ST. LAWRENCE HIGH SCHOOL

A JESUIT CHRISTIAN MINORITY INSTITUTION

STUDY MATERIAL FOR CHEMISTRY (CLASS-12)

TOPIC-BIOMOLECULES (PART-2)

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Enzymes

Enzymes constitute a group of complex proteinoid compounds, produced by living organisms which catalyse the chlemical reaction.

Non-proteinous components enhance the activity of certain enzymes and are known as co-enzymes. These include metal ions like Mn^{2+}, Mg^{2+}, K^{+}, Na^{+}, Zn^{2+}, Co^{2+} etc., heterocyclic ring systems (pyrrole, purine, pyridine, etc.), a sugar residue, phosphoric acid residue of vitamins like thiamine, riboflavin etc.

Endoenzyme acts in the same cell in which it is synthesised, while exo-enzyme acts outside the cell in which it is synthesised.

Nomenclature

They are usually named by adding the suffix 'ase' to the root name of the substrate e.g., urease, maltase, diastase, invertase, etc.

Oxidative Enzymes

They catalyse oxidation-reduction reaction and are mostly conjugated proteins.

Some Common Enzyme

Name	Substrate	Products
Urease	Urea	CO₂ + NH₃
Maltase	Maltose	Glucose
Invertase	Sucrose	Glucose + fructose
Amylase	Starch	Maltose
Trypsin	Proteins	Amino acids
Ascorbic acid oxidase	Ascorbic acid	Dehydroascorbic acid

Characteristic Features of Enzymes

1. **Rate of reaction** They increase the rate of reaction up to 10^{6} to 10^{7} times.
2. **Specific nature** Urease catalyse the hydrolysis of urea and not methyl urea, so these are specific in nature.

3. **Optimum temperature** It is about 20-30°C.
4. **pH of medium** It is about 7 but for pepsin, it is 1.8·2.2 and for trypsin, it is 7.5-8.3.
5. **Concentration** Dilute solutions are more effective.
6. **Amount of enzyme** Very small amount can accelerate the reaction.
7. **Enzyme inhibitors** These compounds inhibit the enzyme action. With the help of such compounds, the reaction can be controlled.

Mechanism of Enzyme Action

Enzyme + Substrate → [Enzyme substrate] → Product + Enzyme Activated complex

Applications of Enzymes

(i) Treatment of diseases The congenital disease phenyl ketonurie caused by phenylalanine hyroxylase can be cured by diet of low phenylalanine content. Enzyme streptokinase is used for blood clotting to prevent heart disease.

(ii) In industry Tanning of leather, fermentation process etc.

Nucleic Acids

Important Terms of Nucleic Acids

1. Nucleotlde

Nucleotides consist of 5-carbon sugar + nitrogenous base + 1, 3-phosphate groups.

2. Pentose sugar

It is either ribose or deoxy ribose (not having oxygen at C_2).

3. Nitrogenous base

Derived from purines having two rings in their structure e.g., Adenine (A) and Guanine (G) and derived from pyrimidines having one ring in their structure e.g.,

Thymine (T), Uracil (U) and Cytosine (C).

Two H-bonds are present between A and T (A = T) while three H-bonds are present between C and G (C ≡ G).

4. Ribonucleotide

Phosphate unit + Ribose + one base unit from A, G, C, or U.

5. Deoxyrlbo nucleotide

Phosphate unit + Deoxyribose + one base from A, G, C or T.

6. Nucleoside

Ribose-/deoxyribose + one base unit from A, G, C, Tor U.

DNA and RNA

Nucleic acid is polynucleotide, present in the living cells or bacterial cells having no nucleus and in viruses having no cells.

(i) DNA Deoxy ribonucleic acid.

DNA + H_2O → Phosphoric acid + deoxyribose + A, G, C, T

(ii) RNA Ribonucleic acid

RNA + H_2O → Phosphoric acid + Ribose + A, G, C, U

Structure of DNA

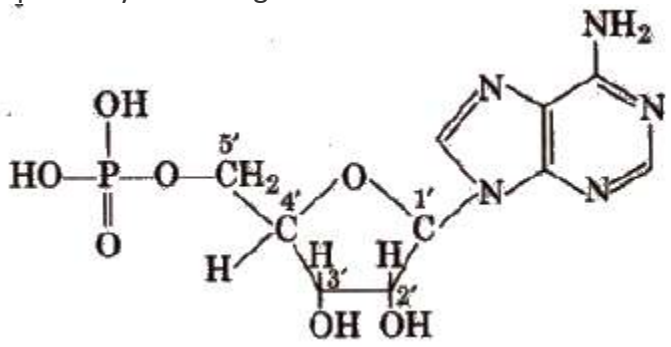
It consists of two polynucleotide chains, each chain form a right handed helical spiral with ten bases in one turn of the spiral. The two chains coil to double helix and run in opposite direction. These are held together by hydrogen bonding.

Structure of RNA

It is usually a single strand of ribonucleotides and take up right handed helical conformation. Up to 12000 nucleotides constitute an RNA.

It can base pair with complementary strands of DNA or RNA according to standard base pairing rules-G pairs with C, A pairs with U or T. The paired strands in RNA-RNA or RNA-DNA are anti parallel as in DNA.

In both DNA and RNA, heterocyclic base and phosphate ester linkages are at C_1 and C_5' respectively of the sugar molecule.



Types of RNA

1. Messanger RNA (m-RNA) It is produced in the nucleus and carries information for the synthesis of proteins.
2. Transfer RNA (Soluble or Adoptive RNA) (s-RNA, t-RNA) It is found in cytoplasm. Its function-is to collect amino acids from cytoplasm for protein synthesis.

Functions of Nucleic Acids

1. Direct the synthesis of proteins.
2. Transfer the genetic information (hereditary characters).

Replication

It is a process in which a molecule of DNA can duplicate.

Template It means pattern. In the process of replication of DNA, the parent strand serves as template.

Gene The portion of DNA carrying information about a specific protein is Called gene.

Genetic code The relation between the amino acid and the nucleotide triplet is called genetic code.
Codons The nucleotide bases in RNA function in groups of three (triplet) in coding amino acids. These base triplets are called codons.
The world code is used with reference to DNA, codon with reference to m-RNA and anticodon with reference to t-RNA.

Lipids
The constituents of animals and plants soluble in organic solvents (ether, chloroform. carbon tetrachloride), but insoluble in water are called lipids. (Greek lipose = fat)

Types of Lipids
(i) Simple lipids
(a) Fats and oils on hydrolysis give long chain fatty acids + glycerol.

(b) Waxes Long chain fatty acids + long chain alcohols.
Vegetable and animal oils and fats have similar chemical structure and are triesters of glycerol, called glycerol.

Simple glycerides contain one type of fatty acids. Mixed glycerides contain two or three types of fatty acids.

Common saturated fatty acids CH_3-$(CH_2)_n$COOH.
When n = 4 caproic acid; n = 6 caprylic acid; n = 8 capric acid, n = 10 lauric acid n = 12 myristic acid; n = 14 palmitic acid, n = 16 stearic acid.

Common unsaturated acids
$C_{17}H_{33}$COOH oleic acid; $C_{17}H_{33}$COOH linoleic acid.
Difference between oils and fats Oils are liquids at ordinary temprature (below 20° and contain lower fatty acids or unsaturated fatty acids.
Fats are solids or semisolids above 20°C and contain higher saturated fatty acids. Oils and fats act as “energy reservoirs” for the cells.

(ii) Phospholipids Phosphate + glycerol + fatty acids + a nitrogen containing base.
Function of phospholipids are
1. As emulsifying agents since they carry hydrophilic polar groups and hydrophobic non-polar groups.

2. They absorb fatty acids from the intestine and transport to blood cells.

(iii) Glycolipids They contain one or more simple sugars and are important components of cell membranes and chlorplast membranes.

(iv) Steroids and Terpenes Menthol, camphor are common plant terpenes. Carotenoids and pigments are also terpenes.

(a) Essential oils The volatile, sweet smelling liquids obtained from flowers, leaves, stems, etc. Example of terpenes are esters of lower fatty acid, e.g., clove oil, rose oil, lemon oil.
(b) Drying oils The oils which are converted into tough, transparent mass when exposed to air by oxidation polymerisation process are called drying oils. e.g., Linseed oil, perilla, poppy seed oils.

Cotton seed oil and til oil are semidrying oils.

Acid Value
It is the number of milligrams of KOH required to neutralise the free acid present in 1 g of oil or fat.

Saponification Value
It is the number of milligrams of KOH required to saponify 1g of oil or fat or the number of milligrams of KOH required to neutralise the free acidresulting from the hydrolysis of 1 g of an oil or fat.

Iodine Value
It is the number of grams of iodine absorbed by 100 g of oil or fat.

Relchert-Meissel Value (R/M Value)
It is the number of cc of N/10 KOH required to neutralise the distillate of 5 g of hydrolysed fat.

Blood
An average person has about 6.8 L of blood which is about 6-10% of the body weight. pH of blood is about 7.4.

Haemoglobin is globular protein. It is made up of four polypeptide chains which are arranged in tetrahedral manner. Each chain is associated with a non-protein part, called haem.
Haemoglobin
These axe the chemical substances which are produced by ductless glands in the body. Hormones acts as chemical messengers.

Some examples of ductless ‘(endocrine) glands are thyroid, pitutary, adrenal, pancreas, testes and ovaries.

Hormones are divided into three types:

1. steroids
2. proteins or polypeptides
3. amines.

	Hormone	Source	Chemical name	Function
1.	Thyroxin	Thyroid	Amino acid	Stimulates metabolism.
2.	Adrenaline	Adrenal	Amine	Increases pulse rate and blood pressure, release glucose from glycogen and fatty acids from fats.
3.	Insulin	Pancreas	Peptide	Decreases blood glucose.
4.	Glucogon	Pancreas	Peptide	Increases blood glucose.
5.	Testosterone	Testes	Steroid	Controls normal functioning of male sex organs.
6.	Estrone and Estradiol	Ovary	Steroid	Controls normal functioning of female sex organs.
7.	Progesterone	Ovary	Steroid	Prepare uterus for pregnancy, controls menstrual cycle.
8.	Cortisone	Adrenal cortex	Steroid	Metabolism of water, mineral salts, fats, proteins and carbohydrates.

Insulin is a protein hormone which is secreted by β-cells of the pancreas. Insulin was the first polypeptide in which the amino acid sequence was experimentally determined. Its deficiency leads to diabetes mellitus.

Vitamins

- Vitamins are a group of organic compounds which are essential for normal growth and nutrition and are required in very small amounts for maintaining optimum growth and a good health.

- Their absence causes specific deficiency diseases.

- Most of the vitamins cannot be synthesised in our body but plants can synthesise almost all of them.

- Vitamin D is an exception because it can be made in the skin from exposure to sunlight.

Classification of Vitamins

On the basis of solubility in water, vitamins are classified into the following two types:

- Fat soluble vitamins: Vitamins A, D, E and K are oil soluble.

- Water soluble vitamins: The group includes Vitamins B and C. These are stored in much lesser amounts in the cells.

Note: Vitamin H (Biotin) is an exception, since it is neither soluble in water nor in fat.

Some important Vitamins, their Sources and their Deficiency Diseases are dictated in the table given below

Name of Vitamin	Important Sources	Deficiency Diseases
Vitamin A	Fish liver oil, Milk, butter, egg yolk, green and yellow vegetables.	Night blindness, Xerophthalmia (hardening of cornea of eye).
Vitamin B_1	Yeast, milk, green vegetables, cereals, fruits, egg yolk.	Beriberi (loss of appetite, retarded growth)
Vitamin B_2	Egg yolk, liver, milk, green leafy vegetables.	Cracked lips, sore tongue, digestive disorders and burning sensation of the skin.
Vitamin B_6	Milk, egg yolk, cereals, yeast, legumes.	Nervous disturbances and convulsions.
Vitamin B_{12}	Meat, fish, kidney, eggs.	Pernicious anaemia (RBC deficient in haemoglobin)
Vitamin C	Citrus fruits, amla and green leafy vegetables.	Scurvy (bleeding gums)
Vitamin D	Exposure to sunlight, fish and egg yolk	Rickets (bone deformities in children) and osteomalacia (soft bones and joint pain in adults)
Vitamin E	Milk, ghee, vegetable oils like wheat germ oil, sunflower oil, cotton seed oil.	Increased fragility of RBCs and muscular weakness
Vitamin H	Milk, yeast, liver, kidney.	Loss of hair, dermatitis.
Vitamin K	Green leafy vegetables, fish, meat, cereals.	Increased blood clotting time

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