Unit 2 Notes

I. Energy Flow & Organisms

A. First Law of Thermodynamics: Energy cannot be created or destroyed, but it may change form.

1. Organisms can't make their own energy, but must harvest it from another source (sun, other organisms).

2. After harvesting the energy, it is changed into a storable form, and eventually changed again to make free energy.

B. Second Law of Thermodynamics: Systems tend to change in ways that increase disorder (entropy).

1. To maintain order in a system (organism, building, etc.), free energy must be used.

a. Because energy conversions are not 100% efficient, each time energy changes form to provide free energy, some escapes (usually as heat).

b. To remain ordered, organisms and ecosystems must continually receive new energy to replace the energy that has become unusable (10% rule).

II. Metabolism and Energy Transfer

A. Enzymes are proteins that act as catalysts.

1. Activation energy is normally prevents chemical reactions in living things.

2. By decreasing activation energy, enzymes make rapid chemical reactions possible.

a. One or more reactants (substrates) fit into an enzyme's active site (groove in tertiary structure).

b. Interaction with the substrate(s) causes the enzyme to change shape, putting stress on chemical bonds.

c. The reaction occurs, the product(s) are released, and the enzyme is ready for another reaction.

3. An enzyme works best at a certain temperature, pH, and salinity. (out of range → denature)

B. Metabolism, all the chemical activities that take place in an organism, consists of two basic classes of reactions.

1. Synthesis (anabolic) reactions use free energy to form large, complex molecules from small, less complex ones.

2. Decomposition (catabolic) reactions break large molecules into smaller molecules, releasing free energy (& heat).

3. Synthesis and decomposition reactions are coupled.

C. ATP is a molecule that serves as "energy currency."

1. As various food molecules are decomposed, free energy and heat are released.

2. The free energy is stored by synthesizing ATP from ADP and an inorganic phosphate molecule (P_i).
($ADP + P_i$ + free energy → ATP)

3. The free energy stored in ATP is released when the bond between the second and third phosphate group is broken. (ATP → $ADP + P_i$ + free energy)

4. ATP is formed and consumed rapidly – 10 million molecules are consumed and regenerated per second per cell.

5. ATP is used as an energy carrier in all known living cells.

III. Digestion

A. There are two main categories of digestion (processes that break down food).

1. Physical digestion breaks big pieces of food into smaller pieces of the same food, increasing surface area.

2. Chemical digestion breaks complex food molecules into smaller, more simple ones.

a. Most animals and fungi rely on extracellular digestion.

i. Complex animals use a specialized "external" digestive cavity separated into specialized regions which vary according to the species' diet.

ii. Fungi digest food outside of themselves and then absorb the nutrients.

b. Most plants, bacteria, and protists use intracellular digestion.

B. Human digestion follows a specific series of steps.

1. Food is physically (teeth) and chemically (saliva w/ amylase (carbohydrates → maltose)) digested in the mouth and formed into a bolus.

2. As the bolus is swallowed, the epiglottis covers the trachea to prevent choking.

3. Peristalsis moves the bolus down the esophagus, through the cardiac sphincter, and into the stomach.

4. Food is digested further in the stomach for 2 – 4 hours.

a. Food entering the stomach stimulates the release of the hormone gastrin which causes the secretion of HCl (pH drops → amylase is denatured).

b. The low pH causes inactive pepsinogen to become the active, protein digesting enzyme pepsin.

c. Food is turned into "soupy" chyme and passed through the pyloric sphincter.

5. The chyme is pushed into the small intestine.

    a. The duodenum (1st part of the S.I.) receives pancreatic juice and bile salts.

        i. Bile salts (from the liver / gall bladder) emulsify fat droplets (physical digestion).

        ii. The pancreatic juice raises the pH and supplies trypsin (peptide enzyme), lipase (fat enzyme), and, amylase (carbo. enzyme).

    b. As nutrients pass through the S.I., more proteinases, lipases, and carbohydrases are secreted, eventually digesting food into monomers.

    c. The monomers are small enough to be absorbed into the bloodstream by villi (fingerlike projections rich in capillaries).

6. Undigested material passes to the large intestine.

    a. Water is absorbed (usually…).

    b. Bacteria produce vitamins (B & K) which you absorb.

    c. The remainder (feces) is stored in the rectum and then eliminated through the anus.