

# 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
<b>Experimental:</b> 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"> <li>• Learn key plant physiological lab techniques and methods</li> <li>• Construct hypotheses and predictions</li> <li>• Practice process of science</li> </ul>
<b>Experimental:</b> 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"> <li>• Advance and learn new laboratory skills</li> <li>• Work collaboratively in groups</li> <li>• Data analysis</li> </ul>
<b>Critical thinking:</b> Research Project proposal	Literature search and research proposal design Each group proposes own project	<ul style="list-style-type: none"> <li>• Advance information literacy and information synthesis skills</li> <li>• Construct hypothesis by seeking knowledge on own</li> <li>• Collaborative work</li> </ul>
<b>Critical thinking:</b> working with data	Each student analyzes own experimental data	Learn skills in analysis, synthesis, and expression of data
<b>Scientific Communication (Written)</b>	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"> <li>• recording observations and data</li> <li>• appropriate use of literature</li> <li>• scientific writing</li> </ul>
<b>Scientific Communication (Oral)</b>	Online oral research presentations (based on "Three-Minute Thesis or 3MT")	Learn and advance skills in: <ul style="list-style-type: none"> <li>• oral communication style</li> <li>• comprehension</li> <li>• engagement</li> </ul>

## 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.

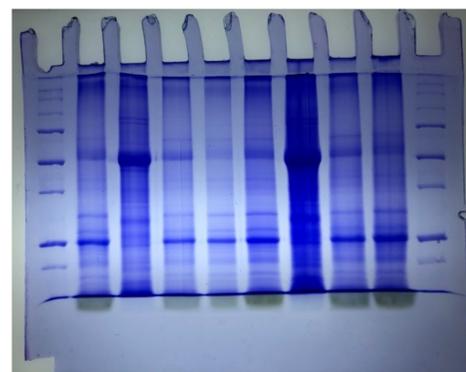
## EXAMPLES OF UNDERGRADUATE RESEARCH PROJECTS



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/>