

Mitochondria Inner Structure

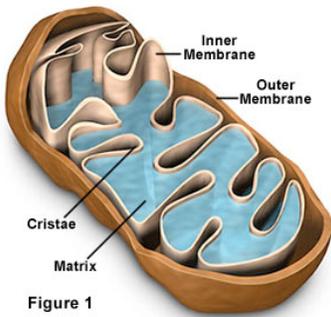


Figure 1

## Adv. Biology: Photosynthesis and Cellular Respiration Study Guide

Plant Cell Chloroplast Structure

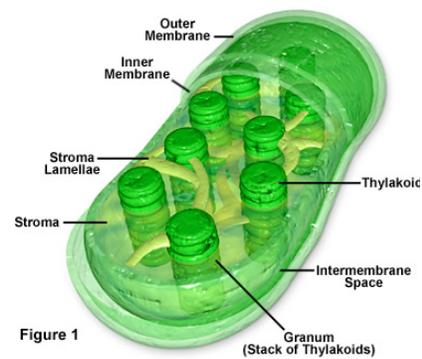
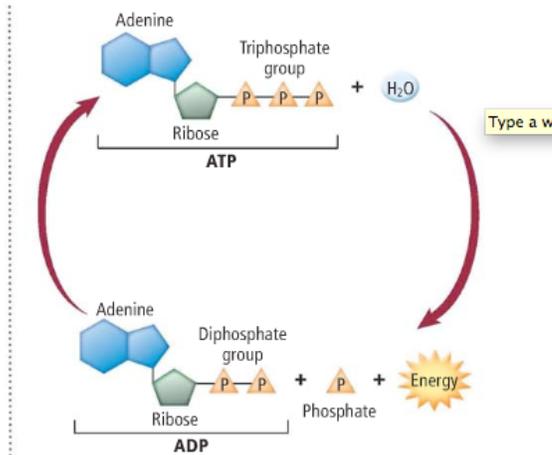


Figure 1

- Chapter 8
- All vocabulary – See Notes
- Energy: ATP, ADP, AMP; ATP cycle



■ **Figure 8.4** The breakdown of ATP releases energy for powering cellular activities in organisms.

- **ATP: Adenosine Triphosphate** - the most important biological molecule that provides chemical energy.
- **ADP: Adenosine Diphosphate** – a molecule formed when, ATP releases energy when the bond between the second and third phosphate groups is broken forming a molecule (ADP) and a free phosphate group. **Energy is stored in the phosphate bond formed when ADP receives a phosphate group and becomes ATP.** ATP and ADP can be interchanged by the addition or removal of a phosphate group.
  - Sometimes ADP becomes Adenosine Monophosphate (AMP) by losing an additional phosphate group.
- **AMP: Adenosine Monophosphate** – sometimes ADP becomes this by losing an additional phosphate group. **There is less energy released in this reaction, so most of the energy reactions in the cell involve ATP and ADP.**
- \*Describe how ATP works
  - ATP releases energy when the bond between the second and third phosphate groups is broken, forming a molecule called adenosine diphosphate (**ADP**) and a free phosphate group
- Thermodynamics: the two laws
  - **Thermodynamics** - the study of the flow and transformation of energy in the universe.

- **The first law of thermodynamics** is the law of conservation energy, which states that energy can be converted from one form to another, but it cannot be created nor destroyed.
  - For example, the stored energy in food is converted to chemical energy when you eat and to mechanical energy when you run or kick a ball.
- **The second law of thermodynamics** states that energy cannot be converted without the loss of usable energy.
  - The energy that is “lost” is generally converted to thermal energy. Entropy is the measure of disorder, or unusable energy, in a system. Therefore, the second law of thermodynamics can also be stated “entropy increases.” One example of the 2nd law is evident in food chains.
- Compare and contrast heterotrophs and autotrophs.
  - **Autotrophs** are organisms that make their own food.
  - **Heterotrophs** are organisms that need to ingest food to obtain energy.
- Metabolism - all of the chemical reactions in a cell.
  - A series of chemical reactions in which the product of one reaction is the substrate for the next reaction is called a metabolic pathway. Metabolic pathways include two broad types: catabolic and anabolic pathways.
- Definition of anabolic and catabolic reactions and ATP synthase
  - **Catabolic pathways** release energy by breaking down larger molecules into smaller molecule.
  - **Anabolic pathways** use the energy released by catabolic pathways to build larger molecules from smaller molecules
- Ultimate source of energy – **Sunlight**
- **Compare and contrast photosynthetic and chemosynthetic organisms**

○ <b>Photosynthetic</b>	○ <b>Chemosynthetic</b>
<p><b>Light</b> energy from the sun is converted to chemical energy for use by the cell. Used by plants Uses sunlight as energy via photosynthesis. This energy is made into glucose, which is eventually converted into ATP after many cycles. This ATP is a ready source of energy for the plant.</p>	<p><b>Chemical</b> energy is used to build carbon-based molecules.</p> <ul style="list-style-type: none"> <li>• Some organisms don't need sunlight and photosynthesis as a source of energy and live in places that never get sunlight.</li> </ul>
<b>Both</b>	
Types of Cell Energy - <b>Together they fuel all life on earth</b>	

- 
- Photosynthesis:
  - Equation



- Steps

- **Phase One: Light Dependent Reactions**

- **Captures and transfers energy**
- Takes place in thylakoids
- Water and sunlight is needed – captures energy from sunlight (carbon dioxide and chloroplasts are also needed)
- Chlorophyll absorbs energy
- Energy is transferred along the thylakoid membrane then to light-independent reactions
- Oxygen is released
- The light-dependent reactions include groups of molecules called photosystems.
- **Electron Transport**
  - Light energy excites electrons in photosystem II and also causes a water molecule to split – **photolysis**. This releases an electron into the electron transport system, H<sup>+</sup> into the thylakoid space, and O<sub>2</sub> as a waste product. **Releases electrons in electron transport chain.**
    - The excited electrons move from **photosystem II** to an electron-acceptor molecule in the thylakoid membrane.
  - The electron-acceptor molecule transfers the electrons along a series of electron-carriers to **photosystem I – another electron trans. chain**
    - Photosystem I transfers the electrons to a protein called ferredoxin.
    - Ferredoxin transfers the electrons to the electron carrier NADP<sup>+</sup>, forming the energy-storing molecule NADPH.

- **Phase Two: Light Independent Reactions (Calvin Cycle)**

- **Uses energy from the first stage to make sugar**
- In Stroma
- In the second phase of photosynthesis, called the Calvin cycle, energy is stored in organic molecules such as glucose.
- Six CO<sub>2</sub> molecules combine with six 5-carbon compounds to form twelve 3-carbon molecules called 3-PGA.
- The chemical energy stored in ATP and NADPH is transferred to the 3-PGA molecules to form high-energy molecules called G3P.
- Two G3P molecules leave the cycle to be used for the production of glucose and other organic compounds.

- An enzyme called **rubisco** converts the remaining ten G3P molecules into 5-carbon molecules called RuBP.
  - Why is it important?
    - **Purpose of Photosynthesis = to convert sunlight energy to chemical energy.**
    - Life is powered by sunlight. The energy used by most living cells comes ultimately from the sun. Plants, algae, and some bacteria use energy from sunlight, particularly blue and red wavelengths, to build molecules which later can be split through cellular respiration to retrieve some of that energy. Storing energy in molecules and then oxidizing those molecules to retrieve the stored energy maintains all life on Earth. Plants are often called 'producers' because they produce energy-storing molecules used by almost all other organisms on Earth. By eating plants, herbivores 'steal' these energy-storing molecules to maintain their own life processes. By eating animals, carnivores 'plunder' the molecules that store the energy originally captured by plants. By feeding on dead tissue, decomposers exploit whatever molecules remain in the dead the plants, herbivores, and carnivores. Ultimately, the process of photosynthesis is the most important chemical reaction on Earth. As biologists are well aware, "Roses are red, violets are blue. If the green plants go, then so do you!"
- **Summarize the two phases of photosynthesis:**
  - light dependent - **light energy is absorbed and then converted into chemical energy in the form of ATP and NADPH.**
  - light independent (Calvin Cycle) -**energy is stored in molecules such as glucose – makes sugar.** the ATP, and NADPH that were formed in phase one are used to make glucose. Once glucose is produced, it can be joined to other simple sugars to form larger molecules. These molecules are complex carbohydrates, such as starch. The end products of photosynthesis also can be used to make other organic molecules such as proteins, lipids and nucleic acids.

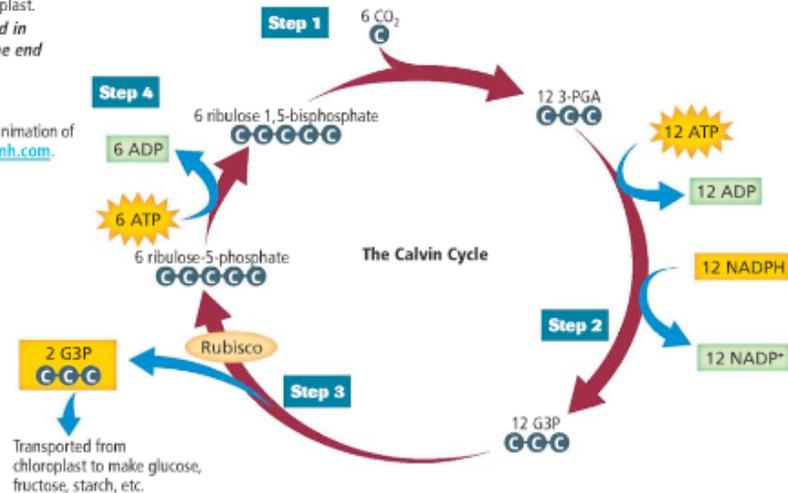
- Calvin cycle:

■ **Figure 8.9** The Calvin cycle joins carbon dioxide with organic molecules inside the stroma of the chloroplast.

**Determine** the compound in which energy is stored at the end of the Calvin cycle.

**Concepts in Motion**

**Interactive Figure** To see an animation of the Calvin cycle, visit [biologygmh.com](http://biologygmh.com).



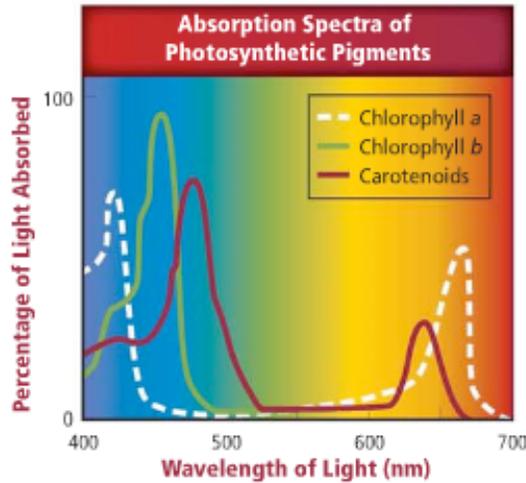
- where does it take place? - **Stroma**
- what is another name for the Calvin cycle? - **light independent reactions**
- what are the main steps?
  - **In the second phase of photosynthesis, called the Calvin cycle, energy is stored in organic molecules such as glucose.**
  - **Six CO<sub>2</sub> molecules combine with six 5-carbon compounds to form twelve 3-carbon molecules called 3-PGA.**
  - **The chemical energy stored in ATP and NADPH is transferred to the 3-PGA molecules to form high-energy molecules called G3P.**
  - **Two G3P molecules leave the cycle to be used for the production of glucose and other organic compounds.**

- When is glucose formed in photosynthesis? – **After/ end of calvin cycle w/ oxygen**
- Photolysis – **The splitting of water with hydrogen and oxygen ions – during phase 1.**
- Rubisco and its role in the Calvin cycle - **an enzyme that converts** the remaining ten G3P molecules into 5- carbon molecules called ribulose 1, 5- biphosphates (RuBP). These molecules combine with new carbon dioxide molecules to continues the cycle. The final step of the Calvin cycle
- Where does each phase of photosynthesis occur?
  - Phase 1 – Chloroplasts – **Thylakoids (Chlorophyll)**
  - Phase 2 - **Stroma**

- Structure of Chloroplast:
  - **Thylakoid** - flattened saclike membranes that are arranged in stacks. One of the main compartments essential to photosynthesis. (**Phase 1**)
  - **Grana** - the stacks of thylakoids
  - **Stroma** - the fluid compartment that is outside the grana. This is the location of the light-independent reactions in **phase two** of photosynthesis. One of the main compartments essential to photosynthesis.
  - **Chlorophyll** – the major pigments in plants. It absorbs most wavelengths of light except green.
- The role of glucose in photosynthesis and cellular respiration – **product of photosynthesis and reactant for cellular respiration**
- Explain the function of the chloroplast during the light reactions – **capture light energy in photosynthetic organisms.**



- **absorption spectrum**



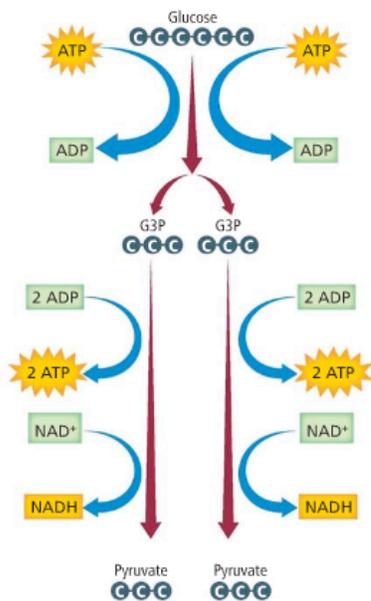
■ **Figure 8.6** Colorful pigments found in the leaves of trees differ in their ability to absorb specific wavelengths of light.

- reflection – **green region of spectrum, why plant parts that have chlorophyll appear green to the human eye.**
- ROYGBIV – **Visible light spectrum**
- chlorophyll a and b – **there are two types of chlorophyll. A absorbs darker colors. B absorbs lighter colors.**
- What are some of the alternatives to photosynthesis? - **C4 and CAM**
- What do C4 and CAM plants do?
  - C4 – **fix carbon dioxide in to 4-carbon compound instead of 3 carbons compounds like the cycle. Minimizes water loss, keep stomata (Pores) closes. Ex – sugar cane, corn.**
  - CAM – **CO<sub>2</sub> enters the leaves only at night when it is cooler and more humid during the day CO<sub>2</sub> enters the Calvin Cycle. Occurs in water conserving plants. Ex – cactus, orchids, pineapple.**
- Cellular Respiration:
  - Equation



- why is it necessary? - **The function of cellular respiration is to harvest electrons from carbon compounds, such as glucose and use that energy to make ATP. ATP is used to provide energy for cells to do work.**

- Cellular respiration steps:



■ **Figure 8.12** Glucose is broken down during glycolysis inside the cytoplasm of cells. **Summarize** the reactants and products of glycolysis.

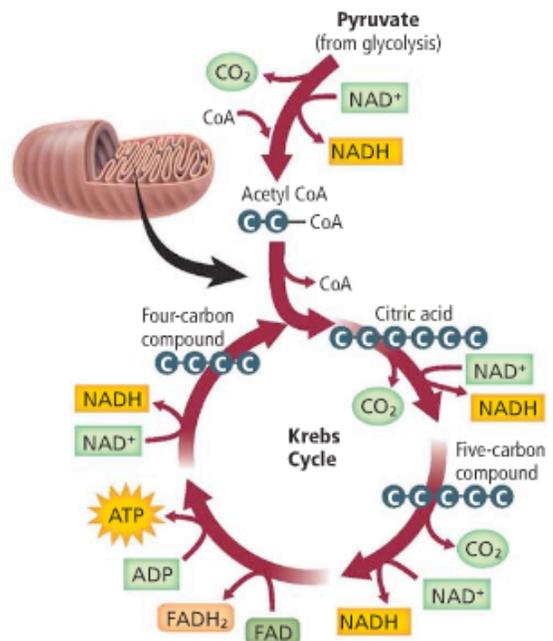
- Glycolysis - **the process when glucose is broken down in the cytoplasm**

■ **Figure 8.13** Pyruvate is broken down into carbon dioxide during the Krebs cycle inside the mitochondria of cells.

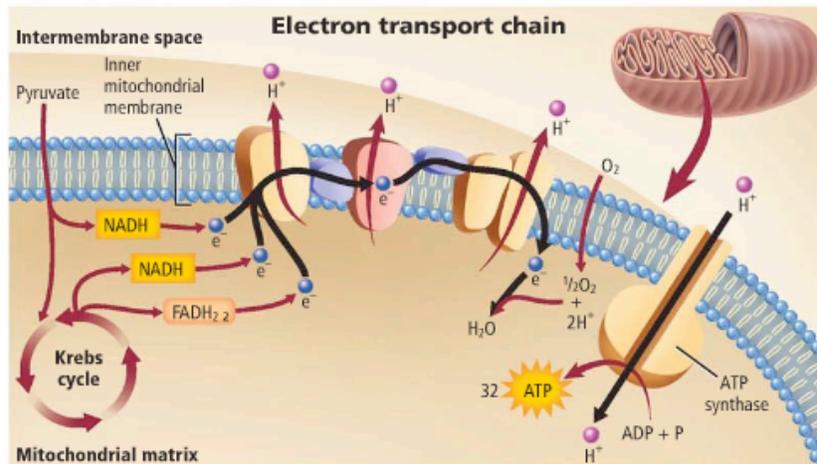
**Trace** Follow the path of carbon molecules that enter and leave the Krebs cycle.

**Concepts In Motion**

**Interactive Figure** To see an animation of the Krebs cycle, visit [biologygmh.com](http://biologygmh.com).



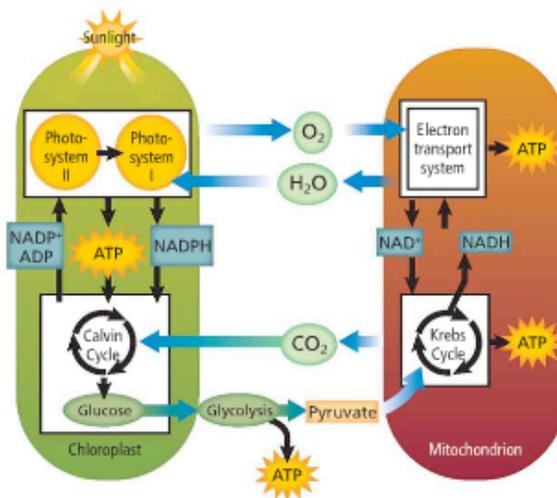
- Krebs cycle (citric acid cycle) - **(or tricarboxylic acid (TCA) cycle) series of reactions in which pyruvate is broken down into carbon dioxide.**



■ **Figure 8.14** Electron transport occurs along the mitochondrial membrane.

- electron transport chain
- Where does each step in cellular respiration occur?
  - Glycolysis – **in cytoplasm ANAEROBIC**
  - krebs cycle (citric acid cycle) – **in mitochondria - AEROBIC**
  - electron transport chain – **along mitochondrial membrane AEROBIC**
- What is the final electron acceptor in the electron transport chain of cellular respiration? - **Oxygen**
- NADP<sup>+</sup>/NADPH – what is the role of these electron carriers?
- **\*\*\*Compare and contrast photosynthesis and cellular respiration.**

○ <b>Photosynthesis</b>	○ <b>Cellular Respiration</b>
<ul style="list-style-type: none"> <li>• Produces glucose and oxygen</li> <li>• Only plant cells</li> <li>• Requires sunlight</li> <li>• Requires chloroplasts and chlorophyll</li> <li>• Requires Carbon Dioxide and water</li> <li>• Carbon dioxide taken in, (oxygen out )</li> </ul>	<ul style="list-style-type: none"> <li>• Produces CO<sub>2</sub> and Water</li> <li>• Animal and plant cells</li> <li>• Requires mitochondria, oxygen and glucose</li> <li>• Breaks down glucose – energy released</li> <li>• Doesn't require sunlight</li> <li>• Oxygen taken in, (Carbon Dioxide out )</li> </ul> <p>The process by which mitochondria break down food molecules to produce ATP organisms</p>
<b>Both</b>	
<b>Important processes that cells use to obtain energy</b>	



■ **Figure 8.16** Photosynthesis and cellular respiration form a cycle in which the products of one metabolic pathway form the reactants of the other metabolic pathway.



## Photosynthesis and Cellular Respiration

As you have learned, photosynthesis and cellular respiration are two important processes that cells use to obtain energy. They are metabolic pathways that produce and break down simple carbohydrates.

**Figure 8.16** shows how these two processes are related. Recall that the products of photosynthesis are oxygen and glucose—the reactants needed for cellular respiration. The products of cellular respiration—carbon dioxide and water—are the reactants for photosynthesis.

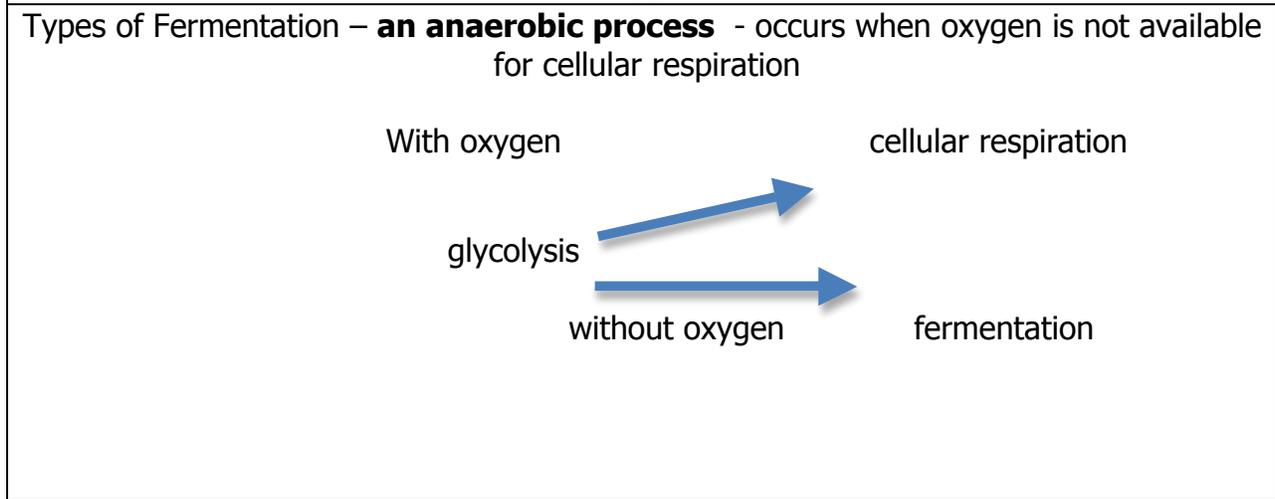


- How many ATPs are formed in cellular respiration? **36**
- What about fermentation? **2 ATP**
- What does net gain mean? - **overall gain including what left cell**
- Anaerobic/aerobic processes
  - Anaerobic – **no oxygen is required**
  - Aerobic – **require oxygen**
- **Fermentation: lactic acid/alcoholic – compare and contrast**

○ <b>Lactic Acid</b>	○ <b>Alcoholic</b>
<p style="text-align: center;"><b>Lactic Acid Fermentation</b></p>	<p style="text-align: center;"><b>Alcohol Fermentation</b></p>
<p>Enzymes convert the pyruvate made during glycolysis to lactic acid. This</p>	<p>occurs in yeast and some bacteria. The picture above show the chemical reaction</p>

<p>involves the transfer of high-energy electrons and protons from NADH. Skeletal muscle produces lactic acid when the body cannot supply enough oxygen, such as during periods of strenuous exercise. When lactic acid builds up in muscle cells, muscles become fatigued and might feel sore. Lactic acid also is produced by several microorganism that often are used to produce many foods, including cheese, yogurt, and sour cream.</p>	<p>that occurs during alcohol fermentation when pyruvate is converted to ethyl alcohol and carbon dioxide. Similar to lactic acid fermentation, NADH donates electrons during this reaction and NAD+ is regenerated.</p>
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**Both**



• **Compare and contrast cellular respiration and fermentation**

○ <b>Cellular Respiration</b>	○ <b>Fermentation</b>
<p>Oxygen – 36 ATP The process by which mitochondria break down food molecules to produce ATP organisms</p>	<p>2 ATP – Not enough Oxygen</p>
<b>Both</b>	
Both Cell Processes	