

## Chapter 6 – Ground Rules of Metabolism

### Lecture Outline

#### *Impacts, Issues: Alcohol, Enzymes, and Your Liver*

- A. The liver is the body's detoxification center.
  - 1. Beverage alcohol (ethanol) is degraded to non-toxic acetate with the help of catalase, alcohol dehydrogenase, and other enzymes present in the liver.
  - 2. Excessive amounts of alcohol over a lifetime can lead to liver disease and failure.
- B. The liver is the largest gland in our body and it performs other functions relative to food utilization, including synthesis of plasma proteins.
- C. Binge drinking is considered the most serious drug problem on U.S. campuses.
  - 1. 44 percent of 17,600 students in 140 surveyed colleges report averages of five alcoholic drinks/day.
  - 2. Binge drinking can kill you suddenly.

#### 6.1 Energy and Time's Arrow

- A. What is Energy?
  - 1. *First law of thermodynamics* states that the total amount of energy (capacity to do work) in the universe is \_\_\_\_\_; it cannot be created nor destroyed; it can only change form.
  - 2. Energy can be of \_\_\_\_\_ quality, that is, highly concentrated and usable; or it can be of \_\_\_\_\_ quality, such as heat that is released into the universe.
  - 3. \_\_\_\_\_ is the capacity to make things happen, to do work; it can also be called chemical energy
  - 4. \_\_\_\_\_ is the energy of motion; it includes heat energy.
- B. The One-Way Flow of Energy
  - 1. *Second law of thermodynamics* states that the spontaneous directional energy flow is from \_\_\_\_\_ - to \_\_\_\_\_ -quality forms.
  - 2. Each conversion produces energy (usually heat) that is \_\_\_\_\_ for work.

## II. Time's Arrow and the World of Life

- A. Cellular mechanisms \_\_\_\_\_ when and where energy will flow from one substance to another during chemical reactions.
1. Starting substances are called \_\_\_\_\_, substances formed before the end of a reaction are called *intermediates*, and those remaining at the end of the reaction are the *products*.
  2. \_\_\_\_\_ are the catalysts working to speed up specific reactions.
- B. Activation Energy—Why the World Doesn't Go Up in Smoke
1. \_\_\_\_\_ is required to overcome the strength of chemical bonds in reactants.
  2. Every single reaction has a characteristic \_\_\_\_\_ energy, which is the minimum amount of energy needed to start a reaction.
- C. Up and Down the Energy Hills
1. \_\_\_\_\_ (“energy in”) reactions require energy input resulting in products with *more* energy than the reactants had; for example, photosynthesis.
  2. \_\_\_\_\_ (“energy out”) reactions release energy such that the products have *less* energy than the reactants; for example, aerobic respiration.
- D. ATP—The Cell's Energy Currency
1. \_\_\_\_\_ is composed of adenine, ribose, and three phosphate groups;
    - a. Energy input links phosphate to \_\_\_\_\_ to produce ATP (phosphorylation).
    - b. ATP can in turn donate a \_\_\_\_\_ to another molecule, which becomes primed and energized for specific reactions.
  2. ADP can be recycled to ATP very rapidly in the ATP/ADP cycle.

### 6.3 How Enzymes Make Substances React

#### A. Enzymes have four features:

1. Enzymes \_\_\_\_\_ reactions.
2. Enzymes can be \_\_\_\_\_.

3. Enzymes, at least some of them, can recognize both \_\_\_\_\_ and products in order to catalyze a reaction in both directions.
  4. Enzymes are very \_\_\_\_\_ about the substrates to which they will bind and thereby bring about change.
- B. Enzymes increase the rate of a reaction by \_\_\_\_\_ the activation energy.
- C. Enzymes have \_\_\_\_\_, which are areas that allow a chemical binding of the *substrate* to the enzyme; the substrate is complementary in size, shape, and solubility.
- IV. Enzymes Don't Work in a Vacuum
- A. Effects of Temperature and pH
1. Because enzymes operate best within defined temperature ranges, temperatures decrease reaction rate by disrupting the bonds that maintain shape (denaturation).
  2. Most enzymes function best at a pH near \_\_\_\_\_
- V. Metabolism—Organized
- A. Types of Metabolic Pathways
1. Metabolic pathways are \_\_\_\_\_ of reactions in cells.
    - a. In \_\_\_\_\_ pathways, small molecules are assembled into large molecules; for example, simple sugars are assembled into complex carbohydrates.
    - b. In \_\_\_\_\_ pathways, large molecules such as carbohydrates, lipids, and proteins are broken down to form products of lower energy. Released energy can be used for cellular work.
- B. The Direction of Metabolic Reactions
1. Chemical reactions can proceed from \_\_\_\_\_ to products, which, if they are allowed to accumulate, will convert back to reactants.
  2. The direction of reaction depends on \_\_\_\_\_ and the collision of molecules.
  3. When a reaction approaches \_\_\_\_\_, the forward and reverse reactions proceed at equal rates.
    - a. There is no \_\_\_\_\_ change in concentrations.