Unit 4 - Biochemistry

Cliff Notes – 3.4 & 3.5 Organic Molecule Structure & Function

Mr. Lillibridge

B-3.4 Summarize how the ***structures* of organic molecules (including proteins, carbohydrates, and fats) are related to their relative caloric values.**

B-3.5 Summarize the ***functions* of proteins, carbohydrates, and fats in the human body.**

Holt Biology:
Modern Biology:

Key Concepts:
- **Organic molecules**
- **Caloric value**
- **Protein**: amino acid
- **Carbohydrates: monosaccharides**
- **Fats (lipids)**:
    - glycerol
    - fatty acids

All organisms composed of carbon atoms are considered ***organic molecules***. Most organic molecules are made of smaller units that bond to form larger molecules. Energy is stored in the bonds that link these units together. The amount of energy stored in these bonds varies with the type of molecule formed. As a result, not all organic molecules have the same amount of energy available for use by the organism. The energy stored in organic molecules determines its ***caloric value***. Proteins, carbohydrates, and fats/lipids are three organic molecules with different *structures* and different caloric values based on those *structures*.

In addition, proteins, carbohydrates, and fats have important *functions* within the human body.

- ***Structure: Proteins*** are molecules composed of chains of ***amino acids***.
    - Amino acids are molecules that are composed of carbon, hydrogen, oxygen, nitrogen, and sometimes sulfur.
    - There are 20 amino acids that chemically bond in various ways to make proteins. Twelve of these amino acids are made in the body; others must be consumed from foods such as nuts, beans, or meat.
    - Although proteins are more important as a source of building blocks, amino acids may be used by the body as a source of energy (through the process of cellular respiration), but first they must be converted by the body to carbohydrates. This process does not happen as long as there is a carbohydrate or lipid available.
    - As a source of energy, proteins have the same caloric value per gram as carbohydrates.

- ***Function: Proteins*** are involved in almost every function in the human body. For example, they serve as the basis for structures, transport substances, regulate processes, speed up chemical reactions, and control growth.

- When proteins are consumed, the bonds that hold the amino acids together are broken during the process of digestion so that individual amino acids are absorbed into the bloodstream through the walls of the intestines.
- The amino acids are carried by the blood stream to cells throughout the body where they cross into the cells through the cell membrane.
- Once inside the cell, they are used as raw materials to make all of the proteins required by the organism.

- Because of their structures, proteins serve different functions. For example,
  - *Structural* proteins are used for support such as connective tissue and keratin that forms hair and finger nails.
  - *Transport* proteins transport many substances throughout the body such as hemoglobin which transports oxygen from the lungs to the other parts of the body to be used by cells in cellular respiration.
  - *Hormone* proteins coordinate body activities such as insulin which regulates the amount of sugar in the blood.
  - *Contractile* proteins help control movement such as proteins in the muscles which help control contraction.
  - *Enzymatic* proteins accelerate the speed of chemical reactions such as digestive enzymes which break down food in the digestive tract.

- ***Structure: Carbohydrates*** (sugars and starches) are molecules composed of carbon, hydrogen, and oxygen.
  - The basic carbohydrates are simple sugars (***monosaccharides***) such as glucose. These simple sugars can bond together to make larger, complex carbohydrate molecules, for example starch or cellulose.
  - Carbohydrates are important because they the main source of energy for the cell.
    - When carbohydrates are synthesized during the process of photosynthesis, the plants or other photosynthetic organisms use them as a source of energy or they are stored in the cells.
    - When complex carbohydrates are consumed, the process of digestion breaks the bonds between the larger carbohydrate molecules so that individual simple sugars can be absorbed into the bloodstream through the walls of the intestines.
      - The bloodstream carries the simple sugars to cells throughout the body where they cross into the cells through the cell membrane.
      - Once inside the cells, simple sugars are used as fuel in the process of cellular respiration, releasing energy which is stored as ATP.
  - The caloric value of carbohydrates is dependent on the number of carbon-hydrogen bonds. If an organism has a greater supply of carbohydrates than needed for its energy requirements, the extra energy is converted to fats and stored by the body.

- ***Function: Carbohydrates*** are important as an energy source for all organisms and as a structural molecule in many organisms.
  - Carbohydrates are a primary source of fuel for cellular respiration.

- Carbohydrates are also used to store energy for short periods of time.
- The carbon, hydrogen, and oxygen that compose carbohydrates serve as raw materials for the synthesis of other types of small organic molecules, such as amino acids and fatty acids.
- Some carbohydrates (such as cellulose) are used as structural material in plants.
  - For most animals, foods that contain these carbohydrates are important as fiber which stimulates the digestive system.

- ***Structure: Lipids****,* including ***fats****,* are organic molecules composed of carbon, hydrogen, and oxygen.
  - Lipid molecules are made of two component molecules (***glycerols*** and ***fatty acids***) so they are structurally different from carbohydrates. Fats/lipids have more carbon-hydrogen bonds than carbohydrates.
  - Due to the structure and number of the carbon-hydrogen bonds that hold the different types of molecules (proteins, carbohydrates, or fats) together, fats contain more energy (ATP) per gram than carbohydrates or proteins, which explains why fats have a greater caloric value.
  - Fats are important to organisms for energy when carbohydrates are scarce, but when there is no shortage of food, stored fat accumulates.
    - When fats are consumed, the molecules are broken down during the process of digestion so that individual glycerol and fatty acid molecules are absorbed into the bloodstream through the walls of the intestines.
    - The blood stream carries the glycerol and fatty acid molecules to cells throughout the body where the molecules cross into the cells through the cell membrane.
    - Once inside the cell, glycerols and fatty acids are stored for later use or used as fuel for cellular respiration if there are no carbohydrates available.
    - The process of cellular respiration releases the energy that is held in the chemical bonds of the glycerol and fatty acid molecules.

- ***Function: Fats (lipids)*** are important to organisms for energy when carbohydrates are scarce since they are the primary way to store energy.
  - Fats serve a variety of functions in humans, such as providing long-term energy storage, cushioning of vital organs, and insulation for the body.
  - Fats also serve as a major component of cell membranes and are one of the raw materials necessary for the production of some vitamins and hormones.

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Multiple Choice.

1. What might happen if you did not consume carbohydrates?
   a. Your body would dry out
   b. You would die from lack of oxygen
   c. You wouldn't get the energy you needed to function
   d. Your body wouldn't be able to build new muscle mass

2. The four elements that make up these biomolecules are carbon, hydrogen, oxygen and _?_.
   a. Nitrogen
   b. Nickel
   c. Iron
   d. Calcium

3. If the human body were a car, the glucose would be _?_.
   a. The engine
   b. The motor oil
   c. The wheels
   d. The gasoline

4. What might happen if you did not consume enough lipids?
   a. You would die of dehydration
   b. Your body might not be able to store energy
   c. You might not be able to go to the bathroom
   d. Your cells would not be able to breakdown sugars

5. What might happen if you consumed too many lipids?
   a. You might develop heart disease
   b. Your cells might swell up with too much water
   c. You might get a very high fever
   d. You might wind up with too much energy

6. In your body, where can you find protein?
   a. In your hair and nails
   b. Within your bones
   c. In tissues and cartilage
   d. Just about anywhere

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7. What are nucleic acids responsible for?
   a. Removing wastes from the body
   b. Providing short bursts of energy
   c. Encoding information used for the body's functions and growth
   d. Delivering chemical messages between the brain and the body

8. Why should you eat right?
   a. Because it will make you thin and good-looking
   b. Because your doctor says so
   c. Because your body will gradually lose water if you don't
   d. To provide your body with the proper raw materials it needs to function

9. Which of the following groups of terms is associated with carbohydrates?
   a. monosaccharide, glycogen, cellulose
   b. monosaccharide, cellulose, lipid
   c. disaccharide, polysaccharide, steroid
   d. polysaccharide, amino acid, ATP