Teaching Biochemistry in the 21st Century: Stimulating Student Learning by Combining Online Activities with Classical Lecture-Style Instruction

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With the enormous knowledge base that defines 21st century biochemistry, instructors are forever faced with the hard challenge of deciding what to teach and when to teach it. One of the main challenges instructors face is to identify those topics around which "big ideas" or major biochemical themes can be organized so as to cross-fertilize students' understanding of large conceptual swaths of biochemistry, independent of specific process or organism (e.g. the structure and function of hemoglobin as related to the allosteric regulation of protein functions in general). A second major challenge the instructor faces is to implement the teaching process with student-centered activities that facilitate deep understanding as well as retention. While the classical lecture-style of instruction is still widely employed to teach biochemistry, especially in large class settings, the advent of the internet makes it possible – even easy – to provide students with a variety of activities and resources that help them take ownership of their learning. In my own biochemistry lecture course, students are provided with a host of online learning resources designed to address different student learning styles and needs. All of the lectures, for example, are posted online as streaming videos along with digital copies of the PowerPoint lecture slides for easy, 24/7 review of the material covered in lecture. Students are also provided access to a robust instructional biochemistry web site (http://tutor.lscf.ucsb.edu/instdev/sears/biochemistry/) replete with tutorials, self-grading practice quizzes, concept overviews, interactive 3-D molecular structures, and interactive protein function data charts. While many of these resources allow students to monitor their own progress in the course, some also allow me, the instructor, to gauge what students already know and what they are or are not learning. For example, online "pre-course" assessment quizzes administered to students during their first week of instruction help me assess their mastery of some of the most fundamental biological and chemical concepts that I expect they have already learned about in their required pre-requisite general chemistry, organic chemistry, and introductory biology courses. The surprising and consistent finding from these assessments, however, is that many students do not have sufficient mastery (i.e., problem-solving ability) in many basic topics that stem from these courses, such as reversible equilibrium chemistry, Le Chatelier's Principle, acid-base chemistry, the inferred covalent structure of organic molecules, etc. Thus, if we hope to train biochemistry students to become the future problem solvers in this discipline, it may be necessary to develop more nuanced curricula where basic concepts like these are woven more deeply into the overall fabric of biochemistry instruction.