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Unit 2 Biology Notes

Biochemistry

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

Key Concepts:
Organic molecules (as listed in the indicator)
Caloric value
Protein: amino acid
Carbohydrates: monosaccharides
Fats (lipids): glycerol, fatty acids

All organisms are composed of *organic molecules* which contain carbon atoms. 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.

- ✓ ***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.
- ✓ ***Carbohydrates*** (sugars and starches) are molecules composed of carbon, hydrogen, and oxygen.

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- ✓ 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.
- ✓ ***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.
- ✓ 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.
    - ✓ 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.

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

Key Concepts:

Proteins Carbohydrates Fats

Proteins, carbohydrates, and fats have important functions within the human body.

- ✓ *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.
- ✓ Proteins are more important as a source of building blocks than as a source of energy. Proteins can function as an energy source only if there is a shortage of carbohydrates or lipids.
- ✓ 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.

- ✓ *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.
- ✓ *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.

B-2.8 Explain the factors that affect the rates of biochemical reactions (including pH, temperature, and the role of enzymes as catalysts).

Key Concepts:
Biochemical reactions: activation energy
pH: buffers
Catalyst: enzyme

It is essential for students to understand that *biochemical reactions* allow organisms to grow, develop, reproduce, and adapt. A chemical reaction breaks down some substances and forms other substances. There are several factors that affect the rates of biochemical reactions. · Chemical reactions (including biochemical reactions) can occur when reactants collide with sufficient energy to react. The amount of energy that is sufficient for a particular chemical reaction to occur is called the ***activation energy.***

- ✓ Sometimes a chemical reaction must absorb energy for the reaction to start; often, but not always, this energy is in the form of heat.
- ✓ Energy, as heat or light, can also be given off as a result of biochemical reactions, such as with cellular respiration or bioluminescence.
- ✓ Changes in temperature (gaining or losing heat energy) can affect a chemical reaction.
- ✓ *pH* (a measure of the acidity of a solution) in most organisms needs to be kept within a very narrow range. *Buffers* within an organism are used to regulate pH so that pH homeostasis can be maintained. A small change in pH can disrupt cell processes.
- ✓ A *catalyst* is a substance that changes the rate of a chemical reaction or allows a chemical reaction to occur (activate) at a lower than normal

temperature. Catalysts work by lowering the activation energy of a chemical reaction. A catalyst is not consumed or altered during a chemical reaction, so, it can be used over and over again. *Enzymes* are proteins which serve as catalysts in living organisms.

- ✓ Enzymes are very specific. Each particular enzyme can catalyze only one chemical reaction by working on one particular reactant (substrate).
- ✓ Enzymes are involved in many of the chemical reactions necessary for organisms to live, reproduce, and grow, such as digestion, respiration, reproduction, movement and cell regulation.
- ✓ The structure of enzymes can be altered by temperature and pH; therefore, each catalyst works best at a specific temperature and pH.