

# Unit 1

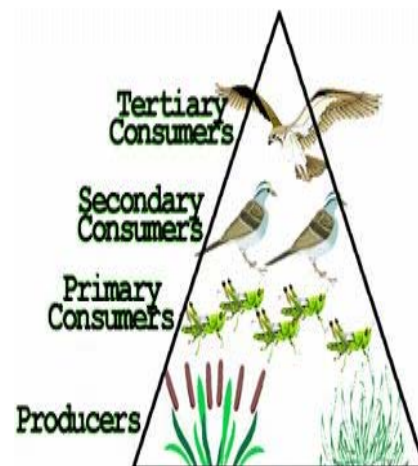
## Matter & Energy for Life

Chapter 3  
Energy For Cells

Biology 2201

## Energy in Cells

- Only about 2% of the sun's energy reaches the earth
  - Energy is harvested by photosynthesis
  - 10% of this energy is passed up the food chains from primary consumers up to tertiary consumers.
  - Some energy is lost as heat during each conversion



## Types of Energy

- Energy
  - The capacity to do work
  - Light, heat, electrical, etc
- Potential Energy
  - Stored energy
  - Sugar, ATP
- Kinetic Energy
  - Energy of Motion
- Chemical Energy
  - Energy stored in bond in the atoms between molecules
  - Once bonds are broken the energy is released
- Metabolism
  - Total of all the chemical reactions that take place within a cell
  - Includes all of the building up and breaking down of substances in a cell
  - Relies on chemical energy within the cell

## Photosynthesis

- The process by which an organism captures the energy of the sun to convert CO<sub>2</sub> and water into glucose.
- Light energy is converted into chemical energy.
- The process looks as follows:
 

Light , chlorophyll
- carbon dioxide + water → glucose + oxygen
 
$$6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow 6\text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2$$

## Importance of Photosynthesis

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1. It is the chief source of energy on earth.
2. It supplies most of the oxygen found in the atmosphere.
3. It is the first step in food chains.



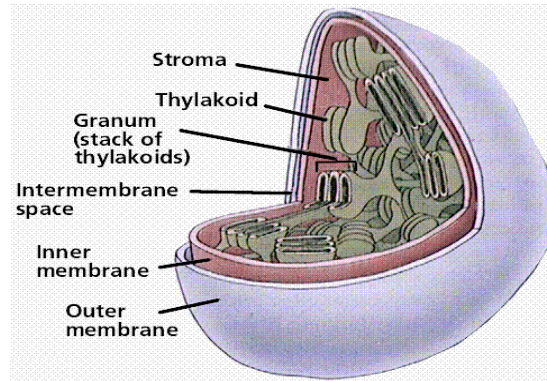
## Who Does It? Who Doesn't?

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- Organisms that carry on photosynthesis are called *autotrophs* or *producers*. They contain *chlorophyll* inside cell organelles called *chloroplasts*.
- Organisms that are not able to carry on photosynthesis are called heterotrophs and capture their food. They depend on plants directly or indirectly as their source of food.

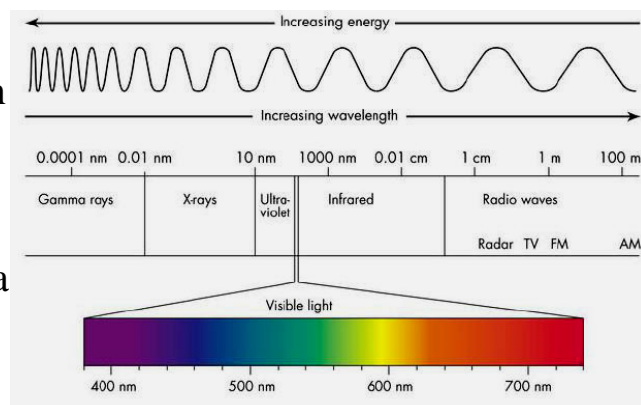
# Chloroplast

- Energy is put into this system during a 'Light reaction' in the Thylakoid.
- Sugars are created during a 'synthesis reaction' that can take place in the dark. Also called 'dark reaction' or 'Calvin Cycle'



# What is Light?

- Visible light makes up a very small portion of the range of radiations known as the **electromagnetic spectrum**.
  - All light travels as a wave that behaves as a particle
  - Composed of small packets of energy called **photons**



## Photosynthetic Pigments

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- In order to capture sunlight, plants require special pigments.
- A pigment is any substance that can absorb light.
- Several types of pigments are necessary to trap the full light spectrum.
- These pigments consist of
  - red, orange, yellow, green, blue, and violet

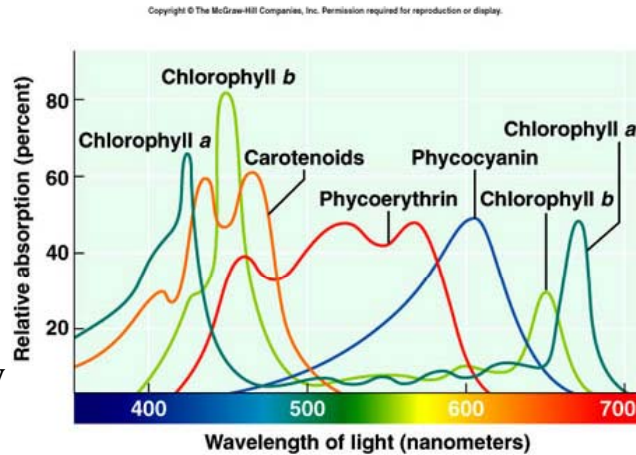
## Pigments - Chlorophyll

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- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>□ Most important pigment</li> <li>□ Present in the largest numbers compared to other pigments</li> <li>□ Capture red and blue light while reflecting green</li> <li>□ Green in color</li> <li>□ There are two types</li> </ul> | <ul style="list-style-type: none"> <li>□ Chlorophyll A           <ul style="list-style-type: none"> <li>■ This is the primary photosynthesis pigment. It directly converts light energy to chemical energy.</li> </ul> </li> <li>□ Chlorophyll B           <ul style="list-style-type: none"> <li>■ Absorbs light energy and transfers it to chlorophyll A.</li> </ul> </li> </ul> |
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## Carotene & Xanthophylls

- Carotenes
  - Orange in colour
- Xanthophylls
  - Yellow in colour
- Both absorb light in the regions of the colour spectrum not covered by chlorophyll



## Light Reaction vs. Dark Reaction

### Light Reaction

- Requires light and takes place on the thylakoid membrane of the chloroplast.
- Chlorophyll captures the sun's energy and uses it to produce oxygen and high energy compounds which are used in the dark reaction.

### Dark Reaction

- Does not require light, but does depend upon the high energy chemical products made in the light reaction.
- This reaction occurs in the stroma.
- The reaction produces glucose and is often called carbon fixation

## Rate of Photosynthesis – 4 Factors

1. Light Intensity
  - The greater the amount of light, the more photosynthesis occurs
2. Temperature
  - below 0°C and above 35°C there is little photosynthesis
3. Water
  - when in short supply, photosynthesis slows down
4. Minerals
  - When in short supply, photosynthesis slows down

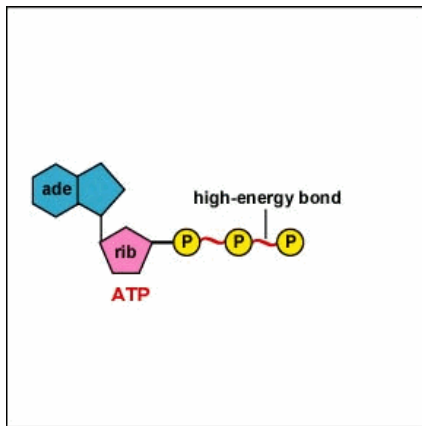
## Cellular Respiration

- This is the process of releasing energy, within a cell, through a complex series of chemical reactions.
- It occurs at the mitochondria, and consists of the step-by-step breakdown of a nutrient, most commonly glucose, in order to release energy.
- This energy is then stored in the cell in the form of ATP.
- $$\begin{array}{l} \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O} + \text{ATP} \\ \text{glucose} \quad + \text{oxygen} \quad \rightarrow \text{carbon dioxide} + \text{water} \quad + \text{ATP} \end{array}$$

## Importance of ATP formation

- ❑ The energy stored in glucose is not readily available to all cell parts, whereas ATP is.
- ❑ Releases energy in the cell with greater control than if the energy came directly from glucose.
- ❑ The ATP acts as the intermediary between energy-releasing (exergonic) and energy-requiring (endergonic) reactions in the cell

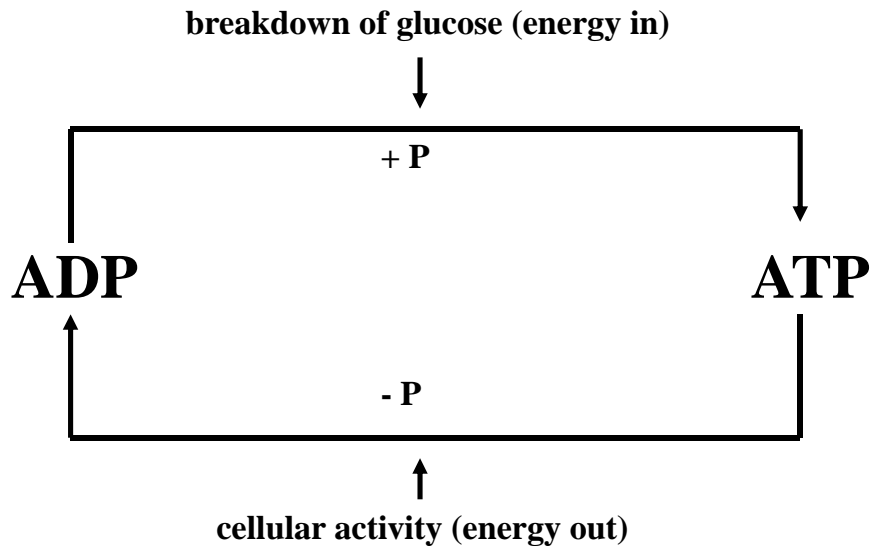
## What is ATP?



- ❑ Adenosine Triphosphate
- ❑ A high-energy compound found within cells
- ❑ Composed of a molecule of adenosine and three molecules of phosphate. The phosphates are held to the adenosine by high energy bonds
- ❑ The bonds break, releasing energy along with ADP (adenosine diphosphate) and a phosphate



## ATP –ADP Cycle



## Aerobic vs. Anaerobic Respiration

### Aerobic Respiration

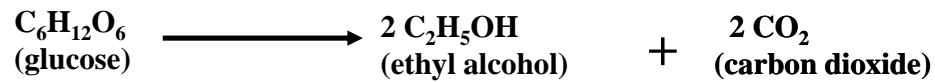
- Glucose is completely oxidized into  $\text{CO}_2$  and  $\text{H}_2\text{O}$  in the presence of  $\text{O}_2$  to release energy.
- It is the most common form of glucose breakdown, and allows for the maximum amount of energy to be released from the glucose
- Ongoing in all cells most of the time to produce energy

### Anaerobic Respiration

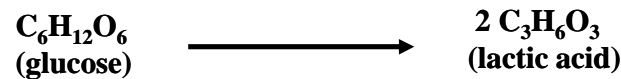
- Glucose is broken down in the absence of oxygen to release energy.
- It creates little energy for the cell. It occurs in smaller organisms and in larger organisms when oxygen is not present.
- Location
  - It occurs in the cytoplasm of plant and animal cells.
- Muscles get sore during exercise because of the lactic acid build-up in the tissues resulting from A.R

## Two Aerobic Respiration

### Alcohol Fermentation:



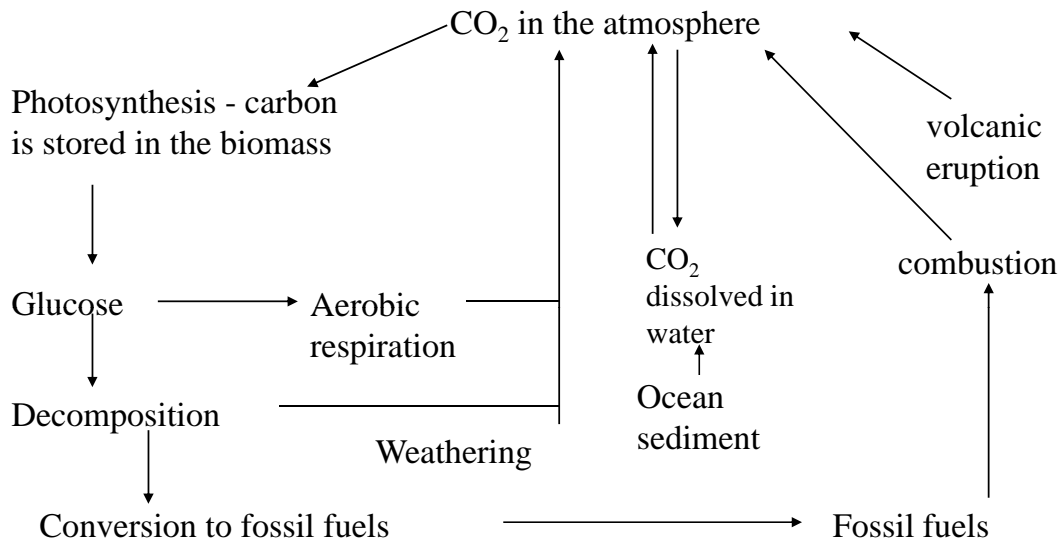
### Lactic Acid Fermentation:



## The Carbon Cycle

- Respiration and photosynthesis are dependant upon each other
  - Two halves of the carbon cycle
- Photosynthesis produces the raw materials for respiration, and respiration produces the raw materials for photosynthesis

## The Carbon Cycle



## How Do we Affect the Carbon Cycle?

- Agriculture
- Clear-cutting
- Mining
- Burning fossil fuels
- Each of these has an overwhelming effect on the levels of carbon available for cycling
- All of which add carbon to the atmosphere, affecting levels stored in biotic sources (plants / animals)

■ See page 88 in textbook

## Chapter 3 Review and Test

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- Chapter Review Assignment

Hand-out Questions

Due: \_\_\_\_\_

- Test Date:

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