that are on average 50 nm in diameter with long-term stability at physiological conditions, as determined by Electron Microscopy, Fluorescence Correlation Spectroscopy and Dynamic Light Scattering. Using laser excitation, these nanoemulsions can vaporize into microbubbles in the presence of silica coated gold nanoparticles for efficient drug release and imaging using high contrast imaging modalities such as photoacoustic microscopy. Taken together, the size and stability of these PFC nanodroplets make them cost effective drug delivery vehicles suitable for efficient internalization by cancer cell lines.

Biophysics Education

1673-Pos Board B624

A New Course and Textbook on Physical Models of Living Systems, for Science and Engineering Undergraduates

Philip Nelson.
Physics/Astronomy, Univ Pennsylvania, Philadelphia, PA, USA.

I'll describe an intermediate-level undergraduate course developed over several years at University of Pennsylvania and elsewhere. The only prerequisite is first-year university physics and calculus. The course is a response to rapidly growing interest among undergraduates in several science and engineering departments.

Students acquire several research skills that are often not addressed in traditional courses:

- Basic modeling skills
- Probabilistic modeling skills
- Data analysis methods
- Computer programming using a general-purpose platform like MATLAB or Python
- Dynamical systems, particularly feedback control.

These basic skills, which are relevant to nearly any field of science or engineering, are presented in the context of case studies from living systems, including:

- Virus dynamics
- Bacterial genetics and evolution of drug resistance
- Statistical inference
- Superresolution microscopy
- Synthetic biology
- Naturally evolved cellular circuits.

Publication of a new textbook by WH Freeman and Co. is scheduled for December 2014.

1674-Pos Board B625

Making Molecular Graphics Accessible in the High School Classroom with VMD Lite

Conner Herndon, James Gumbart.
Physics, Georgia Institute of Technology, Atlanta, GA, USA.

Visual Molecular Dynamics (VMD) is an indispensable tool for visualization of biomolecular structures as well as data analysis of molecular dynamics simulations. Although VMD is useful for the trained scientist, its extensive toolset naturally takes time to understand and use effectively, limiting its utility in the high school classroom. To attenuate VMD's otherwise steep learning curve, we have developed VMD lite, a graphical user interface (GUI) that provides many of VMD's powerful capabilities in a simplified format. Alongside the GUI we have written self-guided lesson plans that integrate with the typical high school curriculum. These lesson modules are designed in accordance with the next generation science standards, leading the student to critically evaluate relationships between important concepts in molecular biology, physics, and chemistry. This software is supplied free through VMD, and its database of self contained lesson plans will be continually modified and extended to reflect current curricula.

1675-Pos Board B626

The Pedagogical Value of Linderstrøm-Lang's Protein Ontology

Ryan M.B. Hoffman, Andrew B. Ward.
Integrative Structural and Computational Biology, The Scripps Research Institute, La Jolla, CA, USA.

In his 1951 Lane Medical Lectures, Kaj Ulrich Linderstrøm-Lang (LL) organized protein structure into a three-tiered hierarchy, with the amino acid sequence comprising the primary structure, local-in-sequence interactions stabilizing the secondary structure, and long-range interactions stabilizing the tertiary structure. Here we call this 'the LL ontology.' Extensions of this ontology to quaternary, quinary, and even senary structural levels have been proposed in the literature, with the quaternary level being nearly universally adopted in undergraduate curriculums. We argue that, since the microscopic nature of protein-protein interactions are identical for a ternary versus a quaternary interface, the inclusion of quaternary structure is not edifying in the context of an undergraduate curriculum. Protein-protein interactions can be treated as general phenomena that are mediated by protein conformational states without an essentialist invocation of quaternary structure. The LL ontology also carries with it the implication that secondary structure is always ontologically prior to tertiary structure, or that tertiary structure is always prior to quaternary structure. These generalizations are disproven by the existence of chameleon sequences (primary structural elements that occur in different secondary structural contexts) and by the existence of intrinsically disordered proteins (proteins lacking a stable three-dimensional fold in the absence of a binding partner.) We argue that, in terms of the pedagogy of protein structure, students are best served by studying the first three tiers of the LL ontology to provide a still-useful descriptive language for all proteins. Folding should not be presented as a simple ascension of this hierarchy unless a framework mechanism is being explicitly discussed. Ultimately we favor the energy landscape as a universal descriptor for the interplay between protein folding and function.

1676-Pos Board B627

Experiences Gained Creating a Biophysics Major at a Predominately Undergraduate Institution

Justin J. Link.
Physics, Xavier University, Cincinnati, OH, USA.

Xavier University, a liberal arts predominately undergraduate institution (PUI) located in Cincinnati, OH, implemented a Biophysics major in the Department of Physics in spring 2012. The program is built upon foundational physics courses and is unique due to the possible selection of upper-division courses that students elect to take towards their undergraduate degree. A capstone course is offered to bring all prior knowledge in the fundamental sciences together to approach complex problems in biology. Due to the flexibility of the program, it serves students well who are interested in pursuing advanced degrees in Biophysics or Biomedical Engineering. It also offers students interested in the health professions an alternate path towards medical school which can be advantageous in the application process. This session will express some of the advantages and challenges to creating such a program at a liberal arts PUI and discuss the capstone course within the major.

1677-Pos Board B628

A Diy Langmuir trough Made with Adruino, LabVIEW, and 3D Printed Parts for Education and Research

Eric J. Alfuth, Tomas Chester, Nate Roisen, Cain Valtierrez, Vision Bagonza, Benjamin L. Stottrup.
Physics, Augsburg College, Minneapolis, MN, USA.

Maker and DIY projects and resources have exploded in popularity and accessibility. We describe the development of a Langmuir trough system and accessories by undergraduates. LabVIEW provided the base user interface while Arduino micro-controllers were used as the interface electronics. We present a cost effective way to build a modular and disposable Teflon trough. We demonstrate that Arduino and LabVIEW interface effectively. Using a home built 3D computer-controlled router we are able to build barriers and other necessary elements. Additionally, students have designed and assembled several accessories including an automatic cleaning and deposition system. These engineering systems have been incorporated into both curriculum and research in the Biophysics lab at Augsburg College. The development of this system introduces students otherwise pursuing physics and mechanical engineering careers to research questions and challenges at the cutting edge of biophysics and materials science.

1678-Pos Board B629

Delicious Biophysics: Cooking as a Prolific Support to Teach Biophysical Concepts

Christophe Lavelle.
CNRS UMR7196 / INSERM U1154, CNRS, Paris, France.

Molecular biology, a term coined in 1938 by Warren Weaver, director of Natural Sciences for the Rockefeller Foundation, began in the 1930s when physicists and chemists took an interest in biology with the hope of understanding life at its most fundamental level. 50 years after, Hungarian physicist Nicholas Kurti and French chemist Hervé This laid the foundations for a new scientific discipline, naturally coined Molecular gastronomy, dedicated to the study of physical and chemical processes occurring during meal preparation, hence with the hope of understanding cooking at its most fundamental level. Amazingly, this discipline finds its premise in the statement of the renown French chef Georges Auguste Escoffier, who wrote more than a century ago in the preface of its famous Guide Culinaire (which still serve today as a reference for many chefs worldwide): ''Cooking, without ceasing to be an art, will become scientific and subject its formulas, empirical too often, to a method and a precision that will leave nothing to chance''.

We will show how an interdisciplinary approach mixing biopolymer physics, thermodynamics, physiology and macromolecules biochemistry (among other subjects) can indeed help better understand culinary phenomena and ultimately influence the way we cook and eat. Doing this, we will also demonstrate that food transformation and consumption incidentally provide interesting supports for innovative pedagogical approaches in biophysics at any level, suggesting promising (and appetizing!) opportunities to raise interest in biophysics among students as well as more general public audiences.

1679-Pos Board B630
The Molecular and Cellular Biophysics of Probiotic Bacteria
Astghik Z. Pepoyan.
Food Safety & Biotechnology, Armenian National Agrarian University, Yerevan, Armenia.
Elie Metchnikoff proposed the use of probiotics a century ago. Probiotics regulate the integrity and functionality of gut microbiota. Currently, the scientific attention is more focused on the strain-specific features of probiotics and their use against pathogens or for the treatment of diseases and imbalances of the intestinal microbiota. New developments in nanobiotechnology, the potential use of genetically modified probiotics in foods, or the application of transgenic bacteria in environmental bioremediation require a new look at probiotics' investigations.
At the same time, biophysics describes the biological functions of organisms in different levels in language of the biological molecules' structure and activities. The including of molecular and cellular biophysics of probiotic bacteria in education programs will promote the development of nutritional and health sciences.

1680-Pos Board B631
Enjoy Co-Learning in Acacemic Meetings and Conferences: How to Enhance Communication Among Peers in Biophysics and Neighboring Fields
Senkei Umehara.
Department of Innovation Research, Japan Science and Technology Agency, Chiyoda-Ku, Tokyo, Japan.
Biophysics has high potential in liaising with neighboring fields of study. Providing both theoretical and technological means to help generalize complex biological systems, it bridges apparent gaps between such disciplines as informatics and modeling, engineering, physics, chemistry, specialized branches of biological sciences, and applications in agriculture, pharmacology and medicine, to name a few. Obviously, individual biophysicists can benefit from this potential by nature, but more opportunities to catalyze interactions with outside world would make them even happier.
Here we try to show some practical tips to increase the chance of educational or co-learning opportunities among participants in academic meetings and conferences. These tips are gained through the management of funding programs adopting a ''virtual institute'' system, where multidisciplinary players are joined from remote places. Through examples of good practices, future conference organizers would be able to develop ideas that can effectively be implemented in their own planned gatherings. Moreover, we hope that students and early career biophysicists would find clues to broaden their research, which eventually lead to more impactful academic achievements and societal contributions in the future.
In previous biophysics meetings in Japan and the United States, we have introduced to fellow researchers some science communication opportunities, which include informal education in science festivals or events, public dialogs in a world café format, and crisis communication. This time the focus will rather be more expert-oriented, but the point is that any encounters with someone outside of one's own expertise would be a golden opportunity for breakthrough. Our hope is to have individual scientists recognize the importance of multifaceted perspectives that are often provided outside their own laboratories, and inspire them to enjoy more ''close encounters'' within the scientific community and beyond.

1681-Pos Board B632
Cloud Experimentation for Biology: Systems Architecture and Utility for Online Education and Research
Zahid Hossain[1], Xiaofan Jin[2], Engin Baumbacher[3], Alice Mira Chung[2], Stephen Koo[4], Jordan David Shapiro[2], Cynthia YTram Truong[2], Sean Choi[4], Paulo Blikstein[3], Ingmar Hans Riedel-Kruse[2].
[1]Computer Science and Bioengineering, Stanford University, Stanford, CA, USA, [2]Bioengineering, Stanford University, Stanford, CA, USA, [3]Education, Stanford University, Stanford, CA, USA, [4]Computer Science, Stanford University, Stanford, CA, USA.
Interacting with biological systems via experiments is important for academia, industry, and education, but access barriers exist due to training, costs, safety, logistics, and spatial separation. Automated high-throughput equipment combined with web streaming could enable interactive biology experiments online, but no such platform currently exists. Here we present a cloud experimentation architecture (paralleling cloud computation), that is optimized for a class of domainspecific equipment (biotic processing units) to share and execute many experiments in parallel by mapping synchronous equipment cycles to asynchronous user actions. We implemented an instance of this architecture that enables chemotactic stimulation experiments with the slime mold Physarum polycephelum. A user study in the blended teaching and research setting of a graduate-level biophysics class demonstrated that this platform lowers the access barrier for nonbiologists, enables discovery, and facilitates learning analytics. This architecture is flexible for integration with various biological specimens and equipments to facilitate scalable interactive online education, collaborations, conventional research, and citizen science.

1682-Pos Board B633
An Interdisciplinary Hands-On Module for Science Outreach in Resource-Limited Settings
Vernita D. Gordon, Karishma S. Kaushik, Ashley Kessel, Nalin Ratnayeke.
Department of Physics and Center for Nonlinear Dynamics, The University of Texas at Austin, Austin, TX, USA.
Collaboration across disciplines has played a pivotal role in understanding and advancing science. However, opportunities to gain interdisciplinary research experience continue to remain uncommon. We have developed a hands-on, experimental module that uses an interdisciplinary approach, combining biology experiments and a physics-based analytical model, to address a scientific problem. This module was first implemented at the Hands-on Research in Complex Systems School held at The Abdus Salam International Centre for Theoretical Physics (ICTP), Trieste, Italy from 29 June - 11 July 2014. In our experience, this module was robust, reproducible, resource-efficient, and cost-effective. These serve as favorable features in taking this module to diverse settings such as undergraduate research manifestos, STEM camps, school programs, and laboratory training workshops. Given the paucity of structured training or education programs that integrate diverse scientific fields, this module can provide valuable, interdisciplinary, research experience in science outreach and education initiatives.

1683-Pos Board B634
Protein Structure Solution Skills Made Accessible: Steps Toward an Online Classroom
Gundula Bosch[1], Lauren E. Boucher[2], Alexia S. Miller[2,3], Jurgen Bosch[2].
[1]Molecular Microbiology & Immunology, Johns Hopkins School of Public Health, Baltimore, MD, USA, [2]Biochemistry & Molecular Biology, Johns Hopkins School of Public Health, Baltimore, MD, USA, [3]Program in Molecular Biophysics, Johns Hopkins School of Medicine, Baltimore, MD, USA.
The ability to solve and interpret protein structures is a critical skill set for molecular life scientists of many disciplines. However, courses teaching practical crystallography skills are rarely integrated into regular graduate or undergraduate curricula. Moreover, expert-led workshops are often expensive and have long wait lists. In our molecular biophysics program, we currently address this issue through offering an immersive, active-learning workshop covering hands-on crystallography skills in a blended delivery format. Preliminary evaluation results recently indicated long-term, sustained structure solving skills in our learners.
In order to reach a broader learner population, we are now taking the next steps toward developing an online course environment, to enable also full-time students, postdoctoral fellows and professional scientists, independent of institutional affiliation and geographic location, to take the course at their own pace in a part-time modus.
Our instructional strategies comprise:
- Modular topic preparation through individual readings and recorded mini-lectures;
- Readiness checks through short quizzes;
- Problem-based learning by provision of real-world data sets through server-download;
- Peer-to-peer consultation on intermediate structure solution steps via online team space;
- Progress assessment through regular update reports and feedback by the instructor team via discussion forum and real-time online meet-ups;
- Online presentation as well as peer- and instructor critique of a final project, mimicking a conference presentation that focuses on the structure solution pathway.
- Three to six months after the course, we provide our learners with an unknown dataset to solve on their own, to evaluate the level of sustained learner performance post instruction.

We will present the current status of our online implementation efforts, as well as first insights from a pilot feasibility study with national and international off-site participants.