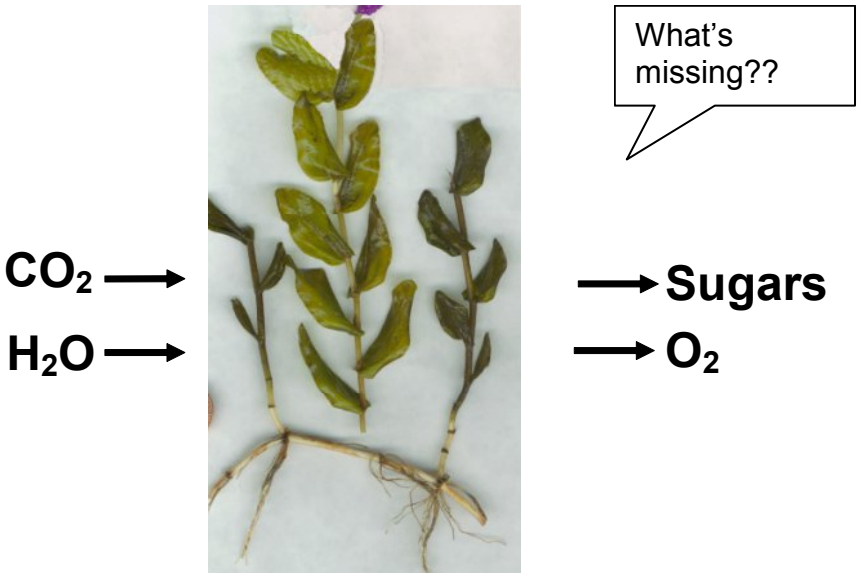
Photosynthesis and Respiration in Submersed Aquatic Vegetation

Background

Plants capture light and convert it to chemical energy (food) through a process called photosynthesis. A pigment contained in the plant cells, chlorophyll, captures the light energy and transfers it to a chemical called adenosine tri-phosphate (ATP). This energy is then used by the plant to make sugars and other molecules we commonly call "food". Without this process the only things you would have available to you to eat are salt and water. All other foods originate in one way or another from plants.



Submersed Aquatic Vegetation or SAV is a type of plant that grows completely underwater. In fact, if left out of the water for any length of time, it will dry up and die.

Scientists can determine the amount of light required for SAV survival and growth by measuring the amount of oxygen the plant produces under varying light levels. Here we will use the same technique to explore the relationship between light and photosynthesis in a species of SAV (Potamogeton perfoliatus or redhead grass) found in the mid-salinity waters of the Chesapeake Bay. We will determine the relative rate of photosynthesis by measuring the change in oxygen produced over time, using an oxygen

Overall objective

To explore the amount of light required for photosynthesis by an aquatic plant.

Methods

Students will divide into groups of 4-5 students per group. Each group will be provided with 3 bottles:

Bottle A is unshaded (100% light),
Bottle B is shaded 50% of ambient light,
Bottle C is completely darkened (0% light)

One group will be the "control" group.

Figure 1: Bottle setup for photosynthesis experiment

Part A. Determining the Initial oxygen concentration

1. Fill each labeled bottle with filtered river water to overflowing from bucket provided.
2. a. Plant Groups: Place three 10 cm. segments of SAV plants in bottles.
   b."Control" Group: Fill bottles with water. Do NOT add plant to bottle.
3. Place a stir bar into each bottle.
4. Place bottle on stir plate and set stirring speed so that the water is significantly stirred.
5. Immediately have the instructor measure the initial oxygen concentration of all bottles using the oxygen meter.
6. Tightly cap your bottles and place in a water bath for at least 1 hour (note the time).
7. For shaded bottle (B), add shade cover before placing bottle in water bath.
8. Record your oxygen readings (mg/l) under the Initial O2 column on the data sheet.

Light Bottle

Shade Bottle

Dark Bottle

Part B. Determining the Final oxygen concentration

1. After an incubation period of at least one hour, retrieve your bottles from the water bath and note the time.
2. Have the instructor measure the oxygen concentration in each of the bottles.
3. Record the oxygen readings (mg/l) in the Final O2 column of the data sheet.

Results: Data Analysis

Part C. Determining Photosynthesis in relation to light level

1. Calculate the change in oxygen as by subtracting the Initial O2 from the Final O2.
2. Obtain data from the control group and record readings from the "blank" bottles on your data sheet.
3. Use the data from the control bottles to correct your readings by subtracting the change in oxygen in the blank bottles from the corresponding readings in all three experimental bottles.
4. Each group is considered a replicate. On your data sheet, average the data from all three groups for each light level to determine the average oxygen change.
5. Graph your results to show the relationship between light and photosynthesis as measured by the change in oxygen.

Example:

Bottle #	Initial O2	Final O2	O2 Change
A. Light	7.0	9.0	+2.0
B. Shade	7.0	8.0	+1.0
C. Dark	7.0	5.0	-2.0
Control Light	7.0	7.1	+0.1
Control Shade	7.0	7.1	+0.1
Control Dark	7.0	6.9	-0.1

Correction for Control (O2 Change - Control)	
A. Light	+2 - (+0.1)=+1.9
B. Shade	+1.0-(+0.1)=+0.9
C. Dark	-2.0-(-0.1)=-1.9

Photosynthesis Data Sheet

Date:_____Team Name:_____

Oxygen Reading (mg O2/l)

Record your initial and final oxygen readings from your bottles below. Once you have recorded the final readings, calculate the change in oxygen. Make sure to indicate with a minus sign (-) if the oxygen change is negative (if the oxygen concentration decreased) and + if the oxygen increased.

Initial Time:_____Final Time:_____

Bottle #	**Initial O2**	**Final O2**	**O2 Change** (Final O2 – Initial O2)
Plant Light	_____	_____	_____
Plant Shade	_____	_____	_____
Plant Dark	_____	_____	_____
Control Light	_____	_____	_____
Control Shade	_____	_____	_____
Control Dark	_____	_____	_____

Correction for Control

In this section, subtract the change in oxygen in your control bottles from the change in oxygen in your bottles containing plants. Remember that subtracting a negative is adding a positive [1- (-1)=2].

	O2 Change	**–**	**Control O2 Change**	**=**	**Final O2 Change**
Light	_____	-	_____	=	_____
Shade	_____	-	_____	=	_____
Dark	_____	-	_____	=	_____

Data From Other Teams: Final O2 Change (mg O2/l)

Copy the Final O2 Change data from the other teams and then calculate the Average O2 Change.

Team Name:	_____	_____	_____	**Average**
Light	_____	_____	_____	_____
Shade	_____	_____	_____	_____
Dark	_____	_____	_____	_____

Questions and Conclusions

1. What were the “control” and variables for this experiment?

2. How do you know photosynthesis was occurring?

3. What effect did shading have on the photosynthesis of SAV? Explain your answer.

4. Was photosynthesis occurring in the dark bottles? Explain your answer.

5. Formulate a conclusion for your experiment based on the data obtained.

6. What are the physical conditions needed for SAV growth?