Part I. Multiple choice (3% × 10 = 30%):

1. Compare the pH of the mitochondrial matrix and inner membrane space. (A) The pH is lower in the matrix. (B) The pH in both regions is the same. (C) The pH is lower in the inner membrane space. (D) The comparison of pH varies from moment to moment depending on energy needs of the cell.

2. The compounds α-D-fructofuranose and β-D-fructofuranose are (A) enantiomers, (B) isomers, (C) anomers, (D) conformational isomers.

3. Fatty acids are oxidized in the (A) mitochondrial matrix, (B) cytosol, (C) endoplasmic reticulum, (D) mitochondrial inner membrane space.

4. The pKa's of the side chain group and the α-carboxyl group of glutamate are 4.1 and 2.1, respectively. Which statement accounts for this difference? (A) The side chain has more possible resonance structures. (B) The α-carboxyl group has less steric hindrance and is therefore ionized more easily. (C) The side chain is a different functional group than the α-carboxyl group. (D) The α-carboxyl group is closer to the α-amino group than the side chain is.

5. What is the function of pyruvate dehydrogenase? (A) To completely oxidize pyruvate to three molecules of carbon dioxide. (B) To convert phosphoenolpyruvate to pyruvate. (C) To regulate PFK-1. (D) The conversion of pyruvate to carbon dioxide and acetaldehyde.

6. Determine the mRNA sequence for the following DNA sequence:
   5' GCCATTTCCCCGTTA 3'
   3' CGGTAAGGGGCAAT 5'
   (A) 5' CGGTAAGGGGCAAT 3' (B) 5' GCCAUUUCCCCGUA 3'
   (C) 5' TAACGGCAAAATGCG 3' (D) 5' UAACGGCAAAUGGC 3'

7. Which of the following statements about fatty acids is not true? (A) The double bonds found in fatty acids are nearly always in the trans configuration. (B) The configuration around the double bond in fatty acids causes a bend or "kink" in the fatty acid chain. (C) Saturated fatty acid chains can pack closely together. (D) Unsaturated fatty acids produce flexible, fluid arrays because they cannot pack closely together.
8. The right hand side figure is a plot of $v_e$ vs. $[S]$ for an allosteric enzyme. Which of the following best describes the plot?
(A) Adding a positive effector to curve 1 would result in curve 2. (B) Adding a positive effector to curve 2 would result in curve 3. (C) Curve 1 represents maximum inhibition. (D) Curve 3 represents the effect of adding a negative effector to curve 2.

9. HIV protease and Chymotrypsin are similar in that: (A) both use Scrime as the nucleophile. (B) both cleave hydrophobic containing peptides. (C) both are monomeric proteins. (D) both use Aspartate to activate the nucleophile.

10. After the reaction with Rubisco, the major difference between the Calvin Cycle and gluconeogenesis in liver is the following reaction. (A) The reduction of 1,3 bisphosphoglyceric acid uses NADPH instead of NADH. (B) The reduction of 1,3 bisphosphoglyceric acid uses NADH instead of NADPH. (C) Phosphatases are not required in plants. (D) The formation of 1,3 bisphosphoglyceric acid from 3-phosphoglyceric acid uses GTP instead of ATP.

Part II. Answer the following questions:

1. Name (or draw examples) of the four types of weak interactions that contribute to the formation of α-helices and β-sheets in proteins. (4%)

2. Explain why humans cannot digest grass (cellulose consisting of glucose subunits) but can digest starch, which is also made of glucose subunits. Why can goats and cows digest both? (6%)

3. Which of the two pieces of double-stranded DNA has the higher melting temperature? Why? (6%)

(A) 5’ CGATGCCAGT 3’
3’ GCTACGGTCA 5’

(B) 5’ TAGCTTTATC 3’
3’ ATCAGAATAG 5’
4. Protein A has a binding site for butylamine with a $K_d = 10^{-6}$ M. Protein B also binds butylamine with a $K_d = 10^{-9}$ M. Which protein has a higher affinity for butylamine? Why? (5%)

5. Citrate synthase and isocitrate dehydrogenase are two key regulatory enzymes of the citric acid cycle. Why are these enzymes good candidates for regulatory enzymes? Name one negative regulator for each of these enzymes. (7%)

6. Describe the two complexes of oxidative phosphorylation that feed electrons into the reduction of ubiquinone (Q). Be sure to explain what compounds provide the electrons for each enzyme complex. Which complex is also part of the citric acid cycle? (7%)

7. Describe how the rate of transcription of the lac operon is affected when E. coli cells are grown in the presence of (a) lactose plus glucose, (b) glucose alone, and (c) lactose alone. (9%)

8. People on high-protein diets are advised to drink lots of water, why? (6%)

9. The genes for both the $\alpha$- and $\beta$-globin chains of hemoglobin contain introns (i.e., they are split genes). How would this fact affect your plans if you wanted to introduce the gene for $\alpha$-globin into a bacterial plasmid and have the bacteria produce $\alpha$-globin? (6%)

10. Compare the ATP yield of three glucose molecules that enter glycolysis and are converted to pyruvate with that of three glucose molecules that proceed through the pentose phosphate pathway such that their carbon skeletons (as two F6P and one GAP) re-enter glycolysis and are metabolized to pyruvate. (6%)

11. Endothelial cells and pericytes in the retina of the eye have different mechanisms for glucose uptake. The figure at the right shows that rate of glucose uptake for each type of cell in the presence of increasing amounts of sodium. What do these results reveal about the glucose transporter in each cell type? (8%)