COVID-19



A case-based learning approach to online biochemistry labs during COVID-19

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Abstract

With biochemistry forced to transition to remote-teaching online, the cooperative active learning and problem-solving normally in labs have been limited. With little ability to perform experiments with laboratory equipment, determining how to mimic the qualities integral to these labs in an online environment is necessary. We propose one possible solution to provide online labs: short case-based learning activities.

KEYWORDS

biochemistry, case-based learning, COVID-19, online teaching, remote-teaching

Case-based learning (CBL) has shown successful results in improving student achievement, facilitating retention of information, and increasing positive perception towards biochemistry courses. 1-3 Though creation of biochemistry cases has been discussed in a step-by-step guide before, instructions on how to translate cases to online-only instruction is necessary. One must begin first with a learning objective in mind, keep cases concise to only one or a few paragraphs, and encourage student cooperation for cases to work effectively.⁴ We suggest using current online conference tools which separate students into groups. These small groups can communicate via voice chat and text with the teacher attached to monitor their work. Students in each group can work on cases using a shared document online which the instructor has access to, making cooperative learning possible. This shared document can then be turned in via a web link.

One example case idea for biochemistry is described in the next paragraph, where students are trying to figure out the identity of unknown amino acids. Instructors may ask each group to identify possible amino acids for every band and what evidence they have to support their hypothesis. Note that the case study is written to promote inquiry, a vital component of case studies, in that the five unknown amino acids cannot be identified without synthesizing the information from the three experiments

described (e.g. multiple amino acids have similar isoelectric points, similar molecular weights and similar properties).

Biochemistry case: Three students test a mixture of five unknown amino acids using different biochemistry laboratory techniques to figure out what is in the mixture. Student 1 performed isoelectric focusing by placing the mixture at pH 7 and waited for changes. Four bands appeared with the following isoelectric points: Band 1: 11, Band 2: 9.5; Band 3: 5, Band 4: 3. Student 2 performed a native gel. Using the location of the bands, molecular weight per mole was determined. These g/mole results are as follows: Band 5: 240, Band 6: 174, Band 7: 147, Band 8: 146, Band 9: 133. Student 3 performed sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE). This student obtained similar results to Student 2; however, the student observed the band at 240 disappear, instead seeing a thicker band much further down the gel. See Figure 1 for how to approach creating a CBL activity.

After personally using a CBL biochemistry curriculum online, it is important that instructors know that it was a challenge initially but became easier with experience. Groups of five students seem to work best online and approximately 10 questions should be given. Questions should ideally apply concepts to real-world situations and slowly develop from simple to complex.

FIGURE 1 Scheme for how to approach creating a case-based learning (CBL) activity



- Design learning objectives using Bloom's taxonomy which are measurable, achievable given time constraints, and relevant to the topic.
- The learning objective for this case can be: Students in this course will synthesize provided results from isoelectric focusing, native gels, and SDS-PAGE to correctly identify components of an unknown solution.

Step 2:

Organize

- Organize students into online groups using a shared document and explain the expectations of the activity.
- In this case, groups were kept small with five or less students. The instructor explained that students should read the case study and work together to answer questions.

Step 3: Implement

- Provide inquiry questions for each group to answer. Examples used in this case are listed below.
- Name the parts and functional groups of amino acids. What is an R group? What is the difference between an acidic versus basic amino acid? Which amino acids have a chiral R group? How is pI calculated differently for an acidic/basic amino acid versus an amino acid with an uncharged side chain? Is pI higher in acidic side chain amino acids or lower than amino acids with no charged side chain? Identify the amino acid that made band 1. What reason might there be four bands on student 1's gel but five bands on student 2's gel? What is the difference between a native gel and SDS PAGE?

Step 4: Evaluate

- Evaluate students using challenging questions. These questions should synthesize the information from each test in the experiments conducted to find whether students truly understand the material. Examples from this case are below.
- Another student claims band 5 is Proline; explain whether this student
 is correct or incorrect and why. Using the data provided, what are the
 five amino acids in the unknown mixture; write their one letter and
 three letter names. Draw the structures of the five amino acids from the
 unknown mixture. Using an amino acid found at band 1, 2, and 4,
 determine the order of their elution in an anion exchange column at pH
 0.5

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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How to cite this article: Thibaut D,

Schroeder KT. A case-based learning approach to online biochemistry labs during COVID-19. *Biochem Mol Biol Educ*. 2020;48:484–485. https://doi.org/10.1002/bmb.21408