

COVID-19

An online course on applied biochemistry and molecular biology through case-based learning

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Abstract

An undergraduate online course on Applied Biochemistry and Molecular Biology was developed through different formats of case study that included lecture, class discussion, small-groups discussion, and individual work. Cases covering health, biotechnology, agriculture, and other issues were developed or adapted from the literature to reach the desired learning goals. Multiple web resources were employed for information integration that were presented and discussed in the synchronous sessions and assignments. Formative and summative assessment was achieved through multiple-choice questionnaires, exams, and homework assignments.

KEYWORDS

active learning, distance learning, molecular biology

Applied Biochemistry and Molecular Biology is a course offered to Biochemistry and Pharmacy majors in their senior year at the School of Chemistry, National Autonomous University of Mexico (UNAM). During the 16-week semester, class meets two times per week for 2 h. The main objective of the course is to apply Biochemistry and Molecular Biology principles and techniques to solve specific problems related to Medicine, Biotechnology, Agriculture, and other relevant issues that students would find during their professional careers. The syllabus for this course is quite flexible so case studies can be developed on the current events to stimulate student engagement, provided they address the learning goals.

In Mexico, as in the most countries, the COVID-19 pandemic is disrupting education at all levels including undergraduate training. The emergency transition forced both, theoretical and practical instruction to a remote mode until the end of 2021. During the first semester in

2022, the most public and private universities return to face-to-face or hybrid teaching modes.

In biological sciences, active learning is an interactive and engaging process for students that has a wide meaning and includes over 300 teaching strategies.¹ Among those strategies, case-based learning and problem-based learning are student-centered that improve student performance on complex task, and foster better retention of knowledge.² Both strategies begin with a situation or real-life scenario that students must address by applying the fundamental concepts of a subject area. Ideally, cases and problems must be complex enough to promote student collaboration in small groups and a general class discussion.

The online course was designed to cover relevant learning goals in Biochemistry and Molecular Biology by using several strategies. Table 1 shows 5 out of 10 cases covered in this course, as well as an example of the learning goals and supporting materials. We employed online

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TABLE 1 Sample of cases, learning goals and supporting online resources employed in the applied biochemistry and molecular biology course

Case	Example of learning goals	Supporting resources	Assessment ^a
Initiation and progression of colon cancer	Analyze the nature of human tumorigenesis through accumulation of mutations.	Building a model of tumorigenesis: www.coursesource.org	1; 2
Development of mRNA vaccines against SARS-CoV2	Predict how the characteristics of eukaryotic mRNAs were applied for the development of vaccines	Coronavirus biology: youtube/r2mOU2qOCYs	1; 2; 3; 4
Mechanism of pathogenesis of plant viroids	Infer the role of non-coding RNAs on gene expression regulation	Introduction to microRNAs: ibiology.org , https://youtu.be/dupzE66J8u4	1; 2; 3
Gene edition using CRISPR-Cas: tomatoes with long shelf life	Understand the molecular mechanisms operating in CRISPR-Cas gene editing	CRISPR Explained: Gene editing history, technology, and applications: youtu.be/tNocAc5TKvw	1; 2; 3
Molecular visualization tools for drug discovery; AlphaFold Protein Structure Database	Interpret information on macromolecule–ligand interaction through molecular visualization tools	alphafold.ebi.ac.uk	1; 2

Note: 1—formative assessment through multiple-choice questions; 2—summative assessment through exams that include multiple-choice questions, short-answer questions and essay-type questions; 3—homework assignments on specific topics that were not reviewed thoroughly in class; 4—in-class discussion, led by the professor or by a student team.

^aFormative assessment through multiple-choice questions.

resources for case studies such as CourseSource (www.coursesource.org) and the National Center for Case Study Teaching in Science (www.nsta.org/case-studies). Part of the material was adapted to our learning goals and PowerPoint presentations and handouts were prepared in Spanish. Usually for each topic, the professor gives an introductory lecture on the fundamental processes, and some online material, particularly selected presentations from the iBiology site (www.ibiology.org) were presented. We took advantage of the automatic language subtitle feature provided by YouTube (www.youtube.com).

Synchronous online sessions were conducted using the Zoom platform (www.zoom.us), and two of its features were employed frequently to promote discussion and active learning: (1) break-out rooms for random teams composed by 4–5 students to discuss specific questions on a case, and (2) polls to answer questions on the case, thus resembling an audience response system (“clicker”) employed in face-to-face format. Primary scientific literature was consulted, and selected figures and data sets were employed to elaborate questions so the students could practice data analysis skills.³ Evaluation was completed through formative assessment using a multiple-choice questionnaire after a video presentation, for example, and by summative assessment exams that included multiple-choice, questions, short-answer questions and essay type questions (Table 1). In some cases, homework assignments were

completed on specific topics that were not reviewed thoroughly in class.

Teaching through case analysis requires plenty experience to motivate and ask the right questions to promote student-driven discussion. However, it is quite flexible and allows several formats such as lecture, class discussion, small-groups and individual work,⁴ and there is plenty of useful material that can be adapted to the specific learning goals. So far, all formats have been employed, student response has been positive, and we will systematically assess the efficacy of each case through evaluations and student feedback.

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