

Name \_\_\_\_\_

Course/Section \_\_\_\_\_

Date \_\_\_\_\_

Professor/TA \_\_\_\_\_



### Activity 10.2 How do C<sub>3</sub>, C<sub>4</sub>, and CAM photosynthesis compare?

1. Carbon dioxide enters plant leaves through the stomata, while oxygen (the photosynthetic waste product) and water from the leaves exit through the stomata. Plants must constantly balance both water loss and energy gain (as photosynthesis). This has led to the evolution of various modifications of C<sub>3</sub> photosynthesis.

	C <sub>3</sub>	C <sub>4</sub>	CAM
Draw simplified diagrams of the cross sections of a leaf from a C <sub>3</sub> , a C <sub>4</sub> , and a CAM plant.			
a. How are the leaves similar?			
b. How are the leaves different?			
c. How and when does carbon dioxide get into each leaf?			
d. Which enzyme(s) (1) capture carbon dioxide and (2) carry it to the Calvin cycle?	(1) (2)	(1) (2)	(1) (2)

e. What makes C<sub>4</sub> photosynthesis more efficient than C<sub>3</sub> photosynthesis in tropical climates?

f. How is CAM photosynthesis advantageous in desert climates?

2. Photosynthesis evolved very early in Earth's history. Central to the evolution of photosynthesis was the evolution of the enzyme rubisco (an abbreviation for ribulose biphosphate carboxylase oxidase). To the best of our knowledge, all photosynthetic plants use rubisco. Rubisco's function is to supply carbon dioxide to the Calvin cycle; however, it does this only if the ratio of carbon dioxide to oxygen is relatively high. (For comparison, a relatively high ratio of carbon dioxide to oxygen is 0.03% carbon dioxide to 20% oxygen.) When the carbon dioxide-to-oxygen ratio becomes low, the role of rubisco switches and it catalyzes photorespiration, the breakdown of glucose to carbon dioxide and water.

a. Why could we call photorespiration a "mistake" in the functioning of the cell?

b. Rubisco is thought to have evolved when Earth had a reducing atmosphere. How does this help explain this "mistake"?

3. The metabolic pathways of organisms living today evolved over a long period of time—undoubtedly in a stepwise fashion because of their complexity. Put the following processes in the order in which they might have evolved, and give a short explanation for your arrangement.

- \_\_\_ Krebs cycle
- \_\_\_ Electron transport
- \_\_\_ Glycolysis
- \_\_\_ Photosynthesis