The following questions test the reader's understanding of the building blocks of proteins -- the amino acids. They also contribute to an understanding of how these properties affect the properties of the protein (such as solubility, charge) and how these properties might help design methods of separation and purification of proteins and peptides.

NH_2 — A L I V E — COOH

Given the above peptide, answer the following questions:

1. This is a:

A) Septapeptide (7). _

B) Pentapeptide (5). _

C) Hexapeptide (6). _

D) Tetrapeptide. _

E) Sequence of DNA. _

B) Pentapeptide (5). is correct.

Since there are 5 1-letter codes shown, the peptide is a pentapeptide.

The NH_2- before the "A" represents the free amino group of that amino acid -- the first in the polypeptide. This end is called the "N-terminal" end.

Similarly, the COOH at the other end of the peptide represents the "C-terminal" end of the polypeptide.

Here is a fully protonated pentapeptide:

The N- and C-terminals are shown in blue boxes.

Hint:

The letters in the peptide sequence above are the standard 1-letter codes used for the 20 amino acids found in proteins. (See a complete table at the end of these questions).

2. The amino acid residue "I" in the above peptide is:

A) Nonpolar. _

B) Polar, uncharged. _

C) Polar, acidic. _

D) Polar, basic. _

E) Nonpolar, aromatic. _

3. The amino acid residue "L" in the above peptide is:

A) Lysine. _

B) Leucine. _

C) Phenylalanine. _

D) Tyrosine. _

E) Glutamic acid. _

4. The peptide has ___ ionizable groups.

A) 7. _

B) 2. _

C) 3. _

D) 4. _

E) 5. _

5. Assuming some solubility of the above peptide, in electrophoresis under alkaline conditions,…

A) It would migrate towards the anode. _

B) It would migrate towards the cathode. _

C) It would remain at the origin. _

D) The direction it migrated toward would depend on how alkaline the pH was. _

E) It would precipitate out. _

Hint 1: What is electrophoresis?

Electrophoresis is a process whereby a mixture of charged molecules to be separated are placed in an electric field on a porous support material. The charged particles (proteins, amino acids, nucleic acids, or any other molecule) migrate toward the electrode of opposite charge at a rate depending on their size and charge. The more charged they are, the faster they will move. The larger they are, the slower they move.

Hint 2: How is the peptide charge determined?

The overall charge on a peptide depends on the charge on each of the composite amino acid residues. This in turn depends on the presence of dissociable groups and the pH. When pH's are equal to the pK of the dissociable group, exactly half of the total number of groups are dissociates (and therefore charged). When pH's are greater than pK, more than half are dissociated. The exact ratio can be calculated by the Handerson-Hasselbalch equation.

A chart of the pK of the various groups of the 20 amino acids found in proteins is shown in Table 1.