

## - Ch. 10.2 - Photosynthesis Converts Light Energy to the Chemical Energy of Food

- **PHYSICALLY PRINT OUT** this PDF and **HANDWRITE** (with a black or blue pen) your answers directly on this PDF. Typed or digitally-written work is **not** accepted. Do **not** answer questions on separate paper.
- **Importantly, study guides are NOT GROUP PROJECTS!!!** You, and you alone, are to answer the questions as you **read** your assigned textbook. You are **not** to share answers with other students. You are **not** to copy any answers from any other source, including the internet.
- **Get in the habit of writing LEGIBLY, neatly, and in a medium-sized font.** AP essay readers and I will skip grading anything that cannot be easily read so start perfecting your handwriting, and don't write so large you can't add all the relevant details and key elaborations in the space provided.
- **SCAN** physical documents in color and with good resolution. Then, upload your final work as **PDFs to Archie**. Avoid uploading dark, shaded, washed-out, sideways, or upside-down scans of homework. Keep completed physical study guides organized in your biology binder to use as future study and review tools.
- **READ FOR UNDERSTANDING** and not merely to complete an assignment. **First**, read a section quickly to get an overview of the topic covered. Then, read it a **second** time slowly, paraphrasing each paragraph **out loud** and analyzing every figure. Finally, read it a **third** time as you answer the study guide questions if assigned and start building your memory. Try to write answers out in your own words, when possible, and try to purposefully and accurately use all new terminology introduced.

1. What is **photosynthesis**?
2. Just like obtaining energy to do work with is necessary for life, obtaining carbon in a usable form is essential for organisms to be able to construct all the organic (carbon-based) compounds they need. **There are two modes by which organisms obtain their carbon: Autotrophic Nutrition (performed by organisms known as Autotrophs) vs Heterotrophic Nutrition (performed by organisms known as Heterotrophs).**
  - a. What is an **autotroph**?
  - b. How do autotrophs produce organic molecules? Asked differently, **where do autotrophs obtain C atoms from**?
  - c. Autotrophs are nicknamed the **Producers**. Why are **Producers such important members of Earth's ecosystems**? (Why are they so important to other non-producer organisms?)
  - d. Since almost all **plants are Producers (Autotrophs)**, which nutrients do they need to survive?
    - 1.
    - 2.
    - 3.
3. Living organisms and cells engage in **three types of work** as you hopefully recall from Ch.8:
  1. **Mechanical Work** = moving structures in the cell or organism such as causing a flagella to undulate
  2. **Chemical Work** = performing non-spontaneous, endergonic chemical reactions to build products that store more Gibbs Free Energy than the reactants had
  3. **Transport Work** = moving solutes against their concentration gradients across membranes

**Since work is a non-spontaneous process,  
all work requires Energy!**

When **plants, photosynthetic bacteria** (cyanobacteria or blue-green bacteria), and **photosynthetic protists** (like Algae) engage in the chemical work that is photosynthesis, energy is needed. After all, synthesizing organic molecules, like simple sugars G3P and glucose from smaller inorganic precursors, which occurs during photosynthesis, (and then converting that G3P and glucose into all sorts of other organic monomers used to make macromolecules out of) is an **endergonic process**.

While **CHEMOautotrophs** obtain their energy from the chemical bonds of inorganic molecules, **plants are referred to as PHOTOautotrophs, and obtain their energy from a different source**. Where do **photoautotrophs (like plants) obtain their energy from?**

4. To review, which two domains and which two kingdoms contain **organisms capable of doing photosynthesis?**

Domains = \_\_\_\_\_ + \_\_\_\_\_

Eukaryotic Kingdoms = \_\_\_\_\_ + \_\_\_\_\_

5. a. How do **heterotrophs differ from autotrophs?**

b. **Heterotrophs obtain their C atoms from the organic molecules made by autotrophs (producers)**. What is **another name for heterotroph?**

c. **One subcategory of heterotrophs is referred to as the Decomposers**. What makes a decomposer different from other heterotrophs?

d. What **two types of heterotrophic organisms are often decomposers** in ecosystems?

1. \_\_\_\_\_

2. \_\_\_\_\_

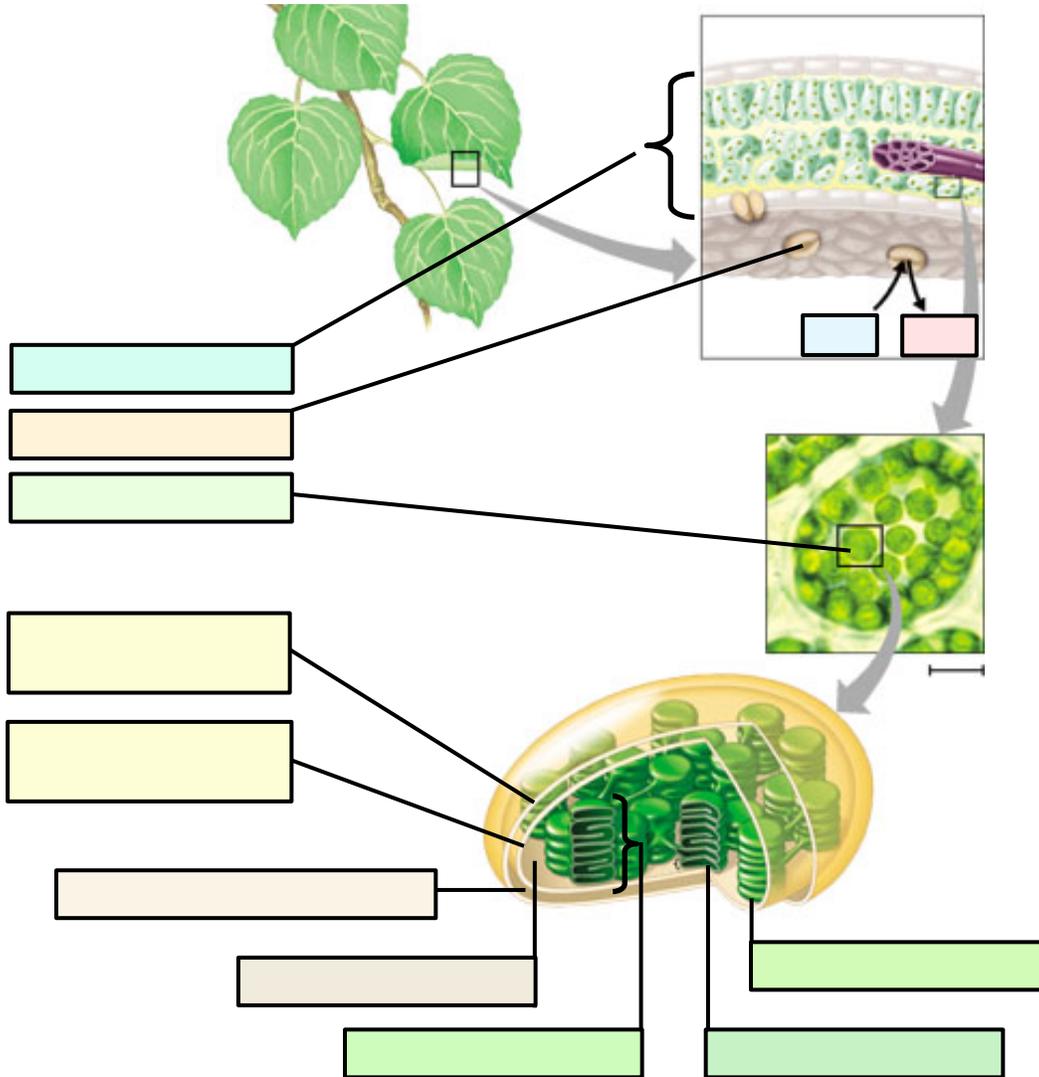
6. Why are so **heterotrophs dependent on photoautotrophs?** *(Check your answers by going to the Ch.10.1 Concept Check Question #1 in Appendix A of your textbook)*

7. Fossil fuels (high-energy organic molecules that we make the gasoline that powers cars, for example, from) are being depleted faster than they are replenished. Therefore, researchers are developing ways to produce "biodiesel" from the products of photosynthetic algae. They have proposed placing containers of these algae **near** industrial plants and highly congested city streets. Considering the requirements for photosynthesis, how does this arrangement make sense? *(Check your answers by going to the Ch.10.1 Concept Check Question #2 in Appendix A of your textbook)*

Throughout this chapter, please keep in mind that plants have **both mitochondria and chloroplasts** and do both cellular respiration and photosynthesis!

8. In which organisms did **photosynthesis probably first evolve**?
  
9. a. What are **chloroplasts** and what takes place in them?  
  
b. What is thought to be the **ancestor of modern-day chloroplasts**?  
  
c. Chloroplasts are found in all green plant tissue cells. A high concentration of chloroplasts is found in the mesophyll tissue in plants. Where do we find **mesophyll** cells?
  
10. What are the microscopic **openings** (usually more concentrated on the bottom sides) **of leaves called** that allow for CO<sub>2</sub>, O<sub>2</sub> and H<sub>2</sub>O gas exchange?
  
11. Leaves also contain **veins**, which contain **two types of transport tissues** as you will learn about later, the **xylem** and **phloem**. What is **transported through these veins**?
  - 1.
  - 2.
  
12. Describe the following **parts of the chloroplast**:
  - a. **Stroma** =
  
  - b. **Thylakoids** =
  
  - c. **Thylakoid Space** =
  
  - d. **Grana** =
  
13. a. What is **chlorophyll**?  
  
b. What **role does chlorophyll play in photosynthesis**?

14. Label the following illustration showing the **plant tissues involved in photosynthesis**.



15. What is the **net (balanced) equation of photosynthesis**? This formula is the opposite of cellular respiration. *Know both!*

16. The most typical photosynthesis type is called **C3 photosynthesis** (C3 - carbon 3). Why do you think this is the case?

17. If an organism engages in photosynthesis (like a plant, protist algae, or cyanobacterium), does the organism still engage in cellular respiration?

18. Using radioactive  $^{18}\text{O}$  as the basis of your discussion, explain how we confirmed that the **oxygen released in photosynthesis comes from water and not the carbon dioxide consumed during photosynthesis**.

19. Let's review both Cellular Respiration & Photosynthesis. Try to fill in the paragraphs below from memory **after** reviewing the next few paragraphs of your text so you force yourself to think through what you are learning.

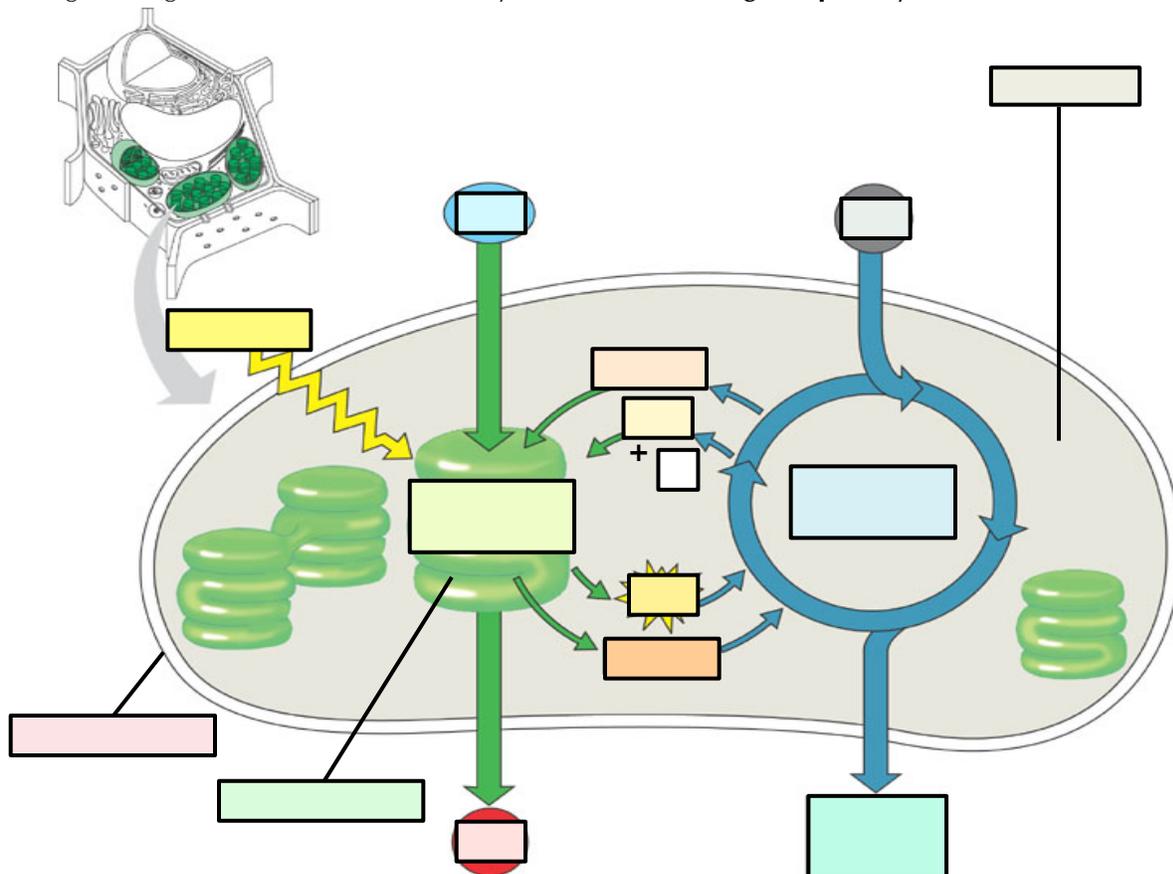
**In Cellular Respiration** = "Redox reactions are involved in both photosynthesis and cellular respiration. During cellular respiration, energy is \_\_\_\_\_ from sugar when \_\_\_\_\_ associated with \_\_\_\_\_ (from the sugar) are transported by carriers to \_\_\_\_\_, forming \_\_\_\_\_ as a by-product. The electrons lose \_\_\_\_\_ as they 'fall' down the \_\_\_\_\_ toward electronegative oxygen (an exergonic process). The mitochondria harnesses that energy to **synthesize** (energy-storing) \_\_\_\_\_ an endergonic process)"

**In Photosynthesis** = "Photosynthesis reverses the direction of electron flow. \_\_\_\_\_ is split, and \_\_\_\_\_ are transferred along with \_\_\_\_\_ from the water to \_\_\_\_\_, reducing it to (high energy) \_\_\_\_\_. Because the electrons **increase** in \_\_\_\_\_ as they move from water to sugar, this process requires \_\_\_\_\_ and is \_\_\_\_\_. This energy boost is provided by \_\_\_\_\_ .

20. a. **Photosynthesis involves two processes**, each with multiple steps. What are the two main stages of photosynthesis called?

1. \_\_\_\_\_ 2. \_\_\_\_\_

b. Using the diagram below, label and identify these **two broad stages of photosynthesis**. *Memorize this well!*



21. During the **Light Reactions**, \_\_\_\_\_ energy is converted into \_\_\_\_\_ energy.
22. a. What is the **main (pigment) molecule used to absorb light energy** during the Light Reactions?
- b. What molecule do we **obtain electrons from** for photosynthesis during the Light Reactions?
- c. What is the **electron carrier reduced during the Light Reactions** of photosynthesis?
23. What occurs during the Light Reactions process called **photophosphorylation**?
24. a. What is **carbon fixation**? *This occurs in the Calvin-Benson Cycle, the second phase of photosynthesis.*
- b. Where does the **carbon used in this process originate from**?
- c. What is the **end result of electrons being added to the carbon obtained from CO<sub>2</sub> during the Calvin Cycle**?
- d. What **molecule delivers the** (high energy) **electrons** to the carbon intermediates that are being reduced in the Calvin Cycle?
- e. What **molecule delivers energy** to the carbon intermediates that are being converted into carbohydrates (sugar) being reduced in the Calvin Cycle?
25. Though the **Calvin Cycle in most plants occurs during daylight**, the process also goes by the names **Light-Independent Reactions** or **Dark Reactions**. Please clarify this contradiction in naming.
26. How do the molecules of CO<sub>2</sub> used in photosynthesis reach **AND** enter the chloroplasts inside leaf cells (*See Concept 7.2 in Ch.7*). (*Check your answers by going to the Ch.10.2 **Concept Check Question #1** in Appendix A of your textbook*)
27. Suppose someone were to state that the light reactions do not depend on the Calvin cycle and with a continual input of light, keep producing ATP and NADPH endlessly. Would this person be correct in your opinion? Why? (*Check your answers by going to the Ch.10.2 **Concept Check Question #3** in Appendix A of your textbook*)