these images to calculate structural parameters of DNA, such as radius of gyration, persistence length, and contour length. This laboratory will expose undergraduates to some of the fundamental AFM techniques that make it a revolutionary tool in biophysical research.

**1109-Pos Board B864**

**Open Plans of a Multi-Functional, Low Cost Fluorescence Microscope for Teaching and Research**

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The specialized functionality and high cost of commercial quality optical microscopes can be a significant barrier to teaching/research laboratories with constrained resources. In order to address these broader needs, as well as to meet specific biophysics imaging needs in our lab, we have designed an economical, multifunctional microscope. This microscope, called the SwingScope, combines functions traditionally fulfilled by two separate fluorescence microscopes, one upright and one inverted. It utilizes commercially available optical components and requires less than one day for an undergraduate student to assemble. The cost of the microscope components/software is less than $10k, which is an order of magnitude cheaper than an upright and an inverted commercial fluorescence microscope. The detailed plans and component lists will be made available as free documents, and the system is open-source whenever possible (ImageJ, μManager, Arduino). Additionally the Swingscope can rotate 180 degrees around the sample, enabling contact-angle measurements as well as 3D reconstruction techniques. We have used the SwingScope to measure dynamics of single supported phospholipid bilayers (1% fluorescence), and preliminary point-spread functions indicate a 2μm resolution at 10x magnification. In addition to its research applications, we are exploring its assembly and use as a teaching laboratory experiment for undergraduates.

**1110-Pos Board B865**

**Biomedical Imaging in the Undergraduate Science Curriculum**

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In recent years, physics (and mathematics) have become very critical and conspicuous contributors to biology and medicine. One notable reason is the indispensable role that sophisticated imaging techniques now play in fundamental biological research and in diagnosing and treating many serious diseases. In light of this, we recently developed an undergraduate course in which imaging serves as a foundation for integrating physics with material that is engaging and relevant, especially to students majoring in physics and/or the life sciences. Our course is in some respects similar to traditional medical imaging courses that focus on the physical basis of prominent medical imaging modalities, such as ultrasonography and magnetic resonance imaging (MRI). However, in addition to these and related techniques, our imaging course also deals extensively with optical microscopy. We included this imaging modality because undergraduates in the life sciences are extensively exposed to optical microscopy in teaching and research settings and because optics is an extremely important branch of applied physics. We also use a mix of lecture- and laboratory-based pedagogical approaches. It has been gratifying to find that the course is very enthusiastically received by students at our institution majoring in biology, biochemistry, chemistry, and/or physics; thus, here we describe some of our most popular lecture topics and associated experimental activities to help pave the way for other educators who are interested in teaching a similar course.