Chloroplasts and Mitochondria

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:

$$6 \text{CO}_2 + 6 \text{H}_2\text{O} + \text{energy (from sunlight)} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{O}_2$$

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? **Plant**
2. What is the energy autotrophs use to make their own food? **Energy from sunlight**
3. The food making process is called **Photosynthesis**
4. What are the raw materials for photosynthesis? **CO}_2, \text{H}_2\text{O}, \text{and energy (from sun)**
5. What simple sugar is produced? **Glucose**
6. What gas is USED? **CO}_2** RELEASED? **O}_2**
7. Where are most photosynthetic cells in plants found? **Leaves**
8. About how many chloroplasts can be found in photosynthetic cells? **Thousands**
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.

9. How many membranes surround a chloroplast? Two

10. The outer membrane is smooth.

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

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

13. Other pigments that trap sunlight are called accessory pigments. What colors are these pigments? Red, Orange, Yellow, Brown

14. STACKS of thylakoids are called grana (plural) or GRANUM (singular).

15. Stacks or grana are connected to each other by lamellae.
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 about 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.

16. Why are mitochondria called the powerhouse of the cell? *Because they break chemical bonds of glucose to release energy to do work in a cell.*

17. What cell process occurs in the mitochondria? *Aerobic cellular respiration*

18. Why do some cells have MORE mitochondria? *They are more active. Give an example. Muscle cells*

19. What simple sugar is broken down in the mitochondria? *Glucose*

20. Where does the energy in glucose come from ORIGINALLY? *From the sun*
21. Where is this energy stored in glucose? *In the chemical bonds*

22. Why is cellular respiration an aerobic process? *Requires oxygen*

23. What energy is released when the chemical bonds of glucose are broken? *ATP*

24. Name two other organelles besides the mitochondria that contain DNA and have a double membrane. *Nucleus & Chloroplast*

25. Describe the outer membrane of the mitochondria. *Is smooth*

26. Why is the inner mitochondrial membrane folded? *To increase surface area (which helps with cellular respiration)*

27. What are the folds called? *Cristae*

*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**
**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.

28. What does ATP stand for? **Adenosine triphosphate**

29. What three main things make up an ATP molecule? **Nitrogen-containing base, a 5-carbon sugar, and 3 phosphate groups.**

30. How many high-energy bonds does ATP contain (look at the diagram below)? **2**

31. Where are these high-energy bonds found in ATP? **They bond the phosphate groups together.**

32. What helps weaken these bonds so energy can be released and then later help reform them? **Enzymes**

33. When ATP loses a phosphate group **energy** is released for cells and a molecule of **ADP** 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**