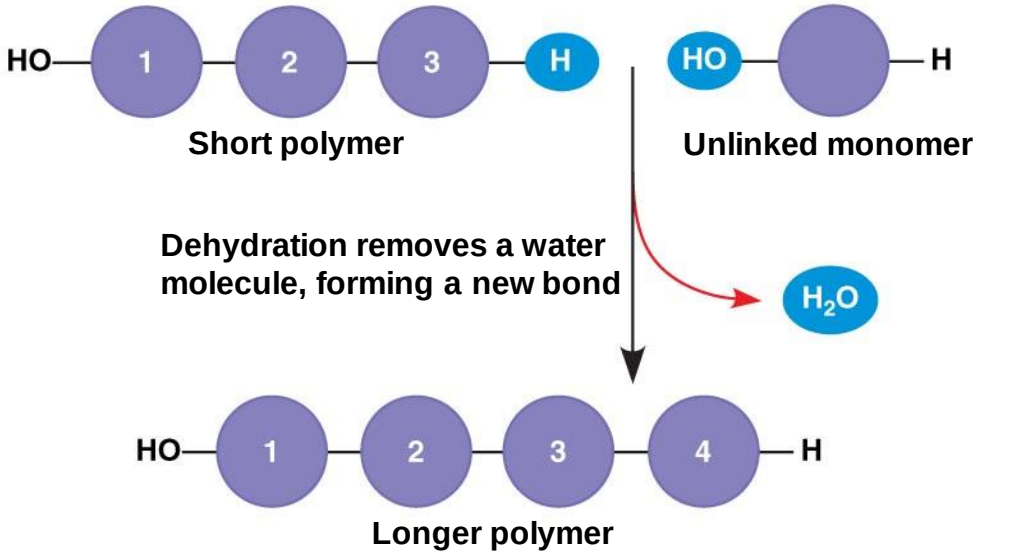
Living Metabolism

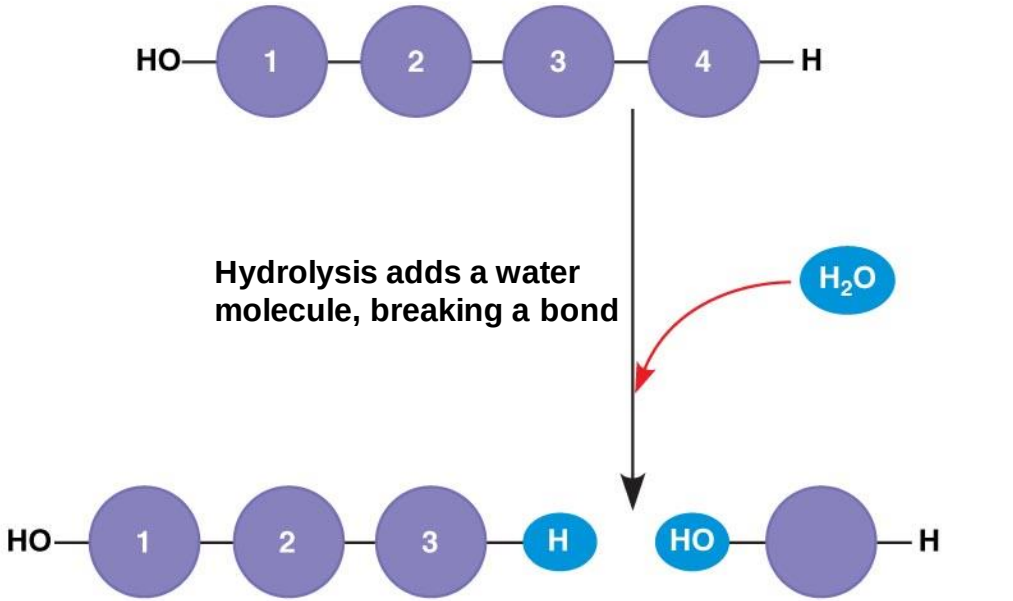
Metabolism

- The sum total of all chemical reactions occurring in an organism.
- A **chemical reaction** is a process that changes, or transforms, one set of chemicals into another by changing chemical bonds.

Dehydration and Hydrolysis Reactions



(a) Dehydration reaction in the synthesis of a polymer



(b) Hydrolysis of a polymer

Remember!

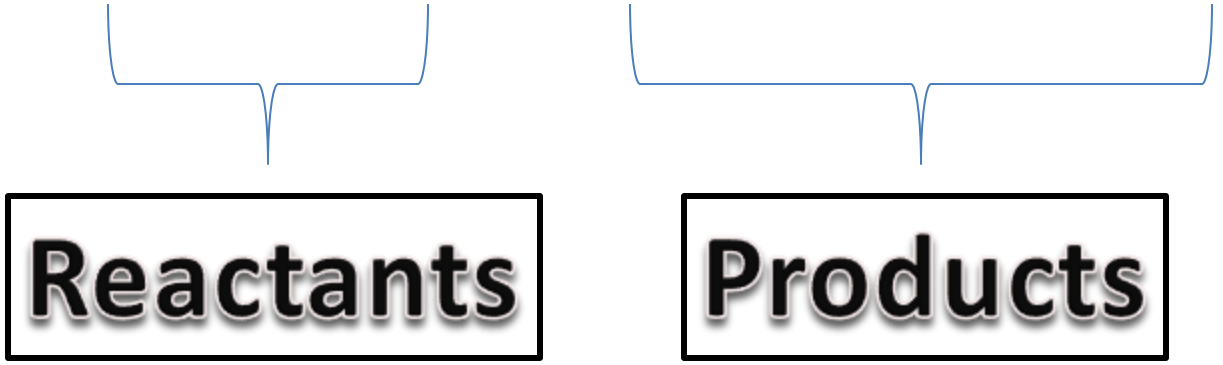
- Parts of a Reaction
  - **Substrates (a.k.a. Reactants)**
  - **Products**
- Reactants or Substrates enter a chemical reaction and are turned into products

Metabolism Movie

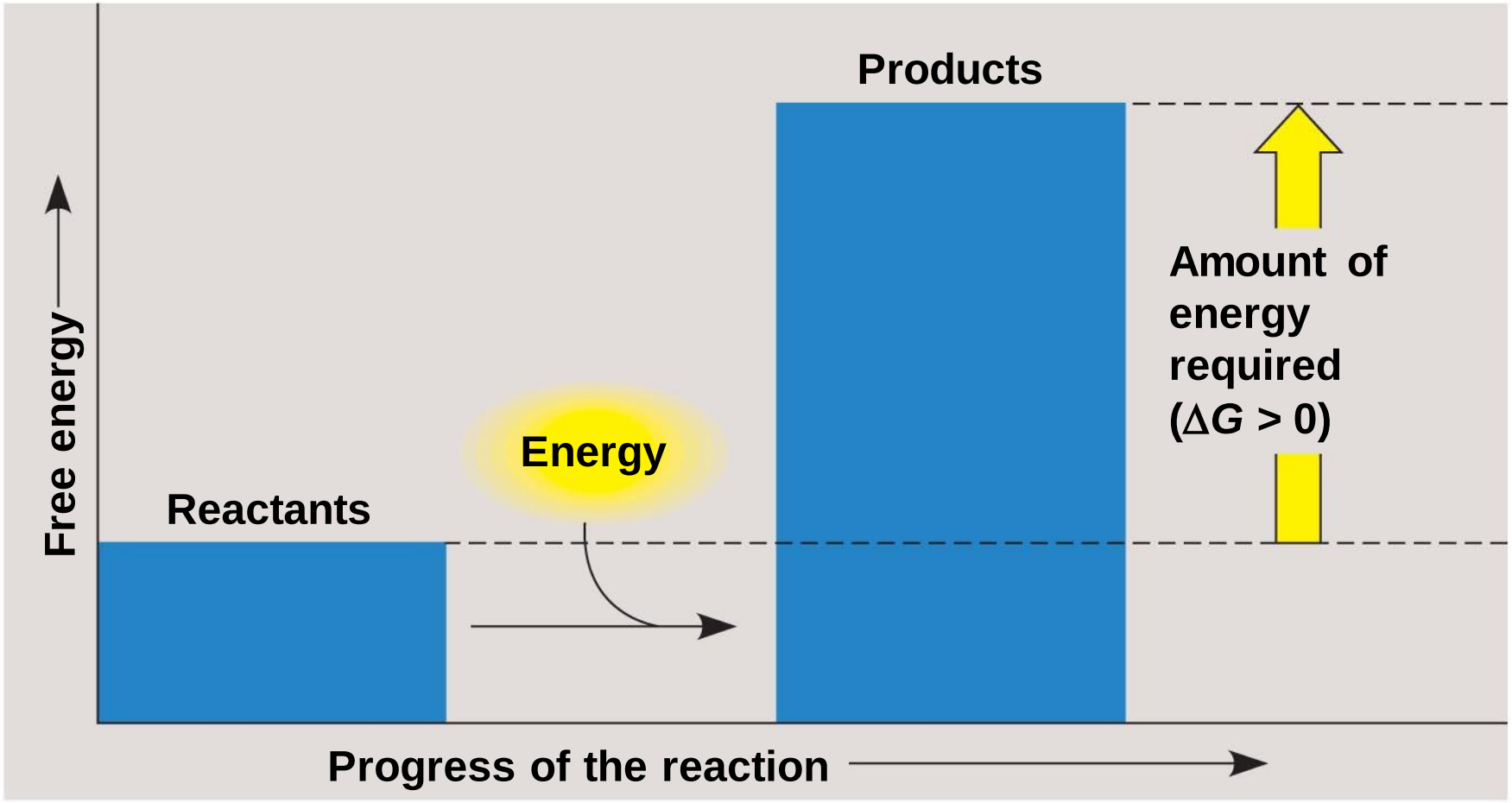
- http://www.youtube.com/watch?v=0kZLQGByXN4#t=17

Two Types of Metabolic Activity

- **Anabolism**
  - Combining small molecules into larger molecules.
  - Example: **Photosynthesis**
  - Light + 6 CO_2 + 6 H_2O → $C_6H_{12}O_6$ + 6 O_2

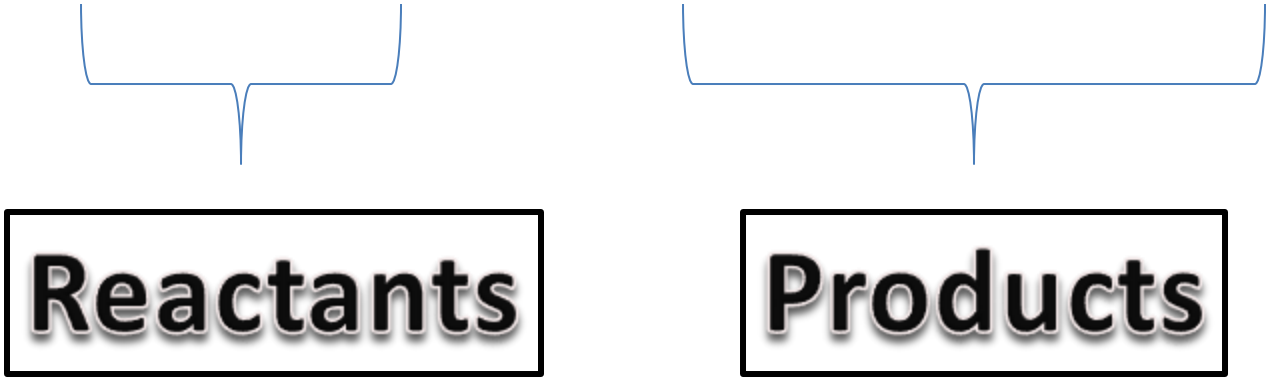


Anabolism
(Dehydration Synthesis)

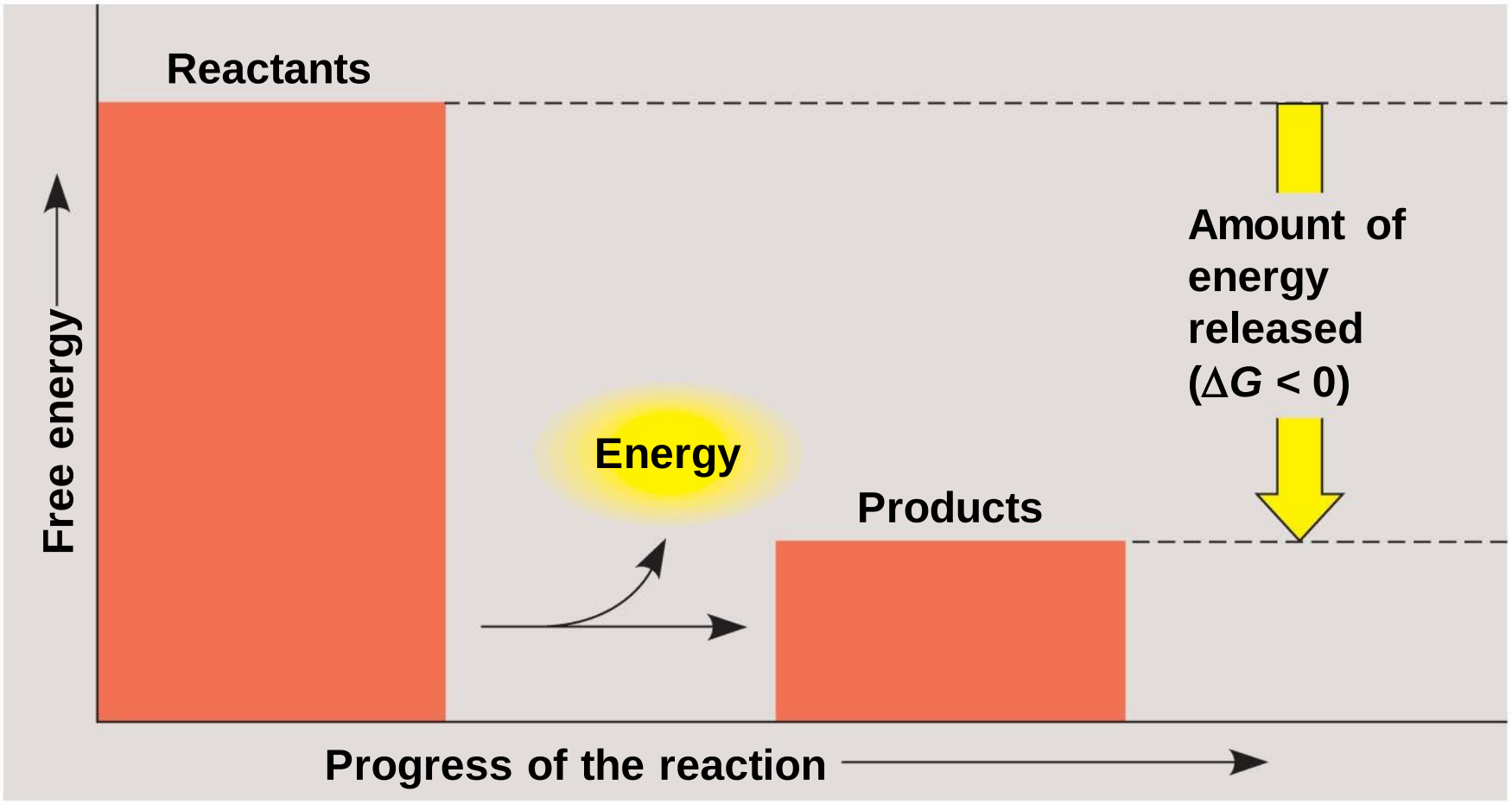


(b) Endergonic reaction: energy required

- **Catabolism**
  - Breaking down large molecules into smaller molecules
  - Example: **Cellular Respiration**
  - $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$



Catabolism
(Hydrolysis Reaction)



(a) Exergonic reaction: energy released

Photosynthesis and Cellular Respiration are Coupled Chemical Reactions

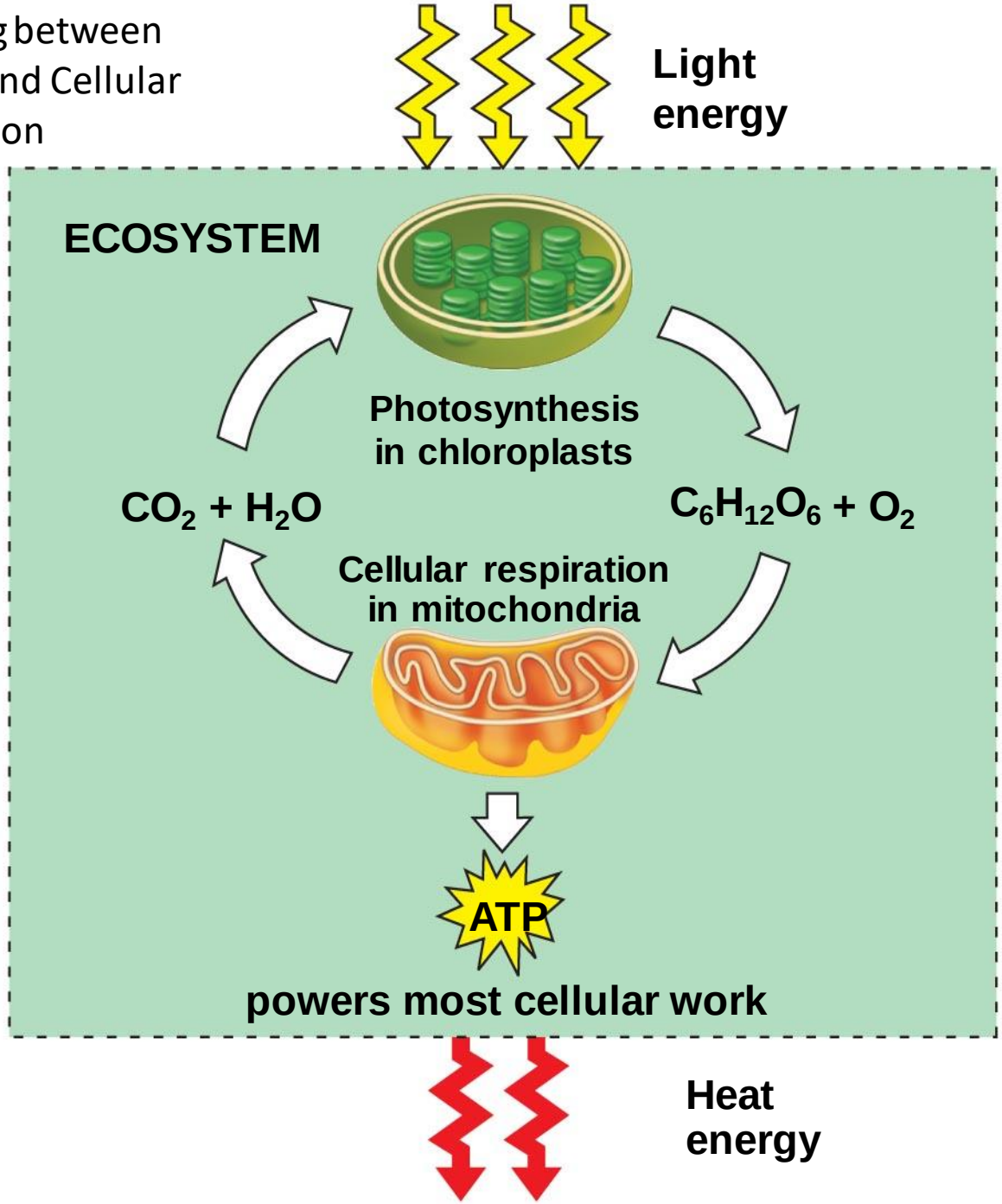
$$\text{Light} + 6\,CO_2 + 6\,H_2O \rightarrow C_6H_{12}O_6 + 6\,O_2$$

Photosynthesis

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{ATP}$$

Cellular Respiration

Energy Coupling between Photosynthesis and Cellular Respiration



Remember!

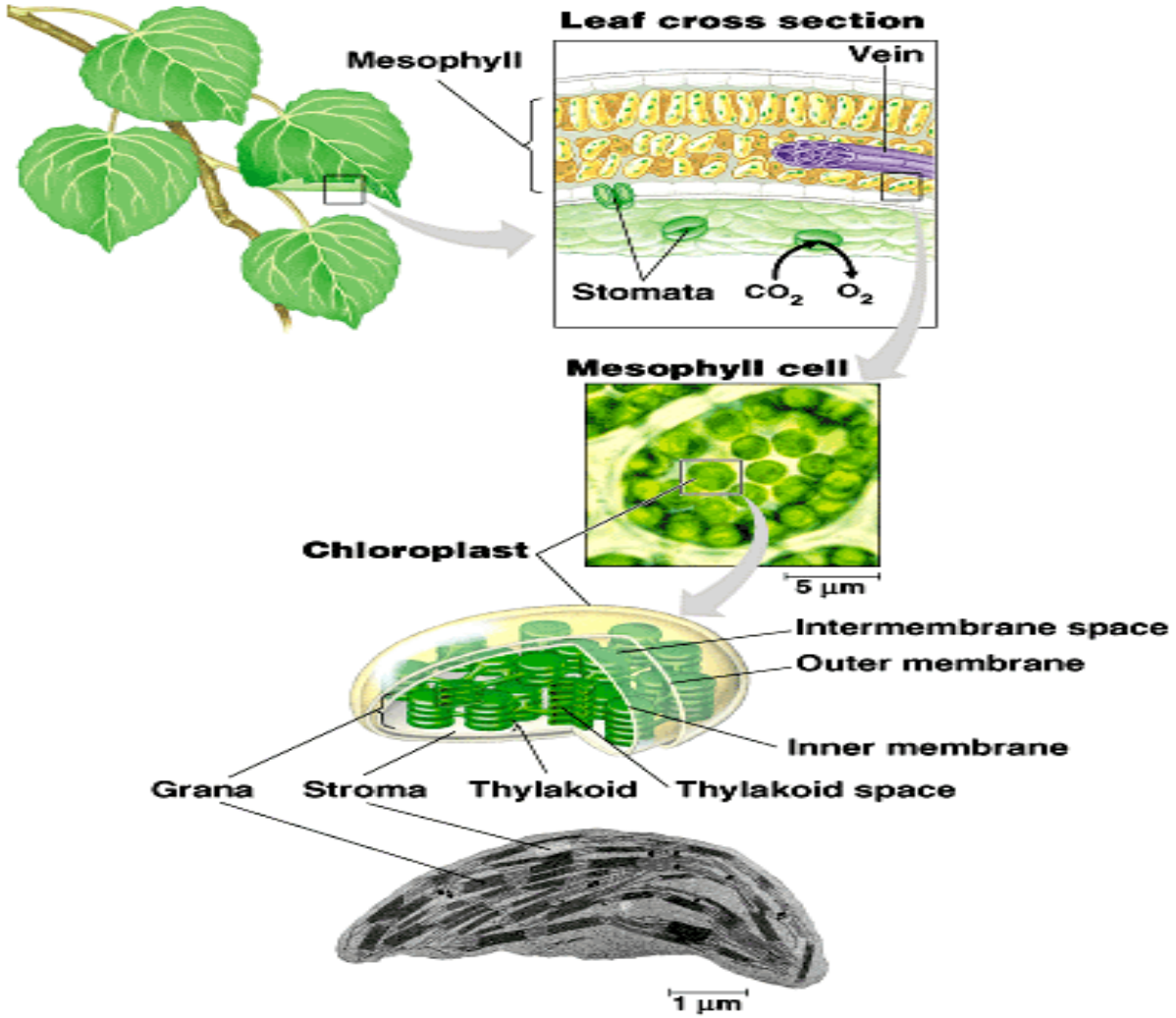
- Photosynthesis and Cellular Respiration are basically the same reaction, only one is the reverse of the other
- The materials made by photosynthesis (glucose and oxygen) are the same ones required for respiration
- If we write the equation for photosynthesis:
  - Energy (light) + 6 CO_2 + 6 H_2O → $C_6H_{12}O_6$ + 6 O_2
- We can rearrange it to make the equation for cellular respiration:
  - $C_6H_{12}O_6$ + 6O_2 → 6CO_2 + 6H_2O + Energy (ATP)

Where does photosynthesis happen?

Chloroplasts

Where are chloroplasts?

Chloroplasts in plant leaf cells



What color are chloroplasts? Why?

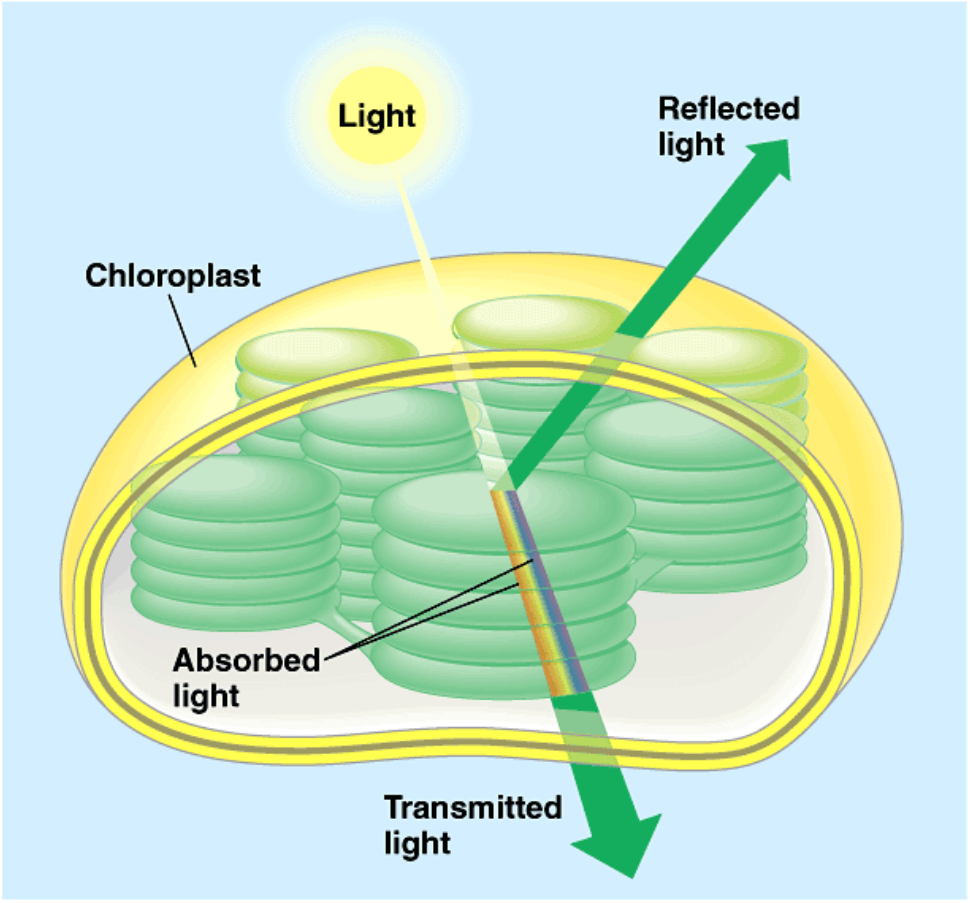
Green

Because they contain a green pigment called **chlorophyll**

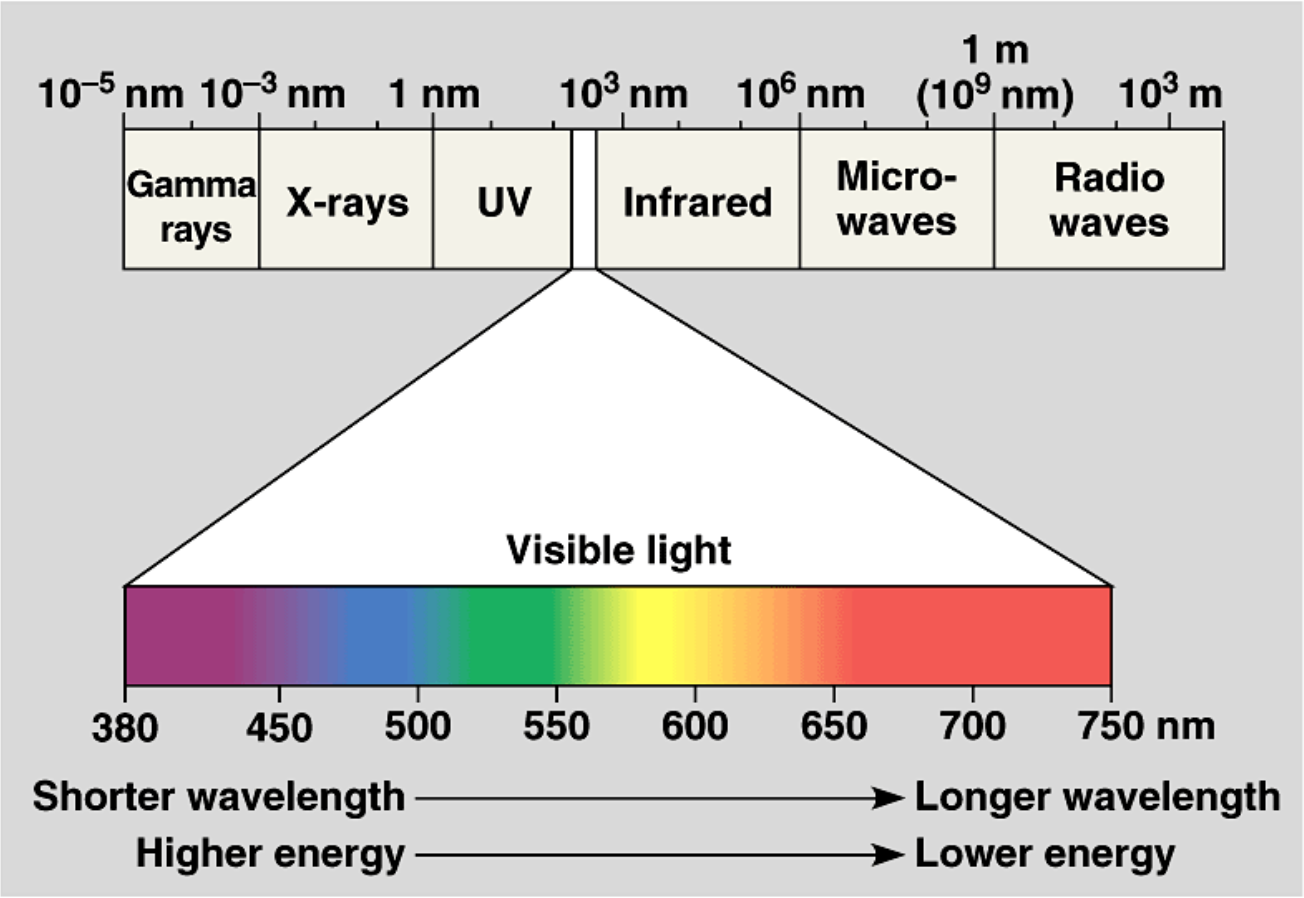
Fun Fact: Why is chlorophyll green?

- Because it doesn't absorb wavelengths of light between 500-600 nm very well
- In other words, it reflects green light

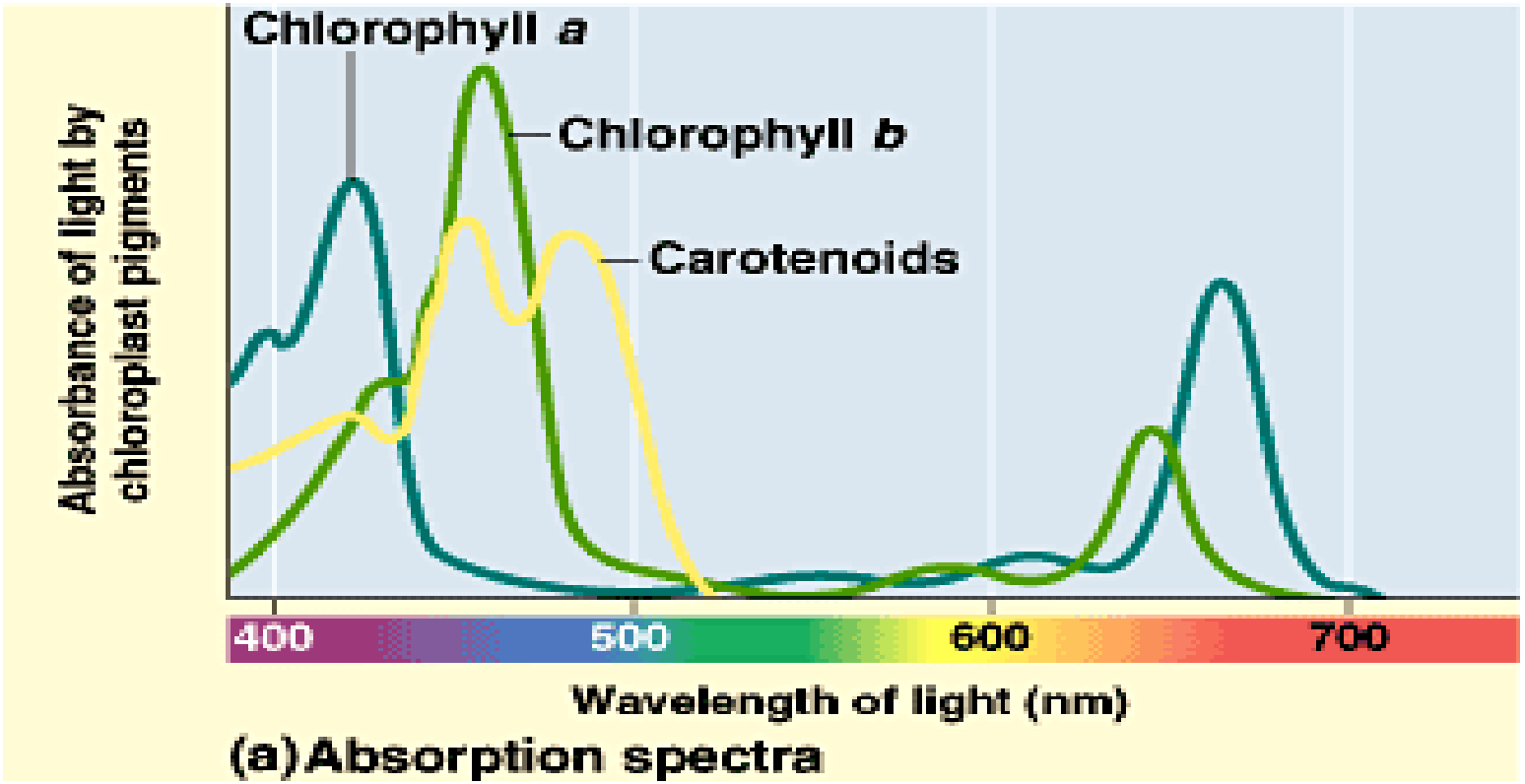
Absorption vs. Reflection



Electromagnetic Spectrum



Chloroplasts *absorbing* the blue and the red light waves. The green is NOT being absorbed.



Fun Facts: How long is a nanometer?

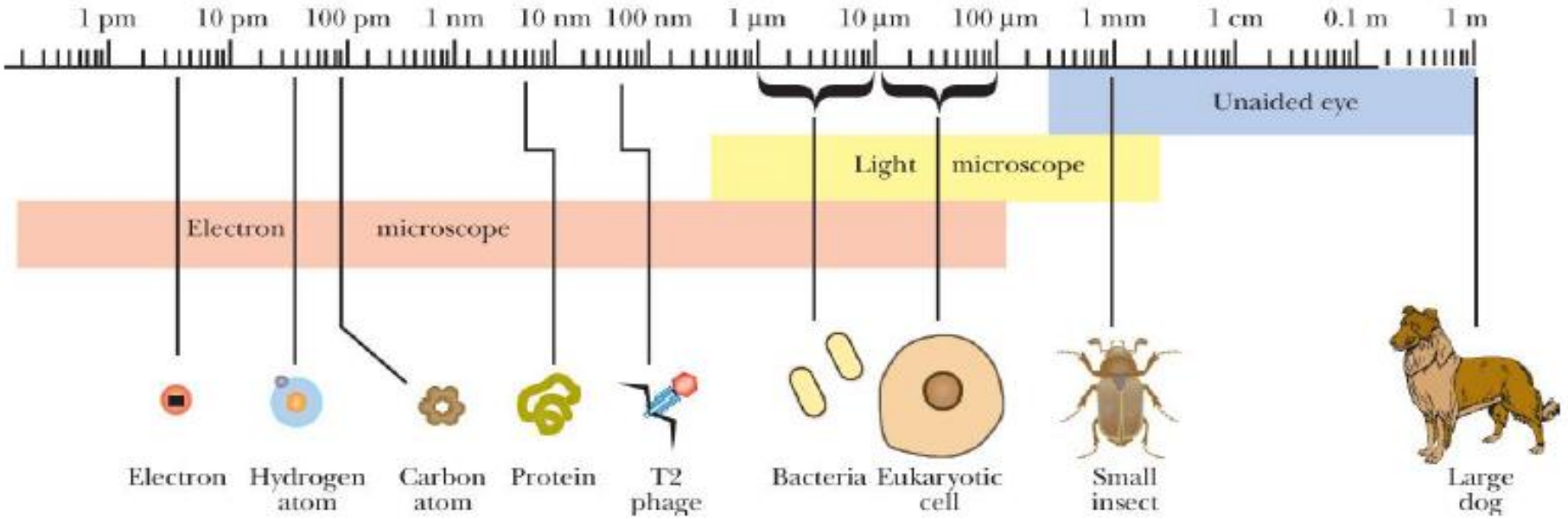
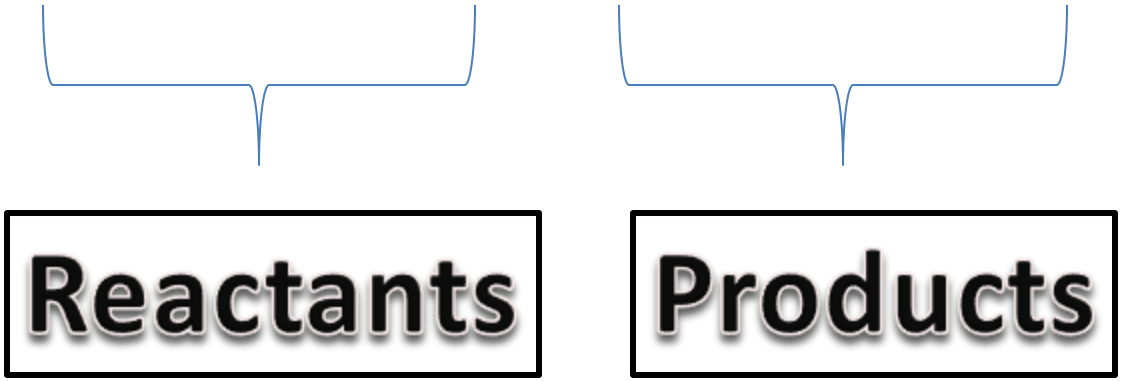


FIGURE 7.1

Size Comparisons
The objects range in size from 1 meter to 1 picometer.

- Chlorophyll is a pigment that absorbs light energy in order for photosynthesis to occur.
- Energy (light) + 6 CO_2 + 6 H_2O → $C_6H_{12}O_6$ + 6 O_2



What happens to the glucose made in photosynthesis?

- Some is stored as starch (anabolism)
- Some is broken down to make ATP (catabolism)

Carbohydrate Digestion in Humans

- Begins in the Mouth: Mechanical & Chemical Digestion
  - Mechanical: physically break food into smaller pieces
  - Chemical: chemically change the food, e.g. starch is converted into maltose

Alpha Amylase & Maltase

- The salivary glands produce an enzyme called amylase that catalyzes the hydrolysis of starch (a polysaccharide) into maltose (a disaccharide).
- The sm. Intestine produces an enzyme called maltase that catalyzes the hydrolysis of maltose into glucose (a monosaccharide)
- *Remember: enzyme names end with ase and sugar names end with ose*

Where does the glucose go?

- It's absorbed through the walls of your sm. intestine, dumped into your blood stream and then transported to every cell in your body.
- Where does the glucose go once in the cell?

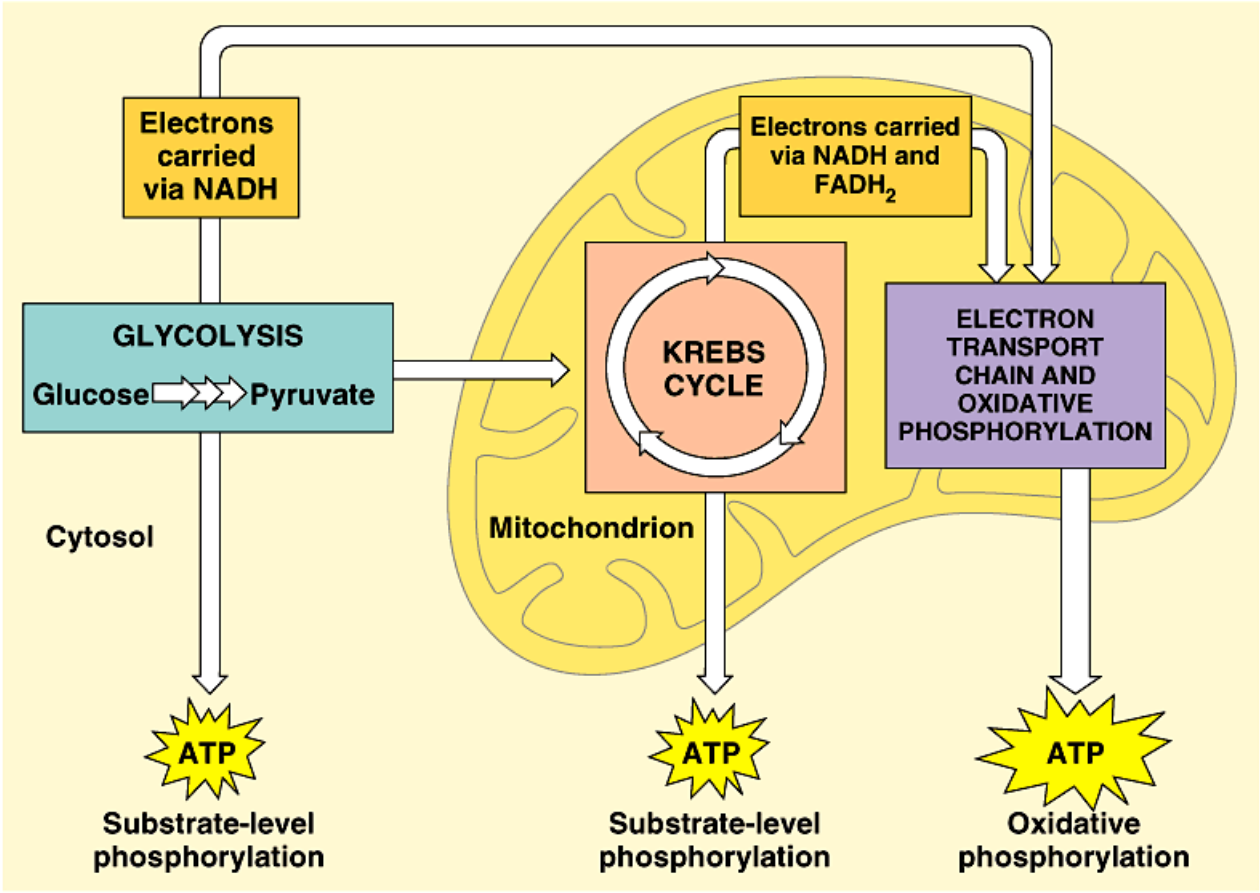
Mitochondria

What happens in the mitochondria? Why?

- **Cellular Respiration**
- $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$

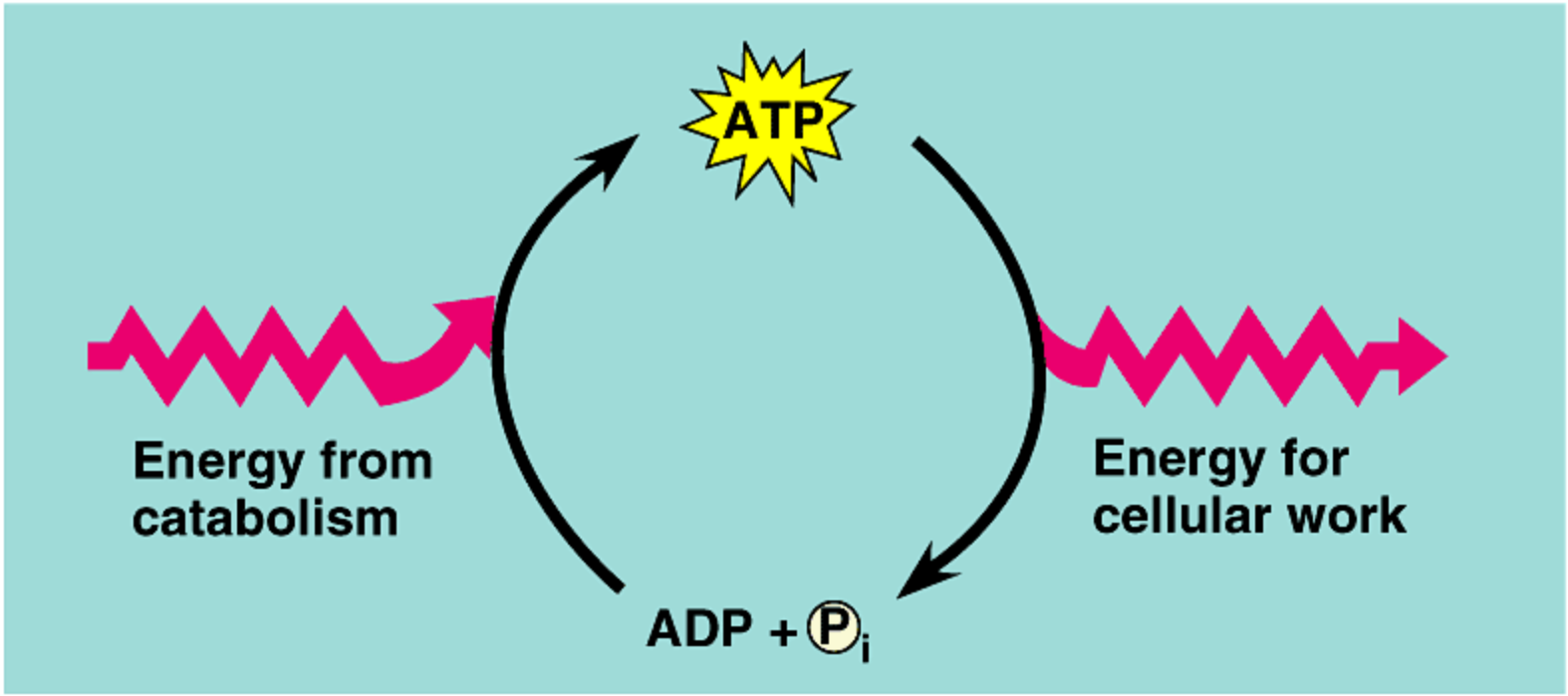
- The purpose of cellular respiration is to make ATP
- Since this type of cellular respiration requires O_2, it is called aerobic respiration (Glycolysis, Krebs Cycle, Electron Transport Chain)

The Process of Cellular Respiration

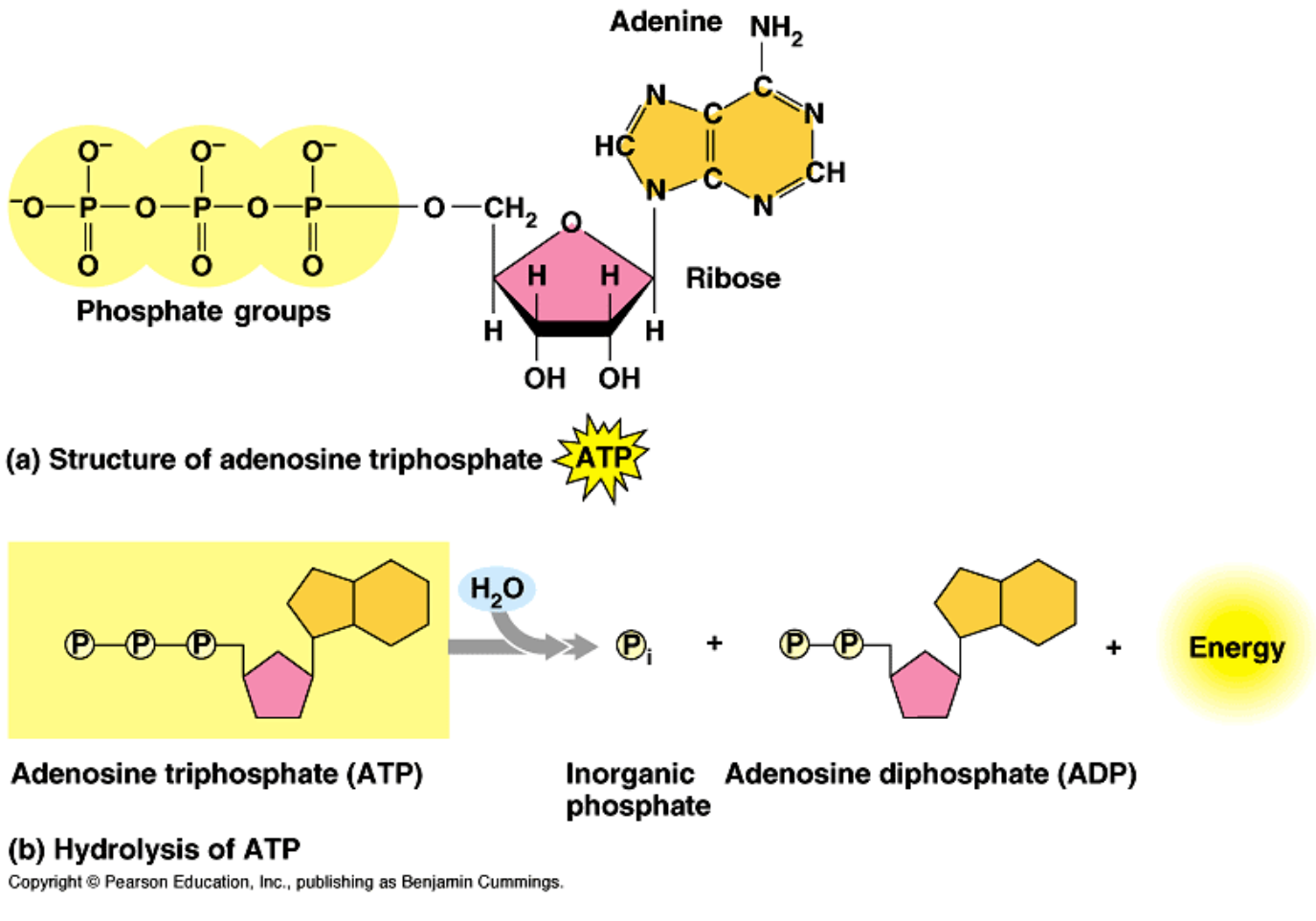


ATP

- **ATP or Adenosine triphosphate** is the energy molecule of the cell

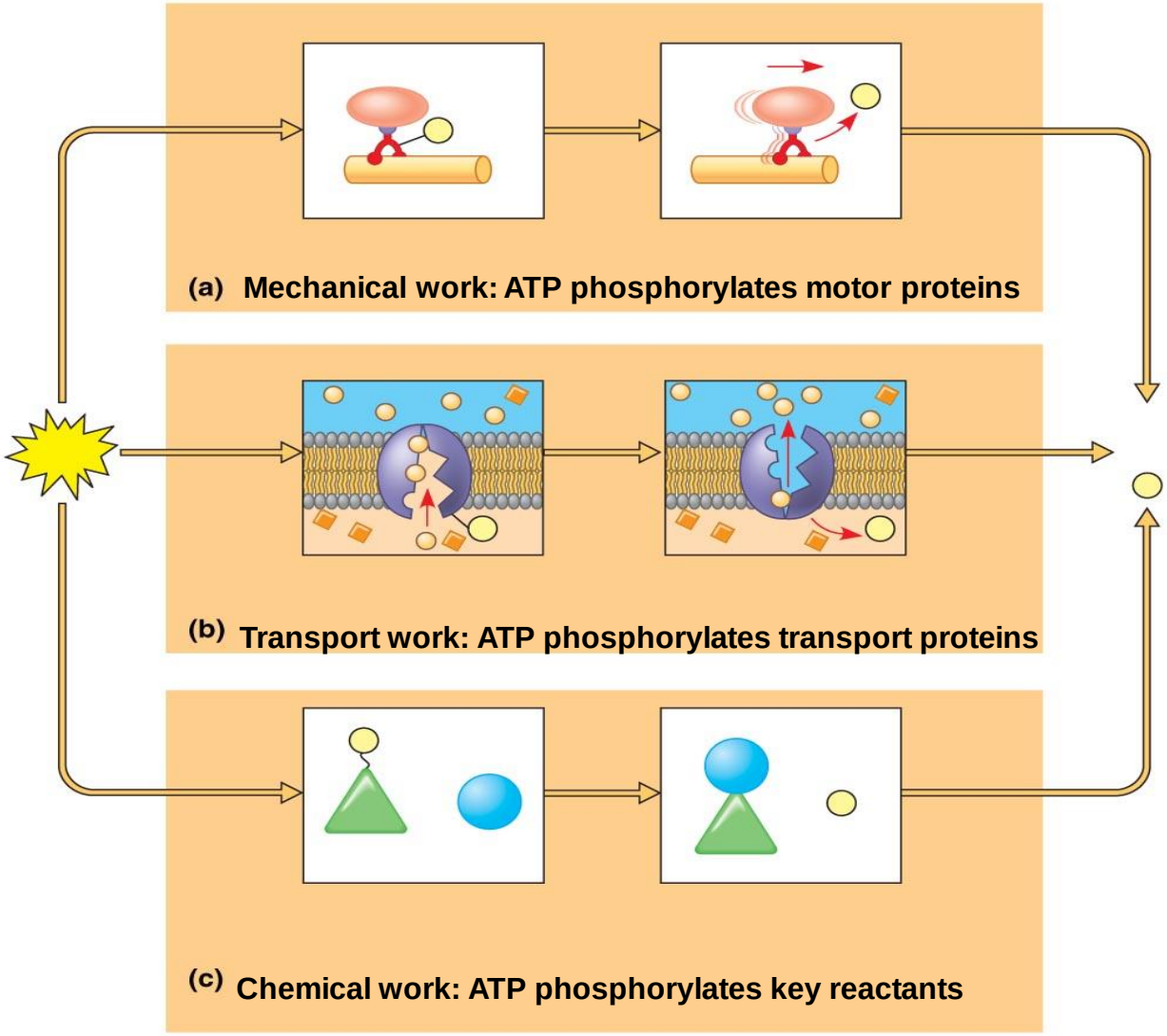


ATP Structure



ATP Function

- ATP provides the energy cells need to do work



How do cells make ATP without O_2?

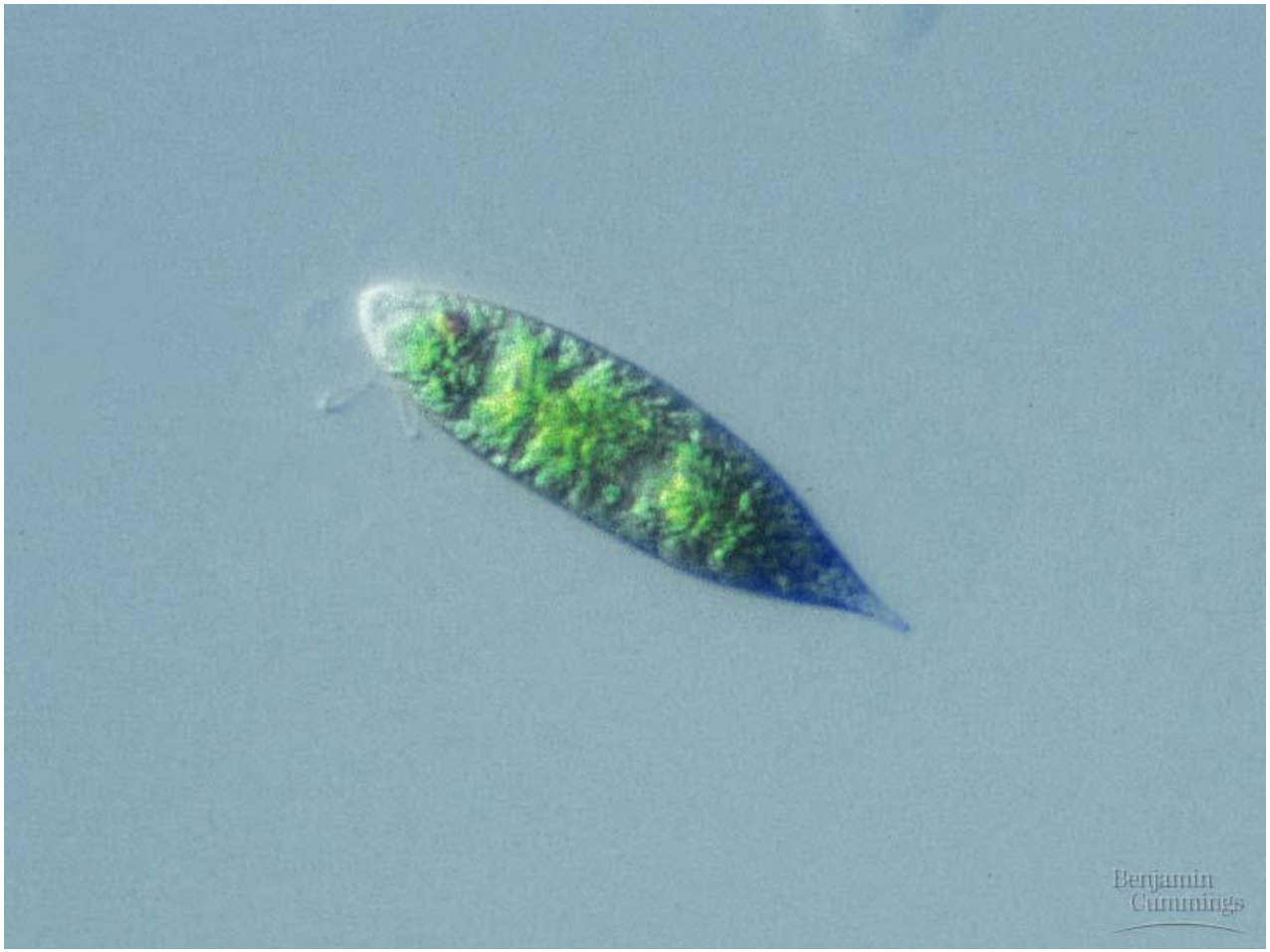
- When there isn't enough O_2 for aerobic cellular respiration, your cells use anaerobic cellular respiration (glycolysis, fermentation) to produce ATP
- Fermentation
  - Lactic Acid or Alcoholic
  - Interesting Fact: the build up of lactic acid causes your muscles to burn during intense exercise.

Autotroph

- Organisms that are able to produce their own food through photosynthesis are called autotrophs
  - Photo "light" synthesis "putting together"
  - Auto "self" troph "food"
- Autotrophs make carbs that serve as food for them and almost all other organisms on earth

Autotroph - Plants

Autotroph - Phytoplankton

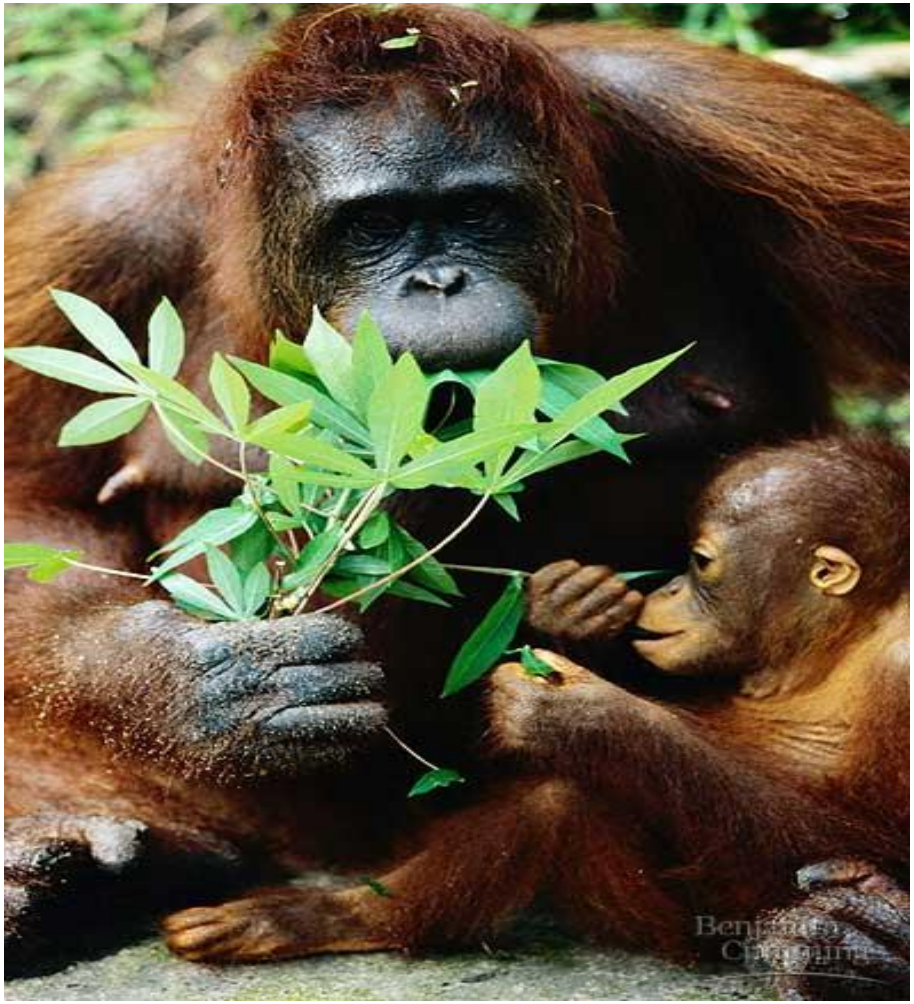


Autotroph - Bacteria

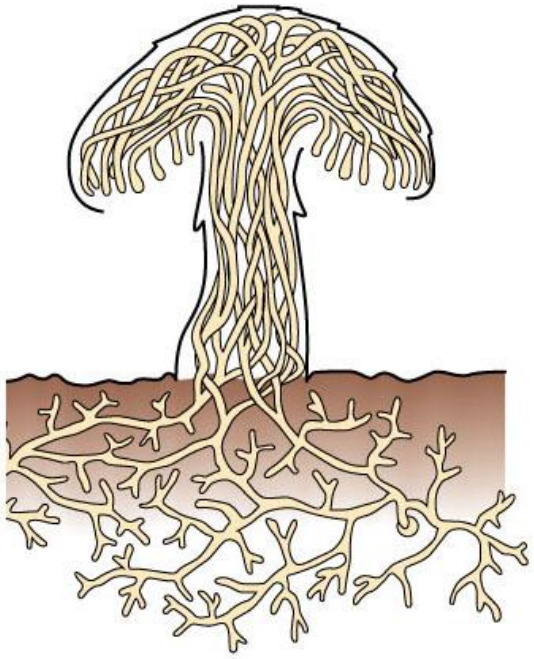
Heterotroph

- Organisms that are not able to make their own food are called heterotrophs
  - Hetero “other” troph “food”
- Heterotrophs consume other organisms or parts of other organisms for food.

Heterotroph - Animal



Heterotroph - Fungus



Remember!

- Autotrophs can make their own food (glucose), but they still have to break it down to make ATP
- Heterotrophs cannot make their own food, which means they gave to get the glucose they need by eating other organisms. Then they can break the glucose down to make ATP
- This means that BOTH autotrophs and heterotrophs use cellular respiration in order to break down glucose and make ATP