III. An Overview of Cellular Respiration (9.2)

A. What is Cellular Respiration?

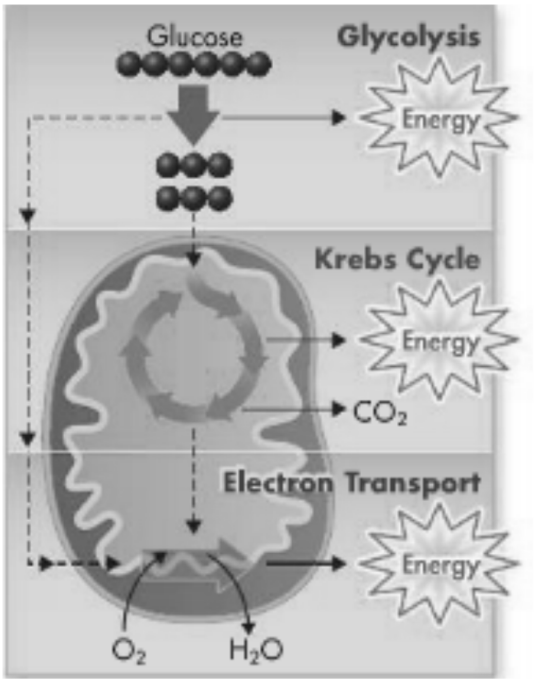
1. Cellular Respiration is the process that releases energy from food in the presence of oxygen (O_2)
   a. the actual process takes place inside the mitochondria
   b. cellular respiration is a complex series of chemical reactions but can be easily represented by the chemical equation:

$$O_2 + C_6H_{12}O_6 \quad CO_2 + H_2O + \text{Energy}$$

2. The Three Stages of Cellular Respiration:

Glycolysis, Krebs cycle, Electron Transport

   a. Glycolysis: the first stage of Cellular Respiration (cytoplasm)
      * 1 molecule of glucose (a 6 C molecule)is broken down and transformed into 2 molecules of pyruvic acid (2, 3-C mol.)
      *Glycolysis produces a net gain of 2 ATP's and 2 e- carrier molecules called NADH
   b. Kreb's Cycle(citric acid cycle): 2nd stage, 2 molecules of pyruvic acid are broken down to produce 2 ATP's, 5 e- carriers and CO_2
   c. Electron Transport: Final Stage, uses the 7 e- carriers and O_2 to convert ADP into 32 ATP's



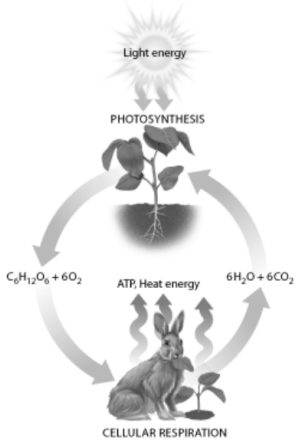
B. Oxygen and Energy

1. Oxygen (O_2) is required at the end of the Electron Transport stage
   a. when a cell's demand for energy increases, the demand for O_2 increases
      *breathing and heart rate increase as well
2. Stages of cell respiration that require O_2 are said to be aerobic pathways
   a. the Kreb's Cycle and Electron Transport
3. Glycolysis does not use or require O_2 it is said to be anaerobic
   a. only part of cell respiration that does not occur in the mitochondria

IV. Comparing Cell Respiration and Photosynthesis

A. A Marrige of Opposites

1. the chemical reactions for Cell Respiration and photosynthesis are the reverse of each other
2. The two form a cycle of CO_2 and O_2 and energy in and energy out



9.3 Fermentation

V. How do organisms generate energy when O_2 is not available?

A. Glycolysis

1. can produce 2ATP's without O_2
2. Problem: in a few seconds, all available NAD+ fill with e-
   *without Electron Transport NADH can't get rid of e-
   *if the cell runs out of NAD+, Glycolysis stops

B. Fermentation

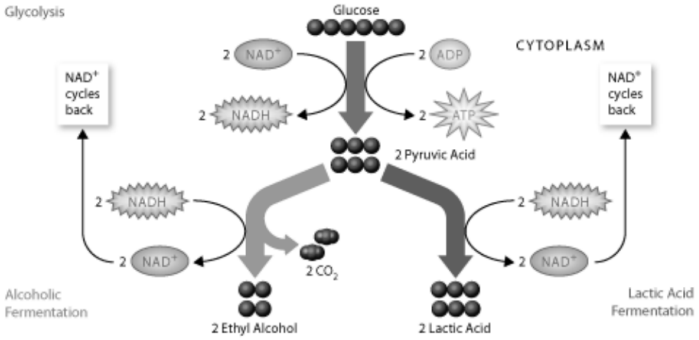
1. allows for the production of ATP when O_2 is not present
   a. fermentation causes NADH to transfer its e- to pyruvic acid converting NADH back to NAD+ (allowing glycolysis to continue)
2. occurs in the cytoplasm of cells

C. Alcoholic Fermentation

1. Yeasts and a few other organisms
2. After Glycolysis: Pyruvic acid + NADH Alcohol + CO_2 + NAD+
3. process is used to make alcoholic beverages and bread
   a. when yeast runs out of O_2, fermentation produces CO_2 gas that causes bread dough to 'rise'

D. Lactic Acid Fermentation

1. most organisms (us) convert pyruvic acid to lactic acid
2. lactic acid fermentation does not produce CO_2 but still regenerates NAD+
3. After Glycolysis: pyruvic acid + NADH Lactic acid + NAD+
4. Certain bacteria produce lactic acid during fermentation to produce foods and beverages like cheese, yogurt, buttermilk and sour cream
5. Humans carry out lactic acid fermentation best in our skeletal muscle



VI. Energy and Exercise

A. For Short, Quick bursts of Energy Our Body Uses...

1. ATP stored in muscles
   a. small amount, a few seconds of intense activity
2. ATP from Lactic Acid Fermentation
   a. can supply about 90 seconds of intense activity (sprint race)
   b. lactic acid builds up in muscle cells
   c. extra O_2 is required to get rid of the lactic acid
      *sprinters breathe deeply after the race to help clear the lactic acid
      *climbing stairs can produce the same results

B. For Exercise Longer than 90 seconds the Body can only use...

1. ATP from Cellular Respiration
   a. the first 15-20min of activity will be fueled by stored glycogen in the muscles. Glycogen converts to glucose
   b. for longer activity, the body will turn to stored body fat to fuel cellular respiration (aerobic activity is good for weight control)
2. Since Cellular respiration produces ATP slowly, athletes must pace themselves