

Overall Objective

Provide a virtual laboratory environment where students design experiments in order to answer scientific questions related to photosynthesis and cell respiration.

Labs at a Glance

	Question	Lab Context	Independent Variable	Dependent Variable	Learning Goal
Tree Lab	Where does the mass of a growing plant come from?	Potted plant grown indoors for 5 years.	N/A (observational study)	N/A (observational study)	The increase in mass of a growing plant does not come from the soil.
Light Lab	How does the amount of light seedlings receive affect how large they grow?	Seedlings grown in trays in a laboratory for 10 days.	Amount of Light	Plant Height	Plants need sunlight to photosynthesize and increase in height/mass.
Bee Lab	How do the amount of plants in a terrarium affect the survival of bees?	Plants grown in terraria in a laboratory, under domes containing bees for 10 hours.	Number of Plants	Number of Living Bees	The oxygen that plants release through photosynthesis is needed by animals like bees to survive.
Farm Lab	How do atmospheric CO ₂ levels impact crop yield?	Analyze historical climate data from a global location for 90 days of a growing season.	CO ₂ Levels in atmosphere	Crop Yield in metric tons	Increased CO ₂ levels increase the rate of photosynthesis.
Rotten Lab	How do oxygen levels in packaging affect food freshness?	Harvested produce shipped in cold storage over the course of 20 hours.	O ₂ Levels in packaging	Drops of Condensation, and Measured Weight Loss of produce	Plants need O ₂ to respire and use the stored glucose made from photosynthesis. Lower O ₂ levels will keep food fresh longer.

General Lab Instructions

- Before setting up the experiment and collecting data, students select a hypothesis.
- Once they enter the "lab" and set up their conditions, students tap the play button in the upper right hand corner to advance through the next time increment and collect data.
- If at any point during data collection students opt to change a variable, the data collection restarts from the beginning.
- Once data collection is finished, students are prompted to "Complete the Lab Report."

General Lab Report Instructions

- To complete the Lab Report, all three tabs, which are along the bottom, must be filled out. This will require three different kinds of interactions:
 - Tapping on the answer to a multiple choice question.
 - Typing a response to an open ended question. Since this pops up the keyboard on the iPad screen, the user will need to hit the [down keyboard] icon.
 - Graphing the lab data. In the Lab Results section under Graph Data, the student taps "Edit" in the upper left hand corner, and is prompted to supply a graph title, select a graph type, and specify which variable plots to each of the x-axis and the y-axis. Tapping "Done" renders an illustration of the graph based on the student choices. Changes can be made by tapping again on the Edit button.

N.B. Once in the Lab Report section, if you return to the Lab by tapping "<Lab" in the upper left hand corner, you will be required to collect your data again from the beginning. Also, if for any reason you quit the app while in the Lab or Lab Report, you will need to re-run the data collection in order to complete your work.

Labs by Section

Tree Lab (in Carbon Cycle)

Type: Observational study

Question: Where does the mass of a plant come from when it grows?

Hypotheses:

- The mass of the growing plant comes primarily from the soil.
- The mass of the growing plant does NOT come primarily from the soil.

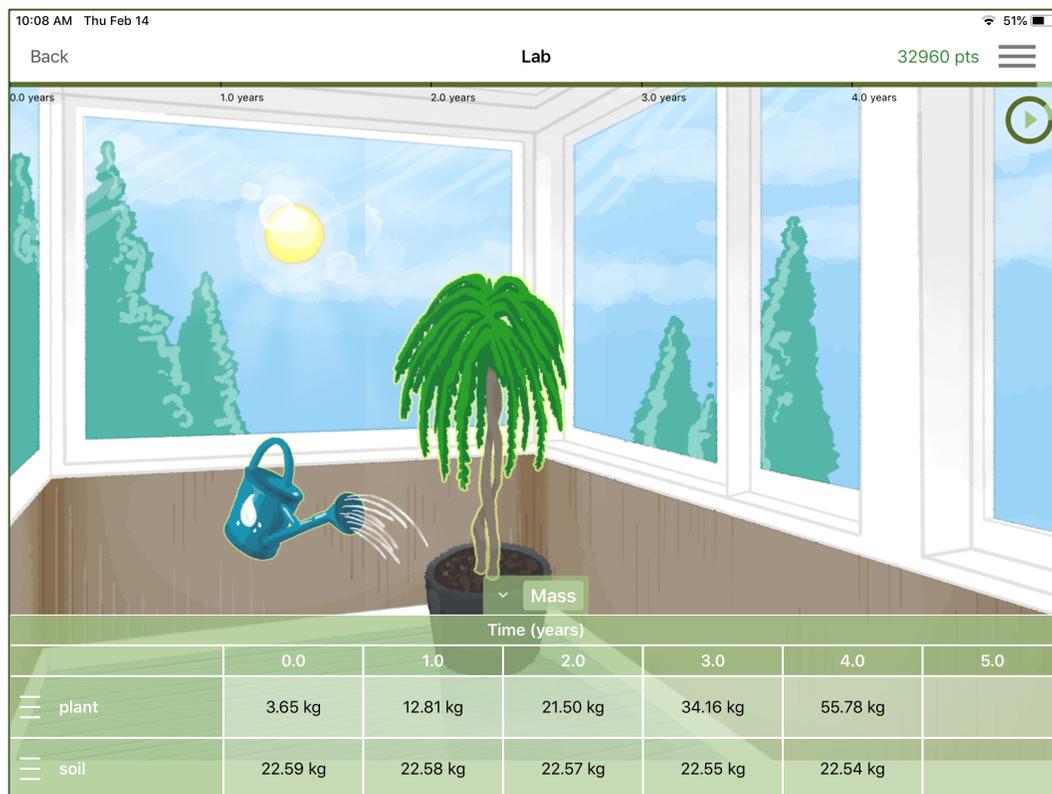
Context: Potted plant grown indoors on a sun porch for 5 years.

Variables: Since this is an observational study, there are no variables to adjust.

Simulated Lab Duration: 5 years (in 1-year increments)

Key Concept: Hypothesis.

Learning Goal: The increase in mass of a growing plant does not come from the soil.



Light Lab (in Capture Light)

Type: Controlled Experiment

Question: How does the amount of light seedlings receive affect how large they grow?

Hypotheses:

- Seedlings will grow largest when they receive a small amount of light.
- Seedlings will grow largest when they receive a large amount of light.
- Seedlings will grow the same size regardless of the amount of light.

Context: Seedlings corresponding to the user's selected crop, grown in trays in a laboratory.

Number of Conditions: 2 seedling trays.

Independent Variable: Amount of light. User taps the light to set the level.

Dependent Variable: Height of plant.

Potentially Confounding Variable: Amount of water. User able to set water level by tapping the watering pots.

Simulated Lab Duration: 240 hours (in 48-hour increments).

Key Concepts: Independent and Dependent Variables; Conditions.

Learning Goal: Plants need sunlight to photosynthesize and increase in size.



Bee Lab (in Break Water)

Type: Controlled Experiment

Question: How do the amount of plants in a terrarium affect the survival of bees?

Hypotheses:

- Bees will survive longest when there are the least number of plants inside the terrarium.
- Bees will survive longest when there are the greatest number of plants inside the terrarium.
- Bees will survive the same amount of time regardless of how many plants are inside the terrarium.

Context: Plants grown in terraria with bees, in a laboratory.

Number of Conditions: 2 terraria.

Independent Variable: Number of plants. User taps the seed trays to select the number of plants.

Dependent Variable: Number of bees. Each terrarium starts with 3 bees.

Potentially Confounding Variable: Amount of light. User able to set light level by tapping the light.

Simulated Lab Duration: 10 hours (in 2-hour increments).

Learning Goal: The oxygen that plants release through photosynthesis is needed by animals like bees to survive.



Farm Lab (in Make Sugar)

Type: Natural Experiment

Question: How do atmospheric CO₂ levels impact crop yield?

Hypotheses:

- Crop yield will be highest when atmospheric CO₂ levels are high during the growing season.
- Crop yield will be lowest when atmospheric CO₂ levels are high during the growing season.
- Crop yield will not depend on atmospheric CO₂ levels during the growing season.

Context: Use historical data to compare how crops grow at one global location in different years with varying CO₂ levels.

Number of Conditions: 3 separate growing seasons.

Independent Variable: CO₂ levels in the atmosphere.

Dependent Variable: Crop yield in metric tons.

Control Variables: Amount of Sunlight, Temperature; Precipitation (since this is a natural experiment using historical data, the user cannot modify these variables).

Simulated Lab Duration: 90 days (in a single increment).

Learning Goal: Increased CO₂ levels increase the rate of photosynthesis.



Rotten Lab (in Use Sugar)

Type: Natural Experiment

Question: How do oxygen levels in packaging affect food freshness?

Hypotheses:

- Produce will be freshest when it is packaged with oxygen below normal atmospheric levels (<21%).
- Produce will be freshest when it is packaged with oxygen at normal atmospheric levels (=21%).
- Produce will be freshest when it is packaged with oxygen below above atmospheric levels (>21%).

Context: Harvested produce shipped in cold storage.

Number of Conditions: 2 shipping containers.

Independent Variable: Oxygen levels in the packaging.

Dependent Variable: Drops of Condensation, and Produce Weight Loss (two observable phenomena that act as proxies for rate of respiration).

Simulated Lab Duration: 20 hours (in 4-hour increments).

Learning Goal: Plants need oxygen and use stored glucose to respire. Higher rates of water condensation (a product of respiration) and loss of mass (a sign of glucose being used up during respiration), signal higher rates of respiration.

