MCB 102 Section Week 2 Practice Problems: Amino Acids
Answer Key

1. Which of the following statements about aromatic amino acids is correct?
A) All are strongly hydrophilic.
B) Histidine's ring structure results in its being categorized as aromatic or basic, depending on pH.
C) On a molar basis, tryptophan absorbs more ultraviolet light than tyrosine.
D) The major contribution to the characteristic absorption of light at 280 nm by proteins is the phenylalanine R group.
E) The presence of a ring structure in its R group determines whether or not an amino acid is aromatic.

(Ans: C)

2. Which of the following statements about cystine is correct?
A) Cystine forms when the —CH2—SH R group is oxidized to form a —CH2—S—S—CH2— disulfide bridge between two cysteines.
B) Cystine is an example of a nonstandard amino acid, derived by linking two standard amino acids.
C) Cystine is formed by the oxidation of the carboxylic acid group on cysteine.
D) Cystine is formed through a peptide linkage between two cysteines.
E) Two cystines are released when a —CH2—S—S—CH2— disulfide bridge is reduced to —CH2—SH.

(Ans: A)

3. In a highly basic solution, pH = 13, the dominant form of glycine is:
A) NH2—CH2—COOH.
B) NH2—CH2—COO-.
C) NH2—CH3+—COO-.
D) NH3+—CH2—COOH.
E) NH3+—CH2—COO-. (Ans: B)

4. In the amino acid glycine, what effect does the positively charged —NH3+ group have on the pKa of an amino acid's —COOH group?

Ans: The positively charged amino group stabilizes the negatively charged ionized form of the carboxyl group, —COO–, and repels the departing H+ thereby promoting deprotonation. The effect is to lower the pKa of the carboxyl group (see Fig. 3-11, p. 83).

5. What is the pI, and how is it determined for amino acids that have nonionizable R groups?

Ans: The pI is the isoelectric point. It occurs at a characteristic pH when a molecule has an equal number of positive and negative charges, or no net charge. For amino acids with nonionizable R groups, pI is the arithmetic mean of a molecule's two pKa values: pI = 1/2 (pK1 + pK2)

6. The amino acid histidine has a side chain for which the pKa is 6.0. Calculate what fraction of the histidine side chains will carry a positive charge at pH 5.4. Be sure to show your work.
Ans: pH = pKa + log [A-]/[HA]
pKa – pH = log [HA]/[A-]
antilog (pKa – pH) = [HA]/[A-]

antilog (6.0 – 5.4) = [HA]/[A-]
4 = [HA]/[A-] or
4[A-] = [HA]

Therefore, at pH 5.4, 4/5 (80%) of the histidine will be in the protonated form.

7. The amino acid histidine has three ionizable groups, with pKa values of 1.8, 6.0, and 9.2. (a) Which pKa corresponds to the histidine side chain? (b) In a solution at pH 5.4, what percentage of the histidine side chains will carry a positive charge?

Ans: (a) 6.0; (b) 80%. (See the previous problem for expanded solution to this problem.)

8. Draw the structure of Gly–Ala–Glu in the ionic form that predominates at pH 7.

Ans: The peptide must have an amino-terminal Gly residue, a carboxyl-terminal Glu residue, and ionized amino and carboxyl groups.