CHAPTER

3 Biomolecules

Carbon compounds that we get from living tissues can be called 'biomolecules'.

Chemical Analysis

Living tissue (a vegetable or a piece of liver) + Trichloroacetic acid (Cl_3CCOOH)

↓

Thick slurry

↓

Stain using cheesecloth/Cotton

↓

Entire chemical composition of living tissues or organisms

↓

Filtrate (Acid-Soluble or micromolecules)	Retentate (Acid-Insoluble or macromolecules)
M. wt.= 18-800 Da	M. wt.= >10,000 Da
Inorganic substances e.g. water, ions, gases	Polymeric form (Protein, Polysaccharides, Nucleic Acids)
Organic substances (Simple sugars, Amino acids, Nucleotides)	Lipids (not a polymer) ❖ Not strictly a macromolecules ❖ M. wt.= < 800 Da

Elemental Analysis

It gives elemental composition of living tissue in the form of Hydrogen, Oxygen, Chloride, Carbon etc.

Living Tissue —Weight→ Wet Weight; —Dry→ Dry Weight

Dried living tissue —Burn (All. carbon compound oxidise to CO_2 and H_2O)→ 'Ash' contains only inorganic elements

Micromolecules or Biomolecules

Amino Acids

- ❖ They are substituted methanes.
- ❖ 20 types of amino acids occur in proteins.

Lipids

- ❖ Water insoluble.
- ❖ Fatty acids and glycerol are simple lipid.
- ❖ Oils have lower melting point.
- ❖ Lecithin (phospholipids) found in cell membrane.

Nucleotides

(Nucleosides + Phosphate group)

- ❖ DNA and RNA consist of nucleotides that function as genetic material.

Primary and Secondary Metabolites

Primary metabolites	Secondary metabolites
Identifiable functions & roles in normal physiologial processes	Not involved in primary metabolism
Examples- amino acids, sugars, etc.	Examples- alkaloids, flavonoids, rubber, essential oils, antibiotics, coloured pigments, scents, gums, spices.

Biomacromolecules

Molecular weight ranging from 18 to 800 daltons(Da)

Proteins

- ❖ Monomer- Amino acids (linked by peptide bonds)
- ❖ Heteropolymer
- ❖ Collagen & RuBisCO are the most abundant proteins in the animal world & in the whole of the biosphere, respectively.
- ❖ Biologist describe structure of proteins at 4 levels-
  1. **Primary:** Positional information of sequence of amino acids.
  2. **Secondary:** Thread folded in the form of helix (only right handed).
  3. **Tertiary:** Three dimensional view (like a hollow woolen ball).
  4. **Quaternary:** More than one polypeptide chain is involved. E.g. haemoglobin consists of 4 subunits.

Polysaccharides

- ❖ Monomer- Monosaccharides (linked by glycosidic bonds)
- ❖ Cellulose, starch, & Inulin are homopolymers
- ❖ Chitin (homopolymer) is a complex polysaccharides

Nucleic Acids

- Monomer- Nucleotides
- Deoxyribose containing nucleic acid - deoxyribonucleic acid (DNA)
- Ribose containing nucleic acid - Ribonucleic acid (RNA)

Watson-Crick model

- 'DNA exists as a double helix'
- Backbone = sugar-phosphate-sugar chain
- Nitrogen bases are = perpendicular to backbone (inside)
- Two H-bonds between A and T and three H-bonds between G and C base pairs
- At each step of ascent, the strand turns 36°
- 1 turn= 10 base pairs
- 1 complete turn = 34Å
- Rise per base pair = 3.4Å

Dynamic State of Body Contituents

- Living state is a non-equilibrium steady state to be able to perform work
- Metabolism is the sum total of all the reactions occurring within the body
- There are two metabolic pathways-
  - **Anabolic pathways (biosynthetic pathways):** Formation of more complex structure from a simpler structure
  - **Catabolic pathways (degradation pathways):** Formation of simpler structure from a complex structure.

Enzymes

- All enzymes are proteins, except some nucleic acids that behave like enzymes, called ribozymes
- Increase rate of reaction by lowering activation energy.
- Thermal stability is an important quality of enzymes those are isolated from thermophilic organisms

Enzyme Action

$E + S \rightleftharpoons ES$ (transient phenomenon) $\rightarrow EP \rightarrow E + P$

- 'P' is at a lower level than 'S'- Reaction is exothermic.
- 'S' is at a lower level than 'P'-Reaction is endothermic

Factors Affecting Enzyme Activity

1. Temperature

   Optimum temperature = Temperature at which enzyme shows its highest activity.
2. pH

   Optimum pH = pH at which enzyme shows its highest activity
3. Concentration of Substrate.

   Increase in substrate concentration increase the velocity of the enzymatic reaction rises at first but becomes constant when all enzymes get saturated with substrate.
4. Inhibitor

   Binding of the inhibitor shuts off enzyme activity (inhibition)

   Michaelis constant (K_m)- Concentration at which the reaction velocity reaches half its maximum velocity.

   Competitive inhibitor- Inhibitor that closely resembles the substrate in its molecular structure. Effect of the competitive inhibitor can be reversed by increasing the concentration of the substrate.

Classification of Enzymes

- Enzymes are divided into 6 classes each with 4-13 subclasses and named accordingly by a four-digit number. Six classes of enzymes are-
- Oxidoreductases/dehydrogenases, Transferases, Hydrolases, Lyases, Isomerases, Ligases.

Co-factors

- Non-protein constituents bound to the the enzyme to make the enzyme catalytically active.
- Apoenzyme - Protein portion of the enzymes.
- Three kinds of cofactors may be identified: prosthetic groups, co-enzymes and metal ions.