AP Biology 12
Photosynthesis

Name:_____
Date:_____

*Goal: How do the processes of photosynthesis **relate** to one another, and what is their **significance**?*

Answer the following questions:

1) Complete the following chart:

At which stage(s) in the overall process is each of the reactants used?			At which stage(s) in the overall process is each of the products produced?	
$6CO_2$ +	$6H_2O$ +	Energy	→ $C_6H_{12}O_6$ +	$6O_2$

2) Complete the following chart:

What is/are the overall function(s) of Photosystem I?	What is/are the overall function(s) of Photosystem II?	What is/are the overall function(s) of the Calvin Cycle?

3) Complete the following chart:

Are the compounds listed here *used* or *produced* in:	Photosystem I?	Photosystem II?	Calvin Cycle?
Glucose			
O_2			
CO_2			
H_2O			
ATP			
ADP + Pi			
NADH			
NAD^+			

4) Where in the chloroplast do the light reactions occur?

5) Where is the chloroplast gradient developed?

6) Where in the chloroplast does the Calvin cycle occur?

7) All living organisms require a constant supply of ATP to maintain life. If no light is available, how can a plant make ATP?

Name_____ Course/Section_____

Date_____ Professor/TA_____

Activity 10.2 How do C_3, C_4, 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_3 photosynthesis.

	C_3	C_4	CAM
Draw simplified diagrams of the cross sections of a leaf from a C_3, a C_4, 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_4 photosynthesis more efficient than C_3 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 bisphosphate 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 the photorespiration "mistake?"

10.2 Test Your Understanding

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