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Commentary: The "Business" of the Biosciences Can Be Integrated into a Biochemistry Curriculum

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Numerous efforts are underway to rethink how we teach the life sciences and keep our students interested in science. The explosion of knowledge derived from large scale sequencing and the innumerable "omics" efforts has created an opportunity to teach at every level with integrated and systems approaches as well as to rely on the vast new appreciation for the mechanisms of evolution as a unifying principle of all aspects of biology. At least partly as a result of these research advances, there are noteworthy efforts that focus on developing innovative material for the youngest grades, new approaches to teaching introductory biology at the college level, and major advances in the reformulation and integration of curricula for graduate life sciences education. To relate molecular life sciences to the lives and concerns of our students, illustrations of the molecular bases for new cures for diseases, new foods, and novel industrial processes have never been more abundant.

The biotechnology industry, probably far more than any other industry, relies on the advances from our research laboratories that are often literally down the hall from where we teach college and university courses in biochemistry and molecular biology. While we proudly teach our students that the advances in science and technology from our laboratories are the underpinnings of cures and new products, we most often do not include curricula on some of the other critical forces determining what gets to market, which include economics, ownership of intellectual property, and government regulations, just to name a few.

There are numerous reasons to include in our biochemistry and molecular biology curriculum a discussion of some of the forces that often dictate whether or not our research efforts are commercialized. First, our students need to appreciate the amount of capital needed to commercialize a scientific discovery. As informed, scientifically literate citizens, they should appreciate the cost of discovery and commercialization of new pharmaceuticals for both rare and common diseases. In terms of a specific lesson, it could be as simple as discussing how protein tertiary structure is essential to its function and relating this principle to the challenges (and cost) of large scale production and purification of a protein drug. Second, our students need to appreciate that intellectual property is an essential ingredient of the scientific process, and one that is not relegated to the private sector. In fiscal 2004, United States universities filed over 10,000 patents with the United States Patent Office [1]. The patents were filed and the new companies formed so that investors might be willing to provide the resources necessary to develop university-derived discoveries into products, and they would have some assurance of exclusivity in using this particular technology to recoup their investment and make a profit. The lessons of enzymatic inhibition illustrated by human immunodeficiency virus protease inhibitors as AIDS drugs provide superb examples of patented technologies that resulted in not only life saving new drugs but also significant corporate investments, great benefits to universities, and a host of interesting and vexing issues regarding drug availability and pricing around the world. Finally, a discussion of how the life sciences industry is regulated is crucial if students are to understand the standards and scrutiny faced by the industry. The fact that we can have such confidence in the efficacy of our new biotechnology products is at least partly due to the regulatory scrutiny to which they are subject. The strict production requirements (current Good Manufacturing Practices) as well as expensive and time consuming clinical trials to determine both safety and efficacy before a drug can be sold to the public assure an extremely reliable (and some would argue costly) product. The ethical issues surrounding placebo-controlled, double-blind clinical trials on any number of drugs would make an interesting lesson. On the other hand, the highly advertised but untested treatments for everything from wrinkles to obesity and impotence should make for an exciting discussion. The sales of biochemically interesting but untested molecules from creatine, dehydroepiandrosterone (DHEA), and chondroitin sulfate to zinc are all discussion topics about what makes a drug and what is a "dietary supplement." This is all a part of what makes biochemistry interesting and topical, to say nothing of commercially relevant.

There is a host of lessons that can be learned by including the commercial aspects of our life sciences business. What is needed is more curricular material and more case information that can be used in the classroom, and BAMBED should be the home for these types of materials.

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