Biology 4.2
Cellular Respiration

"If thou shalt confess with thy mouth the Lord Jesus and believe in thine heart that God has raised him from the dead, thou shalt be saved" Romans 10:9

Metabolism chart

Cellular Respiration

1. Obtain energy from food.
2. Converts energy from glucose into usable, metabolic, cellular energy (ATP).
3. Glucose + oxygen -> water + carbon dioxide + energy (ATP)
4. 1 $C_6H_{12}O_6$ + 6 O_2 -> 6 CO_2 + 6 H_2O + 36 ATP's
5. Occurs in the mitochondria.
6. Energy lost in chemical reactions is released as heat.
7. Involves glycolysis, the Kreb's cycle, and the electron transport chain.
8. Over forty enzymes are needed to convert glucose into ATP.
9. Aerobic Respiration: requires oxygen. Most cells.
10. Anaerobic Respiration: does not require oxygen.

ATP

1. The primary energy transport molecule for chemical reactions.
2. Three phosphate molecules attached to an adenosine molecule.
3. AMP is adenosine monophosphate
4. ADP is adenosine diphosphate
5. ATP is adenosine triphosphate
6. AMP + P => ADP. ADP + P => ATP.
7. Usable energy is stored in phosphate bonds. High energy bonds in 3rd and 2nd Phosphate.
8. Making and breaking phosphate bonds allows recycling of molecules to transport energy in the cell to metabolic reactions needing energy.

Glycolysis

1. This is a metabolic pathway found in almost all living cells.
2. Ten step breakdown of glucose (6C) into pyruvic acid (3C) => net yield of 2 ATP's (4 -2).
3. One glucose molecule catabolized into two pyruvates.
4. Occurs in the cytoplasm of the cell.
5. No oxygen needed at this stage.
6. Excess pyruvate not needed for ATP production will be converted into fat molecules or amino acids.

Kreb's cycle

1. Also known as the citric acid cycle or tricarboxylic acid cycle (TCA).
2. Yields 2 ATP and other energy molecules from one glucose molecule.
3. Pyruvate, from glycolysis, is transported into mitochondria.
4. Pryuvate (3 C) is converted into acetate (2 C) and releases a CO_2.

5. Acetate + coenzyme A yields Acetyl Coenzyme A (Acetyl-CoA).
6. Acetyl-CoA (2 C) + oxaloacetate (4 C) => citric acid (6 C).
7. Each Acetyl-CoA releases 2 CO_2. A total of 6 per glucose molecule.
8. Chemical reactions of citric acid cycle produces CO_2, ATP, and NADPH.
9. Kreb's cycle is the reason for the carbon dioxide you exhale.
10. Kreb's cycle is used to convert any molecule into another molecule.
11. Kreb's cycle is involved in anabolizing and catabolizing proteins, fats, carbohydrates, and nucleic acids.
12. Needed molecules made from new nutrients or reuse of existing molecules.
13. Modify as needed: Glucose <=> nucleic acids <=> proteins <=> lipids <=> carbohydrates
14. All molecules can be converted into energy molecules.
15. Some animals cannot manufacture all of the required amino acids (essential amino acids).
16. Cellular metabolism is flexible enough to respond to changes in the environment. This self-regulation is called homeostasis.

Electron transport chain (ETC) (Hydrogen Transport System)

1. ETC Maximum Net 34 ATP's formed from 1 glucose.
2. Maximum Net 38 ATP's from 1 glucose <u>including</u> glycolysis and Kreb's cycle. (Actual ~ 29-30)
3. Electrons transported along a chain of molecules in the membrane of the mitochondria cristae.
4. The movement of electrons pumps H+ into the cristae matrix.
5. Concentrated H+ in cristae matrix diffuse through ATP synthase in the membrane to produce ATP (oxidative phosphorylation).
6. The flow of H+ spins the ATP synthase to produce ATP molecules.
7. O_2 is the final hydrogen (electron) acceptor -> water. Absolutely necessary for <u>aerobic</u> respiration.
8. <u>Anaerobic</u> respiration uses S_2.
9. Lack of final electron acceptor causes electron saturation, ATP production stops, metabolism stops, and the cell dies.

Fermentation

1. Breakdown of glucose without ETC.
2. Glycolysis: Glucose -> pyruvic acid = 2 ATP's
3. Fermentation:
    a. Alternative paths to Kreb's cycle and the electron transport chain.
        i. Pyruvic acid -> lactic acid = 2ATP
        ii. Pyruvic acid -> alcohol = 2 ATP
        iii. Alcohol -> vinegar = 2 ATP
    b. There are many fermentation by products.
    c. Very inefficient production of ATP compared to ETC.

Summary

1. Photosynthesis: $6\ CO_2 + 6\ H_2O + \text{LIGHT ENERGY} \rightarrow C_6H_{12}O_6 + 6\ O_2$
2. Cellular respiration: $C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O + 36$ ATP's