

Teaching and Learning in Upper-level Plant Physiology and Development laboratory courses during the COVID-19 pandemic

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INTRODUCTION TO PLANT PHYSIOLOGY AND PLANT DEVELOPMENT COURSES

Two upper-level undergraduate Plant Physiology laboratory courses (BIOL 351 and BIOL 352) were transformed and offered as either as both hybrid and online (web-based) courses during the COVID-19 pandemic (2020-22):

- BIOL 351 and BIOL 352 courses have both lecture and laboratory components
- BIOL 351 focuses on the processes contributing to the assimilation, transport and utilization of water, mineral nutrients and carbon by plants
- BIOL 352 focuses on the processes involved in growth and development
- Third- and fourth-year undergraduate students from the faculties of Science, Forestry and Land & Food Systems take these courses
- Some Botany and Forestry graduate students also enrol in these courses.
- Students take these courses to fulfil their third/fourth year Biology laboratory requirement

OBJECTIVES

- Teach and learn how to use the online format for Plant Physiology undergraduate research
- Design independent, open-ended group research project experiments
- Teach students how to analyze the research data
- Teach students how present the research project results in the form of 3-Minute Thesis* (3MT) presentations and written reports
- Solicit students' feedback on their research experience

RESEARCH ACTIVITIES AND LEARNING GOALS

Components	In Lab/Online activities	Learning Goals
Experimental: Guided investigations in the Plant Physiology	Short Plant Physiology lab investigations (Note: All lab experiments were conducted by TAs; short videos of lab experiments were uploaded)	<ul style="list-style-type: none"> • Learn key plant physiological lab techniques and methods • Construct hypotheses and predictions • Practice process of science
Experimental: Authentic, Independent research project	Independent research projects: Lab and/or field experiments (Note: All lab experiments were conducted by TAs; short lab videos were uploaded)	<ul style="list-style-type: none"> • Advance and learn new laboratory skills • Work collaboratively in groups • Data analysis
Critical thinking: Research Project proposal	Literature search and research proposal design Each group proposes own project	<ul style="list-style-type: none"> • Advance information literacy and information synthesis skills • Construct hypothesis by seeking knowledge on own • Collaborative work
Critical thinking: working with data	Each student analyzes own experimental data	Learn skills in analysis, synthesis, and expression of data
Scientific Communication (Written)	One Research proposal by each student group One Short communication and one Full-length Scientific research paper	Learn and advance skills in: <ul style="list-style-type: none"> • recording observations and data • appropriate use of literature • scientific writing
Scientific Communication (Oral)	Online oral research presentations (based on "Three-Minute Thesis or 3MT")	Learn and advance skills in: <ul style="list-style-type: none"> • oral communication style • comprehension • engagement

UNDERGRADUATE RESEARCH EXPERIENCE

Online Resources for Undergraduate Plant Physiology Labs

Short videos and photographs of plant biology laboratory methods and research experiments were created and uploaded on Canvas course website.

Zoom sessions were used for all lab lectures, discussions, office hours.

Piazza discussion board was used for posting questions and answers.

Students gave online and in person Three-minute Thesis (3MT) research presentations, and submitted their research proposals and reports online on course website.

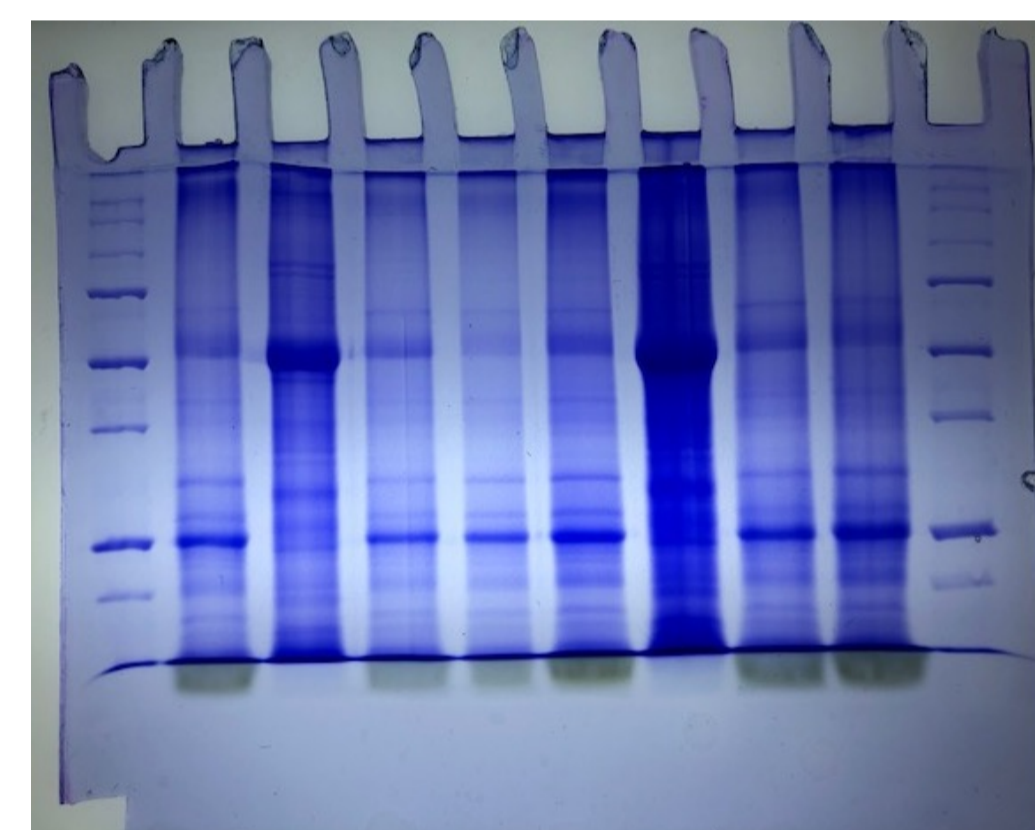
EXAMPLES OF UNDERGRADUATE RESEARCH PROJECTS



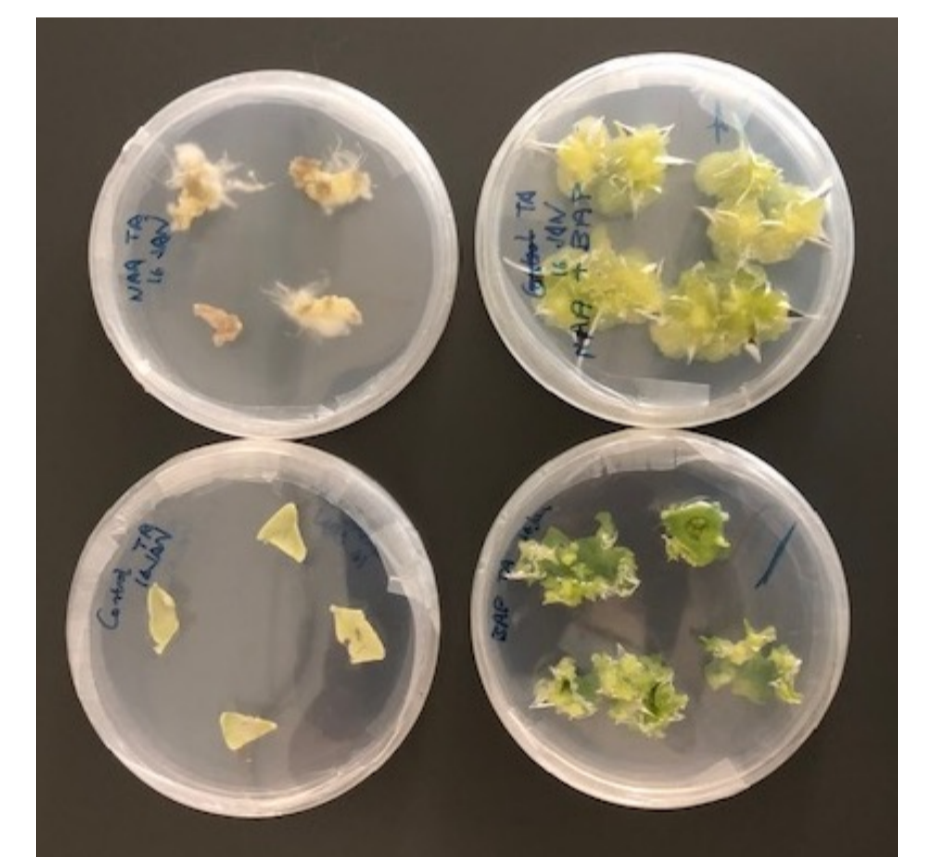
Plant stress physiology



Plant Genetic transformation



Leaf protein profiles



Plant Tissue culture

STUDENT FEEDBACK

"This semester was unique because the first part was fully online, then transitioned to in person. I found that the labs online, while still helpful, were not nearly as helpful as being in person."

"Even though we couldn't have in-person labs due to Covid-19, Dr. Singh was able to virtually deliver the lab to us smoothly."

"I do wish to have been able to do the labs in person but Dr. Singh did a great job at still providing us with enough knowledge to be able to the labs in the future if we ever get a chance."

"Improvements: perhaps more explanations about the techniques could help build a more solid picture of lab work."

Conclusions and Significance

1. A number of online laboratory resources e.g. short videos, photographs were developed during the COVID-19 pandemic. These resources can potentially be used as teaching tools for teaching undergraduate Plant Physiology and Plant Development labs.

2. Several online lab activities e.g. lab lectures, discussions, Q&A sessions worked really well.

3. There is a need for the "in person" component for students to gain full practical experience by conducting their research experiments.

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Three Minute Thesis (3MT) – Founded by the University of Queensland:
<http://threeminutethesis.org/>