biochemistry

Biochemistry is the branch of science which deals with studying various biomolecule that occur in living cells and organisms and their chemical reactions.

carbohydrates, protein, lipids, nucleic acids etc.

carbohydrates

carbohydrates are polyhydroxy aldehydes and Ketones. They are also called Saccharide → sugar.

types

They are generally classified into 3 groups :-

- Monosaccride
- Oligosaccride or dissaccrides.
- Polysaccharides.

Monosaccrides

They are simplest and True ~~by~~ carbohydrates. which are either polyhydroxy Ketone or aldehyde.

Properties :

- Single saccharide unit.
- highly soluble in water
- white crystalline
- very sweet in taste.
- Cannot be further hydrolyzed.

No. of carbon atoms:

Carbon atoms range from 3-6.

$C_nH_{2n}O$.

↳ no. of carbon atoms

Classification:

They can be classified on the basis of functional group :-

Aldose = Glucose / Galactose

Ketose = fructose.

On the basis of carbon atoms :-

Triose ($C_3H_6O_3$)	Glyceraldehyde.	dihydroxy acetone
Tetrose ($C_4H_8O_4$)	erythrose	erythrulose
Pentose ($C_5H_{10}O_5$)	Ribose & dioxyribose	Ribulose
Hexose ($C_6H_{12}O_6$)	Glucose / Galactose	Fructose
Heptose ($C_7H_{14}O_7$)	Glucoheptose	Sedoheptulose.

Glucoheptose ↳ aldehyde

Sedoheptulose. ↳ Ketone

Source :-

Glucose:

naturally in honey & corns. / respiratory fuel.

Galactose:

in dairy products / milk sugar

Fructose:

vegetables & fruits / intermediate in respiration.

Structural Isomers in Carbohydrates:

- **Pyranose:** Six membered ring with five carbon and one oxygen atom.
- **Furanose:** five membered ring with four carbon and one oxygen atom.
- **α sugars:** The carbohydrates having OH group down.
- **β- sugars:** The carbohydrates having OH group up.

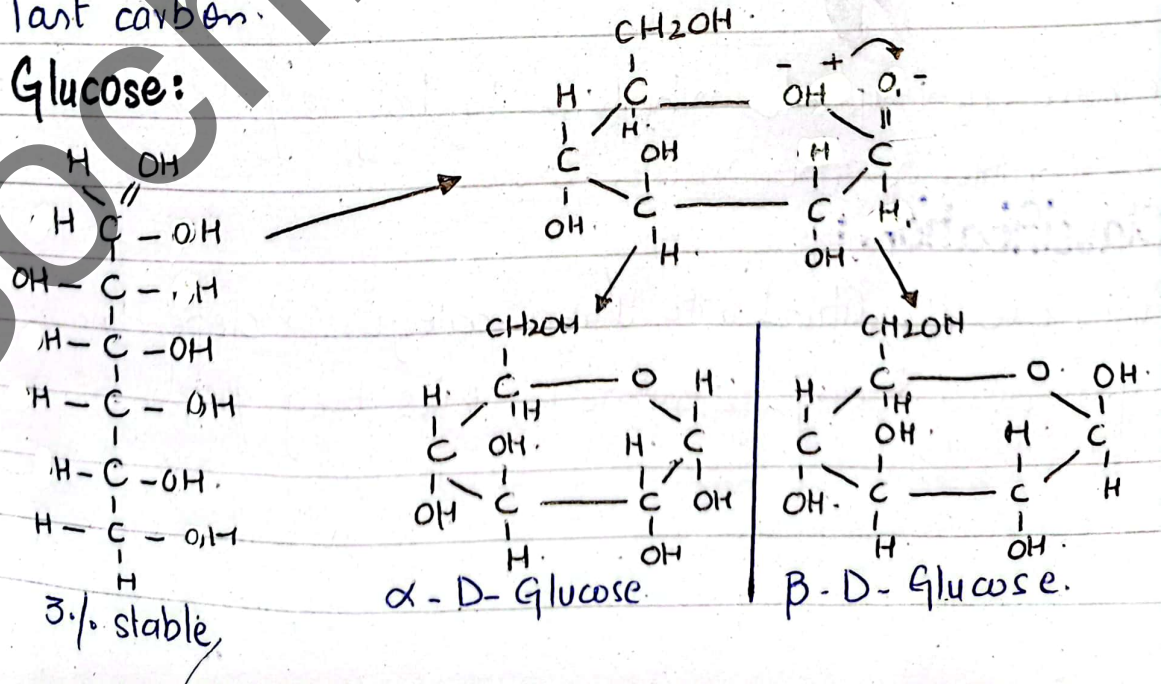
Chemical structures:-

- Monosaccrides are usually found in open chain in crystalline form.
- When dissolved in water (Pentoses & hexoses) are converted into ring chain.

Tip :-

Oxygen atom from aldehyde group reacts with second last carbon.

Glucose:

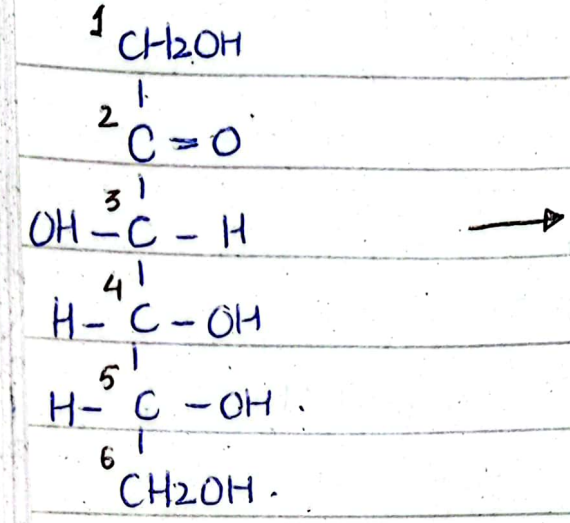


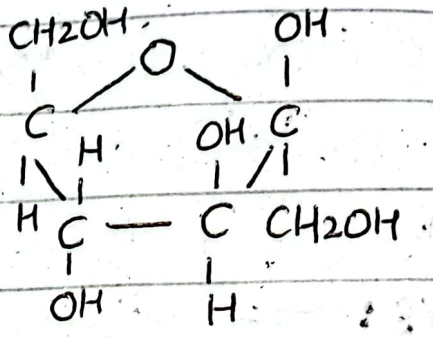
3.1% stable

α - D- Glucose

β - D- Glucose.

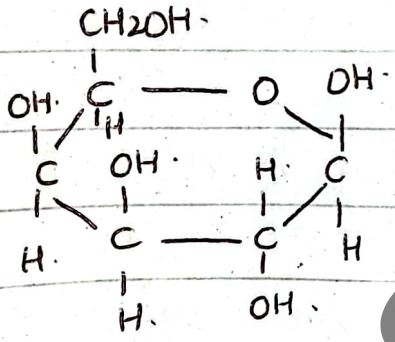
Fructose:





β-fructose.

Galactose:



β-Galactose.

Oligosaccride

Those carbohydrates which on hydrolysis yields 2-10 units of monosaccrides.

Classification:

They are classified into three categories depending upon how many monomeric units they yield.

- **Trisaccharides :-**

They yield 3 monomeric units

example :-

- Raffinose + H_2O ⟶ glucose + galactose + fructose.
- Maltotriose + H_2O ⟶ 3 glucose.
- Nigerotriose + H_2O ⟶ 3 glucose
  ↳ diff from maltotriose.
- Melezitose + H_2O ⟶ glucose + fructose + glucose.

- **Tetrasaccharides :**

They yield 4 monomeric units.

examples :

- Stachyose + H_2O ⟶ 2 galactose + glucose + fructose.
- Maltotretrose + H_2O ⟶ 4 glucose.

- **Disaccharides :-**

These carbohydrates upon hydrolysis yields two monomeric units.

Characteristics :

- They are less sweet.
- Soluble in water. (less).
- Their monomeric units are joined by "glycosidic linkage."
- Can be hydrolyzed.

examples:

Sucrose.

Lactose

Maltose.

→ Sucrose:

"Cane sugar"

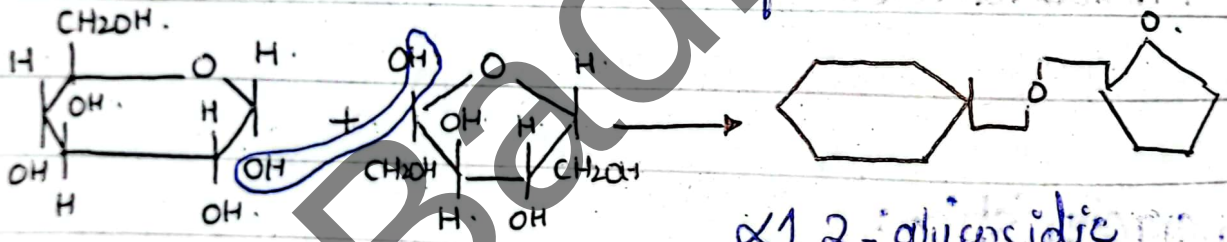
→ table sugar widely used in homes.

→ In plants, the food is formed in this form.

→ formed by glycosidic linkage b/w α glucose and β-fructose.

$C_{12}O_{22}O_{11} + H_2O \longrightarrow C_6H_{12}O_6 + C_6H_{12}O_6$

Sucrose glucose fructose.



α1,2-glycosidic linkage.

* Sucrose.

→ Maltose:

"Malt sugar".

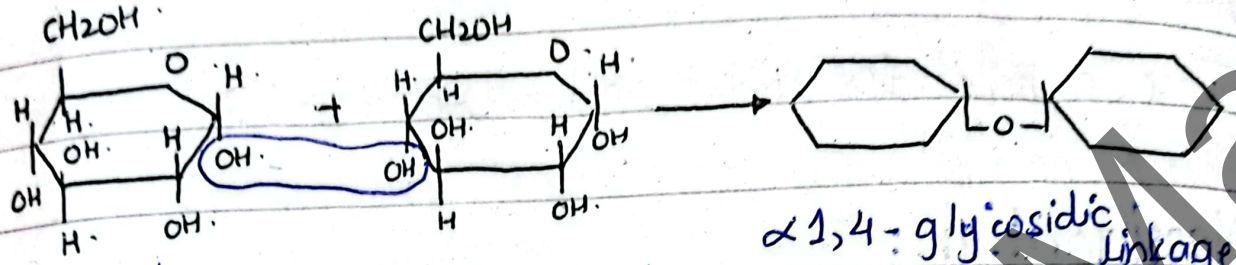
→ Intermediate during breakdown of staich & glycogen.

→ found in seeds.

→ formed by glycosidic linkage b/w α glucose.

$C_{12}H_{22}O_{11} + H_2O \longrightarrow C_6H_{12}O_6 + C_6H_{12}O_6$

maltose — glucose — glucose.

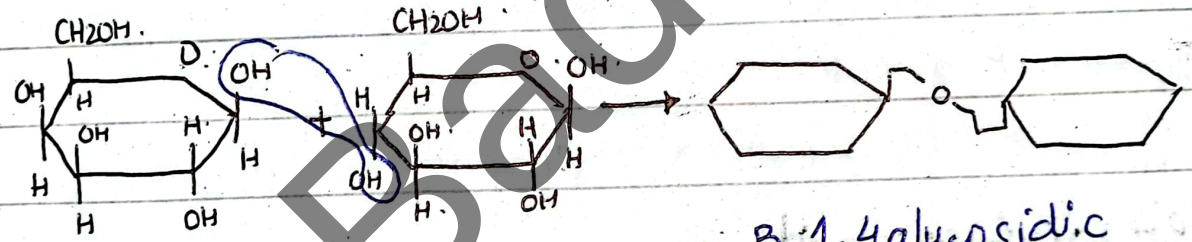


α 1,4 - glycosidic linkage.

→ ~~Galactose~~ : Lactose :-

ee Milk sugar ".

→ formed by glycosidic linkage b/w glucose & galactose.



β, 1,4 glycosidic linkage

Sources :

→ Sucrose :- table sugar, fruits, vegetables

→ Lactose :- milk, dairy products.

→ ~~Galactose~~ :- Maltose :- Grain, processed food etc.

polysaccharide

- Those carbohydrates which yield more than 10 monomeric units.

Classification:

They are classified on the basis of what type of monomeric unit is present.

- **Homopolysaccharide:**

Same monomeric units

starch ∝ glucose.

glycogen ∝ glucose.

cellulose β glucose.

chitin. β - glucose + N-acetyl glucosoamine.

- **Heteropolysacchride.**

Different monomeric units

agar galactose, galactopyranose

pectin. galactose, rhamnose, arabinose, xylose etc.

peptidoglycan. NAG & NAM.

Characteristics:-

- They are insoluble in water.
- Neutral taste.
- High molecular weight

examples :-

- **starch :-** (plant food storage).

α glucose.

- type - amylose (α 1, 4 - glycosdic linkage).
- amylopectin (α 1, 6 glycosidic linkage).

- **Glycogen :** (animal starch)

α glucose.

- **Cellulose :-** (Plant wall).

β - 1, 4 - glycosidic linkage of glucose.

- **chitin :-** (fungal cellulose).

- β - 1, 4 glycosidic linkage.
- derivates of N-acetyl glucosoamine.

Functions / Nutritional Importance :

from book.

Proteins

The name protein is derived from a Greek word "Proteios" meaning "of prime importance"

→ Chemically, proteins are polymers of amino acid or polypeptide chain.

↳ It may have 1 or more than 1 polypeptide.

→ This compound contain following proportions of elements :-

C = 5%, H = 7%, O - 23%, N = 16%, S = 1-3%; P < 1%

Amino Acids :-

They are building blocks of protein.

There are mainly 20 amino acids particularly known for our body.

Divided into 3 main categories :-

- **essential amino acids :**

→ These cannot be synthesized by the body and must be obtained from diet.

Histidine, Valine, Lysine etc.

- **non-essential amino acids :**

→ These can be sythesized by our body.

Glutamic acid, Serine, Alanine etc.

- **Conditionally amino acids :-**

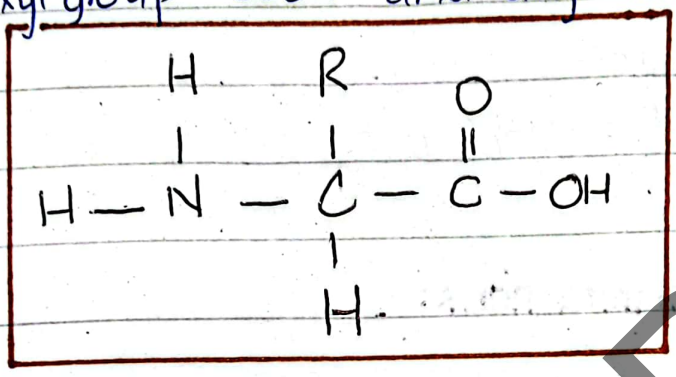
→ These are non-essential but may essential under certain conditions. (illness, stress)

Glycine, Tyrosine, Proline etc.

General structure of amino acids :-

. Amino acids are built on common plan.

. They α carbon, Hydrogen atom, amine grp - NH_2, carboxyl group - COOH and any variable - R group.



Types of bond in protein.

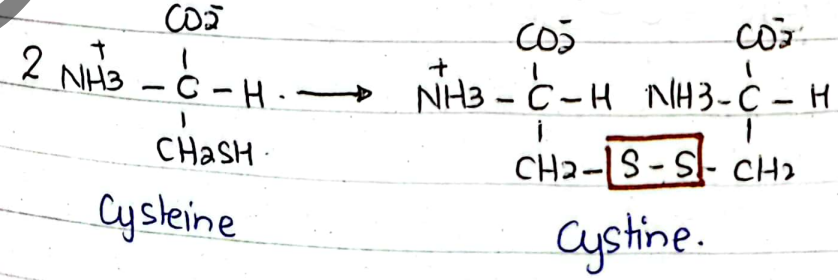
Some are sophisticated types of bond and linkages found :-

Peptide bonds :-

These are covalent bonds that link amino acids together in a protein chain. formed b/w carboxyl group of 1 amino acid & amine grp of another amino acid releasing water.

Disulfide bonds :-

These are covalent bonds formed b/w sulfur atoms of 2 cystein residues. They help to stabilize the protein's tertiary and quarternary structure.



Cysteine

Cystine.

3- Hydrogen ~~atoms~~ bonds:-

formed b/w amine group and help to maintain alpha helixs and β sheets.

4- Ionic bonds :-

Also called Salt bridges.

They contribute to the stability of protein's tertiary structures.

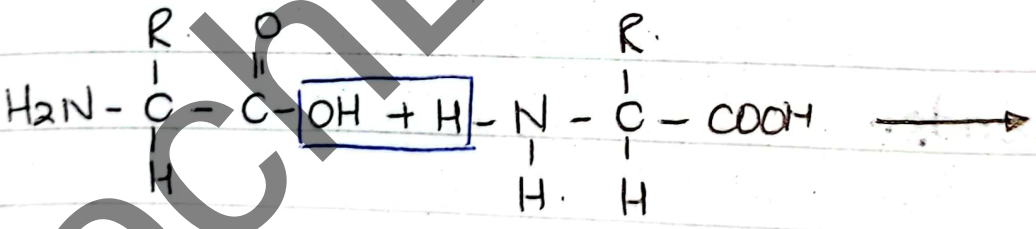
5- Hydrophobic interactions:

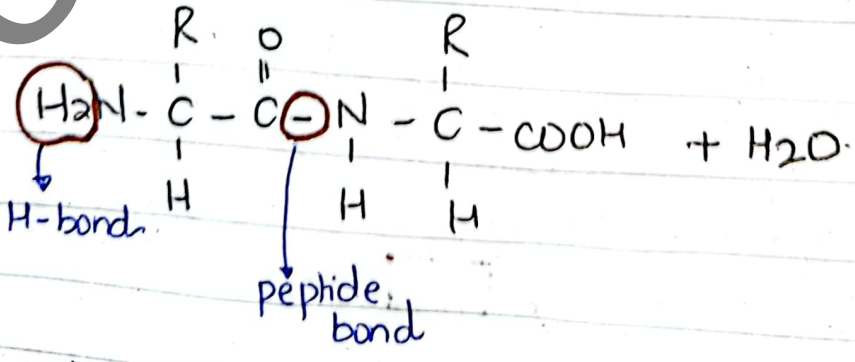
These are non-covalent interactions that occur b/w non-polar side chains of amino acids.

They help to maintain quaternary structure.

Dipeptide and polypeptide :-

- Dipeptide → 2 amino acids join.
- polypeptide → more than 2 amino acids.

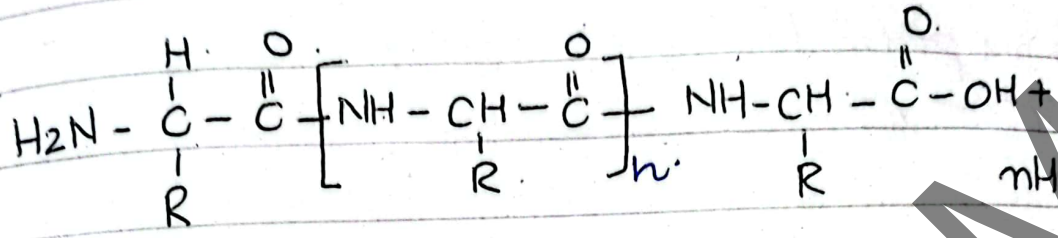




* dipeptide.

→ polypeptide molecular mass = 10,000.

→ protein molecular mass > 10,000.



Classification of Protein

There are classifications :-

1. Simple proteins :-

- These proteins upon hydrolysis yield only amino acids or the derivates.
- entirely made up of amino acids.
- role in enzyme, structural components etc.

Albumins. → egg whites, Globulins. → blood serum, Histones → DNA.

Glutelins. → oats, barley, wheat.

2. Conjugated proteins :-

These proteins that are combined with non-protein (prosthetic grp) compounds. / components.

- Glycoproteins (Protein + carbohydrates) → antibodies.
- Lipoproteins (Protein + lipids) → HDL & LDL.

- Metalloproteins (Protein + metal ions).
  - ↳ Hemoglobin have iron.

- Phosphoprotein (Protein + phosphorus).
  - ↳ Caesin in milk.

- Chromoproteins (Protein + Pigmented grp)
  - ↳ hemaglobin having Heme.

3. Derived Protein :-

- The proteins that have been chemically or physically altered from their native form.
  - denaturation, hydrolysis etc.
- derivates.

proteans, proteose, peptones, peptide

Structural Conformations

There are primary 4 types :-

Primary Proteins :-

A linear polypeptide with a simple sequence.
Albumins, Histones, Globulines etc.

• Secondary Protein:

- refers to local folding into α helix and β- pleated sheets.
- established by H- bonding.

α Keratin, Fibroin, Collagen.

• Tertiary Protein:

- They are overall 3- dimensional shape.
- formed by interactions b/w R- groups.
- linear polypeptide is changed α- helix and β- pleated then they fold again and again by ionic bonds & disulfide bridges to form globular shaped.

Myoglobin, Lysozyme, Ribonudeare, Immunglobin (antibodies).

• Quarternary Protein:

- It's a complex, 4D structure.
- In which more than one molecule of globule combine by hydrophobic interactions.

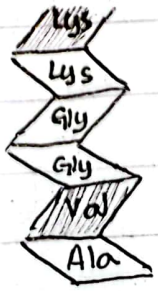
Hemoglobin, Ribosomes, Insulin, DNA polymerase

diagrams:-

1° protein.

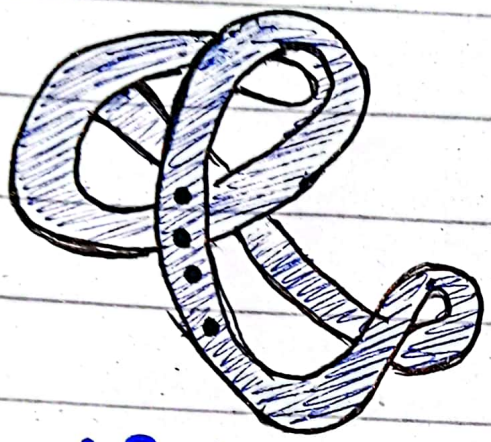
2° protein

α- helix.

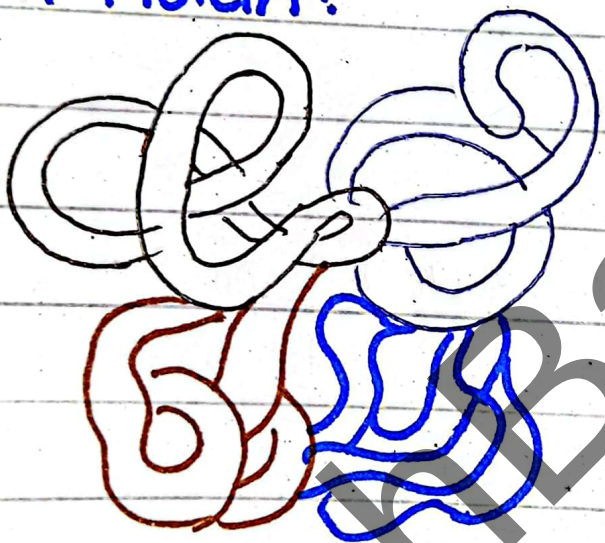


β- pleated.

3° Protein :-



4° Protein :



Properties / Importance

Refer to book.

enzymes

Greek word

En :- in. Zyme :- yeast

Enzymes are biological catalysts that speed up the chemical reactions in living organisms.

Properties :-

- Increase speed of reactions.
- Require small quantity.
- Highly sensitive to pH and temp
- Lower the need of activation energy
- Require co-factor for essential working.

Components :-

It has 2 components :-

protein component = apoenzyme

non-protein component = co-factor or co-enzyme.

inorganic / organics / organo-metallic

Role :-

They act as biocatalyst speeding up metabollic rxns.

Metabolism :-

Metabolism refers to set of life-sustaining chemical reaction that within organism to maintain life.

Catabolism :-

- Catabolism is the set of metabolic pathways that break down large mdecule into smaller units to release energy.
- degradation of complex molecules which can be used for energy production.

- breakdown of fatty acids
- Glycolysis.
- citric acid cycle.

Anabolism:

- The anabolism is the set of metabolic pathways that construct larger molecules from smaller units. They require energy.
- Synthesis of complex molecules.
- protein synthesis
- repair
- maintenance.

Components:-

active sites:-

The specific charge bearing 3D cavity where catalytic activity take place.

Substrate:

The substance on which the enzymes acts.

Product:

The changes that occur in substrate resulting in a new molecule.

Working of enzymes :-

- Enzyme acts on substrate and a complex is formed called Enzyme - substrate complex.
- The enzyme catalyses them, producing some changes.
- Thus binding product is released.

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

Modals :-

Emil Fischer Model :-

- His Model is known as "Lock and Key model"
- A/o him active site has a definite shape particular to a substrate.
- It's not considered flexible rather rigid.
- enzyme act as a key and active site site as lock.
- It reflects that enzymes are highly specific.

hexokinase + glucose ⟶ glucose-6-phosphate.

Daniel Koshland :-

- His model is known as "Induced fit model"
- A/o ~~act~~ him active site is flexible.
- It modifies that when substrate interact with enzymes the amino acid that make up active site. are molded up into precise shape resembling substrate.

• $Hb + 4O_2 \xrightarrow[\text{anhydrase}]{\text{carbonic}} Hb4O_2$

also

• $CO_2 + H_2O \xrightarrow[\text{anhydrase}]{\text{carbonic}} H_2CO_3 \xrightarrow[\text{anhydrase.}]{\text{carbonic}} H^+ + HCO_3^-$

Factors :-

1) Temperature :-

Heating generally increases the molecular motion. This causes increase in speed of reaction up to a Limit.

"The max temp at which enzymes works best is called Optimum temp".

O.T for animals = 37°c

O.T for plants = 60°c

→ If temp ~~it~~ is increased beyond the Limit, catalytic activity gets disturbed. Increase temp provides so much heat that it breaks ionic bond, disulphide bridges & hydrophobic interactions leading to complete opening of protein despoliating the tertiary and quaternary globular structure. This phenomena is called denaturation.

→ If temp is reduced to freezing point, they just become inactive and will regain their activity after accomplishing desired temp.

2. pH :-

The enzymes works best at particular narrow range of pH named as Optimum pH.

→ If pH changes slightly, it's possible that amino acids becomes ionized. But this is temporary.

→ If pH changes exorbitant level, it may lead to completes ionization. The normal is impossible to regain again.

→ Most enzyme works best at 6-7. because active site binds effectively in neutral state. The stability is greater.

pepsin pH = 2, trypsin pH = 8, amylase = 6-7.

3- Substrate concentration :-

rate of reaction is directly proportional to enzyme concentration.

→ If substrates are like 100. And only 1 enzyme is working then the process is slow. But if enzymes are increased to 8 in number then the reactions ~~or is~~ will be rapidly going on.

However, keeping the enzymes constant and increasing substrate conc. The enzymes will be saturated, all the active sites are occupied. Thus activity reduces. This called Saturation.

Inhibition :-

The phenomena in which enzymes fails to catalyze the reaction is called enzyme inhibition and molecules are called inhibitor.

Types :-

1- Reversible :

Known as Competitive Enzymes.

→ The process in which the shape of inhibitor reveals similar to substrate causing the active site to bind with inhibitor and making it's activity stop.

→ It's temporary.

→ Important as Antibiotics.

2- Irreversible :-

Known as Non- Competive Enzymes.

→ The Process in which inbibitor attaches to allosteric site of substrate.

→ They form Permanet covalent bonds with this site. & making the site completely destroyed.

→ Cyanides etc.

lipids

Lipids is a collective name for variety of organic compounds.

"Naturally Occuring heterogenous group of organic compounds of plant and animal origin, being soluble in organic solvents."

↳ acetone, alcohols, ether

-• There are hydrophobic molecule.
water repellant

-• Due to their high content of O, H, C, they give double energy than carbohydrates. (1g = 9Kcal)

Units:-

It is composed of 2 imp units :-

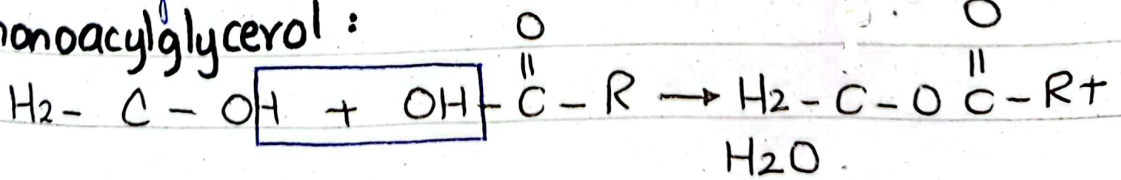
- Glycerol
- fatty acids.
  ↳ (mono-COOH + aliphatic)

formation:-

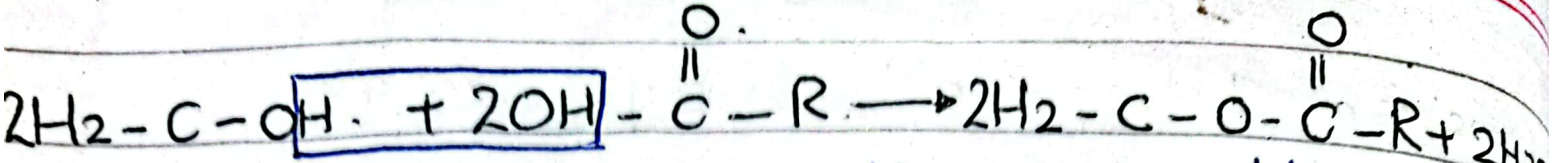
Lipids are also named as "acylglycerol".

By the process of esterfication, alcoholic molecules and fatty acids are combined together releasing a water molecule.

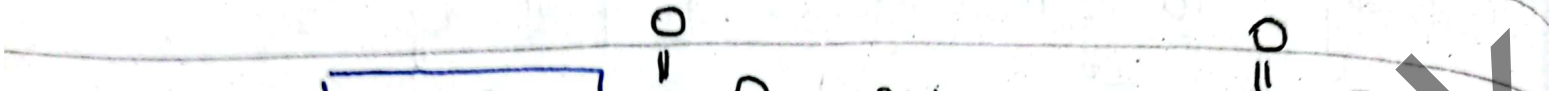
monoacylglycerol :



monoacylgcerol/monoglyceride.



diacylglycerol / diglyceride.



(propane-1,2,3-triol) triacylglycerol / triglyceride.

↳ neutral lipids

Classification :-

Simple Lipids :-

Category of fatty acid formed by fatty acids & glycerol. There's no functional group.

neutral fats, waxes.

Compounds Lipids :-

Category of fatty acids that contain additional functional groups (radicals).

phospholipids, plasmalogen, Lipositol, Sphingomyelin.

Derived Lipids :-

Derived from Simple and Compands lipids through hydrolysis.

Steroids, glycerol, fatty acids, fat-soluble vit.

Properties :-

Hydrophobic nature ; liquids / non-crystalline
Amphipathic character ; form emulsions
low density. ; poor conductor.
high energy content ; lighter, insoluble in H_2O
melting point ; either liquids or solids
Viscosity. ; color occurs due to foreign
(yellow → butter → keratin

Structure :-

- Lipids are generally defined in terms of solubility.
- have Van der Waal forces & hydrophobic effect.

→ Saturated fatty acid.

$$CH_3-CH_2-CH_2-CH_2-CH_2-\overset{\overset{O}{\|}}{C}-OH$$

tail → hydrophobic
head → hydrophillic.

10 carbon fatty acid + glycerol → lipids. } → fats
(saturated) (saturated)

→ Unsaturated fatty acid.

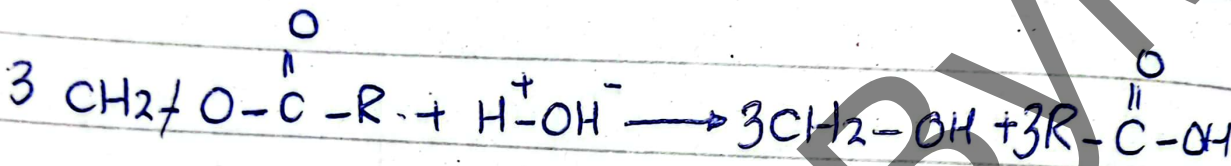
$$CH_3-CH_2-CH_2-CH=CH-CH_2-CH_2-\overset{\overset{O}{\|}}{C}-OH$$

tails → hydrophobic → soluble in oily, dirty
head → hydrophilic → soluble in H_2O

Chemical Properties

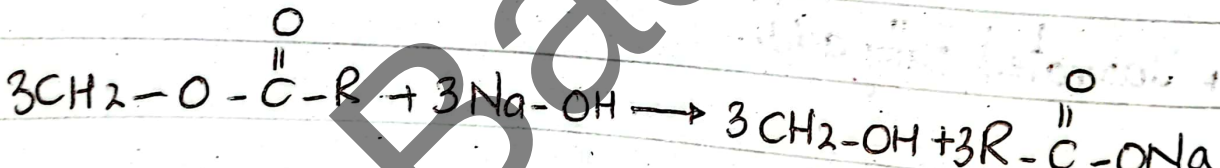
1) Hydrolysis of fats & oils :-

- triesters.
- Lipase (catalyzes the breakdown of fats into acids & glycerol).



2) Saponification :-

- By alkalis & Basic medium
- Na & K salts are Soaps.



Soap.

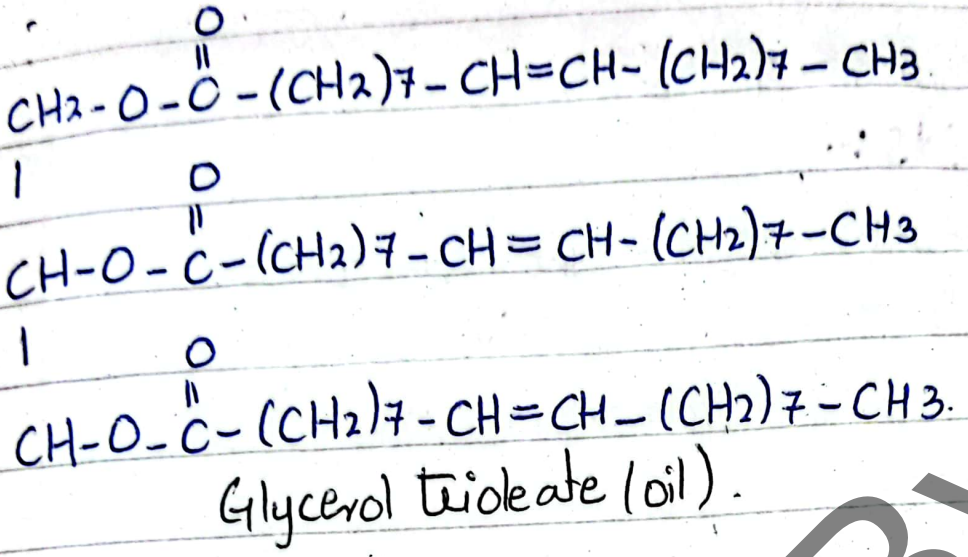
3) Hardening of oil.

Hydrogenation

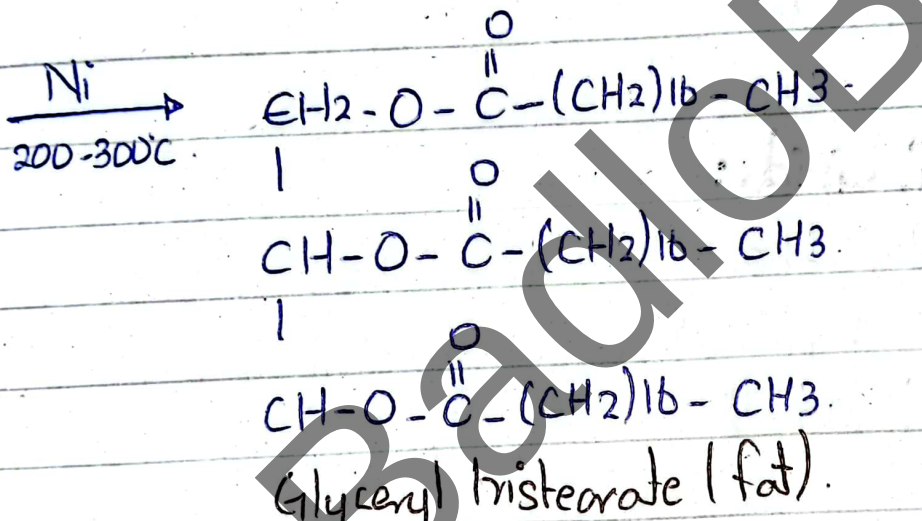
- unsaturated triglyceride = Liquid (oils)
- saturated triglyceride = Solid (fat)
- liquid → semi-solid triglyceride
- Commeical production of vegetable oil / margarine.
- Soap & candle making.

$C_{17}H_{33}COOH$ = oleic acid

$C_{17}H_{35}COOH$ = stearic acid



Glycerol trioleate (oil).



Glyceryl tristearate (fat).

Types:

There are 2 categories of lipids:-

Essential Lipids:-

Essential Lipids are those that the body cannot Synthesize on its own & must be obtained from diet. Crucial for Various bodily functions.

Omega-3 fatty acids

Omega-6 fatty acids.

Non-Essential Lipids:-

Non-Essential Lipids are those that the body can Sythesize from other nutrient. When they are still imp for health.

Cholestreol.

Phospholipids

triglycerides.

nucleic acid

Nucleic acids are large biomolecules essential for all forms of Life. These molecules carry genetic information & are involved in synthesis of Proteins.

"The Molecules that Preserve hereditary information and that transcribe and translate the information allowing the synthesis of different protein for multitude of functions."

→ Initially named as 'Nuclein'. However later discoveries revealed that it's acidic group so it was renamed as Nucleic acid.

→ In animals & plants, it's reside within nucleus control centre of cell. Whereas in bacteria it's reside within Nucleoid region. → (light region of cytoplasm) fluid of cell

Types:-

- Deoxyribonucleic acid (Genetic blueprint).
- Ribonucleic acid (component of coding, decoding, regulation, expression of genes).

Components :-

Nucleic acid is made up of Monomers called Nucleotide.

Nucleotide is composed of three molecule.

→ Nitrogenous base :-

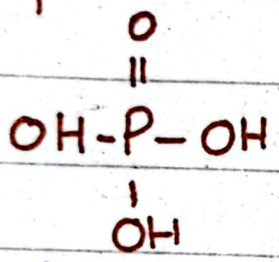
Adenine, Guanine, Thymine, Uracil, Cytosine.

→ Pentose Sugar :-

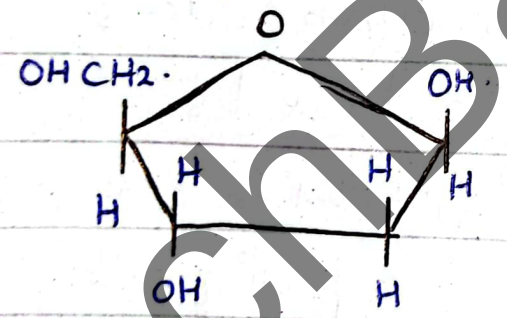
Ribose, deoxyribose

→ Phosphate :

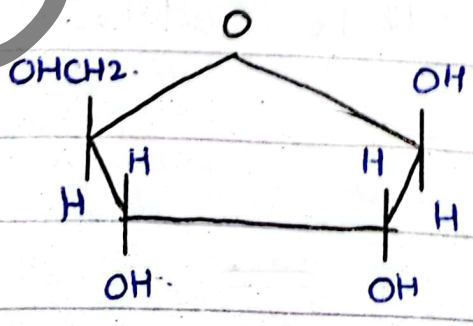
Phosphoric acid



Structure of DNA :-



Structure of RNA



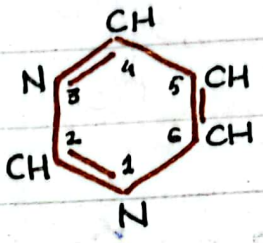
Types of Structure of Nitrogenous bases :-

There are 2 main classes :-

→ Pyrimidine

Single ring.

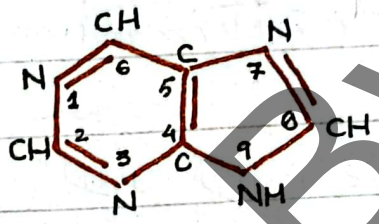
• adenine, Guanine



→ Purine.

2 ring structure.

• Thymine, Uracil, Cytosine.



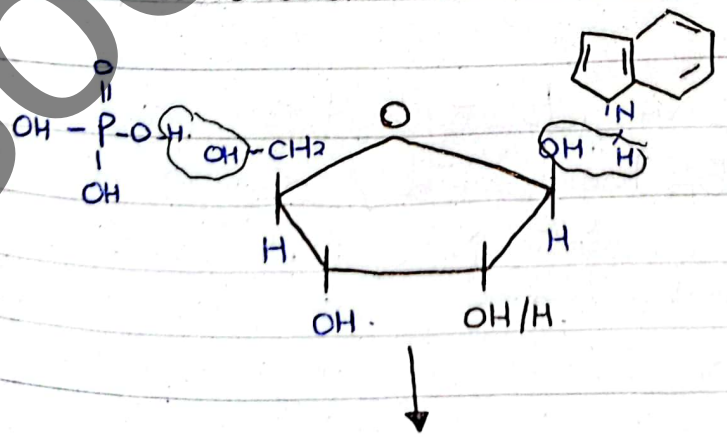
Formation of Nucleotide :-

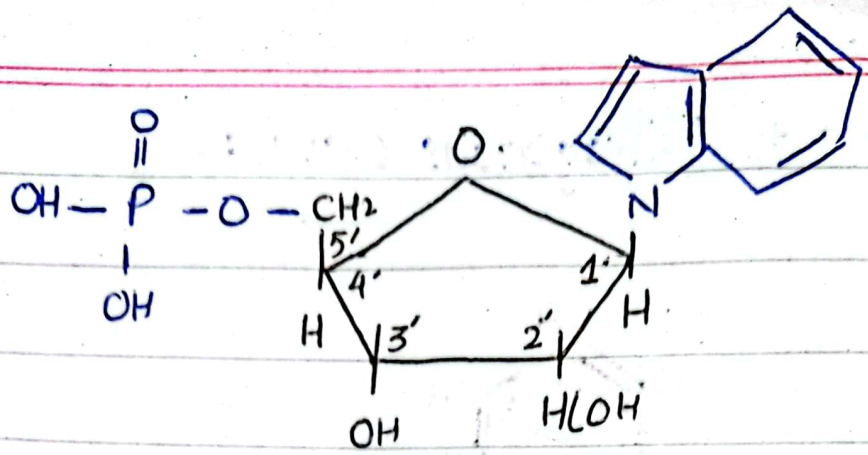
During the formation of Nucleotide, first nitrogenous base is linked with 1' carbon of pentose sugar.

↳ This combination is called Nucleoside.

When phosphoric acid is linked with 5' carbon of pentose sugar of a nucleoside. The Nucleotide is formed.

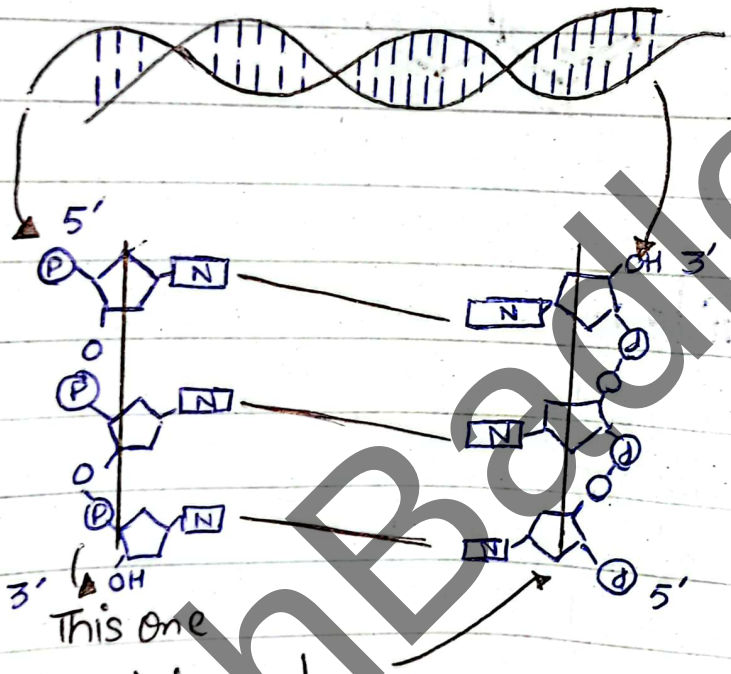
↳ This combination is called Nucleoside phosphate.





Bonding of Nitrogenous Base:

Since, DNA is a 2 stranded structure.



This one strand is made up of many nucleotide attached together.

- The 2 strands of DNA gets attached to eachother due H-Bonding formed / covalent bond b/w 2 Complementary Nitrogenous base.

Adenine = Thymine

Cytosine = Cytosine

difference :-

DNA	RNA
full form	
Deoxyribonucleic acid	Ribonucleic acid
Bases	
Adenine, Guamine, Cytosine & Thymine	Adenine, Guamine, Cytosine & Uracil
function	
Store genetic info.	Helps in Protein synthesis & gene expression
H-bond	
H-bond present	H-bond absent
Strand	
double helical structure	Single strand structure.
Sugar	
Deoxyribose sugar	Ribose sugar
Location	
In nucleus & mitochondria	In nucleus & Cytoplasm
Stability	
More stable due to its double strand	less stable & more prone to degradation
Length	
longer	smaller
Replication	
Self-replicating	Synthesized from DNA
Types:	
One main type	3 mains types & more.

difference

Essential Amino Acids	Non-Essential Amino Acids
Synthesis	
Essential amino acids can not be synthesized by the human body.	Non-Essential amino acids can be synthesized by the human body.
Known as	
indispensable amino acids	dispensable aminoacids
availibity	
Avaliable in animal products.	Avaliable in both plant & animal products
effect	
play vital role in metabolic processes & functioning of tissues & organs.	Have significant effect on the health.
number	
9	11
example	
phenylalanine, valine, threonine, isoleucine etc.	Alanine, arginine, tyrosine, histidine etc.

Micronutrients	Macronutrients.
definition	
Micro ... / nutrients are the elements that are require in minute quantities for plant growth.	Macronutrients are elements that are needed for the growth of plants in high amounts.
Sub-categories	
No sub categories.	Categorized into 2 as primary & secondary.
minerals	
All are minerals.	May be mineral or non-mineral elements.
Nutrients.	
Cl, Fe, B, Mn, Zn, Cu, Mo & Ni.	N, K, Ca, Mg, P & S.
Functions	
Act as co-factors for enzymes & helps in electron transferring.	Have a role in forming carbon compounds & in energy storage reactions.

Butter, cream, lard.	example Coconut oil, olive oil.
high	oxidative Rancidity low.
fats	Oil
definition	
Fats are oily substances in the animal body, found under the skin & around organs	Oils are viscous liquids that occur in fruits/ seed of plants.
Composition	
Saturated fatty acids.	Unsaturated fatty acids
cholesterol level	
Increase	decrease
state	
Solid	liquids.
animal source	**Origin** Plant source.
Essential Lipids	**Non-Essential Lipids**
definition	
must be obtained from diet.	body can synthesized.
Role	
Vital for normal body functioning.	Provide energy & structural components.
requirement	
Must be included in the diet.	Not Necessary to include in diet.
example	
Omega 3 & 6 fatty acids	mono-saturated fats.