Proteins

Proteins are probably the most important class of biochemical molecules, although of course lipids and carbohydrates are also essential for life. Proteins are the basis for the major structural components of animal and human tissue. Proteins are natural polymer molecules consisting of Amino Acids units. The number of amino acids in proteins may range from two to several thousand.

Primary Protein Structure

The **primary protein structure** is defined as the specific sequence of amino acids in the protein. In order to function properly, peptides and proteins must have the correct sequence of amino acids. In the section on peptide bonds, it was shown that a dipeptide consisting of two different amino acids could have two different sequences as in the example gly - ala or ala - gly. Remember that as written left to right in gly-ala, the glycine has the "free" amine terminal end and alanine has the "free" carboxyl acid terminal end.

If three different amino acids (gly, ala, leu) are used to make a tripeptide, how many different sequences are possible? There are six possible sequences:
In the protein hormone insulin, 51 amino acids are found. For a 51-amino acids protein, there are $1.55 \times 10^{66}$ different possible sequences. Many other proteins contain many more amino acids then insulin, but only the correct precise sequence is produced by the body. The procedure used to synthesize the correct sequence of amino acids in proteins is guided by the genetics of DNA and RNA.

### Sickle Cell Anemia

The incorrect amino acid sequence in a protein may lead to fatal consequences. For example, the inherited disease, sickle cell anemia, results from a single incorrect amino acid at the 6th position of the beta-protein chain out of 146. Hemoglobin consists of four protein chains - two beta and two alpha.

![Sickle Cell Anemia Diagram](image)

See the graphic on the left for the sequences. This one alteration of the sequence of amino acids in hemoglobin changes its molecular geometry and hence its ability to carry oxygen and its solubility characteristics. The red blood cells change into a sickled shape instead of the normal round shape, become trapped in the small blood capillaries, and cause a great deal of pain.

**Quiz:** Which type of hemoglobin is apparently more polar and soluble in water?

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Enkephalines

Enkephalins (penta-peptides) have recently been discovered as regulators of nerve impulses involving pain in the brain. Apparently these peptides act as natural analgesics (pain-killers) and their action mimics that of morphine and other opiates. At present it is thought that the morphine-like effects are due to aromatic side chains on phenylalanine and tyrosine which mimic a similar structure on morphine. Apparently, it does not make much difference whether the enkephalin contains methionine or leucine at the acid end of the peptide. The primary structures are:

methionine-enkephalin: tyr - gly - gly - phe - met
leucine-enkephalin: tyr - gly - gly - phe - leu

QUEST. Write the peptide structure for methionine-enkephalin. Enkephalin - Met - Chime in new window

Quiz: Which amino acid is the N-terminal one? Answer

Which amino acid is the C-terminal one? Answer

Angiotnesin Peptide

Hypertension (high blood pressure) is a major human disease and despite much research, the problem is still not completely understood. A major part of the problem involves the action of an octapeptide, angiotensin II. This peptide hormone stimulates the constriction of blood vessels which leads to an increase in blood pressure. Angiotensin II is produced by the removal of two amino acids units on angiotensin I by an enzyme in the blood. Angiotensin I does not constrict blood vessels.
QUES. What is the difference between angiotensin I and angiotensin II? This difference is responsible for difference in physiological action.

Angiotensin I: asp - arg - val - tyr - ile - his - pro - phe - his - leu
Angiotensin II: asp - arg - val - tyr - ile - his - pro - phe.

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