WEEK THREE

Proteins

Proteins consist of amino-acids linked together in chains through peptide bonds.

An amino acid consists of a carbon atom bound to four groups:

1) One is an amino group, —NH_2

2) One is a carboxylic acid group, —COOH (although these exist as —NH_3^+ and —COO^- under physiologic conditions).

3) The third is a simple hydrogen atom.

4) The fourth is commonly denoted "—R" and is different for each amino acid.

The Simplest structure is:

Glycine: $NH_2.CH_2.COOH$

Next would be:

Alanine: $CH^3.NH_2.CH.COOH$

There are twenty standard amino acids.

Some of these have functions by themselves or in a modified form; for instance, glutamate functions as an important neurotransmitter.

The structure of proteins is traditionally described in a hierarchy of four levels.

The **primary structure** of a protein simply consists of its linear sequence of amino acids; for instance, "alanine-glycine-tryptophan-serine-glutamate-asparagine-glycine-lysine-…".

The **Secondary structure** is concerned with local morphology.

Some combinations of amino acids will tend to curl up in a coil called an α-helix or into a sheet called a β-sheet;

Some α-helixes can be seen in the hemoglobin schematic.

The **Tertiary structure** is the entire three-dimensional shape of the protein.

This shape is determined by the sequence of amino acids.

In fact, a single change can change the entire structure.

The alpha chain of haemoglobin contains 146 amino acid residues; Substitution of the glutamate residue at position 6 with a Valine residue changes the behavior of hemoglobin so much that it results in sickle-cell disease.

Finally **quaternary structure** is concerned with the structure of a protein with multiple peptide subunits, like hemoglobin with its four subunits.

Ingested proteins are usually broken up into single amino acids or dipeptides in the small intestine, and then absorbed.

They can then be joined together to make new proteins.

Intermediate products of glycolysis, in the citric acid cycle, and the pentose phosphate pathway can be used to make all twenty amino acids,

Most bacteria and plants possess all the necessary enzymes to synthesize them.

Humans and other mammals, however, can only synthesize half of them.

They cannot synthesize isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine.

These are the **essential amino acids**, since it is essential to ingest them.

Mammals do possess the enzymes to synthesize alanine, asparagine, aspartate, cysteine, glutamine, glycine, proline, serine, and tyrosine.

These are **nonessential amino acids**.

While they can synthesize arginine and histidine, they cannot produce it in sufficient amounts for young, growing animals, and so these are often considered **essential amino acids**.

Proteins play key role as:

Body components (blood, muscle etc.)

Catalysts of chemical reactions (enzymes)

Direct biochemical effects on metabolism, synthesis and immunity (constituent of peptides, hormones, antibodies)

Can be an energy source

Other organic compounds

Other organic compounds in plant and animal bodies include:

Protein- lipid complexes (Lipoproteins)

Protein- carbohydrate complexes (Glycoproteins)

Nucleic acids

Protein- lipid complexes (Lipoproteins)

Found in egg yolk and membrane proteins of animal cells. These membranes are composed of proteins, lipids and carbohydrates in various proportions.

Myelin is a lipoprotein abundant in the nervous system as a sheath around the nerve fibre.

Protein- carbohydrate complexes (Glycoproteins)

Proteins can complex with carbohydrates to form glycoproteins.

These complexes arise from the acceptance of sugars by amino acid residues in the poly-peptide chain.

Mucoproteins are complexes of proteins with amino sugars, glycosamine and galactosamine.

Nucleic acids

Nucleic acids store, transmit and expresses genetic information.

Nucleic acids are composed of subunits called nucleotides.

Nucleotides contain a phosphate group, a sugar and a ring of carbon and nitrogen atoms.

Two types:

DNA (Deoxyribonucleic acid)

These store genetic information in the sequence of the nucleotide subunits.

DNA nucleotides contain a five carbon sugar called deoxyribose. A DNA molecule looks like a double helix.

RNA (Ribonucleic acid)

RNA uses the information in DNA to write the instructions for linking together specific sequence of amino acids in order to form polypeptides per original DNA instruction.

RNA is a single chain of nucleotides. It contains the sugar ribose.