JOURNAL OF MICROBIOLOGY & BIOLOGY EDUCATION
DOI: https://doi.org/10.1128/jmbe.v22i1.2619

JMBE Journal of Microbiology & Biology Education

Supplemental Materials

for

Transitioning Cell Culture CURE Labs from Campus to Online: Novel Strategies for a Novel Time

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Received: 31 August 2020, Accepted: 17 December 2020, Published: 31 March 2021

Appendix 1
Course Descriptions

Plant Biology
Dr. Gary Bates, Professor, NorthWest Arkansas Community College

Lecture and Lab for science classes at NWACC are combined into a single course that meets two days a week for a total of 6 hours. Plant Biology is a mixed course of 24 students with both majors and non-majors consisting primarily of freshmen. Students began the spring semester growing heirloom plants both in tissue culture and in on-campus gardens. Students use micropropagation methods including both callus culture and meristem culture to produce plantlets. This provided the opportunity for the students to experience traditional and molecular cloning technologies used in the horticultural industry. The overreaching goal is to increase certain plant lines for further research ventures while allowing students the opportunity to gain industry usable skills. Students wrote proposals for their project designs comparing plants grown traditionally by seed or cutting to cell culture and completed lab reports at the end of the semester. The CURE aspect of the course counts for 20% of their grade and involved two connected projects for Fall 2020. The first required the students to design a group experiment that test the effects of stress on plant germination and seedling growth in Fast plants. The students then conducted their replicant of the experiment at home with provided materials. The second project involved an introduction to bioinformatics where the students investigated a plant antioxidant gene and its role in seedling stress.

Cell Biology and Genetics (two courses)
Dr. LaShall Bates, Professor, NorthWest Arkansas Community College

Lecture and Lab for science classes at NWACC are combined into a single course that meets two days a week for a total of 6 hours. Cell Biology and Genetics are foundation classes for a major in biological sciences capped at 24 students. Most of the students in these courses are biology or agriculture majors and will transfer to a 4-year institution. Cell Biology is offered in the Fall and Genetics in the Spring with students normally taking both in succession. The CURE for both courses counts for 25% of the grade. The fall 2020 Cell Biology course was pivoted to online in March and the Genetics course was offered as a synchronous online course Fall 2020. For Cell Biology, the CURE project involved designing and implementing experiments to investigate the effects of plant chemicals on glioblastoma cells. Students grew human glioblastoma cells and treated them with phytochemicals to observe their effects on the cancer cells. Students learned the basics of cell culture and conducted initial experiments but were cut short by the pivot and virtual labs pertaining to the content were used to complete the course. The Genetics CURE was broken into a classical and molecular component. For the classical portion, students performed a traditional but take-home plant breeding project using Fast plants. The molecular portion utilized a cBioPortal project investigating the interaction between specific genes and cancer prognosis.

Introductory Cellular and Molecular Biology
Dr. Jacob Adler, Associate Professor, Brescia University

Students in the class were primarily freshmen taking the second of two required introductory biology classes toward a life sciences major. The laboratory consisted of a single, 2-hour meeting per week throughout the spring semester with a focus on skills in microscopy (2 weeks), pipetting (2 weeks), and data analysis and communication of results of a CURE microscopy experiment (12 weeks). This CURE microscopy experiment served as the major assessment for the course. Students used HeLa human cervical cancer cells to study the induction of lipid droplet formation by the addition of specific long-chain fatty acids. The lipid droplets and other cell markers are then visualized using fluorescence microscopy techniques. In groups of 3-4 students, they performed background research, wrote a research proposal, set-up their experiment, analyzed the results, and communicated their project findings via their own website design.

Cell Biology

Dr. Sarah Swerdlow, Associate Professor, Thiel College

The class is primary either second semester freshman/sophomore biology majors or junior/senior conservation biology majors. The course consisted of three, fifty-five minute meetings and one, three hours lab per week throughout the Spring 2020 semester. It iss a four credit course that provides a molecular approach to cell structure and function. Membranes, transport processes, the central dogma of molecular biology, energetics, regulation and interaction of cellular systems are emphasized. There were 3 tests throughout the semester with the final exam consisting of material that could be considered (test 4) in addition to a cumulative section of the final. The tests and final, were mostly essay, however, a portion on each test was also multiple choice. The cumulative section of the final did not have multiple choice and was primarily focused on the students' ability to incorporate information learned throughout the semester and explain how each of the pieces fit together. The students also had "application" questions and, "pre-class" questions that they were to submit to demonstrate that they had done the readings and were prepared for class. The "pre-class" questions were a great way for the students to ask questions before class so that I could get feedback from even the shy students on what they wanted to go over. The students also created a short video presentation to share with their peers to review concepts for the cumulative portion of the final. A large portion of the grade was also based on the Cell culture project. Students used HL60 human leukemia cells to explore autophagy and apoptosis. The students were graded on a laboratory notebook, laboratory participation, a poster and poster presentation based on their experiments and the "Cell Block" that was a requirement for the CBEC grant.

Cell Culture

Dr. Sumali Pandey, Associate Professor, Minnesota State University Moorhead

The class enrolled 10 students, who were primarily sophomores or juniors in their undergraduate degree plan. The class fulfils the requirement for technique focused, writing-intensive course for students listed in Biochemistry and Biotechnology, Cell and Molecular Biology or Health and Medical Sciences major. The course covers concepts related to technique optimization involving animal cell culture and immunochemistry techniques, emphasizes the principles and practices of initiation, cultivation, maintenance and preservation of cells in culture. The laboratory also imparts skills related to experimental design, troubleshooting, budget preparation, data analysis, project management and teamwork, as student teams design their own project, timeline and deliverables. Before the online pivot due to the pandemic, the class met for two hours and fifty minutes duration, twice a week. The students were also encouraged to come in at their own time to maintain their cells.

The overall objective of this CURE is to assess the effect of fungal toxins and anti-fibrotic drugs on airway remodeling. This project includes interdisciplinary collaboration with an organic chemist who synthesized three different analogues of a potential anti-fibrotic drug as a part of his organic chemistry lab project. The cell culture class served as an excellent platform to extend this project in the context of pulmonary fibrosis. Independently designing experiments and performing cell culture assays is an important student learning outcome for this CURE. However, students in this class had no prior exposure to cell culture-based assays, or to the extent of aseptic techniques and lab math required. To enforce a strong foundation, they started out with a step-by-step, iterative approach. All students were first trained to perform a crystal violet dye-based cell viability assay to investigate the effect of different serum concentrations. In a journal club format, students were exposed to the relevant primary literature. Thereafter, students came up with a rationale and experimental design, and independently executed MTT assays to test the cell viability with an analogue of their choice.

The assessments in this class consisted of: i) Maintaining cells (6%), which included points of aseptic technique and a basic quiz on cell-culture; ii) Technique-focused quizzes (16.5%), which assessed student's knowledge of ELISA (basics and data analysis), Western blotting, Quantitative-Real Time PCR, and basic lab math; iii) Cell viability assays (10%), which included points for writing an experimental plan and cell-viability data analysis; iv) Oral presentations in the lab (7.5%) v) Student Academic Conference abstract and poster presentation (15%); vi) Grant proposal (45%), which included points for two drafts, two peer-reviews and a final proposal.

Senior Capstone Research Course
Dr. Amanda Simons, Professor, Framingham State

Three students were enrolled in a section of our senior capstone research course. The semester-long capstone research experience serves small cohorts of students - typically 3-5 per section - who work with a faculty mentor on an independent research project. Students are introduced to the research topic at the beginning of the semester and spend a few weeks exploring the existing literature and constructing an annotated bibliography as a team. Students grew mammalian cells as a precursor to the molecular techniques of RNA isolation and subsequent qPCR to measure changes in gene expression. Students developed individual research questions about how cells reacted to treatment with resveratrol. They each developed a hypothesis and design (in this case, cell-culture based) experiments to test the hypothesis. Assessment is normally through written assignments (annotated bibliography, experimental design and rationale) and a poster presentation. With the pivot to remote learning, both the wet-lab experience and the assessment plan were disrupted.