Unit 1 – CH 3 Photosynthesis

Energy and Cells for Life

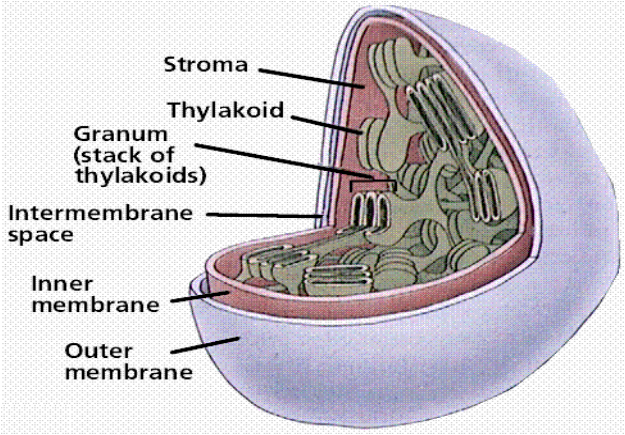
Photosynthesis

- -All living organisms need energy to grow and carry out their required life processes.
- -Some organisms can trap energy directly from the sun and make organic compounds. These are called ***autotrophs***
- (self-feeding). They make food through a process called photosynthesis.
- -In Greek, *photo* means “light”, *syn* means “together” and *sis* means “putting”.

Photosynthesis

- -Photosynthesis actually involves over 100 different chemical relations. We will look at a summary of these.
- -In green plants, chloroplasts are the location of photosynthesis. These are found mostly, but not exclusively in the
- leaves.
- Chloroplasts are small. 40 lined up next to each other are less than 1mm long.

- They can perform thousands of reactions in a second.



Photosynthesis

- -Photosynthesis combines carbon dioxide and water in the presence of sunlight, and chlorophyll to produce
- carbohydrates (usually glucose, a sugar). In other words, light energy is converted into stored chemical energy in the
- bonds of carbohydrate molecules.

Photosynthesis

$$6CO_2 + 6H_2O \xrightarrow{\text{light energy and chlorophyll}} C_6H_{12}O_6 + 6O_2$$

carbon dioxide water glucose oxygen

Importance of Photosynthesis

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.

Rate of Photosynthesis – 4 Factors

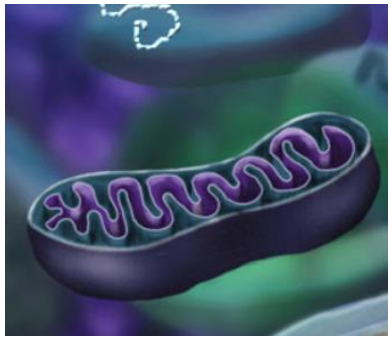
1. Light Intensity
   - The greater the amount of light, the more photosynthesis occurs
2. Temperature
   - below 0°C and above 35°C there is little photosynthesis
3. Water
   - when in short supply, photosynthesis slows down
4. Minerals
   - When in short supply, photosynthesis slows down

Heterotrophs

- -Organisms that can't make their own food, but must instead consume other organisms (plant or animal) are called ***heterotrophs.***

Aerobic Cellular Respiration

- -The energy trapped in plant carbohydrates (starches and sugars) has to be released in animal cells before those cells can use it to function.
- This process occurs in the mitochondria of the cells and is called cellular respiration.



Aerobic Cellular Respiration

- -ALL organisms use cellular respiration to extract energy from organic molecules. (Autotrophs use it too) MOST organisms use *aerobic* cellular respiration. This means the process requires oxygen. (Some organisms use anaerobic respiration).

Aerobic Cellular Respiration

- -Aerobic cellular respiration occurs in the mitochondria. Here, carbohydrates are broken down (metabolized) and combined with oxygen in a series of chemical reactions to release energy is a form that is useful to the cell.

Aerobic vs. Anaerobic Respiration

- Aerobic Respiration
- Glucose is completely oxidized into CO_2 and H_2O in the presence of 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.
- It occurs in the cytoplasm of plant and animal cells.

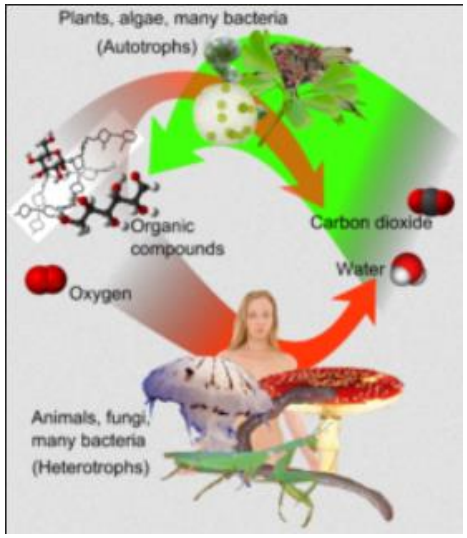
- Muscles get sore during exercise because of the lactic acid build-up in the tissues resulting from A.R

Aerobic Cellular Respiration

mitochondria

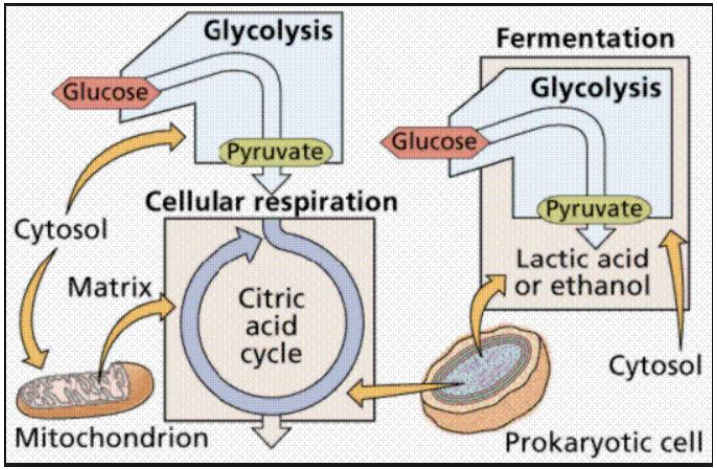
$C_6H_{12}O_6 + 6O_2$ ---------> $6CO_2 + 6H_2O + ATP$

glucose oxygen carbon dioxide water energy



Anaerobic Respiration

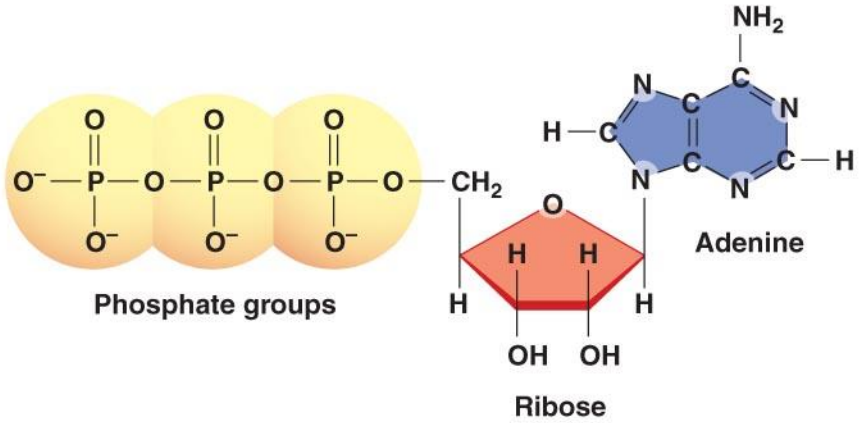
- **Note:** When no oxygen is present, anaerobic respiration can occur, but only 2 ATP are formed for each glucose molecule.



ATP/ -Adenosine triphosphate

- -38 ATP are produced from one glucose molecule in bacterial cells, and 36 ATP molecules are formed in cells with mitochondria. 2 ATP are lost to intermediate energy carrier molecules in the eukaryotic cells.
- -ATP acts as an energy carrier (like a battery) that stores the released energy from carbohydrates and carries it where it is needed in the cell to do work. eg: active transport, produce proteins, contract a muscle...

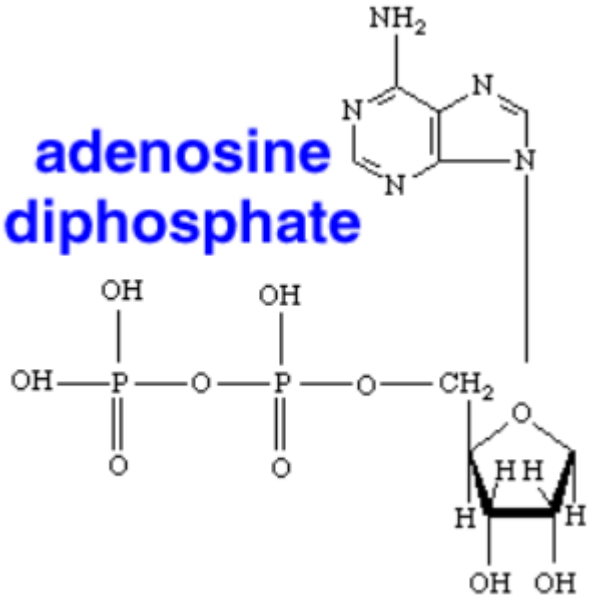
(a) ATP consists of three phosphate groups, ribose, and adenine.



ATP/ -Adenosine triphosphate

- -ATP has a phosphate-to-phosphate bond that is relatively easy to break, but when it is broken, that chemical bond releases enough energy to drive essential cell reactions.
- -After the phosphate group breaks off, the ATP molecule becomes ADP (adenosine diphosphate) and is again available to accept a phosphate group as part of cellular respiration.

adenosine diphosphate



ATP/ -Adenosine triphosphate

- -In an average adult at rest, the cycle of ATP to ADP and back to ATP occurs so often that an estimated 40kg of ATP are processed every day.
- -This process continues over and over in every cell as long as molecules of food and oxygen are available.

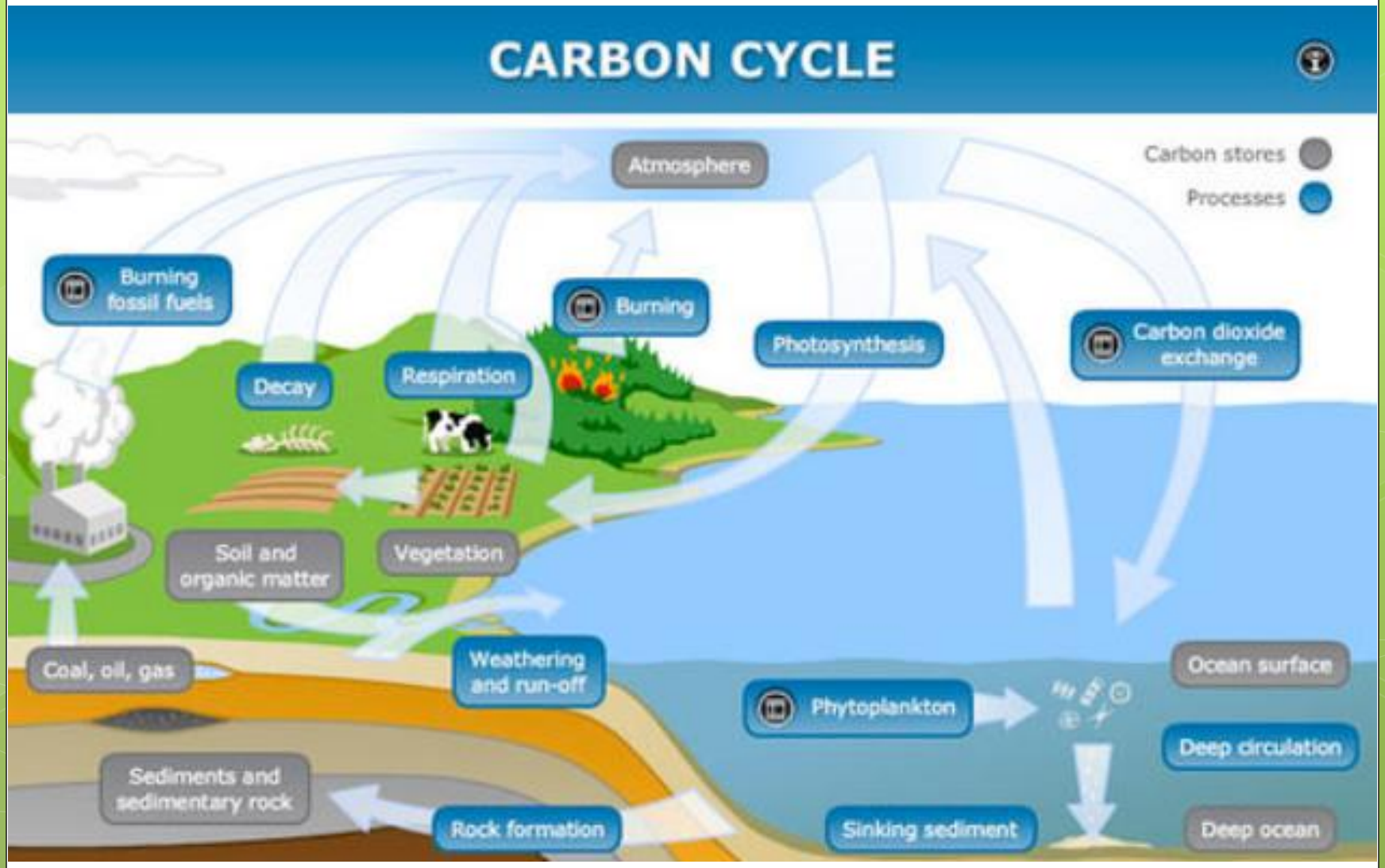
- Photosynthesis and cellular respiration are ***complimentary processes.*** The reactants of one are the products of
- the other. Photosynthesis stores energy and cellular respiration releases it. Together, these processes drive the carbon
- cycle. Carbon, the basic element of most living things enters living systems through photosynthesis during the
- production of carbohydrates. Some of that carbon returns to the atmosphere through cellular respiration in the form
- 2 of CO . (See pg 87, fig 3.18)

Global Implications

- The earth is a closed system: little or no matter comes in from the outside. The processes of photosynthesis aerobic cellular respiration have great importance to our world

1. To Sustain Life

- Nutrients are moved through a series of cycles, the carbon cycle being one. Photosynthesis and respiration are two halves of the living components of the carbon cycle.


CARBON CYCLE
Atmosphere
Carbon stores
Processes
Burning fossil fuels
Burning
Photosynthesis
Carbon dioxide exchange
Decay
Respiration
Soil and organic matter
Vegetation
Coal, oil, gas
Weathering and run-off
Ocean surface
Phytoplankton
Deep circulation
Sediments and sedimentary rock
Rock formation
Sinking sediment
Deep ocean

1. To Sustain Life

- i) On Land
- Photosynthesis takes carbon from CO_2 and forms organic molecules (carbs), for use in life processes and - respiration breaks them down releasing energy and returning CO to the atmosphere once again.
- ii) In the Ocean
- CO_2 dissolves in oceanic water to form carbonic acid which breaks down to form bicarbonate ions (HCO).
- These ions are the source of carbon for all aquatic plants' photosynthesis.

2. In Industry

- Photosynthesis is the biological basis for primary industries worldwide.
- A) Agriculture and B) Forestry
- Both of these involve the harvesting of plants and plant material for food, construction, paper, fabrics, cosmetics, medicines, and personal care products.

2. In Industry

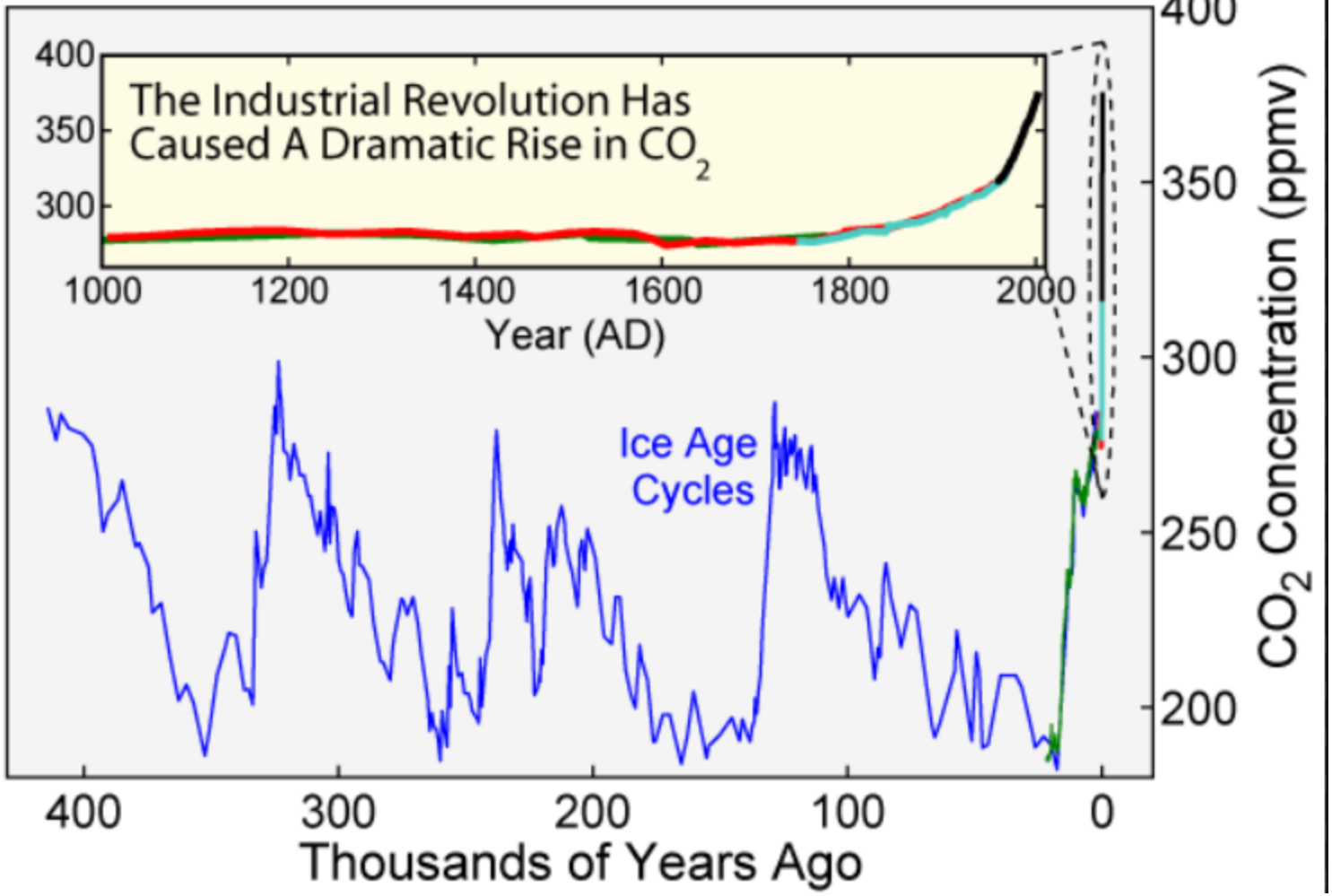
- C) Fisheries
- Depend on aquatic autotrophs as the basis of the aquatic food chain to feed the species they wish to catch. (Herring, turbot, lobster...)

- D) Mining
- The mining of fossil fuels has its beginning when the petroleum and coal of today were the ocean floors and ancient forests millions of years ago. Petrochemicals are the source of fuels (95%), plastics, cosmetics, detergents, drugs, and synthetic fibers like nylon, polyester and synthetic rubber.

3. On the Environment

- The carbon cycle is different today than it was in the past.
- 850, 28 ppm or 0.028% of the atmosphere by volume was CO_2 .
- Today, it is 35ppm, or 0.035%.

Carbon Dioxide Variations



- The increase in CO levels is an important factor in climate change and it is due to:
- Society's dependence on fossil fuels as an energy source.
- The removal and burning of vast stands of trees that otherwise would absorb CO_2 during photosynthesis and store it.
- See bio fact pg 87.