Practice Problems for Proteins

1) What is the isoelectric point for an amino acid or polypeptide.

2) What atoms define the ϕ and ψ angles of a peptide?

3) Draw the structure of a tripeptide, labelling the sidechains as 'R'. Label the bonds that are described by the ϕ and ψ angles.

4) Draw the complete structure of a heptapeptide with the following sequence: LAKINGS

5) Draw the structures of a dialanine peptide with the peptide bond in the trans conformation and in the cis conformation.

6) What is the smallest possible distance between Bragg planes if an X-ray with a wavelength of 1.54 Angstroms is difracted by a protein crystal at an angle of 39.2°?

7) You have a protein that you want to concentrate. What are your options?

8) Draw the important functional groups of a DEAE cellulose and a carboxymethylcellulose matrix at pH 7.0.

9) What is the ionic strength of the following solutions:

0.250 M sodium chloride
0.250 M calcium chloride ($CaCl_2$)
0.250 M ammonium sulfate ($(NH_4)_2SO_4$)

10) You have a protein that is nicely separated using an ammonium sulfate precipitation. You determined the optimal concentration of ammonium sulfate to be 1.5 M. At this concentration most of your protein is in the supernatant, yet large amounts of other proteins are removed.

a) What is wrong with the following purification scheme (may be more than one mistake)?

- ammonium sulfate precipitation (1.5 M), centrifuge, decant and save supernatant
- load supernatant on a DEAE column that has been equilibrated at pH 7.0
- elute from the column by increasing the ionic strength of the buffer (mobile phase)
- concentrate the protein collected by dialyzing it
- load the concentrated protein on a gel filtration column at pH 7.0
- elute from the gel filtration column by decreasing the ionic strength of the buffer
- celebrate

b) Assuming you still use the ammonium sulfate precipitation and the two columns mentioned above, design a better purification scheme.

c) Design a purification scheme from scratch using any methods you want. Assume it will take 2 columns in addition to an ammonium sulfate precipitation, or 3 columns without one, to obtain a sufficiently pure protein.

11) Calculate the isoelectric points of the following amino acids or peptides:

S
R
N
K
C
SCLV
RILG