ALPhA Advanced Laboratories

ALPhA's Laboratory Immersions

Physics of Medicine and the Human Body

Loyola University Maryland, June 19–21, 2017

(2-3 setups for 6 participants)

Host and Mentor

Mary Lowe is a Professor of Physics at Loyola University Maryland. Dr. Lowe earned her Ph.D. in condensed matter physics from the University of Pennsylvania in 1986. Following a postdoc at the Los Alamos National Laboratory, she began working at Loyola University Maryland, where her time is spent primarily on teaching, research, and service. She has taught all levels of lectures and labs for undergraduate physics majors. Her grant-funded teaching projects have included robotics in the introductory physics lab and the development of physics of medicine modules. Over the years, she has conducted research on fluid flows in large, curved ducts and the microcirculation; multiplexed identification and quantification of DNAs on the surface of microscopic beads using flow cytometry; and molecular dynamics simulations of proteins. Much of the work on the physics of medicine was done in collaboration with Nancy Donaldson, Rockhurst University, under NSF grant DUE-1140406. In the process of teaching two courses on the subject, Dr. Lowe has assembled materials from commercial vendors, other universities, and articles.

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Physics has transformed modern medicine through the development of diagnostic and therapeutic techniques. A deeper appreciation of the human body is achieved with an understanding of physics principles. In this Immersion, participants will learn about various types of apparatus for teaching the physics of medicine and the human body. The material targets students who have had 1-2 semesters of introductory physics and is algebra-based.

I believe that participants interested in establishing physics of medicine courses at their own institutions would benefit from a knowledge of what is already out there. On the first day of the Immersion, participants will be provided with an overview of all teaching apparatus that have been used at Loyola in the physics of medicine courses. These include commercial products, apparatus developed by Nancy Donaldson (Rockhurst University) and myself, apparatus developed at other institutions, and computational techniques using Excel or Matlab. Topics that can be studied include fiber optics, MRI, PET, CT, gamma camera imaging, ultrasound imaging, aerobic metabolism, pressure in the lungs and alveoli, biomechanics of the arm, foot, and heart, optics of the eye, spectroscopy associated with the pulse oximeter, and computational methods to analyze sports biomechanics and projectiles. Concurrently, Steve Wonnell (Johns Hopkins University) can show work on diffusion, Brownian motion, and DNA diffraction.

Surveys will be given prior to and during the workshop to determine which topics are of greatest interest to the participants. We will do our best to satisfy all interests on an individual basis, but depending on the timing, it is possible that certain topics cannot be covered within 2.5 days.

In most cases, extensive student guides, instructor guides, and setup notes have been developed for intermediate-level topics; participants will be able to choose a set of topics to study and work on them independently. For advanced physics labs on fiber optics, ultrasound imaging, and certain computational analyses, the written instructional materials may not be as extensive, so participants will receive more individual attention from myself or my associate Alex Spiro. For DNA diffraction, lecture notes on the theoretical background will be provided.

Preparation: About a month before the start of the Immersion, we would like to start organizing your thoughts on which topics you are particularly interested in. A list will be emailed containing the full set of topics.

Equipment and supplies: All items for the Immersion are available at Loyola. Internet access will be available.

Safety considerations: None.

The cost of each setup ranges from $100 - $1000. In a number of cases, the equipment is generally useful for a variety of labs. The cost of oscilloscopes, power supplies, software licenses, microscope, camera, and custom products are not included in the estimate.

Financial support to help purchase apparatus used in Laboratory Immersions is provided on a competitive basis by a program of the Jonathan F. Reichert Foundation. Limitations and exlusions apply, but generally speaking the foundation may support up to 40% of the cost of the required equipment.
