SHORT ANSWER (10 pts each)

1. Show how D-(+)-glucose exists in aqueous solution.

![D-(+)-glucose structure]

2. Show the mechanism of the following glycosidation reaction:

![Glycosidation reaction]

3. Explain what is meant by the "anomeric effect."
4. Show the general structure for an L-amino acid in its zwitterionic form (at physiological pH).

5. Proteins are naturally occurring polymers of amino acids. Explain in a general sense what accounts for the tremendous diversity of protein structure and function.

MULTIPLE CHOICE (5 pts each)

6. Which of the following statements best describes the meaning of mutarotatin?
   (a) A rapid exchange between the α and β forms of diastereomeric sugars.
   (b) A rapid exchange between the D and L forms of a sugar.
   (c) A slow exchange between hydrogen and deuterated hydrogen.
   (d) A slow change in optical rotation to reach an equilibrium value.

7. Which of the following statements best describes the meaning of a glycoside?
   (a) It is the mirror image of a sugar.
   (b) It is the hemiacetal or hemiketal of a sugar.
   (c) It is the acetal or ketal of a sugar.
   (d) It is the enol-keto form of a sugar.

8. Which of the following statements best describes the difference between amylose and amyllopectin?
   (a) Amylose is a branched polysaccharide while amyllopectin is a chain polysaccharide.
   (b) Amylose is a straight-chain polysaccharide while amyllopectin is a branched polysaccharide.
   (c) Amylose is composed of thousands of D-glucose units while amyllopectin is composed of thousands of D-galactose units.
   (d) Amylose is one of the largest molecules found in nature while amyllopectin is one of the smallest molecules found in nature.
9. In aqueous solution, glucose exists as:
   (a) The open-chain form only.
   (b) The cyclic hemiacetal form only.
   (c) The cyclic acetal form only.
   (d) An equilibrium mixture of the open-chain form and cyclic hemiacetal forms.

10. Six-membered cyclic hemiacetals and five-membered cyclic hemiacetals are called respectively:
   (a) mannoses and xyloses.  (c) pyranoses and furanoses.
   (b) maltoses and arabinoses.  (d) none of these.

11. The monomeric units that make up peptides and protein polymers are:
   (a) nucleic acids  (b) amino acids  (c) oligosaccharides  (d) amylopectins

12. Which of the following functional groups contains a peptide bond?
   (a) amide  (b) amine  (c) nitrile  (d) carboxylic acid

13. What are enzymes?
   (a) Saccharides that catalyze chemical reactions.
   (b) Nucleic acids that catalyze chemical reactions.
   (c) Unsaturated fats that catalyze chemical reactions.
   (d) Proteins that catalyze chemical reactions.

14. The only amino acid that contains a secondary amine is:
   (a) lysine  (b) phenylalanine  (c) tyrosine  (d) proline

15. The $\alpha$-carbon of all the amino acids is a chiral center except for:
   (a) glycine  (b) threonine  (c) proline  (d) arginine

**Bonus (+1 pt each): Show the name and structure of any 5 amino acids (be sure to include stereochemistry).