

## Chloroplast Diagram Instructions

*When providing the best possible answer to the following questions please apply all learned scientific techniques and procedures, do not use abbreviations, use proper scientific terminology, show work for all mathematical calculations, use all significant figure and scientific notation rules, apply appropriate writing strategies, and note that at all times spelling counts. Your ability to meet these and all established classroom expectations, including labeling of BINs, providing heading information, and your ability to follow directions may be included in computation of grade.*

**Purpose:** To prepare a model of a chloroplast organelle and to visually represent the reactants and products of the light and dark reactions that occurs during photosynthesis.

**Note:** The detailed directions below are meant for you to follow step-by-step. You should skim all directions before you begin to understand the expectations. You may want to place all items on your diagram before gluing them down to check placement. You will be graded on your ability to follow written directions, application of color, handwriting, neatness and accuracy. Make sure you attach the rubric to the back of your diagram before you hand it in.

**Procedure:** 1. On the arrow sheet, color the following arrows:

A = red

E = purple

Color the thylakoids green.

B = blue

F = leave white

Color the cyclic arrows pink. *(Use*

C = yellow

G = leave white

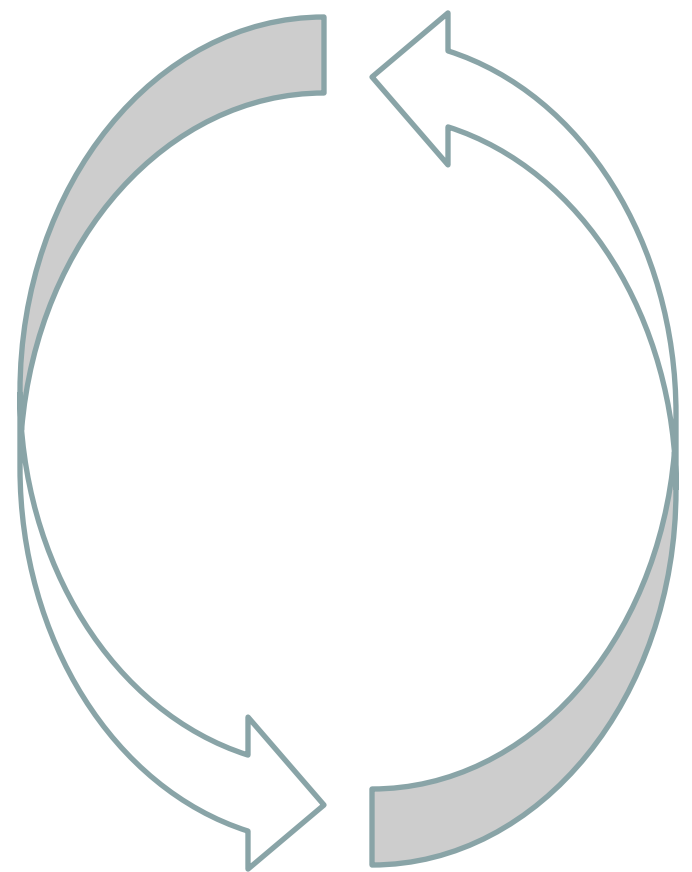
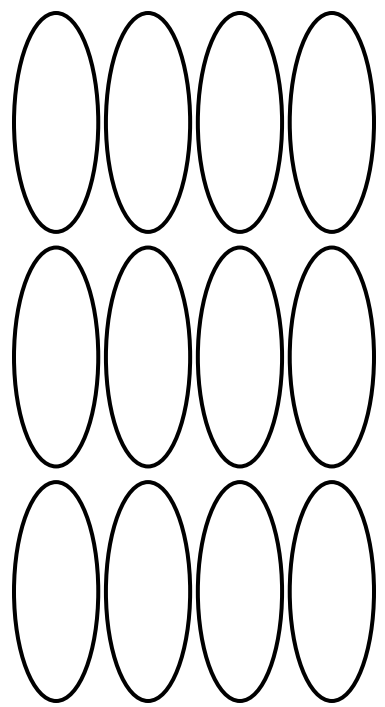
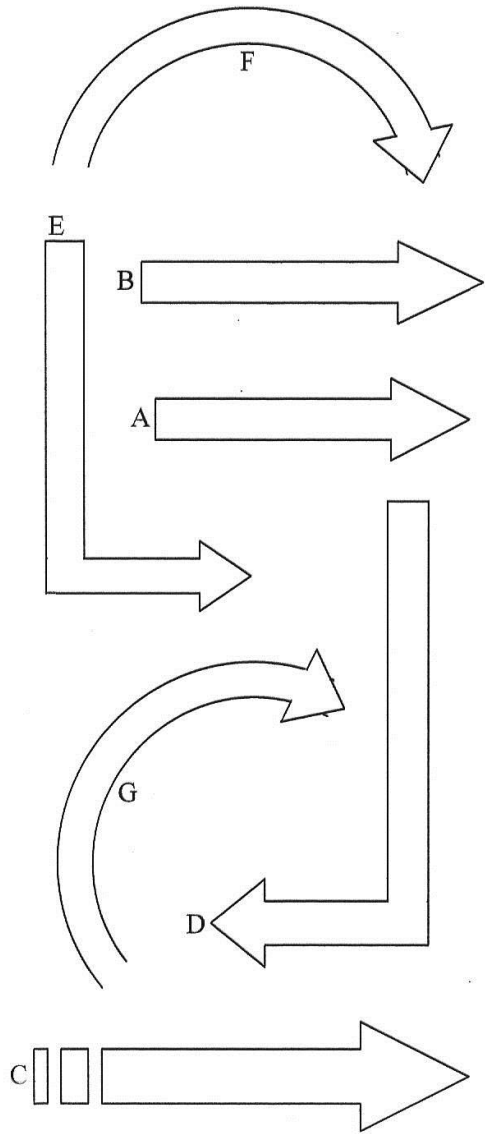
*black to label what they represent.)*

D = orange

2. As you build your chloroplast model leave a 1x3 inch rectangle in each of the four corners of the paper. Also leave a border around the outer edges of your chloroplast big enough to add some labels.
3. Draw your chloroplast on a blank sheet of white paper; be sure to include all parts.
  - a. Label the outer membrane and the inner membranes of the chloroplast.
  - b. Label the intermembrane space
  - c. Color the outer membrane black and the inner membrane brown.
  - d. Color the intermembrane space lighter brown.
  - e. In the box in the upper right hand side, draw a picture of what the chloroplast membrane looks like magnified showing the phospholipid bilayer. Include hydrophilic heads and hydrophobic tails.
  - f. Cut out and paste into one side of your chloroplast the cyclic arrows. Make sure they connect to accurately represent a cycle.
  - g. Color the interior of the chloroplast (including the inside of the cycle) yellow and label it as the stroma
3. Cut out all 12 of your green thylakoid ovals.
  - a. Paste 3 of them in a stack inside your chloroplast model. Draw a circle around this stack of thylakoids and label it as a granum.
  - b. Paste 3 more together in a stack and place them elsewhere in the stroma. Continue this process until you have a total of 4 grana in the stroma of the chloroplast organelle.
  - c. Using a dark green marker, draw lines between the granas. Label these lines as the stroma lamella.
  - d. Draw an arrow pointing to one of your thylakoids and label it.
  - e. Choose one thylakoid and draw and label the lumen.
  - f. Also label the thylakoid membranes on this thylakoid.

4. Cut out or draw a picture of the sun and paste it in the box in the upper left hand corner of the model.
5. Cut out arrow C and write photons on it. Paste it from the sun to the membrane of a thylakoid. This illustrates the sunlight energy called “photons” entering the thylakoids of a chloroplast organelle. Make sure the arrow originates in the sun and that it completely reaches a thylakoid.
6. Cut out arrow B and write water on it. Paste it on the model so that it too points into a thylakoid. Remember that water enters the plant through its roots and makes its way into the thylakoids of a chloroplast organelle as well. Make sure these arrows originate in the correct space and reach their destinations.
7. Write the following information into the box in the lower left hand corner of the paper. *Light reactions occur in the thylakoids where the chlorophyll is located. Energy produced by the “excited” electrons in the chlorophyll break apart H<sub>2</sub>O into hydrogen and oxygen.* The chlorophyll in the thylakoids traps the photons so that it can be used to break the H<sub>2</sub>O apart.
8. Cut out arrow D and write oxygen on it. Paste it on the model leaving a thylakoid and exiting the chloroplast. Oxygen is a by-product of photosynthesis so when the water is broken into hydrogen and oxygen, the excess oxygen is given off as gas – the gas we breathe.
9. Cut out arrow F and write ATP and hydrogen on it. Paste this arrow leaving a granum and entering the Calvin cycle which occurs in the stroma. Left-over energy and hydrogen leave the granum so that it can enter the Calvin Cycle. Make sure these arrows originate in the correct space and reach their destinations.
10. Cut out arrow A and write carbon dioxide on it. Paste it on your model so that it is entering the Calvin cycle from outside the chloroplast. CO<sub>2</sub> enters the plant through holes in the bottom of the leaf called stomata. The CO<sub>2</sub> diffuses into a chloroplast organelle.
11. Write the following **bold** information in the box at the bottom right corner of the page. *Dark reactions occur in the stroma. CO<sub>2</sub> combines with hydrogen in the Calvin Cycle to produce essential carbohydrates.* Specifically, they create a carbohydrate called glucose (C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>) which is necessary for cellular respiration.
12. Cut out arrow E and write glucose on it. Paste it leaving the Calvin cycle and diffusing out of the chloroplast organelle and into the cytoplasm of the cell; make sure you label the cytoplasm of the cell. The glucose can now be stored by the cell or it can stay in the cytoplasm of the cell and undergo glycolysis (step one of cellular respiration).
13. Cut out arrow G and write ADP on it. Paste it leaving the Calvin cycle and entering a granum. ADP is like a dead recyclable battery. Once it uses up its energy it must be recharged. ADP leaves the Calvin Cycle and enters the granum where it will wait to be recharged during the light reactions. This arrow should match up with the arrow with ATP and hydrogen written on it.

**Please attach the provided rubric sheet to your diagram before you hand in the completed diagram. You should use this rubric as a check list to make sure you have all parts completed to the best of your ability!**



## Chloroplast Diagram Rubric

*When providing the best possible answer to the following questions please apply all learned scientific techniques and procedures, do not use abbreviations, use proper scientific terminology, show work for all mathematical calculations, use all significant figure and scientific notation rules, apply appropriate writing strategies, and note that at all times spelling counts. Your ability to meet these and all established classroom expectations, including labeling of BINs, providing heading information, and your ability to follow directions may be included in computation of grade.*

- Items and areas to be colored neatly and correctly and clearly labeled. Spelling counts. (1 point each)

_____ Outer membrane	_____ Grana/granum
_____ Inner membrane	_____ Lumen
_____ Intermembrane space	_____ Thylakoid
_____ Stroma	_____ Thylakoid membrane
_____ Stroma lamella	_____ Sun
- Items and processes to be included. Processes must **clearly indicate origin and destination** and be properly labeled.

_____ Photons leaving sun and entering thylakoid membranes - 3 points
_____ Water entering thylakoid membrane from outside of chloroplast – 3 points
_____ Oxygen exiting thylakoid membrane and exiting chloroplast – 3 points
_____ Carbon dioxide entering chloroplast and ending in stroma – 3 points
_____ Glucose leaving Calvin cycle in stroma and exiting chloroplast – 3 points
_____ ATP & H <sup>+</sup> arrow leaving thylakoid membrane and entering stroma and Calvin cycle – 4 points
_____ ADP arrow leaving stroma and Calvin cycle and entering thylakoid membrane – 3 points
- Additional items and aspects to be included and graded.

_____ Caption one and caption two – 2 points
_____ Phospholipid bilayer correctly represented – 2 points
_____ Good use of color – 2 point
_____ Neat and easy to view – 2 point
_____ Name, date, period and BIN on back of diagram – 5 points
_____ Name, date, period and BIN on rubric and rubric <b>stapled</b> to back of diagram – 5 points