Part I. Choose the right answer or answers (5% × 10 = 50%).

1. Glutamine (A) contains three titratable groups. (B) contains an amide group. (C) is classified as an acidic amino acid. (D) contains a side chain that can form hydrogen bonds in proteins.

2. Which one of the following types of bonds or interactions is least important in determining the three-dimensional folding of most proteins? (A) Hydrogen bonds. (B) Electrostatic bonds. (C) Hydrophobic interactions. (D) Disulfide bonds. (E) Ester bonds.

3. Which of the following conditions result in the passage of undigested carbohydrate into the bowel? (A) Deficiency of intestinal lactase. (B) Deficiency of salivary α-amylase. (C) Malnutrition. (D) Deficiency of intestinal glycogen phosphorylase.

4. The complete oxidation of one mole of glucose results in the release of about 700,000 calories of free energy. If this process is coupled to ATP biosynthesis from ADP + P_i with approximately 40% efficiency, the number of moles of ATP that could be produced under standard conditions would be approximately (A) 2. (B) 7. (C) 20. (D) 40. (E) 100.

5. The conversion of pyruvate to acetyl-CoA and CO\(_2\) (A) is essentially irreversible. (B) involves the participation of lipoic acid. (C) is inhibited when pyruvate dehydrogenase is phosphorylated by a protein kinase in the presence of ATP. (D) involves the participation of biotin.

6. Which one of the following compounds is a precursor in the biosynthesis of cholesterol? (A) Cholesterol. (B) Progesterone. (C) Lanosterol. (D) Cholic acid. (E) Pregerolone.

7. The catabolism of heme (A) occurs in the cells of the reticuloendothelial system. (B) involves the oxidative cleavage of the porphyrin ring. (C) results in the liberation of carbon monoxide. (D) results in the formation of protoporphyrinogen.

8. In which of the following tissues is glucose transport into the cell enhanced by insulin? (A) Brain. (B) Lens. (C) Red blood cell. (D) Adipose tissue. (E) Nerve.

9. Which one of the following compounds is synthesized from glutamic acid, p-aminobenzoic acid, and a pteridine nucleus? (A) Vitamin B\(_{12}\). (B) Cyanocobalamin. (C) Folic acid. (D) Biotin. (E) Coenzyme A.

10. Which of the following statements about DNA ligase is(are) CORRECT? (A) DNA ligase is an important enzyme in replication of DNA because it seals the gaps between RNA primers and the
Part II. Answer the following questions:

1. (a) How can excess acetyl CoA trapped in the mitochondria be utilized as a substrate for fatty acid biosynthesis in the cytosol? (b) When the energy charge in liver cells is low, and oxaloacetate levels are limiting, what is the fate of excess mitochondrial acetyl CoA? Name a physiological condition that causes this. (6%)

2. What hormonal response explains why it is a bad idea to eat a candy bar with high sugar content prior to a bicycle race in which the cyclist's metabolic needs will be dependent on stored fats for energy? (3%)

3. What is the function of the MHC proteins in the immune response? (3%)

4. When saltwater bacteria are placed in a freshwater solution, they often die from osmotic shock. Assuming that the bacteria cannot rapidly pump Na⁺ ions in and out of their membranes, explain why the cells die? (5%)

5. Glycine is an amino acid that is also used as a buffer. The $pK_a$ of the acid group is 2.34; the $pK_a$ of the amino group is 9.6. Draw the structure of glycine in its predominant ionization states at pH 0, 5, and 12. Indicate the net charge of each ionization form. Circle the two forms that are in a 50/50 equilibrium at pH 2.34. (7%)

6. What are the three reactions in the citric acid cycle in which NADH is produced? None of these reactions involves molecular oxygen ($O_2$), but all three reactions are strongly inhibited by anaerobic conditions; explain why. (6%)
7. What are ketone bodies and why do they form during fasting? (4%)

8. Briefly describe how allosteric effects can be used to control biological processes. Your answer should include a discussion of tense (T) and relaxed (R) states. Give either a specific or a general example of how allosteric effects can modify the biological function of a protein. (5%)

9. The cocaine esterase (CocE) from a bacterium that grows in the soil near cocaine-producing plants. The results of a kinetics experiment are shown in which the enzyme concentration was 0.01 μg/mL. The Mₐ of CocE is 63 kDa.
   a. Calculate $V_{max}$ and $K_m$. (2%)
   b. Calculate $k_{cat}$ (in units of sec⁻¹). (2%)
   c. The other enzyme had these kinetic characteristics: $K_m = 200$ mM and $k_{cat} = 1.9 \times 10^2$ sec⁻¹. At $V_{max}$, how much faster is CocE than the other enzyme? (2%)

10. What forces stabilized three-dimensional structure of RNA? Compare and contrast these with forces that stabilize proteins. (5%)