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Optimizing Introductory Physics for the Life Sciences: Placing Physics in Biological Context

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Physics is a critical foundation for today's life sciences and medicine. However, the physics content and ways of thinking identified by life scientists as most important for their fields are often not taught, or underemphasized, in traditional introductory physics courses. Furthermore, such courses rarely give students practice using physics to understand living systems in a substantial way. Consequently, students are unlikely to recognize the value of physics to their chosen fields, or to develop facility in applying physics to biological systems. At Swarthmore, as at several other institutions engaged in reforming this course, we have reorganized the introductory course for life science students around touchstone biological examples, in which fundamental physics contributes significantly to understanding biological phenomena or research techniques, in order to make explicit the value of physics to the life sciences. We have also focused on the physics topics and approaches most relevant to biology while seeking to develop rigorous qualitative reasoning and quantitative problem solving skills, using established pedagogical best practices. Each unit is motivated by and culminates with students analyzing one or more touchstone examples. For example, in the second semester we emphasize electric potential and potential difference more than electric field, and start from students' typically superficial understanding of the cell membrane potential and of electrical interactions in biochemistry to help them develop a more sophisticated understanding of electric forces, field, and potential, including in the salt water environment of life. Other second semester touchstones include optics of vision and microscopes, circuit models for neural signaling, and magnetotactic bacteria. When possible, we have adapted existing research-based curricular materials to support these examples. This talk will describe the design and development process for this course, give examples of materials, and present initial assessment data evaluating both content learning and student attitudes.