Highlights Immune System

1. The immune system contains the innate immunity system and the adaptive immunity system.

2. The innate system uses receptors that bind to common lipopolysaccharide structures on the surface of Gram negative bacteria.

3. The adaptive immune system system contains two major groups of lymphocytes (immune system cells), B cells and T cells. B cells are involved in the production of antibodies and T cells are involved in both cellular killing, as well as stimulation of the B cells.

4. There are five major antibody classes made by the B lymphocytes.

5. The structure of antibodies has several common features. First, they are composed of two sets of Heavy (H) and light (L) chains arranged in a Y shape. Both the H and L chains have constant and variable regions. The variable regions of the H and L chains are adjacent to each other and the variation in these regions are responsible for antibody diversity. The different classes of antibodies vary in the H chains in the constant region.

6. Molecules bound by antibodies are called antigens. Specific structural regions of an antigen bound by an antibody are called epitopes.

7. Antibody diversity arises from recombination of DNA sequences and splicing of mRNA sequences for coding for the variable regions of H and L chains.

8. The result of recombination and an error-prone replication in B cells means that the cells of the immune system have slightly different DNA sequences than the DNAs of all the other cells of the body. Splicing is the third factor contributing to increasing antibody diversity.

9. T cells are part of the cellular immune system (made in the thymus) that acts to 1) induce apoptosis in infected cells (Cytotoxic T cells) or 2) to stimulate B lymphocyte production/action (Helper T cells).

Highlights Energy

1. The free energy of a reaction (Delta G) is the energy that is available for (or required for) doing things in cells (catalyzing reactions, doing work, etc.). By examining the free energy change that occurs in a reaction, one can determine if a reaction is favorable (go forward) or not favorable (go backward). Favorable reactions have Delta G values that are negative (also called exergonic reactions). Unfavorable reactions have Delta G values that are positive (also called endergonic reactions). When the Delta G for a reaction is zero, a reaction is said to be at equilibrium. Equilibrium does NOT mean equal concentrations.

2. For a reaction A <=> B (note that all reactions are theoretically reversible. I use the symbol <=> to indicate a reversible reaction), if the Delta G is negative, the forward reaction (A -> B) is favored. If the Delta G is positive, the reverse reaction (B ->A) is favored. If the Delta G is zero, there is no net change in A and B, as the system is at equilibrium.

3. The term "equilibrium" means that the relative amounts of A and B do not change in the reaction. It DOES NOT mean that the amount of A equals the amount of B.

4. The Delta G for the reaction A<=> B can be calculated from

Delta G = DeltaGzeroprime + RTln ([B]/[A]). I will simplify this for our class to the following form:

Delta G = DeltaGzeroprime + RTln ([Products]/[Reactants])

5. Note that if [Products] > [Reactants], the ln term is POSITIVE. If the [Products] < [Reactants], the ln term is NEGATIVE. If the [Products] = [Reactants], the ln term is ZERO.

6. DeltaGzeroprime is a constant that has a specific value for each reaction.

7. For the hydrolysis of ATP, the DeltaGzeroprime is equal to -30.5 kJ/mol. Consider what this means. For example, if [Products] = [Reactants] (products here are ADP + Pi and the reactant if ATP), then the ln term is zero. This means that when ATP = ADP and Pi, then the Delta G is negative and the further hydrolysis is favored.

8. Metabolic pathways (metabolism = chemical reactions of cells) are usually either catabolic (large molecules broken down to smaller ones) or anabolic (smaller molecules built up into larger ones).

9. Catabolic pathways usually involve oxidation and release energy. Anabolic pathways usually involve reduction and require energy.

10. NAD^+ gains electrons from an oxidation reaction to become NADH. Electron carriers are essential for biological oxidations. FAD gains electrons from an oxidation reaction to become FADH2.

11. For every oxidation (loss of electrons) there is a reduction (gain of electrons). NAD^+, $NADP^+$, and FAD are common acceptors of electrons. Biological molecules are common sources of electrons (as well as acceptors of electrons, depending on the reaction).