Plant Photosynthesis and Respiration

Purpose

Using Arduino micro-controllers with "Lab in Your Pocket" app to verify the rate of photosynthesis and respiration of plant in illuminated and dark environment.

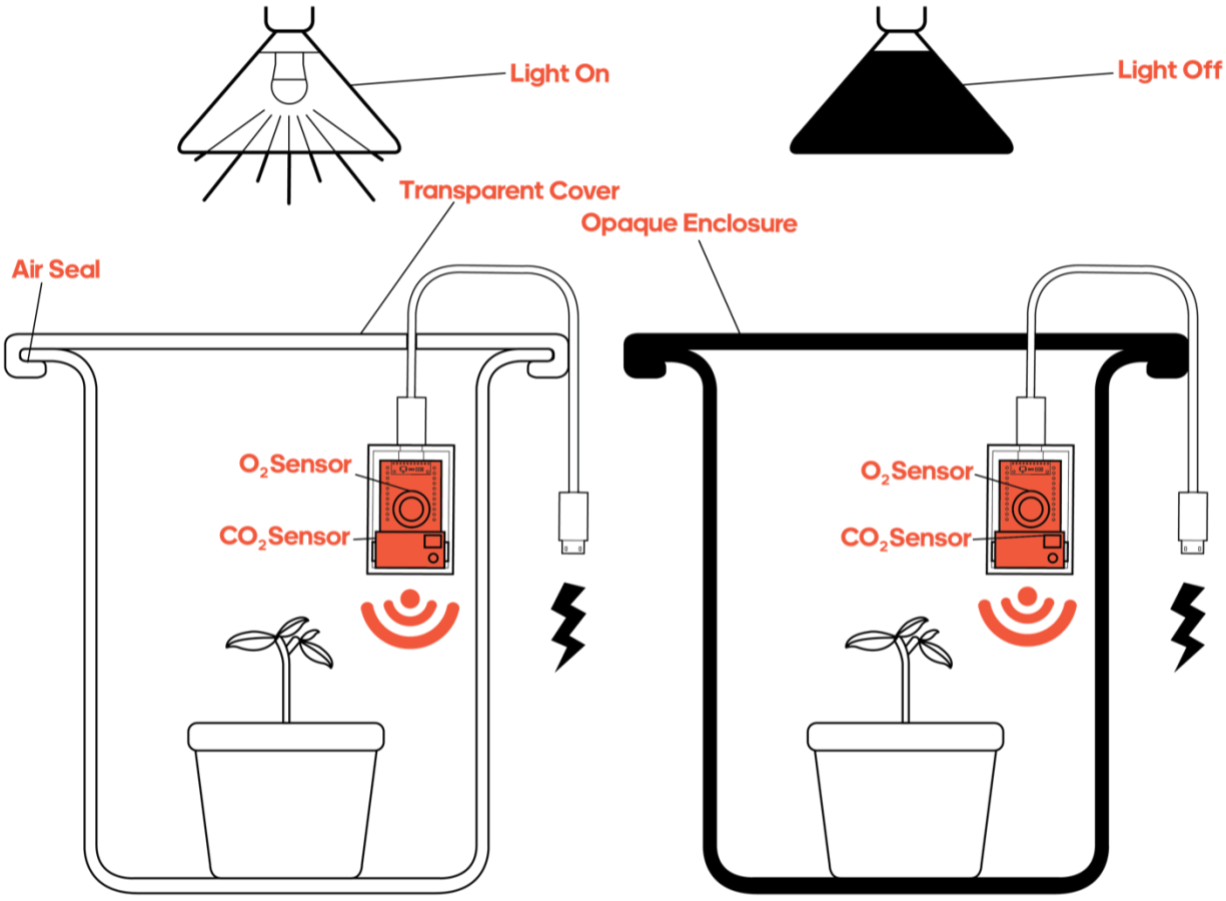
Theory

- Plants undergo photosynthesis when exposed to light. In the meantime, respiration also takes place within the plant cells. Depending on the light intensity of the surrounding, the relative rates of photosynthesis and respiration change from time to time.
- With sufficient light: photosynthesis takes place faster than respiration.
  With dim light: photosynthesis occurs approximately the same rate as respiration.
  With darkness: very low photosynthesis but respiration still takes place.
- The equation of photosynthesis is $CO_2 + H_2O + light \rightarrow glucose + O_2$.
- The equation of respiration is $O_2 + glucose \rightarrow CO_2 + H_2O + energy$.
- The Sun is regarded as the ultimate source of energy for all living organisms on Earth. With plants converting energy from sunlight into storage of fruit, the food chain is fundamentally supported.
- To testify the contribution of light towards photosynthesis, the experiment is designed to observe the amount of O_2 and CO_2 that represent the relative rate of photosynthesis and respiration respectively under different levels of illumination.

Apparatus

- A power bank of D.C. electricity supplies with appropriate voltage (i.e. no more than 5V)
- A mobile device with "Lab in Your Pocket" app
- An Arduino O_2 and CO_2 sensor (provided by PolyU)
- A plant of appropriate size
- A transparent and an opaque environment
- Optional: An Arduino light sensor (provided by PolyU)

Experimental Set-up



Precautions

1. The sensor gives data with a time delay.

Procedure

1. Keep the plant and the sensor together completely inside the sealed transparent environment, with the power cable through it. Leave the cable head outside for connection to the power bank. Put the plant under a static light source.
2. Open “Lab in Your Pocket” app in the mobile device and choose “Environmental Monitoring”.
3. Connect the O_2 and CO_2 sensor to a 5V power supply.
4. (Optional: Connect the light sensor to record the light intensity of the environment.)
5. Tick only the O_2 and CO_2 sensor. Register the sensor with the addresses printed on the sensors. Press “Connect” to connect the sensors. When the connection finishes, the app will automatically jump into a monitoring interface showing the data retrieved from the connected sensor.
6. Wait for 15 minutes and record the data in the data sheet below. Then shut down the sensor and the app.

7. Keep the setup under illumination for 3 hours and reconnect the sensor to the app. Record the data and then shut down the sensor and the app.
8. (Optional: Turn down the light source and repeat the step.)
9. Keep the setup in the sealed opaque environment for 3 hours. Reconnect the sensor to the app and record the data.
10. Compare the data and draw a conclusion on the experiment.

Data

Location: _____

Condition	Date and Time	O_2 Level	CO_2 Level	Light Intensity (Optional)
Start of Experiment				
3 Hours under Light				
3 Hours under Dim Light (Optional)				
3 Hours in Darkness				
Other:				

Discussion

1. When the sensor was first connected, were the readings consistent to our understanding of atmospheric composition?
2. How do O_2 and CO_2 levels change under light and in darkness? What had happened when the plant was put under illumination and in darkness?
3. How does light intensity affect the rate of photosynthesis of plant?
4. What are the possible errors of this experiment? Does it affect the observation?
5. Optional: If light intensity sensor was also used in the experiment with more different light intensity levels, how does the rate of photosynthesis vary with amount of light?