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Comment on "Physics at the Molecular and Cellular Level (P@MCL): A New Curriculum for Introductory Physics"

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I recently became acquainted with the work done by Lisa J. Lapidus on new curricular development for courses on Introductory Physics for the Life Sciences (IPLS) (1). While I enjoyed reading the article, I was expecting a description of the assessment modalities of such a physics course that is highly focused on molecular and cellular biology. The author, however, is still developing this aspect. Several afterthoughts left me wondering about the best assessment modes for this course.

From my perspective, introductory physics remains the only basic course in the life sciences curriculum where students are taught to apply logic and deduction to the resolution of real-world physics problems, and this is in striking contrast to molecular and cellular biology, where memorization is traditionally emphasized. I agree with the many voices that argue that the learning objectives of IPLS are not about gaining new knowledge but, rather, are about gaining abilities and competencies. The assessments discussed in the paper refer to concept inventories, which are indeed conceptual rather than problem based. However, in my opinion, written problem-based exams are better suited to evaluate competencies acquired in introductory physics courses. During their final exam, students may be given a list of all the formulas they need, but it will not help them succeed if they did not practice beforehand how to apply this knowledge thoughtfully. Clearly, students are strongly motivated by real-world physics problems that touch upon some biomedical aspects, but when it comes to developing physics problems solely with molecular and cellular biology content, I do not see too many possibilities of constructions that would require application of logic and deduction. This situation implies a high probability that the teacher will have to recycle exam questions and, accordingly, disfavors the problem based assessment modality for P@MCL. In other words, the use of problem-based assessment, along with these curriculum adjustments, would "throw the baby out with the bathwater," because students would simply train in solving a limited number of typical problems. Probably the optimal assessment mode in such a course would be project based (2). This way, the students have several possibilities to showcase their understanding of physics topics and their competencies to tie together physics and biology—in the form of written essays or video capsules. The evaluation of project-based work, however, may require significant effort on the part of the instructor (3).

With regards to curricular adjustments for P@MCL, the elimination of topics from the IPLS curriculum should not be simply based, in my opinion, on whether there is or is not a biological equivalent. Still, I was surprised to see the suppression of rotations, electromagnetic induction, and DC circuits (including Kirchhoff's laws). In molecular biology we have a perfect example of conversion of rotational work into the universal cell energy currency, ATP, by ATP synthase. Electroencephalographic measurements are based on electromagnetic induction caused by pulsating currents in nerve fibers. Finally, although it is clear that Kirchhoff's laws are not required to understand how transmembrane potential is generated on the cellular and molecular levels, it should be noted that the equivalent resistor-capacitor circuits describe quite accurately the electric behavior dynamics of various living cells. After all, this is the great achievement for which Hodgkin and Huxley were awarded their Nobel Prize.

REFERENCES

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