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Emergent Course Curriculum: Adapting to the Novel Coronavirus

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Abstract: The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) causing the 2019 coronavirus disease (COVID-19) pandemic is tragic, yet we can still learn a great deal about the virus and its effects. The biochemistry of the virus is rather interesting despite its ill effects, and it is important to know how it works to understand how to defeat it. In the spring 2020 semester, I was teaching a senior level biochemistry course that would normally cover topics of DNA replication, RNA replication, protein synthesis, gene regulation, and other biomolecular metabolic pathways. Upon the first call for suspending face-to-face classroom study, my course, with the enthusiastic support of the students in it, changed our focus to understanding these topics in relation to viruses. The course structure was modified to include online quizzes, instead of a written exam, and 5-min videos made by each student describing the biochemical nature of a virus of their choosing, instead of a traditional presentation. The class met through synchronous online meetings on Zoom to discuss topics of virus structure, genomes, replication, and potential treatments and prevention methods such as how vaccines are made. This format allowed both myself and the students in the course to learn a great deal about this current threat and treatments in modern medicine. Concepts and ideas learned here will hopefully plant the seed in the students' minds so they will be strong advocates for science and education.

Keywords: virus, biochemistry, evolution, infection, treatment.

Biochemistry is the study of chemical compounds that move. These chemical compounds move from one end of the cell to the other, from one end of the body to the other, and from one organism to another. Teaching and learning throughout the semester can be much the same: Ideas and concepts move from thoughts within our own minds to our words, and from our words to communicate with others. The coronavirus undergoes a complex biochemical process to infect a host, replicate its components, reassemble and repackage those components, and then release the newly formed viral particles to infect a new host. Developing a course curriculum is also a complex process that involves identifying a host subject, replicating the ideas and information, and reassembling and repackaging the information; then the newly formed ideas and concepts acquired by the students allow them to teach others what they have learned.

A normal semester of a senior-level second-semester biochemistry course covers metabolic processes of photosynthesis, amino acid synthesis, carbohydrate synthesis, fatty acid and sterol synthesis, nucleic acid synthesis, DNA and RNA replication, protein synthesis, and regulation of gene expression. Each of these topics would have been analyzed and discussed in the classroom for a better understanding of the biochemical process. Students are expected to complete exams that consist of challenging questions that test their ability to apply information that they have discussed in class and read in the textbook. They are also expected to analyze current biochemical research by evaluating a peer-reviewed journal article of their choosing and describing a few of the experiments presented in the article. This assignment also offers me the opportunity to learn about the interesting topics that the students choose to present. My second-semester biochemistry course is often one of the last chemistry courses that these students will take before they graduate. Many of them do continue with graduate school, and others are able to find employment in the region after graduation.

Any virus is very much a chemical compound, or rather a mixture of complex chemical compounds. Viral particles consist of proteins, nucleic acids, carbohydrates, and (in certain cases such as the coronavirus) a fatty acid lipid bilayer. The nature of virus propagation relies on it utilizing the host cell's replication mechanisms (de Wit, van Doremalen, Falzarano, & Munster, 2020). Thus, just as a single viral particle would not be able to propagate on its own, a single idea or concept would also not be able propagate without the proper incubation or instruction. All of these structures and topics cross over very nicely with the material we expected to cover in this course. Our immune system has to adapt to any emerging disease or suffer the consequences, and just like our immune system and this disease, the curriculum needs to adapt and evolve.

Upon first exposure to any virus, there is often an incubation period during which the virus travels and replicates in the host's system. News of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was slowly increasing early in the semester, though for the most part here in Indiana, it was seen as something that was happening elsewhere. In late February 2020, reports of countries shutting down, closing businesses and university campuses, still seemed far away (Zhu et al., 2019). At Indiana University Southeast, people took notice and began minimal social distancing steps and hygiene practices, including "coughing in their arm" instead of their hands, elbow bumping instead of shaking hands, and washing the hands regularly. Infections in the United States were still minimal and considered contained. It was not until early March that the first cases at our university started to cause more response. Coronavirus had spread and infected our system.

As a virus infects and attaches itself to the right receptor on the surface of cells, the genetic information from the virus is injected into the host cell. Early in March, the president of our university declared that all classes, after a 2-week spring break, would be converted to online. The idea was to minimize the transmission of the virus by social distancing. This in turn would reduce the burden on hospitals and first responders. The virus had changed and disrupted our cellular activities. During this time, we faculty needed to adapt and treat the symptoms of the disease, in this case, converting our classes to online. Many of the face-to-face courses were converted by using remote synchronous technology, such as the video conferencing platform Zoom. This was perhaps an example of "nonsymptomatic" spread; the classes seemed normal enough. Other classes, such as chemistry laboratories, needed more life support and respirators. The chemistry faculty, with the help of student teaching assistants, were able to quickly adapt and record videos of the remaining experiments to post online. While not the best option for hands-on learning, it served as adequate triage to keep the semester alive. As much as we kept our social distance and wore our online masks, it did not save 100% of our course material. The virus was able to eliminate a few lessons and experiments. Preparing videos provided the life support needed to complete the semester, though the hands-on learning was eliminated from the curriculum. The hands-on nature of the laboratory experience was always (and still is) considered essential work that students perform. As the toilet paper supply disappeared from the shelves, so did the hands-on learning from the classroom.

A healthy immune system naturally will create B cells, each of them fundamentally rearranging their genetic code to ultimately produce a specific antibody that targets an invading pathogen (Flint, Racaniello, Rall, & Skalka, 2015). Upon infection by a pathogen, the specific B cell that recognizes that pathogen will be activated to produce large quantities of a specific antibody to target that incoming pathogen, such as bacteria or a virus. Once activated, these B cells will "remember" the antibody that it produces and be able to respond to future infections from that pathogen. For the biochemistry class, we decided as a group to rearrange our curriculum to learn as much as possible about viruses, and in particular, the novel coronavirus. SARS-CoV-2 contains single-stranded ribonucleic acids (RNAs) as its genetic information (Flint et al., 2015). A single-stranded RNA is either directly read by the host cell's protein-manufacturing system or transcribed to its reverse sequence. Then the RNA can be translated to protein (a different biochemical language) or packaged into a new viral particle for propagation. The virus does all of this by hijacking the host cell's energy and translation mechanisms. We needed to take a similar approach with studying this virus. My class has a required textbook, but that textbook did not have chapters pertaining to virus mechanisms. The genetic material, so to speak, needed to be changed or rearranged to express the appropriate knowledge. Our campus was closed, we were all forced to work and study from home, and there was no access to a photocopier or scanner. Using the resources and tools on hand, photos were taken with my phone camera from a few virology textbooks and then uploaded to our university's online classroom platform, Canvas, to propagate the information to students. By taking cues from the virus, the textbook information was transcribed to Canvas and translated to verbal communication and discussion with the class.

Viral propagation depends on the genetic information to be translated into proteins. These proteins have different functions including the protective coat of a viral particle (those spikes protruding outward), enzymes that break apart (or digest) other proteins to activate them, and polymerase enzymes to copy the genetic material. The uploaded pictures and notes provided our class the material to digest the information. As a class we were able to take these smaller pieces of information that were presented live over Zoom meetings and have active discussions of the material. These meetings were also recorded and then later uploaded to our course Canvas page in case a student needed to listen and view again. During the synchronous course Zoom meeting, students were able to ask questions and discuss the presented topics. Discussions, videos, and PowerPoints were all a protective coat of information. Each of these components could be broken down into smaller bits for easier digestion.

The coronavirus needs to replicate its genome, package it into a protein coat, and envelop itself in the host cell's own lipid bilayer (Flint et al., 2015). Replication of knowledge was accomplished by each student selecting a different virus to research. A mutation occurred! Evolution is essentially genetic information being changed over time while being replicated, which results in a new function or trait. Utilizing the newfound tools from our new "host cell" of the quarantine, the students prepared their own presentation notes detailing the properties of their selected virus and gave their own 5-min presentation using video chat tools such as Zoom or Kaltura. They were able to develop, organize, and prepare a package of their recorded video and PowerPoint notes. Each student video was peer reviewed through the Canvas peer-review system. The peer-review system can be set up in Canvas assignments that includes a rubric, and it will randomly assign a number of reviewers. Each student reviewer followed and scored their peers with the rubric and were also able to comment on the presentations. The rubric ranked the presentations on the discussion of the virus, its biochemical metabolism, how it propagates, any physiological effects, and if there are any treatments available. This proved to be a great way to learn about multiple viruses and allow the students to demonstrate their communication skills.

Once wrapped in the envelope, the coronavirus must exit the host cell to start the cycle again. These student videos wrapped up our semester. With the knowledge and insights gained, the students were better equipped to exit into the world to spread their scientific understanding of the virus. As the semester came to an end, both the students and I were fatigued and weary from the few weeks of isolation. Even so, the virus did not affect our ability to communicate and learn good biochemistry, such as the replication of genetic sequences, synthesis of proteins, formation of lipid bilayers, and the structure and function of viral particles. Fortunately, our class was able to come together with the online sessions to study the biochemistry of SARS-CoV-2 and other viruses. It is my sincere hope that the knowledge we have obtained together as a class will inspire these young scientists to continue their pursuit of scientific principles and potentially infect others with their enthusiasm for truth and knowledge.

An emergent curriculum evolved after exposure to environmental pressure. As an instructor of biochemistry, I see parallels with the viral infection and propagation process and how instruction in the classroom can adapt and change. Even though this pandemic rages on, there is hope of evolving more positive attitudes toward science and education. My teaching has evolved: Will you become infected?

Epilogue

In the months since submitting this essay, I have continued to be plagued by online course development. Unlike vaccinations, teaching online became compulsory for the past couple of semesters. This decision by our university to hold most of our classes online was a good one, which prevented transmission of the 2019 coronavirus disease, and because of my earlier inoculation outlined in this essay, I was better prepared and equipped to develop online courses this past fall and spring semesters. Even so, developing new online courses is exhausting. Perhaps this spring semester is analogous to the second booster shot, which often results in mild symptoms of headaches and tiredness ("What to Expect After Getting a COVID-19 Vaccine," 2021). Despite these current feelings, I am hopeful for the future of both my courses and my health. I am hopeful that everyone will become infected with the enthusiasm to embrace science and education.

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