BIOMOLECULES

1 How To Analyse Chemical Composition ?

[i] Take a living ~~cell~~ tissue [Vegetable or piece of liver] and grind it in Trichloroacetic acid [Cl_3COOH]

[ii] Strain this slurry through a Cheescloth or Cotton. We would obtain fraction.

Filtrate : The acid soluble pool
Retentate : Acid insoluble pool.

* Biomolecules : All the Carbon Compound that we get from living tissue Can be Called biomolecule

Q. How to identify inorganic Element in a living tissue ?

Ans[i] Weight a Small amount of living tissue. and dry it.

[ii] All water Evaporates. The remaining material give dry weight.

[iii] If tissue is fully burnt, all Carbon Compound are Oxidise to gaseous form.

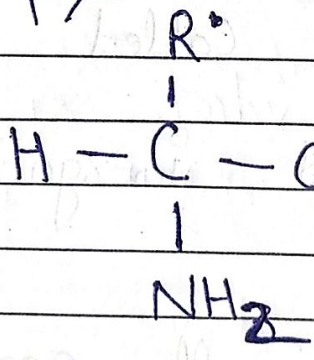
[iv] The remaining ash Contain inorganic element like Calcium, magnesium.

NOTE: Inorganic Compound like Sulphate and phosphorus are found in Acid soluble fraction.

* AMINO ACID

→ Organic Compound Containing an amino group, and an acidic group as substituents on same Carbon i.e α-Carbon. Hence they are Called α-amino acid.

→ four substituent groups occupy four Valence position



→ Carboxyl group

→ Amino group.

→ R group is Variable and based on nature of R group there are many amino acid.

→ Only 20 types of amino acid Occur in protein.

→ If R group is hydrogen than amino acid is called Glycin

R = Methyl group ⇒ alanine

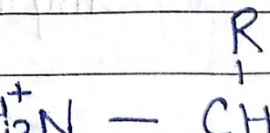
R = Hydroxy methyl [$-CH_2-OH$] = Serine

→ Based on number of amino acid an Carboxyl group they are :-

Acidic ⇒ Glutamic acid
Basic ⇒ lysine
Neutral ⇒ Valine

→ A particular property of amino acid is the ionizable nature of $-NH_2$ and $-COOH$.

• Zwitterionic form



* LIPIDS

→ They are water insolube and Could be Simple fatty acid

→ has a Carboxyl group attached to an R group.

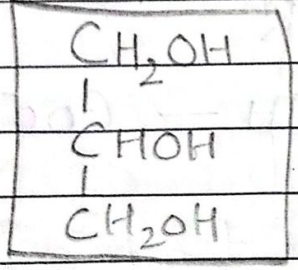
- R group Could be methyl, ethyl or higher num. of $-CH_2$ group [1-19 C].

Ex: palmitic acid ⇒ 16 C include Carboxy Carbon

$$CH_3-(CH_2)_{14}-COOH$$

→ Fatty acid Could be Saturated [C-C] or Unsaturated [C=C]

→ Glycerol is trihydroxy propane is Simple lipid



- Some lipid has both glycerol and fatty acid. They Can be monoglycerides diglycerides and triglycerides.

- lipids are also Called fat and oil based on Melting point.

- Some Lipids has phosphorus and phosphorylated Organic Compound and are known as phospholipids
→ found in Cell membrane
eg: Lecithin.

* Nitrogen bases: Caribon Compound in which heterocyclic ring Can be found
eg: Odenine, guanine, Cytosine, Uracil and thymine

* Nucleoside: When nitrogen bases found attach to sugar they are Called Nucleoside

eg: Adenosine, guanosine, thymidine, Uridine, Cytidine.

* Nucleotide: if phosphate group is also esterified to sugar they are Called Nucleotide.

eg: Adenylic Acid, thymidylic acid etc.

* Primary And Secondary Metabolites

- **Primary Metabolite** : Metabolite that is directly involved in normal growth, development and reproduction

→ perform a physiological function in Organism.

eg: Sugars, proteins, lipid, starch

- **Secondary Metabolite** : Organic molecule produced by an Organism that are not Essential for their growth development and reproduction.

eg: Alkaloids, Flavonoids, Rubber, Antibiotics.

BIOMOLECULES

Micromolecule	Macromolecule
• molecular weight is less than One thousand dalton.	• molecular weight range of ten thousand dalton and above
• Acid soluble	• Acid insoluble.
	• Exception : lipid molecular weight is approx 800 Da.

Q. Why lipid whose molecular weight do not exceed 800 Da, Come under macromolecule?

Ans Because they are arranged in structure like cell membrane and other membrane

Cell membrane and other membrane broken into piece when we grind and form vesicles which are not water soluble. and separated along with acid insoluble pool.

(*) Acid soluble pool represent Cytoplasmic composition

(*) Organelles become acid insoluble fraction.

(*) Water is most abundant [72% - 90%] chemical in Living Organism.

* PROTEIN

⊙ Protein are polypeptide and are linear chain of amino acid linked by peptide bond.

⊙ Protein is Heteropolymer.

⊙ Essential amino acid : Amino acid that have to be supplied through out diet.
eg : Lysine, Leucine, Tryptophan, + 6 more

⊙ Non-Essential amino acid : Amino acid which ~~are~~ our body can make, while we get essential amino acid through diet.
eg : Alanine, Aspartic acid
Cysteine, + 8 more

* function of protein

① Transport nutrients across cell membrane
② Some fight infection
③ Some are hormone
④ Some are Enzymes.

- Collagen : Abundant protein in animal.
- RuBisCo : Ribulase bisphosphate Carboxylase - ~~Oxylase~~ Oxygenase

Abundut protein is biosphere

* Structure Of Protein

- Primary
- Secondary
- Tertiary
- Quaternary

[i] Primary structure : It is the basic structure of protein in which no. of polypeptide are involve having sequence of amino acid.

→ The first amino acid of sequence is called N-terminal amino acid

→ Last amino acid of peptide chain is called C-terminal amino acid.

[ii] Secondary structure protein : protein threads forms helix.

→ There are 3 type of secondary structure.

[a] α helix : The polypeptide chain is coiled spirally in right handed manner.

[b] β-pleated : Two or more polypeptide chain are interconnected by Hydrogen bond.

[c] Collagen : Three strand or polypeptide coiled around one other by hydrogen bond.

[iii] Tertiary structure : Long protein chain is folded upon itself like a hollow woollen ball to give 3 dimensional view of protein.

[iv] Quaternary structure : Each polypeptide develop it own tertiary structure and function as subunit of protein.

eg : In adult hemoglobin 4 subunit are ~~its~~ involved.

2 subunits of α type and two sub-unit of β-type.

* POLYSACCHARIDES

⊙ Long chain of sugar containing different monosaccharide

⊙ Cellulose is polymeric polysacchrides consisting one type of monosacchrides glucose.
→ Homopolymer
→ plant cell wall is made up of cellulose.

⊙ Insulin is a polymer of fructose.

⊙ Starch is present in plant as store house of Energy.

→ forms helical Secondary structure.
→ Hold I_2 molecule in structure.

Starch - I_2 is BLUE in Colour.

⊙ Glycogen also known as Animal starch It is reserve food materials for animal.

→ The right end is Called Reducing end Left end is Called Non-reducing hand.

⊙ Chitin: Complex polysaccharides and are Heteropolymer.

→ Exoskeleton of arthropods is made up of Chitin.

* NUCLEIC ACID

→ They are polynucleotides.

→ A nucleiotide has 3 Component
(i) heterocyclic Compound
[ii] Monosaccharide
[iii] phosphoric Acid or phosphate

Date

[i] Nitrogen bases

- Purines
  - Adenine
  - Guanine
- Pyrimidines
  - Cytosine
  - Thymine
  - Uracil.

[ii] Sugar found in nucleic acid is either ribose or deoxyribose.

→ Nucleic acid Containg deoxyribose sugar is Called DNA

→ Nucleic acid Containing ribose sugar are Called RNA

* NATURES OF BOND LINKING IN POLYMER

⊙ Peptide Bond: Formed when Carboxyl [-COOH] group of amino acid react with amino [$-NH_2$] group of next amino acid with Elimination of water.

⊙ Glycosidic bond: formed b/w Carbons of adjacent monosaccharides
→ formed with release of water [dehydration]

- Ester bond: bond b/w phosphate and hydroxyl group of Sugar.

→ Occur in Nucleic acid.

* WATSON - CRICK MODEL

→ It Say that "DNA exist as a Double helix".

- Two strands of polynucleotide are antiparallel.
- Backbone is formed by Sugar-phosphate Sugar chain.
- Nitrogen bases are projected more or less perpendicular but face inside.

→ A and Gr of one strand Compulsorily base pairs with T and C.

A = T → Double Hydrogen bond
Gr ≡ C → Triple " "

- The strand turn 36° in right handed fashion.
- Pitch = 34 A°
- Dist^n b/w base pair = 3.4 A°

METABOLISM

⊙ Biomolecules are constantly being changed into some other biomolecules and also made from other biomolecules. This is through chemical reaction occuring in all living organism.

⊙ This chemical reaction are called Metabolism.

eg: Hydrolysis of a glycosidic bond in Disaccharide.

⊙ Metabolites are converted into each other in a series of linked reaction called Metabolic pathways.

⊙ Flow of metabolites through a pathway has a definite rate and direction.

This metabolite flow is called dynamic state of body constituents.

⊙ Every chemical reaction is a catalysed reaction.

⊙ The protein which catalysed a reaction is named as Enzyme

⊙ Anabolic pathways : Metabolic pathway that leads to more complex structure from simpler structure.

⊙ Catabolic pathways : Pathway that leads to simpler structure from complex structure.

- Anabolic pathway Consume energy while Catabolic pathway release Energy.
- & ATP [Adenosine triphosphate] is most important form of Energy Currency in Living world.

⊙ The Living state is a non-equilibrium steady-state to be able to perform work.

* ENZYMES

- All Enzymes are Protein.
- Some Nucleic Acid behave like enzymes are Called Ribozymes
- Enzyme are Commonly Called Biocatalysts

⊙ Have primary, secondary or tertiary structure.

⊙ The tertiary structure of Enzyme has pockets or Crevice know as Active site into which substrate fit.

⊙ Inorganic Catalyst work efficiently at high temperature while Enzymes get damage at high ~~temperature~~ temperature.

⊙ Enzymes isolated from thermophilic Organism are stable and their Catalytic powder even at high temperatures [upto 80°C - 90°C]

* CHEMICAL REACTION

- Rate of a Chemical reaction refers to amount of product formed per unit time

$$\text{rate} = \frac{\delta P}{\delta t}$$

- Rate double or decrease by Half for every 10°C change in either direction.

Page No.
Date

$$CO_2 + H_2O \xrightarrow[\text{Carbonic anhydrase}]{\text{Enzyme}} H_2CO_3$$

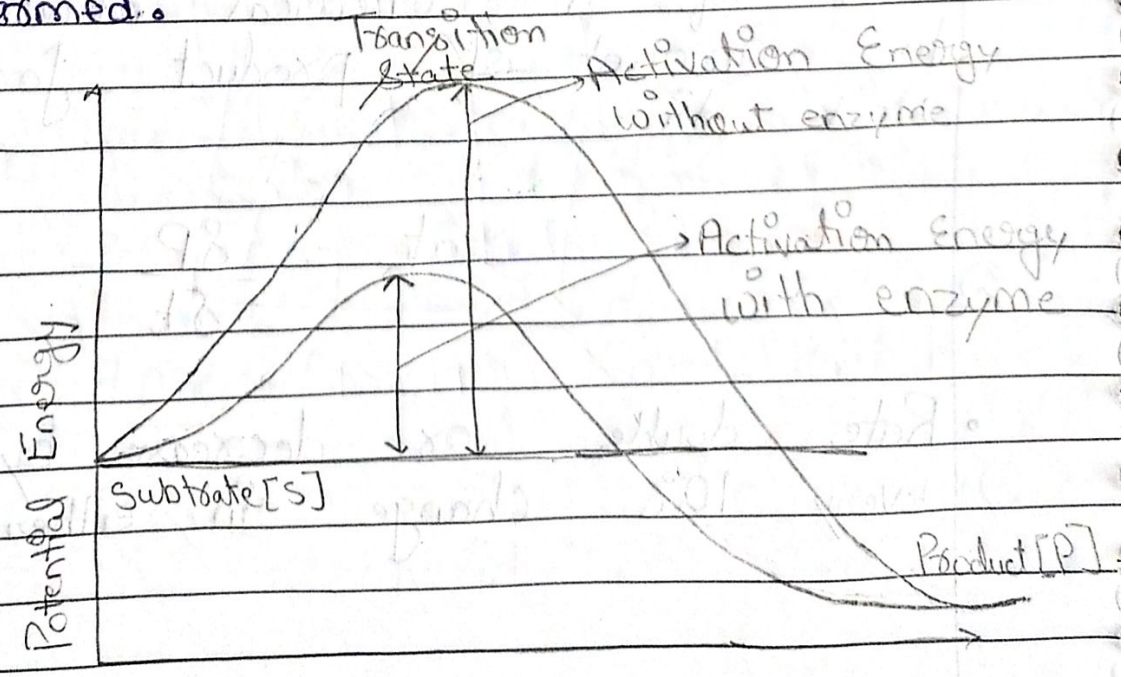
In absence of enzyme

Reaction is very slow. 200 molecule of H_2CO_3 in an Hour.

In presence of Enzyme

Reaction is very fast. 600,000 molecules per second.

- In metabolic pathway, different product are possibe in different condition.
- Transition state: When substrate is bound the enzyme active site then new structure of substrate called Transition state structure formed.



⊙ If 'P' is Lower than 'S' then reaction is Exothermic. Need not supply Energy

⊙ The difference in average energy content of 'S' from that of transition state is Called Activation Energy

* NATURE OF ENZYME ACTION

1. First, the substrate binds to active site.

$$E + S$$

2. The binding of Substrate induce enzyme to alter its shape fitting more tightly around the substrate and form Enzyme - Substrate Complex

$$E + S \rightleftharpoons ES$$

3. Active site of enzyme breaks the chemical bond of substrate and new Enzyme - product Complex formed

$$ES \longrightarrow EP$$

4. Enzyme release the product of reaction and free ~~end~~ enzyme is ready to bind another molecule of substrate

$$EP \longrightarrow E + P$$

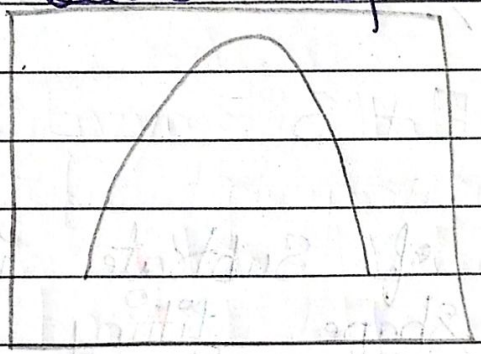
$$E + S \rightleftharpoons ES \longrightarrow EP \longrightarrow E + P$$

* Factors Affecting Enzyme Activity.

1. Temperature: An enzyme is active within a narrow range of temperature.

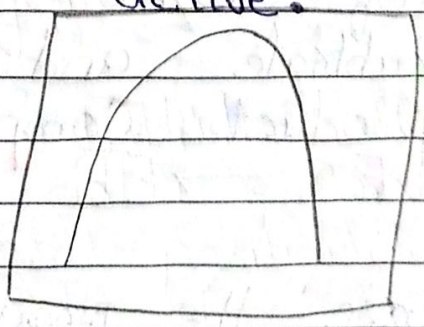
→ Temperature at which enzyme is most active is called optimum temperature

→ Enzyme activity decrease above and below optimum temperature.



Temperature

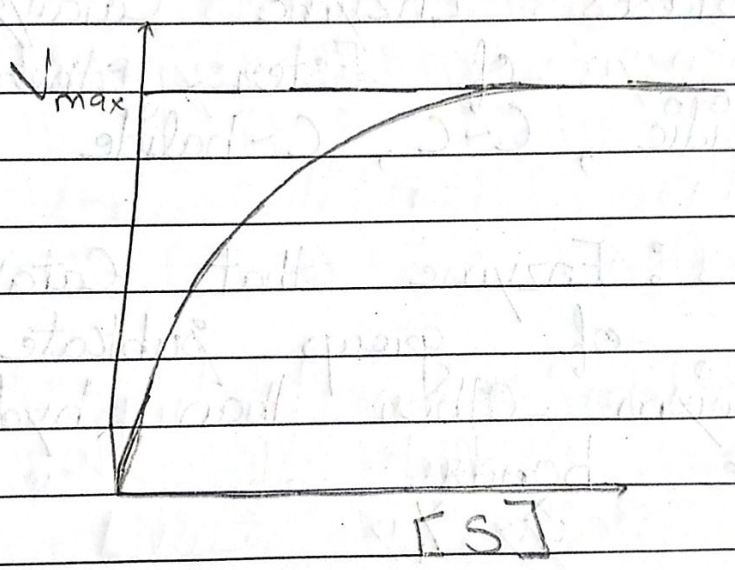
2. pH: Every enzymes has an optimum pH at which it is maximum active.



pH

* Concentration of Substrate

- Increase in substrate concentration increase the rate of reaction. after reaching maximum rate there is no increase in rate with the increase of Concentration.



* CLASSIFICATION OF ENZYMES

1 Oxidoreductases / Dehydrogenases

Enzymes which Catalyse Oxidoreduction b/w two substrates eg.

S reduced + S' oxidised → S oxidise + S' reduced

Date

2. Transferases: Enzymes Catalysing of transfer of a Grsoup Gr [Other than hydrogen] b/w a pair of Substrate. eg:

$$S\text{-}Gr + S' \longrightarrow S + S'\text{-}Gr$$

3. Hydrolases: Enzyme Catalysing hydrolysis of Ester, Ether, peptide, glycosidic, C-C, C-halide or P-N bonds.

4. Lyases: Enzyme that Catalyse removal of group Substrate by mechanism Other than hydrolysis leaving double bonds.

$$\begin{matrix} X & Y \\ | & | \\ C & - & C \end{matrix} \longrightarrow X\text{-}Y + C{=}C$$

5. Ligases: Enzymes Catalysing the linking together of 2 Compounds.

6. Isomerases: Include all enzymes Catalysing inter-Conversion of optical geometric or positional isomers.

* Co-Factors

⊙ Non-protein constituents called Co-factors are bound to Enzyme to make enzyme Active.

⊙ The protein portion in these instances of Enzyme is called Apoenzyme.

⊙ There are 3 kind of Co-factors.

1. Prosthetic Enzyme: Organic Compound.
   → Tightly bound to apoenzyme.

Ex: Peroxidase and Catalase catalyze the breakdown of Hydrogen peroxidise to water and Oxygen.

Haem is prosthetic group and is part of Active site of Enzyme.

2. Co-enzymes: Organic Compound.
   → Association with apoenzyme is transient.

→ Essential chemical component of many Co-enzyme is Vitamin.

eg: Co-enzyme nicotinamide adenine dinucleotide [NAD] and NADP contain Vitamin Niacin.

3. Metals ions :

→ Metal ion form Coordination bond with side chain at active site and at same time form one or more Coordination bond with substrate.

eg: Zinc is Cofactor for proteolytic Enzyme Carboxypeptidase.

* Inhibition, Inhibitor and Competitive inhibitor.

⊙ Inhibition: When binding of chemical shut off Enzyme activity this process is called inhibition.

And the chemical is known as Inhibitor.

⊙ Competitive Inhibitor: When inhibitor resembles the substrate molecule structure and inhibit the activity of Enzyme, It is known as Competitive Inhibitor.