

# Supplemental Material

*CBE—Life Sciences Education*

Linton *et al.*

## Carbon Cycle Activity and Assessments

### In-class activity (Ebert-May *et al.*, 2003):

Given 12 batches of radish seeds, each weighing 1.5 g in three experimental treatments:

1. Four sets of seeds placed on DRY paper towels in LIGHT
2. Four sets of seeds placed on WET paper towels in LIGHT
3. Four sets of seeds placed on WET paper towels in DARK

Student Writing, Discussion, or Discussion and Writing: After 1 week, all plant material was dried in an oven overnight (no water left) and plant biomass was measured in grams. Predict the biomass for each treatment.

Clicker question: Predict the rank of masses from high to low.

- A. 1>2>3
- B. 1>3>2
- C. 2>1>3
- D. 2>3>1
- E. 3>2>1

Instructor shows image of plant growth results, without masses being labeled.

Clicker Question: Rank the mass from high to low.

- A. 1>2>3
- B. 1>3>2
- C. 2>1>3
- D. 2>3>1
- E. 3>2>1

Three Clicker Questions: Which of these processes occurred in Treatment 1 (then 2, then 3)?

- A. Photosynthesis
- B. Cellular respiration
- C. Both
- D. Neither

Instructor shows image of plant growth results with masses labeled.

1. 1.46 g
2. 1.63 g
3. 1.20 g

Student Writing, Discussion, or Discussion and Writing: Explain why each treatment is different than 1.5g.

Coding Rubric:

Treatment 1

- a. These seeds lost mass.
- b. The seeds could not photosynthesize.
- c. These seeds performed cellular respiration.
- d. These seeds released CO<sub>2</sub> to the atmosphere.
- e. These seeds dried out.

Treatment 2

- f. These plants gained mass.
- g. These plants performed photosynthesis
- h. These plants performed cellular respiration
- i. These plants took in CO<sub>2</sub> from the atmosphere
- j. These plants released CO<sub>2</sub> to the atmosphere

Treatment 3

- k. These plants lost mass.
- l. These plants could not photosynthesize.
- m. These plants performed cellular respiration.
- n. These plants released CO<sub>2</sub> to the atmosphere.
- o. no light = no energy for growth

Anywhere

- p. Photosynthesis adds mass.
- q. Cellular respiration decreases mass.
- r. Photosynthesis takes in CO<sub>2</sub>.
- s. Cellular respiration releases CO<sub>2</sub>.
- t. Light is a source of energy.

## **Midterm Exam:**

This drawing below represents a food chain. [Add your own image or drawing]. Organic matter present in each organism represents both stored energy and stored carbon. The arrows represent movement of energy and carbon atoms through the food chain. Answer the following questions based on this drawing.

- a. Where did the energy stored in the organic matter originally come from and by what process did it enter the food chain? What is the final fate of this energy?
- b. In 2-3 sentences, explain the shortest route that a carbon atom in a glucose molecule in one of the animal's [choose any animal] cells could take to end up back in a glucose molecule produced by the plant. For each step identify the processes involved, the path by which the carbon enters or exits an organism, and the form that the carbon will be in.

### **Coding Rubric:**

#### **Part a.**

- a. Energy comes from the sun
- b. Process is photosynthesis
- c. Final fate of energy is that it is no longer usable/lost
- d. Converted to heat

#### **Part b.**

- e. Mention cellular respiration in correct context
- f. Carbon dioxide leaves the body of the animal
- g. Exhalation/breathing/respiratory system
- h. Carbon dioxide in atmosphere
- i. Carbon dioxide entering the plant/plants "use" carbon
- j. Enter through leaves/stomata
- k. Mention photosynthesis in correct context
- l. Mentions light energy is necessary
- m. Produce glucose/food for itself
- n. Plant adds biomass/organic matter
- o. Produce oxygen
- p. Water used in photosynthesis (not as source of matter)

### **Final Exam:**

In the 1640s Jan Baptista van Helmont planted a small willow (2.3 kg) in a pot that contained 90.9 kg of soil. After five years, the plant weighed 76.8 kg, but only 0.06 kg of soil had disappeared from the pot. Where did the extra mass in the tree come from? To receive full points, you must include in your answer a discussion of the source of matter, the pathway by which it entered the plant, and the process involved.

### **Coding Rubric:**

- a. CO<sub>2</sub>
- b. From the atmosphere
- c. Carbon dioxide entering the plant/plants “use” carbon
- d. Enter through leaves/stomata
- e. Mention photosynthesis in correct context
- f. Mentions light energy is necessary for photosynthesis
- g. Produce glucose/food for itself
- h. Plant adds biomass/organic matter
- i. Produce oxygen
- j. Water used in photosynthesis (not as source of matter)