Abstract:

Teaching in the Time of the Coronavirus is an interesting challenge that allows faculty to explore new and exciting ways to get students to engage with the course material. The idea of lectures online with faceless students listening on the other end did not seem to be an effective use of both the student's time and the faculty member's time. Transitioning the lectures to short, structured case-based learning exercises seemed to be a good alternative to online lectures. We were able to demonstrate our semester-long case-based learning curriculum using break-out room during the summer semester. We believe the approach we took in our Medical Biochemistry curriculum by using short, structured cases and break-out rooms as a model on how using cases over lectures can be used by other faculty members in their courses. During our discussion, we hope to provide an example to help other faculty member transition to case-based learning.

Title: Is Case-Based Learning the solution to the Challenges of Teaching in the Time of the Coronavirus?

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Main text:

Teaching in the Time of the Coronavirus has allowed faculty member to explore news ways to present course material to students.[1] Case-Based Learning (CBL) has been shown to be an effective approach to teaching that has allowed students to make educational gains and have better outcomes in the long term.[2,3,4] Even though this is not the first time a step-by-step guide to CBL has been discussed, the approach here could help faculty members begin to develop cases for use in the time of the coronavirus. As with any good lecture, a faculty member needs to begin with what learning objective they plan to present for that topic.[5] The next step is to limit the case length to only two-to-four paragraphs. The most challenging part is to encourage student involvement and collaboration using online breakout rooms in order for students to make educational gain by using the cases. Students working in breakout rooms in small groups allows students to interact with each other and the course material. The faculty member and teaching assistants can move in and out of the breakout rooms to help the students answer their own questions by answering the students' questions with questions. The students can use online tools to collaborate on a collective document that can be turned into the course management system.

During the time of COVID-19, it only makes sense to develop at least one case around the pandemic. During my biochemistry course, the development of a SARS-CoV-2 case made sense because trying to make cases relevant to what is happening around the students only makes sense in order for the students to be more involved in their learning process. There are a number of different topics that can be pursued when talking about the coronavirus, but concentrating on only a few learning objectives per case can help the students learn more about each topic. Being able to have student learn more than just the surface level of various topics will help to ensure that the students learn the material for the long-term.

COVID-19 case: Write the learning objectives using Bloom's taxonomy that can be answered in the time constraints of the meeting time. After determining what learning objectives you are going to cover in the case, introduce the case topic in two-to-four paragraphs depending on the topic. My suggestion is to include one or two journal articles as references for the students in case they need want to research more about the topic. In the COVID-19 case, for example, the students will demonstrate the ability to identify the components of the coronavirus, recognize how mutations in the coronavirus affect the amino acids of different proteins, and describe the processes of qPCR, RT-qPCR, and CRISPR including how they can be used to detect the coronavirus and how CRISPR could be used as a therapeutic agent for the coronavirus. I find that it works opening up the case the night before the class meeting time, but keeping the ten questions about the case until after class begins. Before organizing the students into group of four or five into breakout rooms, I would explain to the students that they should read the case study and answer the questions as a group to get the most out of the CBL exercise. Another thing I found to help the student focus on the questions as a group is to break the questions up into groups of three-to-five questions until all ten questions are revealed. After you explained the case and what is expected from the groups, I would allow students to moved into their breakout rooms and then provide the questions. An example of some of the questions asked are as follows. What are the components of a virus? How does this compare to the structural components of prokaryotes and eukaryotes? What type of bonds/interactions does each group of amino acids make and why can a mutation from one amino group to another cause the coronavirus to behave differently? What is qPCR, RT-qPCR, and CRISPR? How can CRISPR be used to help develop a therapeutic agent for the coronavirus? The last step in the CBL process during class time is to ask students which questions they felt challenging and why. Then, the students felt it was

important to give an overview of each answer before the end of the class session. I debate whether this is the best method or have the students identify the learning objectives they felt were difficult. Then, the students answer those difficult learning assignments as an individual assignment and turn it in before the next class session where you begin the class with the answer from the previous case. It is still a work in process in determining which way is best for evaluating how much the students learned from the CBL exercises.

After implementing over a dozen different cases in one course, it is important to note that implementing CBL at first can be difficult. However, listen to the students and take your own notes when moving between break-out rooms on how to improve the cases and the presentation of each case. Every course is different and each group of students is different. Understanding your students and their challenges is important, this can allow the instructor to tailor the cases to their cohort of students. Even though it may be challenging to get started in a course, it does get easier with experience and the learning outcomes for the student makes it worth it. In my experience, having students work in groups of four or five works best with only about ten questions per case. In regards to the questions, the questions should start from simple to more challenging and the more they can be related to real-life situations. The more students seem to be engaged with the questions of the cases the better they tend to learn the concepts and perform better on the quizzes and exams.

Conflict of Interest: The authors declare no conflict of interest.

Works Cited:

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COVID-19 Case and Testing

Corona Virus Infectious Disease-19 also known as COVID-19 has been identified as the causative agent of a respiratory illness first detected in Wuhan, China in 2019. In scientific literature it is known as a Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). The virus is now responsible for at least 299,300 deaths in the US and 1.6 million deaths globally as of December 14, 2020 (from WHO).

Like most viruses, the coronavirus attaches to receptors on a human cell surface to invade the host cells, however it specifically does this using spike protein via angiotensin-converting enzyme 2 (ACE2). Researchers found that the SARS-CoV-2 spike protein was 10 to 20 times more likely to bind ACE2 on human cells than the spike from the SARS virus from 2003. To help support rapid research advances, the genome sequence of the new coronavirus was released to the public by scientists in China. A piece of the genome predicted to encode for its spike protein based on sequences of related coronaviruses was isolated at a lab located at the University of Texas at Austin and the NIAID Vaccine Research Center (VRC).

In addition to the spike protein, the main protease (M^{pro}, also called 3CLpro) has become a drug target because of its essential role in processing the polyproteins that are translated from the viral RNA. There have been several mutations that have occurred between main proteases of SARS-CoV (2003) and SARS-CoV-2 (2019).

National Public Health Laboratory in Kathmandu, Nepal, submitted the final sequence to the WHO laboratory who confirmed that the final genome of sequenced SARS-CoV-2 consists of a single, positive-stranded RNA that is 29,811 nucleotides long, broken down as follows: 8,903 (29.86%) adenines, 5,482 (18.39%) cytosines, 5,852 (19.63%) guanines, and 9,574 (32.12%) uracils.

Literature cited:
- Sah *et al*. Complete Genome Sequence of a 2019 Novel Coronavirus (SARS-CoV-2) Strain Isolated in Nepal. ASM Microbiology Resource Announcements March 2020, **9** (11) e00169-20; **DOI:** 10.1128/MRA.00169-20
- Zhang *et al*. Crystal structure of SARS-CoV-2 main protease provides a basis for design of improved α-ketoamide inhibitors.Science. **368**, 409–412 (2020).

Questions:

1. What are the components of a virus? How does this compare to the structural components of prokaryotes and eukaryotes? How do coronaviruses infect host cells? (to go deeper, what are the structural components of the coronavirus that make it unique?)

2. Mutations in various SARS-CoV-2 proteins have caused it to become more virulent than other coronaviruses. This increased virulence is due to amino acids interacting more strongly with other molecules. Classify the 20 amino acids into groups and list what type of bonds/interactions each group can make. Also, define each type of bond/interaction.

3. Several mutations were discovered in the spike protein. For the following 3 mutations, indicate what kind of mutation occurred.
   a. T8782S in ORF1a, codons AGT to AGC
   b. L9561S in ORF1a, codons UUA to UCA
   c. L15607L in ORF1b, codons CUA to UUA

4. Mutations were also discovered in the main protease (M^{pro}). Explain why a T285A makes COVID-19 more virulent than an S284A or I286L.

5. What is qPCR and RT-qPCR? Explain the steps in each. How is reverse transcriptase utilized?

6. RT-PCR is being used widely to test for COVID-19, why do you think this is? What does this say about the specificity and sensitivity of the results of the test?

7. Draw the DNA coding template for the following RNA sequence that is a part of the coronavirus:5'-UAAUCAGACAAGGAACUGAUUA-3'

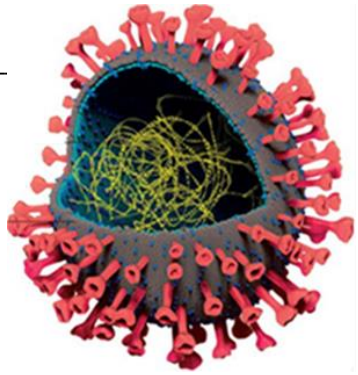
8. What is CRISPR? Explain the step by step process of how CRISPR works?

9. How can CRISPR be used to help develop a therapeutic agent for the coronavirus?

10. It is hypothesized that mutating a gene that codes for the spike protein may inhibit its ability to attach to a host's cell and cause further infection. Explain how site directed mutagenesis can help with this.

Please work together in groups of 4 or 5. Please put YOUR NAMES in the space below.

1. _____ 2._____ 3. _____
4. _____ 5._____



Please answer the questions on the previous page below:

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