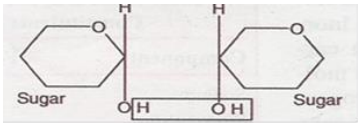
Note:

- Uracil is found only in RNA & thymine in DNA.
- Sugar Ribose (found in RNA) differs from deoxyribose (found in DNA) in having -OH group instead of H at carbon 2.
- Lipids are not strictly biomacromolecule.
- Some Important Bonds-

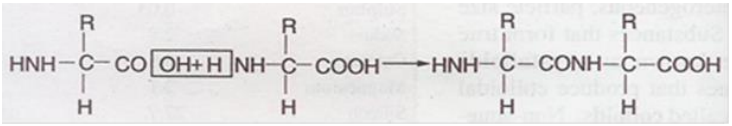
  1. Peptide Bond- Found in Protein. Formed when carboxyl group (—COOH) of one amino acid reacts with the amino group (—NH_2) of the next amino acid with elimination of water.

  2. Glycosidic Bond- Found in Carbohydrates (Polysaccharides) Link monosaccharides & formed by dehydration (removal of water).

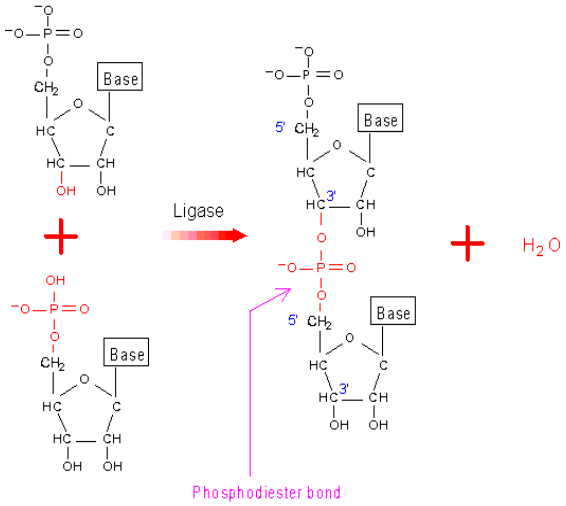
  3. Phosphodiester Bond-Bond between the phosphate and hydroxyl group of sugar. Form one ester bond on either side.



Glycosidic Bond



Peptide Bond



H_2O

Primary & Secondary Metabolites- Various biomolecules present in cells -used in various metabolic reactions of cell.

Primary Metabolites	**Secondary Metabolites**
Found in animal tissues.	Found in plant, fungal and microbial cells.
Have identifiable functions.	Functions are not identifiable in host organism.
Play specific known roles in physiological processes.	Economic importance to humans
Amino acids, carbohydrates, proteins, nucleic acids, etc.	Rubber, drugs, spices, scents and pigments

Some Secondary Metabolites			
Pigments	Carotenoids	Fruits & Vegetable	Photosynthesis & Provide Colour
	Anthocyanins	Red and purple berries, Grapes etc	Absorb blue-green light in plant or fungi.
Alkaloids	Morphine	Opium-poppy plant	Drug- use to relief Pain
	Codeine	Opium-poppy plant	Drug- use to treat Pain/cough
Terpenoides (use in defence)	Monoterpenes	Tea, citrus fruit	Treating early and advanced cancers.
	Diterpenes	Many Plant, fungi, bacteria, sponge etc	Antioxidant, anti-inflammatory, and immune-modulator
Essential oils	Lemon Grass Oil	Lemon Grass	Treat digestive problems and high blood pressure
Toxin	Ricin	Castor beans.	Preventing the cells from making proteins.
	Abrin	Seeds of rosary or jequirity pea	Treatment to kill cancer cells.
Lectins	Concanavalin A	jack-bean	Activates T cells and natural killer cells and triggers anticancer immune responses.
Drugs	Vinblastin	Catharanthus roseus Plant	Slowing or stopping the growth of cancer cells
	Curcumin	Turmeric	management of oxidative. inflammatory conditions, arthritis, anxiety condition
Polymeric Substance	Rubber	Latex of Rubber Plant	Used in medical devices, surgical gloves, aircraft and car tires
	Gums	larch wood chips plant	Water-soluble or capable of absorbing water
	Cellulose	Plant Cell – Cell-wall	Mechanical strength of the cell wall.

Some more functions of Proteins

(i)Helps in transportation of nutrients across the cell membrane by acting as protein transporter.

(ii) Helps in maintenance of pH and regulation of the volume of body fluids.

(iii) Helps at the time of injury in blood clotting and provide immunity.

(v) Helps in growth and repair of body tissues.

Biomacromolecules

- Molecules found in Acid Insoluble Pool.
- Have large in size & have molecular weight more than 10,000 daltons (Da) and above (except lipids).
- Four major types, i.e., proteins, polysaccharides, nucleic acids and lipids.
- Except lipids all other macromolecules are formed by linking monomers.
  (i) **Homopolymers**- made up of same monomer. e.g., Starch, insulin, inulin etc.
  (ii) **Heteropolymers**, made up of two or more monomers, e.g., Proteins.

Q- Why lipids with smaller molecular weight comes under Biomacromolecules?

Ans: Lipids arranged in cell membranes and other membranes. When we grind a tissue, we disrupt the cell structure, cell membrane and other membranes are broken down into pieces and form vesicles that are not water soluble. Therefore, these are separated along with acid insoluble pool and are placed in macromolecules.

Average Composition of Cells

Component	% of the total cellular mass
Water	70-90
Proteins	10-15
Carbohydrates	3
Lipids	2
Nucleic acids	5-7
Ions	1

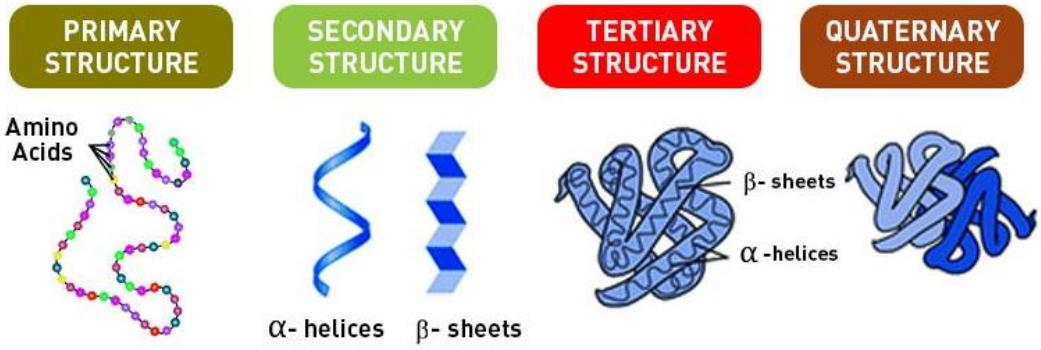
Proteins (Polypeptides)

Chains of amino acid arranged linearly that are linked by peptide bonds.
Most abundant biomacromolecule.
Distance between bonds -0.35 nm.
Heteropolymer of amino acids (20 types)

SN	Protein Type	Function	Example
1	Intercellular Ground Tissue	Structure or framework of your cells and tissues	Collagen
2	Enzyme	Speed up metabolic reaction	Trypsin, Hydrolases, RubisCO
3	Hormone	Chemical messenger-coordinate different functions	Insulin, Glucagon
4	Antibodies	Protect body from unwanted substances.	Immunoglobin (IGG, IGA)
5	Receptor	Detect the signals and then send them to the brain	Thermoreceptor, Olfactory receptor
6	Intra Cellular Channel	Enable transport substance into the cell	GLUT-4- (Glucose transporter-4)
7	Structural Protein	Built structure like cytoskeleton	Tubulin, Keratin
8	Contractile Protein	Carry out muscle contraction-Movement	Actin, Myosin
9	Storage proteins	Storage food	Albumin (egg white)
10	Transport Protein	Transport substances	Haemoglobin

Structure of Proteins

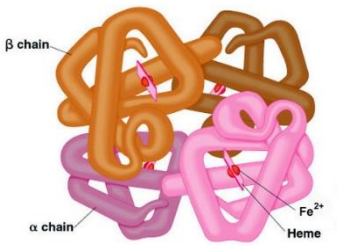
Biologists describe the protein structure at four different levels, i.e., primary, secondary, tertiary and quaternary.



i. Primary Structure- Linear polypeptide chain of amino acids in a particular sequence. Change in Amino acid sequence changes protein.
Left end is represented by the first amino acid called N-terminal and right end represents last amino acid called C-terminal amino acid, e.g., Insulin, ribonuclease.

ii. Secondary Structure-The thread of the primary protein is folded in helix form stabilised by hydrogen bonds between carboxylic group of amino acid and —NH group of amino acid.
α-helix -single spiral formed by hydrogen bonding between every 4th amino acid. e.g., Keratin.
β-pleated sheet - formed by hydrogen bonding between two or more adjacent polypeptide chains. e.g., Silk fibre.

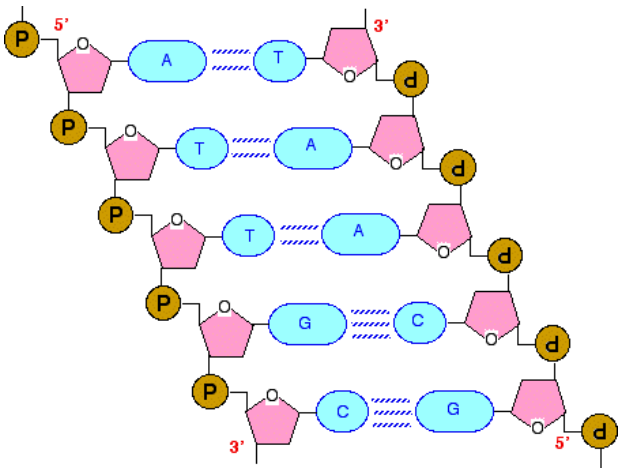
iii. Tertiary Structure (3-dimensional (3-D) - the long protein chain is folded upon itself like a hollow woolen ball. Stabilised by several types of bonds-hydrogen bonds, ionic bonds, van der waals interactions, covalent bonds and hydrophobic bonds. e.g., Myoglobin.
iv. Quaternary Structure- linear strings of spheres (tertiary protein), spheres arranged one upon each other in the form of a cube or plate, etc. e.g., Haemoglobin, lactic acid dehydrogenase enzyme.
Structure of Haemoglobin (Hb)- An iron containing pigment made up of four monomeric sub-units - two subunits (identical to each other) of α type and two subunits of β type.



Accordingly on the basis of shape these are of two main types
i. Fibrous Proteins- Spiral secondary polypeptide chains insoluble in water but soluble in concentrated acids, alkalis and salts, e.g., Collagen of connective tissue, keratin of hair, etc.
ii. Globular Proteins- rounded shape and generally soluble in water and in dilute acids, alkalis, salts, e.g., Egg albumin, serum globulins.
Note:
- Collagen- Most abundant protein in animal world.
- Ribulose bisphosphate Carboxylase-Oxygenase- RuBisCO (Plant Enzyme) - most abundant protein in whole biosphere.

Denaturation of Proteins- On exposed to extreme temperature or pH the weak bonds holding the tertiary and the quaternary structure gets disrupted. This leads to loss of functioning.
Denaturation is not strong enough to break peptide bonds thus, primary structure remains unaffected.
Renaturation- A denatured protein may refold into its original structure when suitable conditions are re-provided.

Nucleic Acids (polynucleotides)
- DNA (Deoxyribonucleic Acid) and RNA (ribonucleic acid) acts as a genetic material are composed of nucleotides.
- Nucleotide Consist of:
    1. Heterocyclic compound- Nitrogenous Base (Purines & Pyrimidines)
    2. Monosaccharide- Pentose Sugar (back bone of RNA/DNA)- Ribose/2-Deoxyribose
    3. Phosphoric acid or phosphate.
- DNA is genetic material found in the nucleus of all living cells except some viruses- more stable than RNA.
- Nucleus of Eukaryotes – linear DNA. In mitochondria and chloroplasts and Nucleus of Prokaryotes- Circular DNA .
- DNA- double helix Structure -by Watson and Crick.
- Two strands of polynucleotides are antiparallel to each other, i.e., both run in opposite directions, one in 5'–> 3' direction and other in 3'—> 5'direction. (Represent carbon No. attached to phosphate group)



Adenine forms double (hydrogen bond) with Thymine and C triple bond with G.
DNA-uniform thickness of 20 A and pitch of is 34. One turn of DNA measures 3.4 nm (rise per base pair) and consists of 10 nucleotides (or ten base pairs).
Nucleic acid plays multiple role in living organism these are given as follows
(i) It enables cell to grow, maintain and divide by directing the synthesis of structural proteins.
(ii) Acts as a genetic material, i.e., transfer hereditary characters from one generation to the next.