A. Multiple Choices (34%, 2% each; **one** correct answer only)

1. The chirality of an amino acid results from the fact that its α carbon
   A. is a carboxylic acid.　　B. is bonded to four different chemical groups
   C. is symmetric.　　D. has no net charge
   E. is in the L absolute configuration in naturally occurring proteins

2. Which of the following would allow you to determine the isoelectric point of a protein?
   A. protein quaternary structure　　B. protein solubility as a function of pH
   C. protein size　　D. protein shape　　E. protein tertiary structure

3. The K_m is:
   A. The time for half of the substrate to be converted to product.
   B. The time for all of the substrate to be converted to product.
   C. The [S] that gives half of the maximum reaction rate.
   D. The [S] that gives the maximum reaction rate.
   E. The [P] that is produced when the enzyme is saturated with the substrate.

4. peptide was found to have a molecular mass of about 650 and upon hydrolysis produced Ala, Cys, Lys, Phe, and Val in a 1:1:1:1:1 ratio. The peptide upon treatment with Sanger's reagent produced DNP-Cys and exposure to carboxypeptidase produced valine. Chymotrypsin treatment of the peptide produced a dipeptide that contained sulfur and has a UV absorbance, and a tripeptide. Exposure of the peptide to trypsin produced a dipeptide and a tripeptide. Deduce the sequence of the peptide.
   A. Val-Ala-Lys-Phe-Cys　　B. Cys-Lys-Phe-Ala-Val
   C. Cys-Ala-Lys-Phe-Val　　D. Cys-Phe-Lys-Ala-Val
   E. Val-Phe-Lys-Ala-Cys

5. An enzyme in liver which removes glucose from blood has a high K_m; another which does the same thing in brain tissue has a small K_m. The usefulness of these two different values is that:
   A. The enzyme in brain tissue can take glucose from the blood stream even when levels are low, and the enzyme in liver will not take glucose from blood unless levels are high
   B. The enzyme in brain tissue can take glucose from the blood stream only when levels are high, and the enzyme in liver will not take glucose from blood unless levels are low
   C. The enzyme in brain tissue can take glucose from the blood stream only when levels are high, and the enzyme in liver will not take glucose from blood at any time
   D. This phenomenon is of no apparent value to the organism
   E. It is actually dangerous for the organism; ideally, both Km's should be high

6. A mixture of urease (pI = 5.1, mol. wt. 482,700), catalase (pI = 5.6, mol. wt. 247,500), lactoglobin (pI 5.2, mol. wt. 37,100) and hemoglobin (pI 6.9, mol. wt. 64,500) were applied in a pH 6.5 buffer to a DEAE-cellulose chromatography column and eluted with the same buffer. What was their order of elution?
   A. urease, lactoglobin, catalase, hemoglobin　　B. hemoglobin, catalase, lactoglobin, urease
   C. urease, catalase, hemoglobin, lactoglobin　　D. lactoglobin, hemoglobin, catalase, urease
   E. cannot be determined from the information given

7. Which of the following protein-modifying reagents specifically cleaves polypeptides on the carboxyl side of methionine residues
   A. Chymotrypsin　　B. Cyanogen bromide
   C. Iodoacetamide　　D. Phenylglyoxal
   E. Pyridoxal 5′-phosphate.

8. Under physiological conditions, which of the following processes is **not** an important method for regulating the activity of enzymes?
   A. Phosphorylation.　　B. Temperature changes.　　C. Adenyl addition.
   D. Disulfide reduction.　　E. Partial proteolysis.

9. Which of the following would allow you to determine the isoelectric point of a protein?
   A. protein quaternary structure　　B. protein solubility as a function of pH
   C. protein size　　D. protein shape　　E. protein tertiary structure

10. G° for the conversion of glycerol-3-phosphate to glycerol + Pi is -2.2 kcal/mole. Thus, you can conclude that
   A. this reaction will occur spontaneously.
   B. this reaction may or may not occur spontaneously, depending on the actual concentrations of reactants and products.
   C. this reaction will only occur spontaneously if it is coupled to another reaction that has a more favorable G°.
   D. this reaction is so strongly favorable that it could be coupled to drive an otherwise unfavorable cell reaction.

11. The fact that allosteric enzymes are remarkably sensitive to control makes them ideal candidates for:
   A. The initial steps in a pathway　　B. The rate-limiting steps in a pathway
   C. The final steps in a pathway　　D. All the steps in a pathway
   E. Alternative pathways

12. An enzyme which has a high turnover number:
   A. Can easily be denatured　　B. Can easily be replaced with another enzyme
   C. Needs a constant supply of cofactors　　D. Converts substrate to product very rapidly
   E. Can be easily controlled

13. Proline disrupts α-helical structure in proteins because it is
   A. an acidic amino acid　　B. an aromatic amino acid
   C. an imino acid　　D. a basic amino acid
   E. a sulfur-containing amino acid

14. A small molecule that *decreases* the activity of an enzyme by binding to a site other than the catalytic site is termed a(n):
   A. alternative inhibitor.　　B. allosteric inhibitor.　　C. stereospecific agent.
   D. competitive inhibitor.　　E. transition-state analog.

15. On the x and y axes of a Lineweaver-Burk plot, the largest values of substrate concentration will be found:
A. At the top of the y axis
B. At the intercept on the y axis
C. At the right end of the x axis
D. At the intercept on the x axis
E. At the origin

16. In the α helix the hydrogen bonds:
A. are perpendicular to the axis of the helix.
B. occur mainly between electronegative atoms of the R groups.
C. occur mainly between electronegative atoms of the backbone.
D. occur only between some of the amino acids of the helix.
E. occur only near the amino and carboxyl termini of the helix.

17. The zymogen chymotrypsinogen is converted to active chymotrypsin by
A. binding of a necessary metal ion
B. reduction of a disulfide bond
C. proteolytic cleavage
D. phosphorylation of an amino acid side chain
E. the action of a signal peptide peptidase

B. Essay

1. How does boiling a protein affect its structural and functional properties? (6%)

2. Classify the following fatty acids as ω-3, ω-6, or neither.
(a) α-linolenate _____ (1%)
(b) linoleate _____ (1%)
(c) arachidonate _____ (1%)
(d) oleate _____ (1%)
(e) $\triangle^{8,11,14}$-eicosatreenoate _____ (1%)
(f) γ-linolenate _____ (1%)

3. (A) increase P_{50} (B) decrease P_{50}
Which of the above represents the direction of change for hemoglobin in the system below under conditions described?
_____, increase with CO_2 concentration (2%)
_____, increase with pH (2%)
_____, decrease with BPG (2%)

4. The bacterium *E. coli* can grow at 20 °C or at 40 °C. At which growth temperature would you expect the membrane phospholipids to have a higher ratio of saturated to unsaturated fatty acids, and why? (6%)

5. What sequences are required in an expression vector (for use with *E. coli*), but are not essential in a cloning plasmid? (6%)

6. Write the sequence of the two 12-residue primers that could be used to amplify the following DNA segment by PCR. (6%)
   GTA GCA ATT GCC CGG TGT GTC ATT GAG TCT TGT AGC ATT GCA TGA GGC TCG GCT GA

7. The citric acid cycle begins with the condensation of acetyl-CoA with oxaloacetate. Describe three possible sources for the acetyl-CoA. (6%)

8. Give the three steps that produce NADH in the citric acid cycle. (6%)

9. Indicate the subcellular location for the following lipid metabolisms in mammals:
   (a) Fatty acid synthesis (1%)
   (b) Fatty acid elongation (1%)
   (c) Fatty acid desaturation (1%)
   (d) Phospholipids synthesis (1%)
   (e) Ketone body synthesis (1%)
   (f) Fatty acid oxidation (1%)

10. What are the P:O ratios for electrons donated by matrix NADH and by succinate. (6%)

11. Why must glycogen control be manifested differently in muscle and liver? (6%)