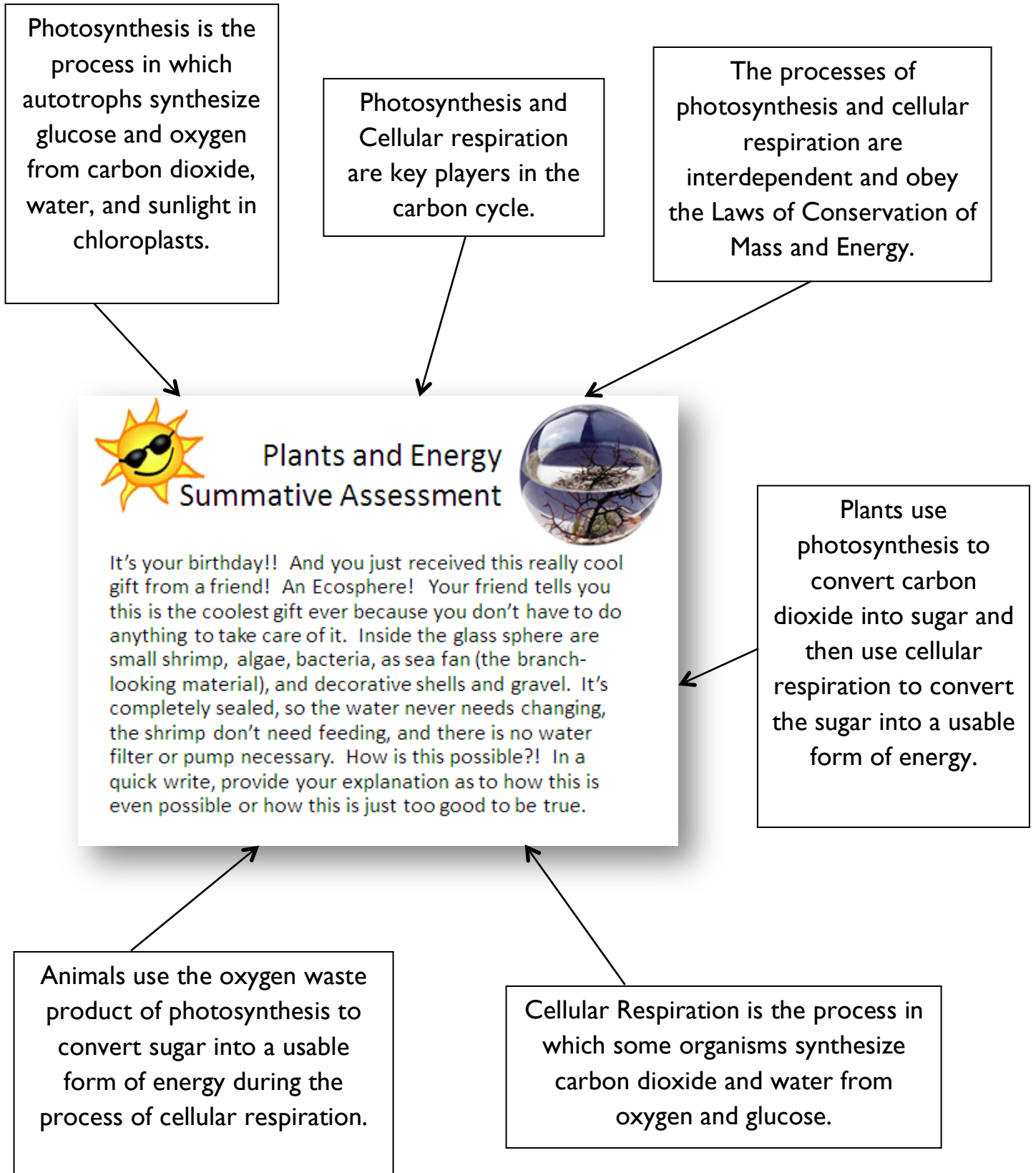


## BUOI I: Plants and Energy Unpacked

On a scale of 1-5 rate your level of understanding for each statement.



It's your birthday!! And you just received this really cool gift from a friend! An Ecosphere! Your friend tells you this is the coolest gift ever because you don't have to do anything to take care of it. Inside the glass sphere are small shrimp, algae, bacteria, a sea fan (the branch-looking material), and decorative shells and gravel. It's completely sealed, so the water never needs changing, the shrimp don't need feeding, and there is no water filter or pump necessary. How is this possible?! In a quick write, provide your explanation as to how this is even possible or how this is just too good to be true.



# PLANTS AND ENERGY (RESPIRATION AND PHOTOSYNTHESIS) 18

**W**e all know that we need oxygen in order to survive. We know this because the air we inhale contains approximately 21% oxygen ( $O_2$ ), but the air we exhale only contains approximately 15% oxygen. We use the oxygen that we get from the air to convert sugar into energy. In fact, we can only survive for a few minutes without oxygen—it is *that* important.

We also know that other animals, such as dogs, birds, and even whales, use  $O_2$  to produce energy. We can see them inhale and exhale air out of their lungs just as we do. Even animals that don't have lungs, such as snails and crickets, use oxygen to produce energy and give off  $CO_2$  as a waste product. It is a unifying characteristic of all animals.

These observations and underlying explanations raise an interesting question: Do plants use  $O_2$  to convert the sugar (which they produce using photosynthesis) into energy and release  $CO_2$  as a waste product as animals do?

Here are three potential answers to this question:

- **Explanation 1:** Plants do not use oxygen as we do. Plants only take in carbon dioxide and give off oxygen as a waste product because of photosynthesis. This process produces all of the energy a plant needs, so they do not need oxygen at all.
- **Explanation 2:** Plants take in carbon dioxide during photosynthesis in order to make sugar, but they also use oxygen to convert the sugar into energy. As a result, plants release carbon dioxide as a waste product all the time just as animals do.
- **Explanation 3:** Plants release carbon dioxide all the time because they are always using oxygen to convert sugar to energy just as animals do. Plants, however, also take in carbon dioxide and release oxygen when exposed to light.

## Getting Started

You can use the following materials to test these three explanations:

- Elodea (an aquatic plant with leaves)
- Aquatic snails
- Water
- Test tubes
- Rubber stoppers (that fit tightly in the test tubes) or parafilm

## SECTION 2: EVALUATE ALTERNATIVES

# 18 PLANTS AND ENERGY

- Two large beakers (to hold the test tubes)
- Light source (and a dark place to store some of your test tubes)
- Bromthymol blue (BTB) (BTB is a pH indicator, which means it changes color as the pH of a liquid varies. It is yellow in acidic conditions, green in neutral conditions, and blue in basic conditions. When  $\text{CO}_2$  reacts with water, it produces a weak acid—the more  $\text{CO}_2$ , the more acidic the water gets.)
- Phenol red (Phenol red is an indicator solution. It is yellow in acidic conditions, pink in basic conditions, and orange in neutral conditions. The pH of water is affected by the presence of  $\text{CO}_2$ . If  $\text{CO}_2$  concentrations increase, phenol red will change from pink to yellow.)

**Safety notes:** Wear indirectly vented chemical-splash goggles, aprons, and gloves. Do not touch the light source as it can burn skin. Wash hands with soap and water after completing the activity.

With your group, determine which explanation provides the best answer to the research question. You can use as many of the supplies available to you to test your ideas. Make sure that you generate the evidence you will need to support an explanation and refute the others as you work. You can record your method and any observations you make in the spaces below.

### **Our Method**

### **Our Observations**

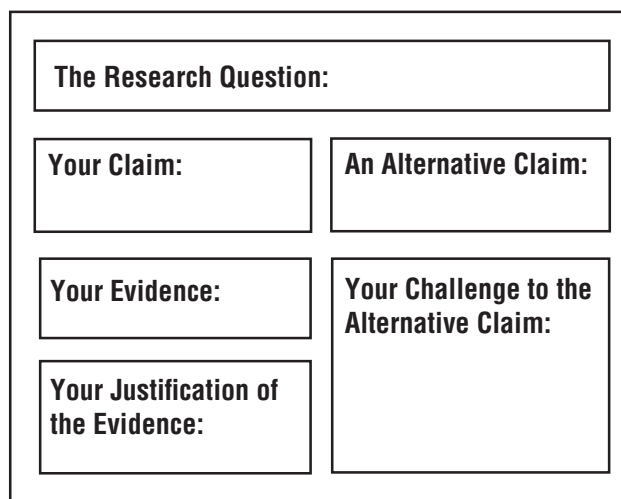
## Argumentation Session

Once your group has decided which explanation is the most valid or acceptable answer to the research question, prepare a whiteboard that you can use to share and justify your ideas. Your whiteboard should include all the information shown in Figure 18.1

To share your work with others, we will be using a round-robin format. This means that one member of the group will stay at your workstation to share your group's ideas while the other group members go to the other groups one at a time in order to listen to and critique the arguments developed by your classmates. Remember, as you critique the work of others, you need to decide if their conclusions are valid or acceptable based on the quality of their claim and how well they are able to support their ideas. In other words, you need to determine if their argument is *convincing* or not. One way to determine if their argument is convincing is to ask them some of the following questions:

- How did you gather your data? Why did you decide to do it that way?
- How do you know your data is high quality (free from errors)?
- How did you analyze or interpret your data? Why did you decide to do it that way?
- Why does your evidence support your claim?
- Why did you decide to use that evidence? Why is your evidence important?
- How does your justification of your evidence fit with accepted scientific ideas?

Figure 18.1. Components of the Whiteboard



## SECTION 2: EVALUATE ALTERNATIVES

Name \_\_\_\_\_ Date \_\_\_\_\_

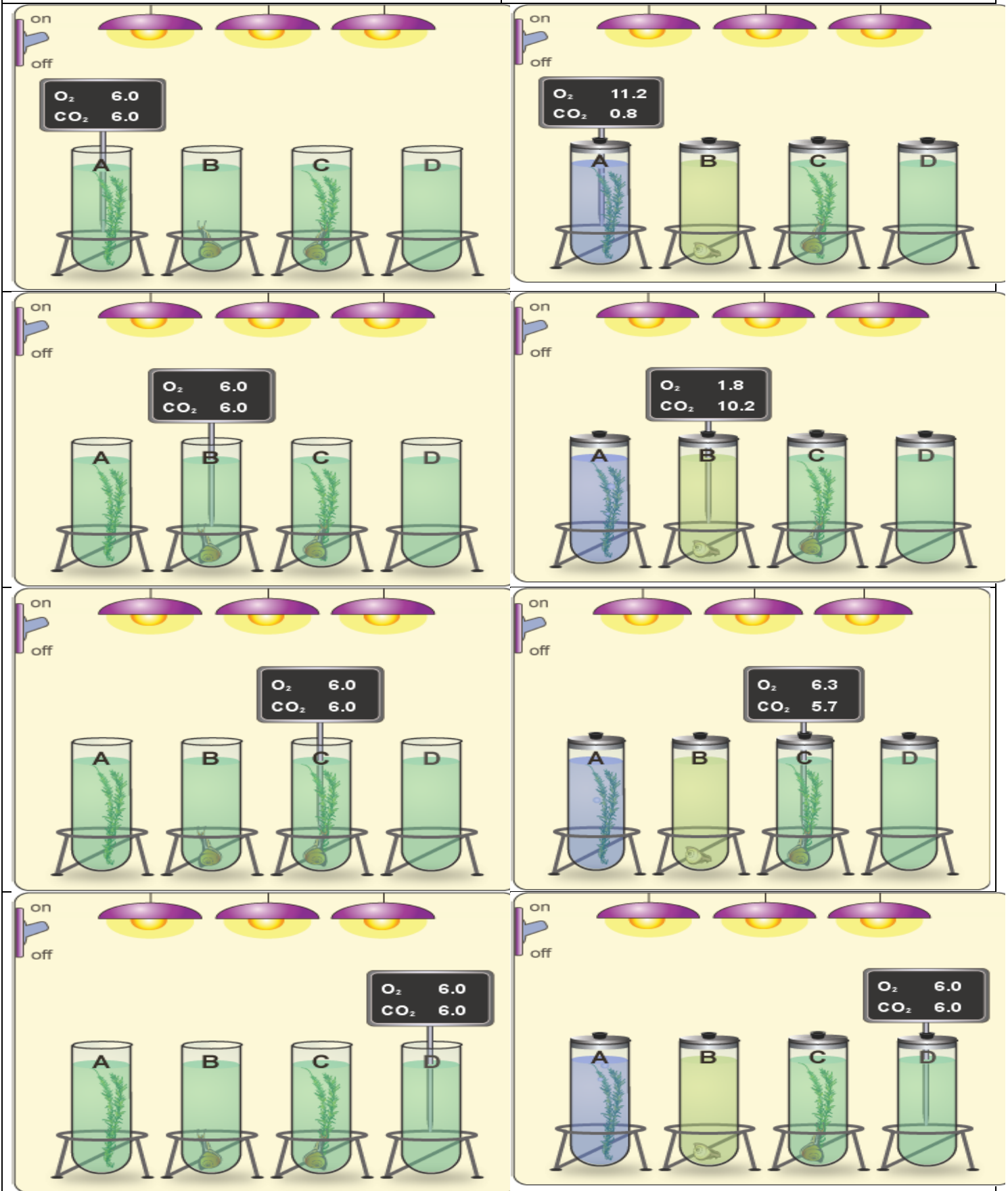
### PLANTS AND ENERGY: **What Is Your Argument?**

In the space below, write a one- to three-paragraph argument to *support* the explanation that you think is the most valid or acceptable. Your argument must also include a *challenge* to one of the alternative explanations. As you write your argument, remember to do the following:

- State the explanation you are trying to support
- Include genuine evidence (data + analysis + interpretation)
- Explain why the evidence is important and relevant
- State the explanation you are trying to refute
- Explain why the alternative explanation is invalid or unacceptable
- Organize your argument in a way that enhances readability
- Use a broad range of words including vocabulary that we have learned
- Correct grammar, punctuation, and spelling errors

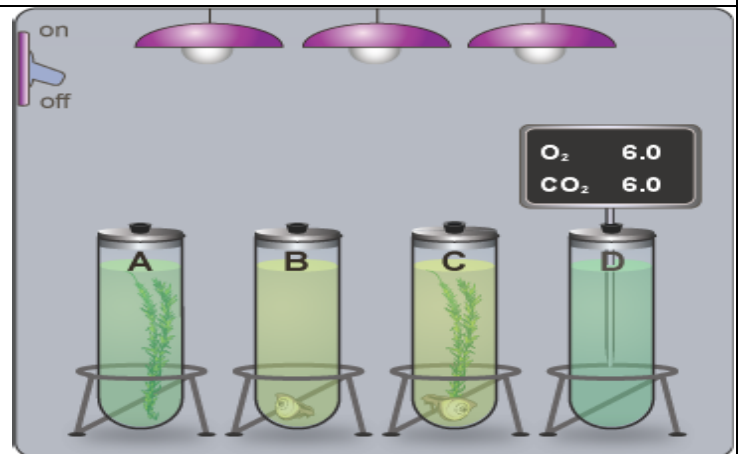
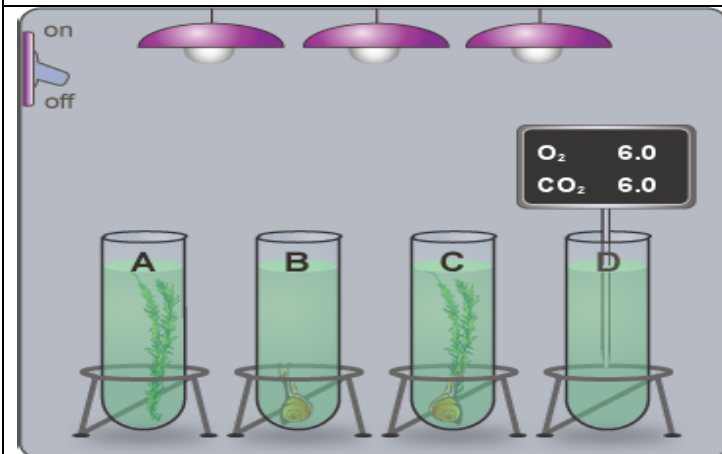
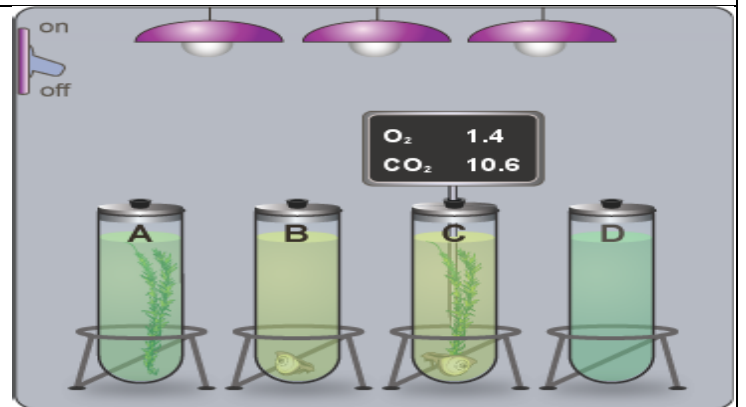
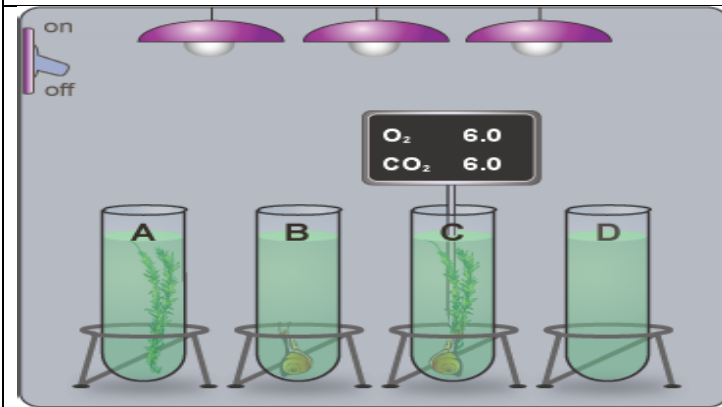
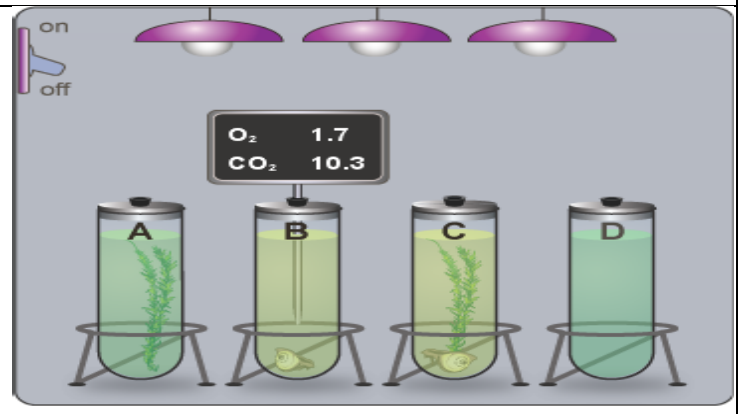
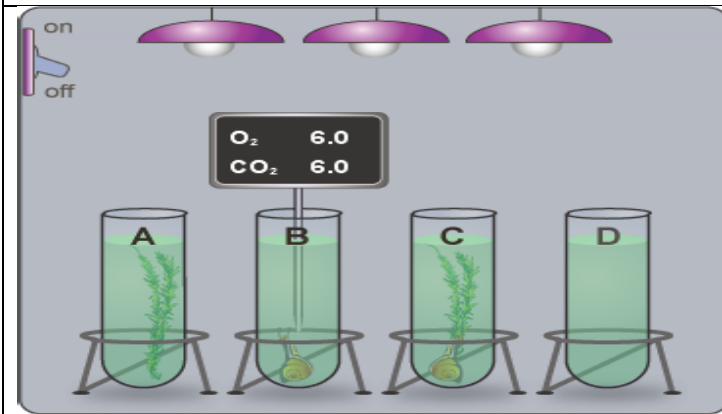
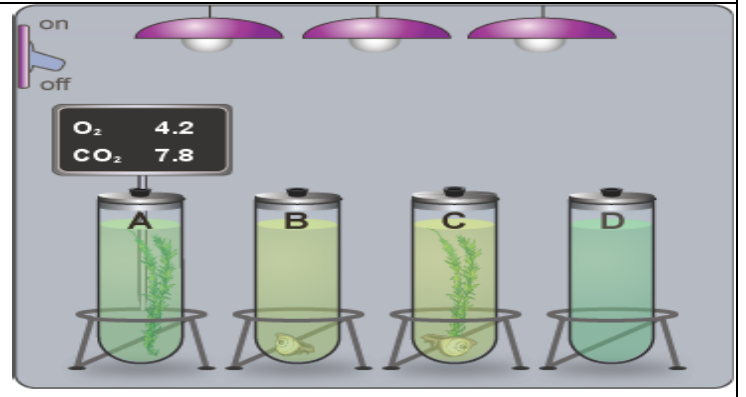
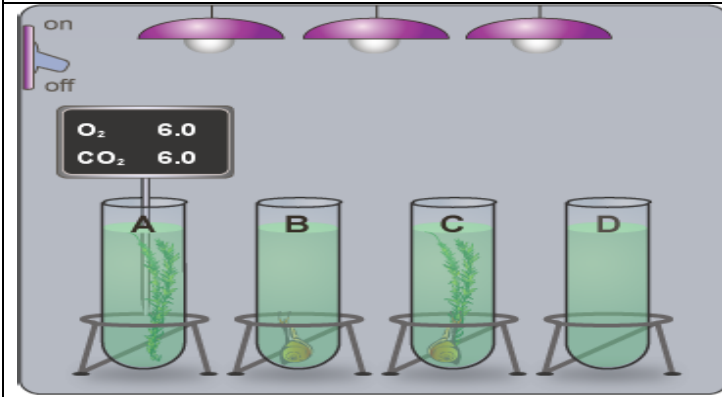
# Initial

# After 24 Hours:



# Initial

# After 24 Hours:





Plants & Snails Data Summary

	A: Elodea Only		B: Snail Only		C: Elodea & Snail		D: Control	
Light	Initial O <sub>2</sub> :	Final O <sub>2</sub>	Initial O <sub>2</sub> :	Final O <sub>2</sub> :	Initial O <sub>2</sub> :	Final CO <sub>2</sub> :	Initial O <sub>2</sub> :	Final O <sub>2</sub> :
	Initial CO <sub>2</sub> :	Final CO <sub>2</sub> :	Initial CO <sub>2</sub> :	Final CO <sub>2</sub> :	Initial CO <sub>2</sub> :	Final CO <sub>2</sub> :	Initial CO <sub>2</sub> :	Final CO <sub>2</sub> :
	Color:		Color:		Color:		Color:	
	Plant/Snail:		Plant/Snail:		Plant/Snail:		Plant/Snail:	
Dark	Initial O <sub>2</sub> :	Final O <sub>2</sub>	Initial O <sub>2</sub> :	Final O <sub>2</sub> :	Initial O <sub>2</sub> :	Final CO <sub>2</sub> :	Initial O <sub>2</sub> :	Final O <sub>2</sub> :
	Initial CO <sub>2</sub> :	Final CO <sub>2</sub> :	Initial CO <sub>2</sub> :	Final CO <sub>2</sub> :	Initial CO <sub>2</sub> :	Final CO <sub>2</sub> :	Initial CO <sub>2</sub> :	Final CO <sub>2</sub> :
	Color:		Color:		Color:		Color:	
	Plant/Snail:		Plant/Snail:		Plant/Snail:		Plant/Snail:	

**The Research Question:** Do plants use  $O_2$  to convert the sugar (which they produce using photosynthesis) into energy and release  $CO_2$  as a waste product as animals do?

**Our Claim:**

**Our Evidence:**

**Our Justification of the Evidence:**