Chloroplasts and Photosynthesis

Plant cells and **some Algae** contain an organelle called the **chloroplast**. The chloroplast allows plants to harvest **energy** from **sunlight** to carry on a process known as **Photosynthesis**. Specialized pigments in the chloroplast (including the common green pigment **chlorophyll**) absorb sunlight and use this energy to combine **carbon dioxide** and **water** and make **GLUCOSE** and **OXYGEN**. The complete the chemical reaction for Photosynthesis is:

$$6\ CO_2 + 6\ H_2O + \text{energy (from sunlight)} \rightarrow C_6H_{12}O_6 + 6\ O_2$$

RAW MATERIALS ENERGY PRODUCTS

In this way, plant cells manufacture **glucose** and other **carbohydrates** that they can store for later use. Photosynthetic cells found mainly in the **leaves** may have **thousands** of chloroplasts.

QUESTIONS:

1. What type of cells contains chloroplasts?

2. What is the energy (where does it come from?) autotrophs use to make their own food?

3. The food making process is called _____.
4. What are the raw materials(reactants) for photosynthesis?

5. What simple sugar is produced?

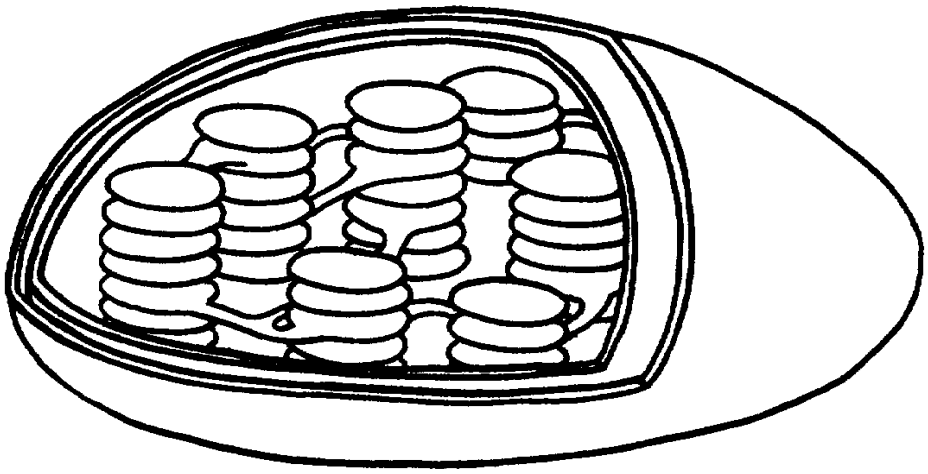
6. What gas is USED? _____ RELEASED? _____

7. Where are most photosynthetic cells in plants found?

8. About how many chloroplasts can be found in photosynthetic cells?

Chloroplasts are double membrane organelles with a smooth outer membrane and an inner membrane folded into disc-shaped sacs called **thylakoids**. ***Color and label*** the outer membrane light green. Thylakoids, containing chlorophyll and other **accessory pigments (red, orange, yellow, brown)**, are in stacks called **granum** (**grana**, plural). ***Color and label*** the grana (STACK) dark green in Figure 1. Grana are connected to each other by structures called **lamellae**, and they are surrounded by a gel-like material called **stroma**. ***Color and label*** the **lamellae brown** in figure 1. ***Color and label*** the stroma light blue in Figure 1.

FIGURE 1-CHLOROPLAST



9. How many membranes surround a chloroplast?

10. The outer membrane is S_____.

11. The INDIVIDUAL SACS formed by the inner membrane are called _____ and are arranged in _____ like pancakes.

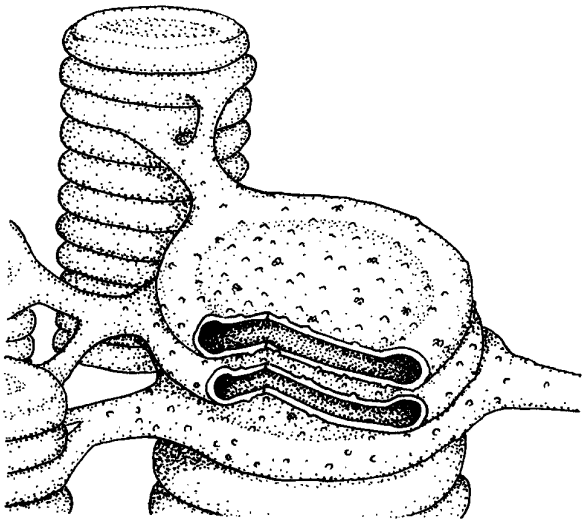
12. What pigment is found inside a thylakoid? What color will it be?

13. Other pigments that trap sunlight are called A_____ pigments. What colors are these pigments?

14. STACKS of thylakoids are called G_____ (plural) or GRANUM (singular).
15. Stacks or grana are connected to each other by _____.

Light-capturing pigments in the grana are organized into **photosystems**. On Figure 2, ***color and label*** a single thylakoid (SINGLE DISK) dark green. In figure 2, ***color and label*** a granum (STACK) red.

FIGURE 2-THYLAKOID



Mitochondria are the powerhouses of the cell because they "burn" or break the chemical bonds of glucose to release energy to do work in a cell. Remember that this energy originally came from the sun and was stored in chemical bonds by plants during photosynthesis. **Glucose** and other **carbohydrates** made by plants during photosynthesis are broken down by the process of **aerobic cellular respiration** (requires oxygen) in the mitochondria of the cell. This releases **energy (ATP)** for the cell. The **more active a cell** (such as a muscle cell), the more mitochondria it will have. The mitochondria are bout the size of a bacterial cell and are often peanut-shaped. Mitochondria have their **own DNA** and a **double membrane** like the **nucleus and chloroplast**. The **outer membrane** is smooth, while the **inner membrane** is convoluted into folds called **cristae in order to increase the surface area**.

1. Why are mitochondria called the powerhouse of the cell?

2. What cell process occurs in the mitochondria?

3. Why do some cells have MORE mitochondria? Give an example.

4. What simple sugar is broken down in the mitochondria?

5. Where does the energy in glucose come from ORIGINALLY?

6. Where is this energy stored in glucose?

7. Why is cellular respiration an aerobic process?

8. What energy is released when the chemical bonds of glucose are broken?

9. Name two other organelles besides the mitochondria that contain DNA and have a double membrane.

10. Describe the outer membrane of the mitochondria.

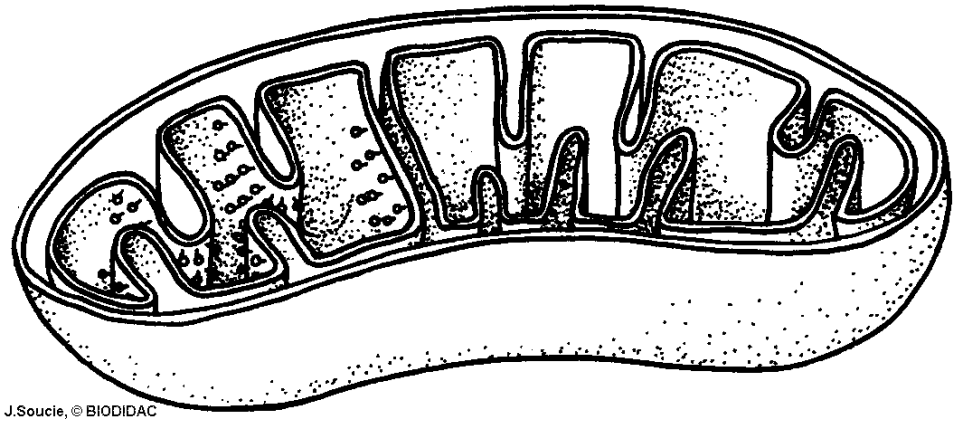
11. Why is the inner mitochondrial membrane folded?

12. What are the folds called?

Color and label the **outer membrane pink** and the **cristae red** on figure 3. This greatly increases the surface area of the membrane so that carbohydrates (simple sugars) can combine with oxygen to produce ATP, **adenosine triphosphate** (the energy molecule of the cell). The **electron transport chain** takes place across the membranes of the **cristae** (**crista**, singular). Inside the folds or cristae is a space called the **matrix** that contains enzymes needed for the **Kreb's Cycle?** ***Color and label*** the matrix yellow on figure 3.

FIGURE 3 - MITOCHONDRIA

Mitochondria



Adenosine triphosphate (**ATP**) is the energy molecule used by all cells to do work. It is a nucleotide consisting of a **nitrogen-containing base** (adenine, thymine, cytosine, or guanine), a 5-carbon **sugar**, and 3 **phosphate groups.** ATP is able to store and transport chemical energy within cells. The LAST TWO phosphate groups (PO4), are joined by HIGH-ENERGY bonds. When these bonds are broken, energy is released for cells to use and ADP forms. Enzymes help to break and reform these high-energy bonds.

13. What does ATP stand for?

14. What three main things make up an ATP molecule?

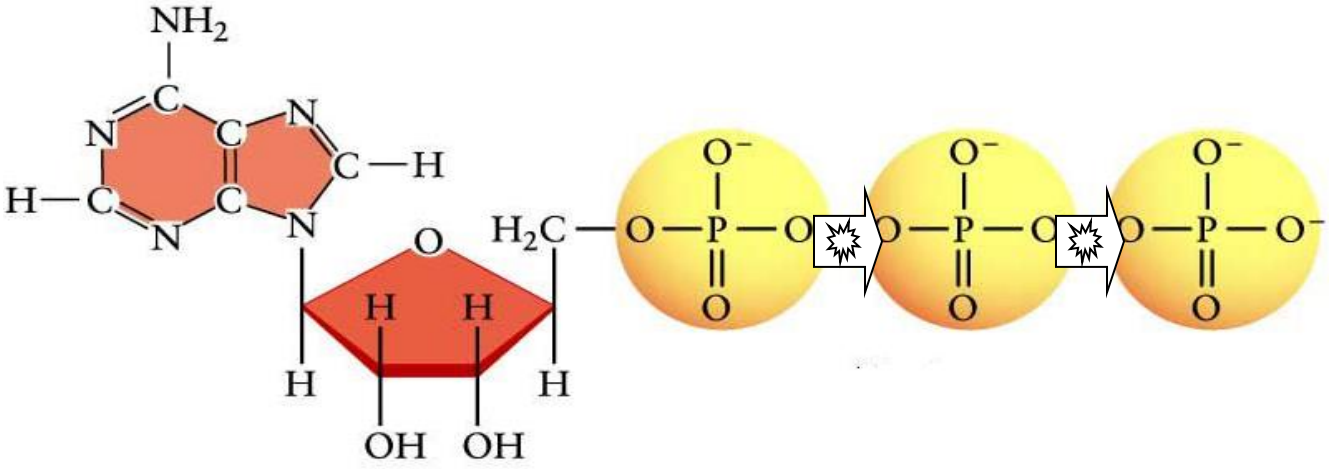
15. How many high-energy bonds does ATP contain?

16. Where are these high-energy bonds found in ATP?

17. What helps weaken these bonds so energy can be released and then later help reform them?
18. When ATP loses a phosphate group _____ is released for cells and a molecule of _____ forms.

In Figure 4, COLOR the 5-carbon sugar RED and LABEL it RIBOSE. COLOR and LABEL the nitrogen-base DARK BLUE. COLOR and LABEL the 3 phosphate groups YELLOW, and COLOR & LABEL the 2 high-energy bonds GREEN.

FIGURE 4 – ATP MOLECULE



Questions:

19. What is the energy molecule of the cell called?

20. What macromolecule made by plants is "burned" in the mitochondria during respiration?

21. Where is chlorophyll found in the chloroplast (what organelle)?

22. In which part of a plant (trunk, stem, branch, leaf) would you expect to find the most chloroplasts and why?

23. How would the number of mitochondria in an insect's wing (our muscles) compare to the amount found in other cells in an insect's body? Explain your answer.

24. What are the raw materials for photosynthesis?

25. What product of photosynthesis is used in cellular respiration?

26. How are photosynthesis and respiration related?

27. What is the energy for photosynthesis (where does it come from)?

28. Besides chlorophyll, what other pigments are found in the chloroplasts?