The Chemistry of Life

Part A - Multiple Choice Questions

1. C
2. C
3. D
4. C
5. D
6. C
7. D
8. A
9. C
10. C
11. B
12. C
13. C
14. A
15. B
16. B
17. C
18. B
19. D
20. D
21. D
22. C
23. B
24. B
25. B
26. A
27. D
28. D
29. A
30. D
31. C
32. A
33. B
34. A
35. B
36. C
37. C
38. C
39. B
40. C
41. C
42. A
43. B
44. C
45. A

Part B. Written Answer Questions

Note: The answers provided here are correct, but they may NOT be the only possible answers.

1. a. (Basis for difference = structure) With reference to fatty acids, saturated means that there are more hydrogen atoms and no double bonds, whereas unsaturated has less hydrogen and at least one double bond.
   b. (Basis for difference = location) With reference to nucleic acids, ribose is the sugar that is in RNA, whereas deoxyribose is the sugar that is in DNA.
   c. (Basis for difference = structure) With reference to amino acids, the carboxyl group consists of CO_2H, whereas the amine group consists of NH_2.

2. a. Glycine is an amino acid (R = H), and therefore it is a component of proteins that can be found in the body.
   b. Glycerol is a 3-carbon alcohol that is a component of molecules such as phospholipids. Phospholipids are a major component of membranes for all body cells.
   c. Glucose is a 6-carbon sugar. It is metabolized for energy by mitochondria, which are in body cells.
   d. Glycogen is a polysaccharide. It is the storage form of glucose for the body.
   e. Guanine is a nitrogenous base and is a component of both RNA and DNA. As such it helps make up genetic material and plays a role in protein synthesis.

3. a. A buffer is a molecule that helps a system maintain a constant pH through its ability to utilize or release hydrogen and/or hydroxide ions. An example of a buffer in the human body is bicarbonate ions.
   b. Dissociate means to break apart into ions. Water (major component of plasma) dissociates into hydrogen and hydroxide ions.
   c. Polypeptides are large molecules that are made out of amino acids. They are components of hydrolysis and dehydration synthesis reactions involving proteins in cells and in the digestive system.
   d. Helix describes the shape of a molecule. Both DNA and proteins (in the body) are helical-shaped molecules.
   e. Cohesion means “stick together”. Water molecules throughout the body are cohesive.

4. a. A water molecule consists of one atom of oxygen and two atoms of hydrogen bonded together by polar covalent bonds. Oxygen is the central atom. The molecule is bent, and the bonding electrons are shared unequally – used primarily by oxygen, which gives oxygen a negative dipole and leaves the hydrogen atoms with positive dipoles.
   b. The polarity of the molecules allows them to form hydrogen bonds with other water molecules. The presence of the hydrogen bonds and the fact that water is so abundant provides the unique properties.
   c. Water is significant in cells because it:
      a) has a high specific heat capacity, which means that takes a lot of energy to change the temperature of water. This is important for organisms because chemical reactions that are part of metabolism are temperature sensitive
      b) is cohesive with other water molecules and, as such, moves through blood vessels as a continuous fluid transporting nutrients and cells around the body.
      c) Is a solvent for inorganic substances, therefore it transports ions as well as (non-polar) molecules that will not dissolve in it.

5. (Using glucose for an example) Two glucose molecules can be combined (using the enzyme, maltase) to form a molecule of maltose and water as a byproduct. This reaction is synthesis because a larger molecule is being made. The hydrolysis of maltose requires maltase again as well as the addition of water. When the enzyme cleaves the maltose the water is required to complete the bonds of the individual glucose molecules that are produced.

6. The empirical formula of carbohydrates is CH_2O. Maltose is $C_{12}H_{22}O_{11}$. It is almost a multiple of the empirical formula, except that a molecule of water (H_2O) is given off as a byproduct.

7. The variability of neutral fats is a product of the variations that are possible in the fatty acids that are combined to make them. The fatty acids could be:
   a) saturated or unsaturated
   b) of different lengths
   c) bonded to any (or all) of the bonding sites on glycerol