



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:



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:

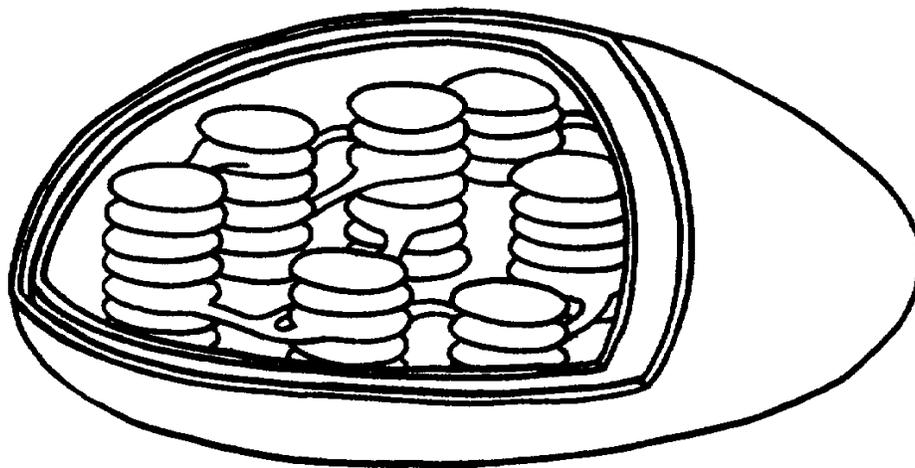
1. What type of cells contains chloroplasts? ***Plant cells***
2. What is the energy autotrophs use to make their own food? ***Light***
3. The food making process is called ***Photosynthesis***
4. What are the raw materials for photosynthesis? ***CO₂ and water***
5. What simple sugar is produced? ***Glucose***
6. What gas is USED? ***CO₂*** RELEASED? ***O₂***
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.

FIGURE 1-CHLOROPLAST



9. How many membranes surround a chloroplast? 2

10. The outer membrane is **Smooth**

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

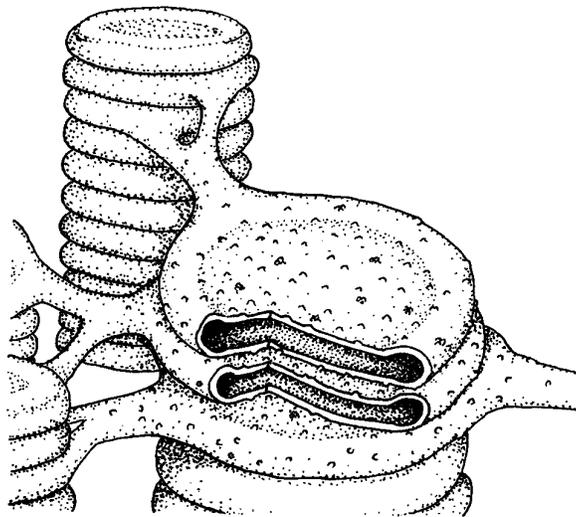
12. What pigment is found inside a thylakoid? What color will it be?

Chlorophyll, 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 **Lammela**

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 **cris^tae** in order to increase the surface area.

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

because they "burn" or break the 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? Give an example.

The more active a cell (such as a muscle cell), the more mitochondria it will have.

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

Glucose

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

Photosynthesis

21. Where is this energy stored in glucose?

chemical bonds of glucose

22. Why is cellular respiration an aerobic process?

Because it needs Oxygen

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

Chemical energy in the form of ATP

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

Nucleus and chloroplasts

25. Describe the outer membrane of the mitochondria.

Smooth

26. Why is the inner mitochondrial membrane folded?

To increase surface area

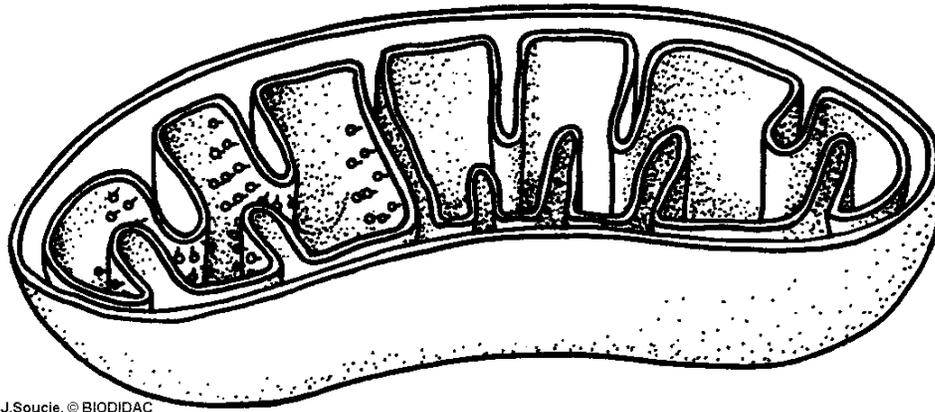
27. What are the folds called?

thylakoids

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



J.Soucie, © BIODIDAC

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 (PO_4), 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 (adenine, thymine, cytosine, or guanine), a 5-carbon **sugar**, and 3 **phosphate groups**.

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

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

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

The LAST TWO phosphate groups (PO₄), are joined by HIGH-ENERGY bonds

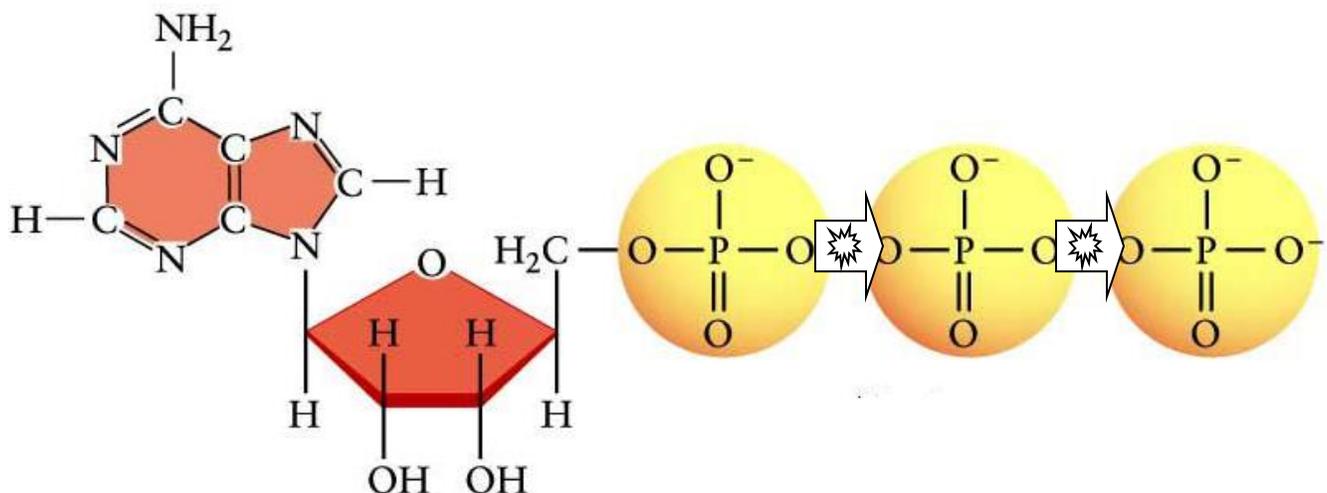
32. What helps weaken these bonds so energy can be released and then later help reform them?

Enzyme

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



Questions:

34. What is the energy molecule of the cell called? **ATP**

35. What macromolecule made by plants is "burned" in the mitochondria? **Glucose**

36. Where is chlorophyll found in the chloroplast? **Grana**

37. In which part of a plant would you expect to find the most chloroplasts and why?
Leaves because they make photosynthesis.

38. How would the number of mitochondria in an insect's wing compare to the amount found in other cells in an insect's body? Explain your answer.
In the wing is more

39. What are the raw materials for photosynthesis?
CO₂ and water

40. What product of photosynthesis is used in cellular respiration?
Glucose

41. What is the advantage of having a folded inner membrane in the mitochondria?
To increase surface area

42. What is the energy for photosynthesis?
Light energy

43. Besides chlorophyll, what other pigments are found in the chloroplasts?
Carotene and zanthophyll