PRODUCTION OF CANCER: A LEARNER CENTERED TEACHING APPROACH FOR CELL BIOLOGY CLASS

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Abstract

Learner centered teaching has been shown to improve, at the very least student interest. Our project introduced a learner centered experiment into a traditional lecture style class of Cell Biology as a way to increase not only interest but retention of information.

Cancer is characterized by uncontrolled cell division, cell growth, and an alteration in gene expression. Previous research involving *Agrobacterium tumefaciens* highlighted the use of this pathogenic bacterium as a learning tool for the cell biology curriculum. During the infectious process, *Agrobacterium tumefaciens* inserts its Ti plasmid into wounded plant cells. A portion of this Ti plasmid, T-DNA, contains genes that encode for the production of hormones, cytokinin and auxin, which increases the levels of these hormones already present in the plant. Together these control cell division and cell growth. Once this T-DNA portion is incorporated into the plant cell, the plant cell loses the ability to regulate the normal production of these hormones.

Groups of students within our sophomore level Cell Biology class introduced *Agrobacterium tumefaciens* into wounded tomato stems, causing the formation of tumors. Then each group was able to watch the development of their tumor due to the plant's inability to regulate cell division and cell growth. Further, the class was able to observe the cytological differences of normal and tumorous tissue. This tumorous tissue observed in the plant was then correlated to changes that occur in cancerous tissue of animals. This project allowed each student to direct their own group project, and thus participate in a learner centered activity.

Background

"The benefits of learner centered education include increased motivation for learning and greater satisfaction with school; these outcomes lead to greater academic achievement (1)".

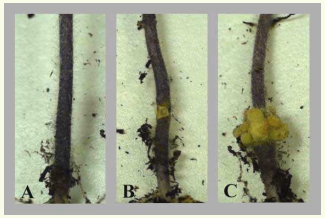
The goal of this project was to provide hands-on activities for students enrolled in a cell biology class knowing that learner centered activities help reinforce the lecture material. We utilized the ability of *Agrobacterium tumefaciens* to induce tumors in tomato plants. We have previously shown that this system mimics cancer in animals in a variety of ways. We are able to see an increase in cell number, changes in shape, size, and changes in nuclei.

A lot of interest has been generated by using active learning techniques to increase retention and understanding of material . "Large-group discussion methods can be used effectively, and pairing, buzz groups, and other peer learning techniques increase the effectiveness of learning in large classes (2)." This project focused on the introduction of such a leaner centered project within our large lecture of cell biology.

References

1. Blumberg, Phyllis. "Developing Learner-Centered Teaching". California: John Wiley & Sons, Inc. 2009.
2. McKeachie, Wilbert J. "Teaching Tips" 9th ed. Massachusetts: D. C. Heath and Company 1994.

Group Tasks

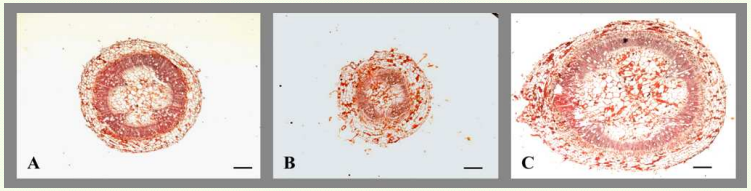


A) Control B) Infected with A136 C) Infected with Wild Type

Task 1: Detail the Size of the Gall Over Time
This task required the group to measure the size of the gall and record that data over the entire semester. Each group was also responsible for recording whether or not the galls ever stopped growing. At the end of the semester, each group was asked to correlate the growth of the gall with the health and size of the plant.

Task 2: After Infection, Collection of Data
After infecting the plants, the students were responsible for collecting data for the entire population of infected plants.
- ***Incidence:* Number of tumors that that form within the population**
- ***Median Time to Tumor*: Time after infection for 50% of the plants to form a tumor**
- ***Multiplicity:* Number of tumors that occur on each plant**

Population of Infected Plants from Fall semester



Task 3: Stain and Check for Cytological Differences That Occur Between Normal and Infected Plants
Pictures of normal and abnormal tissue sections were provided for the students. While the photos were presented to each group, each individual was expected to make his/her own conclusions about the changes that occurred within the tissues and within the individual cells.

Creating a Relationship: Lecture with a Lab

In order to achieve desired effectiveness, each semester the project's schedule was strategically mapped out so that the lecture material and the assigned tasks intertwined. Each semester began with Unit one in lecture covering the introduction of cells. For the project, during this time, the plants were beginning to grow. Unit two introduced DNA , replication, and control mechanisms of replication. Once these topics were presented to the students in lecture, it was time for infection of the plants. After this, the students were introduced to *Agrobacterium tumefaciens* through a PowerPoint presentation describing characteristics of the microbe, the mode of action of infection, and possible changes that might occur in the plants. It was reinforced to the students that *Agrobacterium tumefaciens* causes gall formation because it contains a Ti-plasmid. This is similar to how a virus might be oncogenic. Unit three's lecture material described normal and abnormal tissue organization within animals. Lecture focused on changes within a cell and within the tissue of a tumor, with focus on the disorganization. During this third Unit, the galls of the plants were removed and processed for microscopy. Since this task takes up to 24 hours, the plants were entirely processed outside of class and samples were provided for the students and their groups. Unit four lecture material discussed cellular division and its control mechanisms, and how they can go awry in cancer. Each student wrote their conclusions for the project by comparing normal/ abnormal tissues in the plants and analyzing if these changes were similar to changes in animal cancers.

Students were provided information via in-class discussion, in-class PowerPoint presentations and supplemental videos. Assessments were made via Moodle. These Moodle assignments were a combination of multiple choice questions and essay components. In the Fall semester, a large writing assignment was required.

Sample Assessment Questions :
1. ***Agrobacterium tumefaciens* takes on a specific role in a plant. What is this role?**
2. **In order to infect, why did the plant have to be wounded first?**
3. **Would we expect the same results if we were to use any bacteria? Why or why not?**

Approaching Learner Centered Project

Each semester began by introducing the project and its purpose: "Create neoplastic tissue (tumors) to form in tomato plants. Follow the changes over time in the tumorous and compare those changes to known changes that occur in animal cancers". Students were divided into groups the first week of class in both semesters. This was then followed by an in-class discussion of the project expectations, both as groups and individuals. From this, the students were able to understand the importance of teamwork for this project. Each member would be relying on the others to do their part of the project. Not only did the students work together to complete the tasks at hand, but they were also given opportunities to confer their own understanding.

During the Fall semester, the project required the students meet in a lab outside of the classroom. Each student was responsible for one specific task assigned by their group members. For example, one student was responsible for going to the lab to measure and record the height of the plant at least once every two weeks. That student was also responsible for relaying that information to the other group members during lecture time.

During the Spring semester, the groups met exclusively during class time and more frequently than before. All of the tasks were completed during class time (except infection due to safely concerns). As observations were being made about changes, the group members were more involved. For example, after infection the leaves of the experimental plants began to yellow. Since all members of the group were witness to the changes, all could work together to hypothesize a reason for the changes.

Fall Semester
- **24 groups of 6 to 7 students**
- **Weekly meetings in a lab setting**
- **Tasks divided between the members**
- **Complete lab report due**

Spring Semester
- **25 groups of 3 students**
- **Bi-weekly groups in class before lecture**
- **Tasks weighted equally on group**
- **Sections of lab report due periodically**

Conclusions and Future Directions

This system worked well in a lecture setting and is ideal for a one credit lab course. Until a lab course is offered, safety is a concern; therefore, we are planning to develop this into a virtual lab.

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