

1 **Cell Energy**

Photosynthesis and Respiration

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2 **Photosynthesis** - building from light

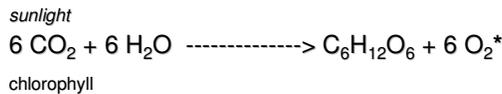
- Definition-the series of chemical reactions in which glucose is organized and oxygen produced from carbon dioxide and water in the presence of chlorophyll and sunlight*

3 **Photosynthesis** - building from light

- cells that make their own food are called producers or autotrophs
- all organisms depend on the sun as their ultimate source of energy *

4 **Photosynthesis** - building from light

- general formula for photosynthesis



5 **Photosynthesis** - building from light

- chlorophyll is necessary for photosynthesis
- chlorophyll is found in the chloroplasts of plant cells packed between layers of lipid called grana (a stack) *
- each layer within the grana is called a thylakoid *

6 **ATP – adenosine triphosphate**

- the energy transfer compound
- composed of three parts:
 - adenine (a type of base found in DNA)
 - ribose-a sugar (monosaccharide)
 - phosphate-an inorganic molecule associated with energy transfer

7 **ATP – adenosine triphosphate**

8 **ATP – adenosine triphosphate**

- $\text{AMP} + \text{Energy} + \text{P} = \text{ADP}$
- $\text{ADP} + \text{Energy} + \text{P} = \text{ATP}$

9 **ATP – adenosine triphosphate**

- breaking ATP to ADP + P yields energy for cell functions

10 **Light Reactions**

(AKA light dependent reactions) *

- Sunlight + chlorophyll react to form energized chlorophyll (energy carrier)
- Energized chlorophyll does two (2) things:
 1. Splits water (H_2O) into 2H and 1 O
 - the oxygen (O) combines to form diatomic molecules (O_2) and

- is released to the atmosphere*
- This is the oxygen we breathe!
- the hydrogen (H) is trapped by NADP forming NADPH which is used in the DARK REACTIONS

11 **Light Reactions**

- NADPH looks like this when constructed in the biology lab

12 **Light Reactions**

- Energized chlorophyll does two (2) things:
 - 2. Adds a Phosphate to ADP forming ATP which is used in the DARK REACTIONS

13 **Light Reactions**

- Remember: Oxygen (O₂) is made and released during the LIGHT reactions*
- NADPH* and ATP are made in the LIGHT reactions and sent to the DARK reactions

14 **Dark Reactions**

- Carbon dioxide (CO₂) + RDP ==> Unstable 6 carbon sugar
- Unstable 6 carbon sugar ==> 2 PGA molecules
- 2 PGA + NADPH* + ATP ==> 2 PGAL + ADP + P + NADP
- 2 PGAL can be converted to two substances:
 - 2 PGAL ==> glucose* (a monosaccharide sugar) *
 - 2 PGAL ==> RDP (which is recycled to the first step again)

15 **Overview of photosynthesis**

16 **Conditions for Photosynthesis**

- Wavelength of the light is important!
 - any color other than green will cause photosynthesis
 - green light is the worst color for photosynthesis*
 - the best colors are usually violet and red

17 **Conditions for Photosynthesis**

- Objects appear green because they REFLECT green light and ABSORB all other colors
- Objects appear red because they REFLECT red and absorb all other colors
- Objects appear black because...*
- Objects appear white because...

18 **Conditions for Photosynthesis**

- Englemann's research proved this before absorbance spectra were available

19 **Conditions for Photosynthesis**

- Temperature
 - increases in temperature will increase photosynthesis (direct relationship)

- enzymes needed for photosynthesis are affected by temperature
- what happens as you sample the QUANTITY of plant growth from the arctic to the equator?

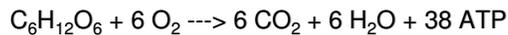
20 **Chemosynthesis**

- The production of organic molecules from inorganic substances without light (non-photosynthetic)
- Some bacteria are capable of chemosynthesis
 - usually found in the ground or on the ocean floor
 - some marine bacteria are capable of chemosynthesis

21 **Chemosynthesis**

22 **Respiration – The Fire of Life**

- Formula for cellular respiration



23 **Respiration – The Fire of Life**

- The aerobic respiration stage occurs within the mitochondrion *

24 **Respiration – The Fire of Life**

- respiration includes all of the chemical processes in which energy is released
- this is similar to the burning of wood, but controlled
- respiration occurs at cell temperatures because of enzymes
- energy is released by oxidation
 - the removal of hydrogen atoms
 - the addition of oxygen atoms

25 **Respiration – The Fire of Life**

26 **Respiration – The Fire of Life**

- Respiration and Photosynthesis are complementary

27 **Respiration – The Fire of Life**

- Cellular Respiration - occurs in two main stages
- 1. anaerobic stage (without oxygen)
 - a. glucose ==> 2 pyruvic acids
- 2. aerobic stage (with oxygen)
 - a. 2 pyruvic acids ==> 2 acetic acids
 - b. the two acetic acids enter the citric acid cycle (Kreb's cycle)
 - c. after many steps 38 ATP molecules and carbon dioxide and water are the final products

28 **Respiration – The Fire of Life**

- The total production is 38 ATP * molecules, but it takes 2 ATP molecules to accomplish this
- The NET energy production is 36 ATP molecules from one glucose molecule during aerobic respiration *

29 **Fermentation**

30 **Fermentation**

- It is similar to respiration, but without oxygen that produces very little energy
- After the usual anaerobic stage of respiration there can be two different pathways for the pyruvic acid without oxygen:
 - 1. glucose can be metabolized to ethyl alcohol + 2 ATP (yeast) (called alcoholic fermentation)*
 - 2. glucose can be metabolized to lactic acid + 2 ATP (human and animal muscles*) (called lactic acid* fermentation)

31 **Fermentation**

- alcoholic fermentation occurs during the production of bread and alcoholic beverages

32 **Fermentation**

- lactic acid fermentation

33 **Fermentation**

- lactic acid fermentation causes sore muscles when we over exercise