الجامعة التقنية الجنوبية

المعهد التقني/ العمارة

قسم تقنيات المختبرات الطبية

المادة: الكيمياء التحليلية والحياتية

Analytical & Biochemical Chemistry

المرحلة الاولى

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Lec.1 **Chemical bonds**

Stag I : chemistry

The aim from lecture:

A. General aims :

Give an general idea about atom, elements, relation between atoms and molecules**.**

B. Special aims:-

1. Knowledge the types of bonds between the atoms and molecules.

2. understanding of the difference among chemical bonds.

introduction:

Chemistry is the science of the composition, structure and properties of matters and the interaction between them. The study of the subject often involves understanding of the material substances behavioral change at an atomic level. To be precise, it is the study of the interaction behavior of electrons at the outer part of the electronic orbital of an atom.

some basic definitions about lecture:

Atom - It is the smallest unit of a substance. All atoms are made up of a number of protons, neutrons and electrons.

Element - It is a substance that cannot be further resolved into simpler substances by chemical means. It consists of a single type of atom of same number of protons. For example, gold and copper are elements with 100% gold atoms and 100% copper atoms, respectively.

Molecules - This is the smallest unit of a compound. For example, water is dihydrogen oxide. The water molecule consists of two hydrogen atoms and one oxygen atom which bind together by covalent bonds.

States of Matter

A sample of matter can be a gas, a liquid, or a solid. These three forms of matter are called the states of matter. The states of matter differ in some of their simple observable properties. A gas (also known as *vapor*) has no fixed volume or shape; rather, it conforms to the volume and shape of its container. A gas can be compressed to occupy a smaller volume, or it can expand to occupy a larger one. A liquid has a distinct volume independent of its container but has no specific shape: It assume the shape of the portion of the container that it occupies. A solid has both a definite shape and a definite volume: It is rigid. Neither liquids nor solids can be compressed to any appreciable extent.

The properties of the states can be understood on the molecular level. In a gas the molecules are far apart and are moving at high speeds, colliding frequently with each other and with the walls of the container. In a liquid the molecules are packed more closely together, but still move rapidly, allowing them to slide over each other; thus, liquids pour easily. In a solid the molecules are held tightly together, usually in definite arrangements, in which the molecules can wiggle only slightly in their otherwise fixed positions. Thus, solids have rigid shapes.

energy:

The effort of power; the capacity to do work, taking the forms of kinetic energy, potential energy, chemical energy, electrical energy, and other types.

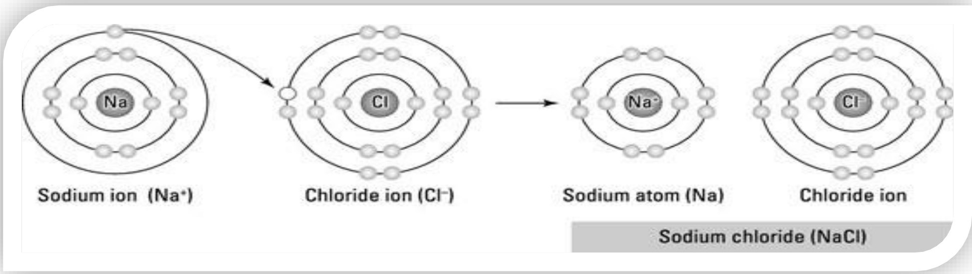
energy: The capacity of a body to do work. Energy occurs in several forms-potential as in a compressed spring or a mass in a high position, kinetic as in motion, chemical as in petroleum and nuclear as in the binding forces of the atomic nucleus. Its effect, when manifested, is to bring about a change of some kind.

Chemical bonds:-

is a lasting attraction between atoms that enables the formation of chemical compounds. The bond may result from the electrostatic force of attraction between atoms with opposite charges, or through the sharing of electrons as in the covalent bonds. The strength of chemical bonds varies considerably; there are "strong bonds" such as covalent or ionic bonds and "weak bonds" such as hydrogen bonding.

Ionic bonding

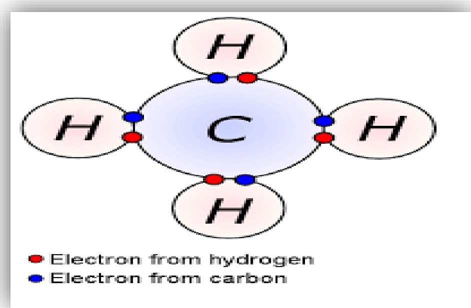
is a type of electrostatic interaction between atoms which have a large difference electronegativity. This chemical bond involves a transfer of an electron, so one atom gains an electron while one atom loses an electron. One of the resulting ions carries a negative charge (anion), and the other ion carries a positive charge (cation). Because opposite charges attract, the atoms bond together to form a molecule.fig(1)



fig(1) show ionic bond of NaCl

2. Covalent bond

The most common bond in organic molecules, a covalent bond involves the sharing of electrons between two atoms. The pair of shared electrons forms a new orbit that extends around the nuclei of both atoms, producing a molecule. There are two secondary types of covalent bonds that are appropriate to biology — polar bonds and hydrogen bonds.



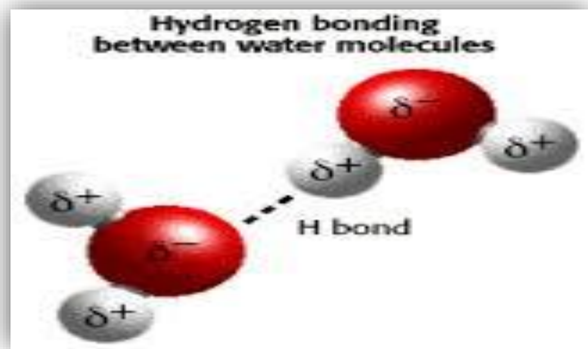
fig(2) Covalent bond

3. Hydrogen bond

A chemical bond in which a hydrogen atom of one molecule is attracted to anelectrone -gative atom, especially a nitrogen, oxygen, or fluorine atom, usually of another molecule**.**

Because they're polarized, two adjacent H_2O (water) molecules can form a linkage known as a *hydrogen bond*, where the (electropositive) hydrogen atom of one H_2O molecule is attracted to the (electronegative) oxygen atom of an adjacent water molecule.

Consequently, molecules of water join together transiently in a hydrogen-bonded lattice. Hydrogen bonds have only about 1/20 the strength of a covalent bond, yet even this force is sufficient to affect the structure of water, producing many of its unique properties, such as high surface tension, specific heat, and heat of vaporization. Hydrogen bonds are important in many life processes, such as in replication and defining the shape of DNA molecules.



fig(3) Hydrogen bond

Lec 2 Methods of concentration expressing

Stag I : chemistry

The aim from lecture:

A. General aims :

Give an general idea to express about concentration of solutions.

B. Special aims:-

1. Knowledge the types of these methods .

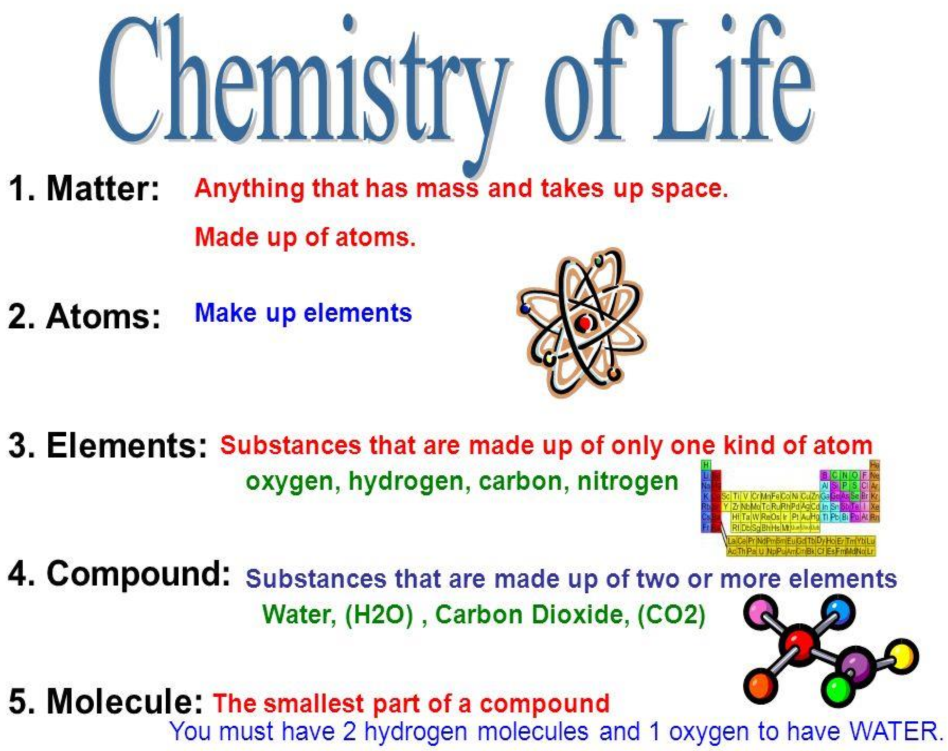
2. calculation of general questions .

- **Chemistry** is the science that study composition, structure and properties of matters and the interaction between them. Or
- It is the study of the interaction behavior of electrons
  - **Analytical Chemistry** deals with methods for determining the chemical composition of samples. its divided to:

1.Qualitative Analysis (identification) its operation used to know the type of species present in compound or mixture

2. Quantitative Analysis its operation used for determination the quantity of species present in substance or mixture in unit.

3.Instrumental Methods: Analytical measurements (conductivity, electrode potential, light absorption or emission, mass-to-charge ratio, fluorescence etc.) by use instrument.



Solution (Sol.) المحلول

It is a homogenous mixture of two or more substance in which the particles are atomic or molecular size, there for it composed of

a- Solute

b- Solvent

Solution types could be:

1- Solid in liquid ex: NaCl in H2O.

2- Liquid in liquid ex: HCl in water.

3- Gas in liquid ex: CO2 in H2O.

4- Gas in gas ex: Helium in Oxygen.

5- Solid in Solid ex: Fe in Al ex: Alloy

6- Liquid in solid ex: Hg in Cu Mercury in copper

7- Gas in solid ex: H in Pd

Aqueous solution: A solution in which the solvent is H2O

Concentration

The amount of solute dissolved in amount of solvent to form the solution, when a solution contains small amount of the solute it's said to be diluted; when it contains large amount of solute it's said to be concentrated. There are four ways to express the concentration:

1. Percentage
   a. W/W
   b. V/ V
   c. W/V

2. Molarity (M)

3. Normality (N)

4. Part per million (P.P.M)

Percent volume n. of mls. of solute dissolved in 100ml. Of solution.

$$\% \text{ volume} = \frac{\text{volume solute (ml)}}{\text{volume solution (ml)}} \times 100$$

Percent mass

$$\% \text{ mass} = \frac{\text{mass solute (g)}}{\text{mass solution (g)}} \times 100$$

Solution = solvent + solute

$$\text{mass/volume } \% = \frac{\text{g solute}}{\text{mL solution}} \times 100\%$$

Expressing concentration of solution

- **Molarity M** : is the number of moles of solute dissolved in one liter of solution. The units, therefore are **moles per liter**, specifically it's **moles of solute** per **liter of solution**.

$\text{Molarity} = \dfrac{\text{moles of solute}}{\text{liter of solution}}$

Example 1. What is the molarity of a 5.00 liter solution that was made with 10.0 moles of KBr ?

Solution:

$$\text{Molarity} = \frac{\text{of moles of solute}}{\text{Liters of solution}}$$

Given: of moles of solute = 10.0 moles
Liters of solution = 5.00 liters

$$\text{Molarity} = \frac{\text{10.0 moles of KBr}}{\text{5.00 Liters of solutio}} = 2.00\ \text{M}$$

$$\text{Molarity} = \frac{\text{Weight (g)}}{\text{Molecular Weight (g/mol)}} \times \frac{1000}{\text{Volume (ml)}}$$

Molecular Weight = Sum. Of atomic weight

Example : Prepare 0.1 M of NaCl in 250 ml of D.Water from Solid?

Wt= M x M.wt. x V(ml) / 1000

= 0.1 x 55.5 x 250 / 1000

= 1.38 mol/L

- **Normality** : is the number of equivalents of solute dissolved in one liter of solution. The units, therefore are **equivalents per liter**, specifically it's **equivalents of solute** per **liter of solution**.

$$\text{Normality} = \frac{\text{No. of equivalents of solute}}{\text{liter of solution}}$$

$$\text{No. of equivalents} = \frac{\text{Weight (g)}}{\text{Equivalent Weight (g/eq)}}$$

$$\text{Normality} = \frac{\text{Weight(g)}}{\text{Equivalent weight (g/eq)}} \times \frac{1000}{\text{Volume(ml)}}$$

$$\text{Eq.Wt} = \frac{\text{M.Wt}}{n}$$

n = No. of (H) atoms for acids

for HCl n=1

n = No of OH groups for bases

for NaOH n=1

n = No of Cation atoms (M+) for salts

for Na_2CO_3 n= 2

- **Relationship between Molarity and Normality**

$$\text{Molarity} = \frac{\text{Weight (g)}}{\text{Molecular Weight (g/mol)}} \times \frac{1000}{\text{Volume (ml)}}$$

$$\text{Normality} = \frac{\text{Weight(g)}}{\text{Equivalent weight (g/eq)}} \times \frac{1000}{\text{Volume(ml)}}$$

$$\text{Eq.Wt} = \frac{\text{M.Wt}}{\text{N}}$$

$$\boxed{N = M \times n}$$

Q / what is the normality of 0.1 mol / l of Na_2SO_4 ?

- **Weight – Volume Percentage (% w/v)**

$$\% \ w / v = \frac{\text{Weight of solute (g)}}{\text{Volume of solution (ml)}} \times 100$$

- **Weight – Weight Percentage (% w/w)**

$$\% \ w / v = \frac{\text{Weight of solute (g)}}{} \times 100$$

- **Volume – Volume Percentage (% v / v)**

$$\% \, w / v = \frac{\text{Volume of solute (ml)}}{\text{Volume of solution (ml)}} \times 100$$

Q/ What is the weight/volume percentage concentration of 250mL of aqueous sodium chloride solution containing 5g NaCl?

Calculate the weight/volume (%) = mass solute ÷ volume of solution x 100
mass solute (NaCl) = 5g
volume of solution = 250mL

w/v (%) = 5g ÷ 250mL x 100 = 2g/100mL (%)

Q / 2.0L of an aqueous solution of potassium chloride contains 45.0g of KCl. What is the weight/volume percentage concentration of this solution in g/100mL?

EX: Calculate the molarity of a solution of NaOH in which 0.40g NaOH dissolved in 500 ml solution.

$$\boxed{\text{Molarity} = \frac{\text{of moles of solute}}{\text{Liters of solution}}}$$

$$M = \frac{0.40}{40 \times 500} \times 1000$$

= 0.02 M

EX: How many grams of NaCl would you need to prepare 200.0 mL of a 5 M solution?

Solution

g = M x L x molar mass

Diluting Solutions

$C_1V_1 = C_2V_2$

C_1 – concentration of stock

C_2 - concentration of diluted solution

V_1 – volume needed of stock

V_2 – final volume of dilution

Example 5:

How many mls of a 5 M stock solution of NaCl are needed to prepare 100 ml of a 0.4 M solution?

C_1 V_1 = C_2 V_2

(5) V_1 = (0.4)(100) V_1= 8 ml

Convert the units (mass in grams, volume in mL):

mass KCl = 45.0g

volume of solution = 2.0L = 2.0 x 10^3mL = 2000mL

a. Calculate w/v (%) = mass solute (g) ÷ volume solution (mL) x 100

w/v (%) = 45.0 ÷ 2000mL x 100 = 2.25g/100mL (%)

- Parts per Millions (PPM)

$$\boxed{\text{PPM} = \frac{\text{Weight of solute (g)}}{\text{Volume of Solution (ml)}} \times 10^{6}}$$

Relationship between PPM and Molarity and Normality

$$\boxed{PPM = M \times M.Wt \times 1000}$$

$$PPM = N \times Eq.Wt \times 1000$$

Standard solutions:

Its solution that contain known concentration of solute (element or substance).

Standard solutions are used to determine the concentrations of other substances. particularly use in titration

Characters of Standard solution

- Its easy to dry.
- Known structure.
- Highest purity.
- Water soluble.
- Not hydroscopic.
- Stable. Not expensive
- Not sensitive to high temperature
- It should have high equivalent weight

The aim from lecture:

To knowledge PH Value

PH Value define

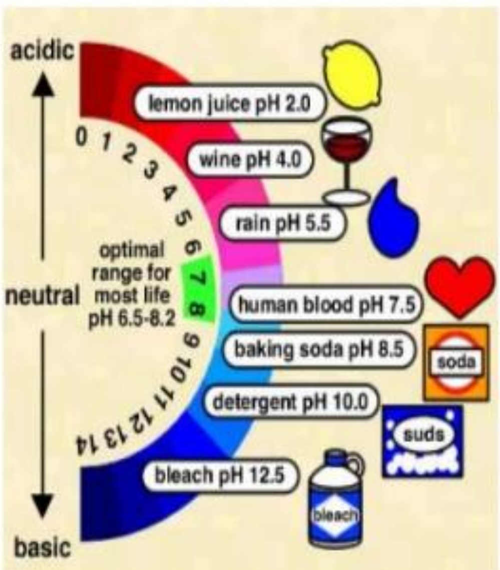
- pH is a unit of measure which describes the degree of acidity or alkalinity (basic) of a solution.
- It is measured on a scale of 0 to 14.
- The formal definition of pH is the negative logarithm of the hydrogen ion activity.
- pH = -log[H+]

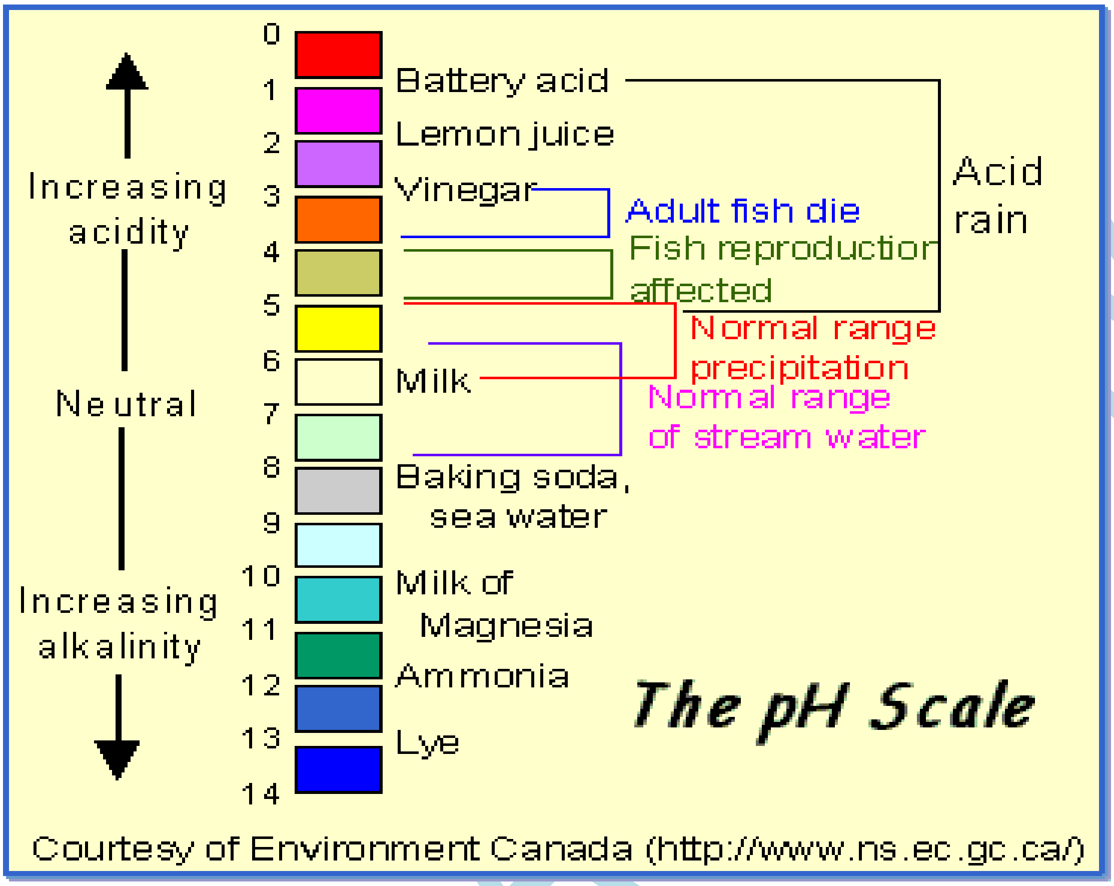
Acids and bases

- Acids have a lot of Hydrogen ions (H^+)
- bases have a lot of Hydroxide ions (-OH).
- A solution is neutral if its pH equals 7.

Acid Base Balance and pH

- Homeostasis of the body fluids at a normal arterial blood pH ranging between 7.35 and 7.45 (7.38-7.42)
- Is the regulation of H^+
- The acidity or alkalinity of a solution which is measured by pH
- ↑ H^+ , ↑ acidic, ↓ pH
- ↓ H^+ , ↑ alkaline, ↑ pH





POH pH &

- PH+POH=14
- pH = -log[H+]
- POH=-log [OH] or
- POH =Log[1/OH]or[OH]=10 -POH

Ex/ **If an acid has an H+ concentration of 0.0001 M, find the pH.**

- **Solution**:
- .اولا تحويل العدد إلى الأس، إيجاد اللوغاريتم، ثم حل معادلة الرقم الهيدروجيني
- $H^+ = 0.0001M = 10^{-4}$; log of $10^{-4} = -4$;

- $pH = -\log[H^+] = -\log(10^{-4}) = -(-4) = +4 = pH$

Questions

Most OH- ions: pH = 10; or pH = 13.

- Least H+ ions: pH = 12; or pH = 13.
- Least OH- ions: pH = 8; or pH = 9.

Buffers

Buffers are the solutions which resist changes in pH when small amounts of acid or alkali is added to them.

A buffer is a pair of weak acid and its salt.

Buffers are of main importance in regulating the pH of the body fluids and tissues

Many biochemical reactions including those catalyzed by enzymes require pH control which is provided by buffers

- Acids are H^+ donors.
- Bases are H^+ acceptors, or give up OH^- in solution.
- Acids and bases can be:
- Strong – dissociate completely in solution
    - HCl, NaOH
- Weak – dissociate only partially in solution
    – Lactic acid $CH_3CH(OH)CO_2H$, carbonic acid H_2CO_3

The Body and pH

- Homeostasis of pH is tightly controlled
- Extracellular fluid = 7.4
- Blood = 7.35 – 7.45

- < 6.8 or > 8.0 death occurs
- Acidosis (acidemia) below 7.35
- Alkalosis (alkalemia) above 7.45

Important not Small changes in pH can produce major disturbances

- Most enzymes function only with narrow pH ranges
- Acid-base balance can also affect electrolytes (Na^+, K^+, Cl^-)
- Can also affect hormones

Lec : 4

_ Stage I : Biochemistry

Introduction:

- **Biochemistry** – a study the moleculare structure and function of organic compounds with living organisms.

The main classes of organic compounds molecules in our bodies:

- Carbohydrates (sugars)
- Lipids (fats)
- Proteins (amino acids), vitamins ,hormone

Carbohydrates (CHO)

large group of organic compounds water-soluble occurring in foods and living tissues and including sugars, starch, and cellulose. They contain hydrogen and oxygen in the same ratio as water (2:1) and typically can be broken down to release energy in the animal body.

Plants harvest energy from sunlight to produce carbohydrates by photosynthesis process:

$$6\ CO_2 + 6\ H_2O + \text{energy (from sunlight)} \rightarrow \text{glucose } C_6H_{12}O_6 + 6\ O_2$$

Animals and humans) break down carbohydrates during the process of metabolism to release energy. For example, the chemical metabolism of the sugar glucose is shown below:

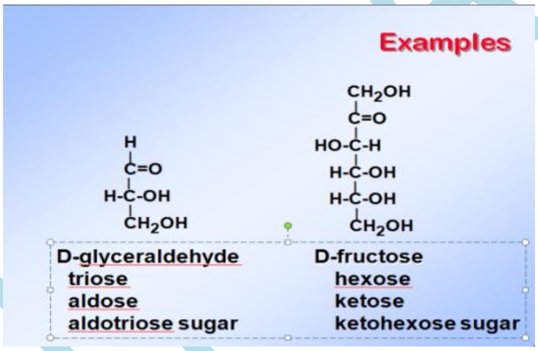
glucose + oxygen → carbon dioxide + water + energy

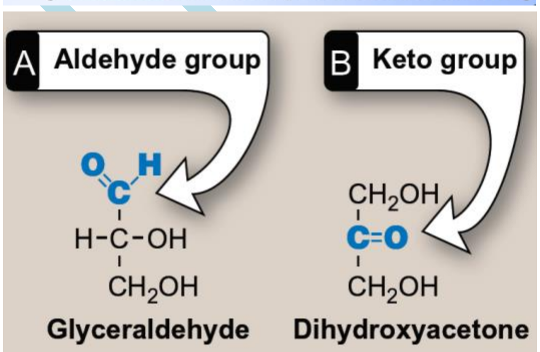
$C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O + \text{Energy}$

Structure of Carbohydrates:

the word of carbohydrate means . Carbo = carbon and hydrate = water hydrolysis, and its containing C, H and O

- Carbohydrates are defined as sugars and their derivatives.&[**Carbohydrates are polyhydroxy aldehydes or ketones, or substances that yield such compounds upon hydrolysis**].
- Remember, poly means many, hydroxy refers to –OH groups and that the carbonyl carbon is either the terminal carbon, therefore an aldehyde, or it is not a terminal carbon, therefore a ketone. The aldehyde saccharides are called aldose and the ketone saccharides are called ketose





Function of carbohydrate

- To provide energy through their oxidation
- To supply carbon for the synthesis of cell components
- To serve as a stored form of chemical energy
- To form a part of the structural elements of some cells and tissues

Classification of carbohydrates

Number of carbohydrate units

Monosaccharides - single sugar unit

Disaccharides - two sugar units

Oligosaccharides - 2 to 10 sugar units

Polysaccharides - more than 10 units

1. Monosaccharides

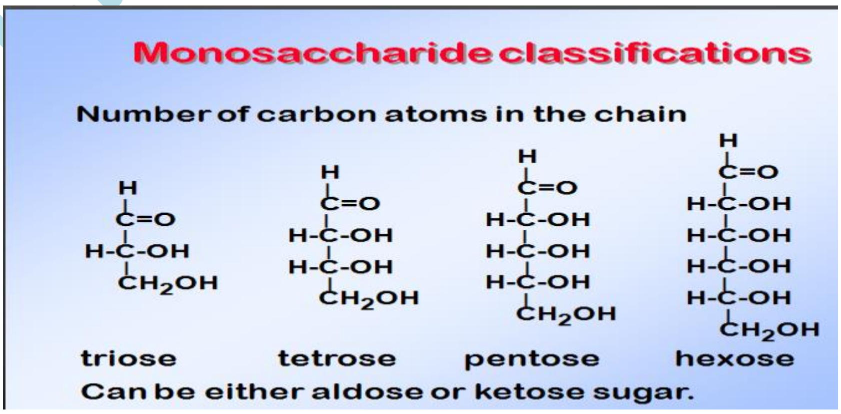
It are classified according to the number of carbons to:

three carbons: triose four carbons: tetrose

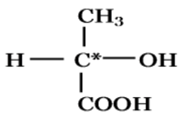
five carbons: pentose

six carbons: hexose like glucose called blood sugar , fructose fruit sugar , galactose

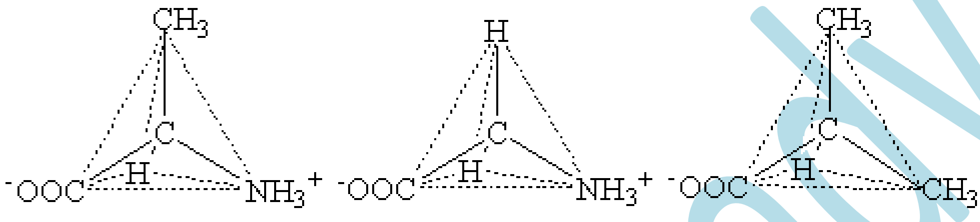
seven carbons: heptose ,ect.



- <u>**A chiral carbon** is carbon atom that has four different groups attached to it.</u>



ex: One of the following three carbons is chiral, which is it and why are the other two not chiral?

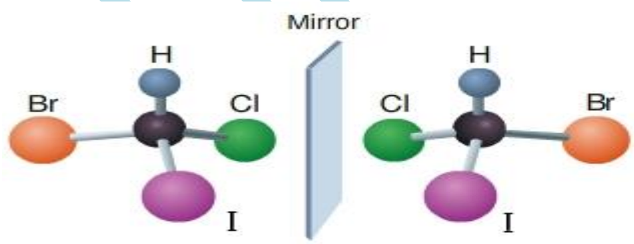


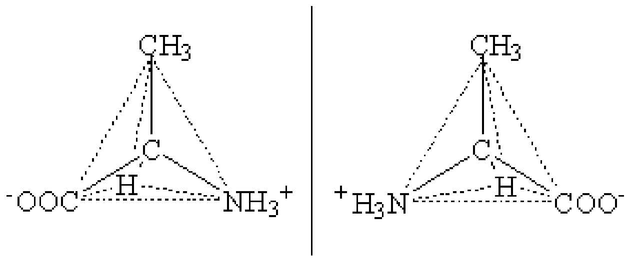
Example A is the chiral carbon. Both B and C do not have 4 different connections. Example B has 2 hydrogen atoms attached to the carbon and example C has 2 methyl groups attached to the carbon.

Isomers: Stereoisomer

The stereoisomer is a special type geometric isomer. The connectivity is the same between two stereoisomers, the difference is their arrangement in 3-dimensional space. They are mirror images of each other. Your hands are mirror images of each other, they are the same, but opposites.

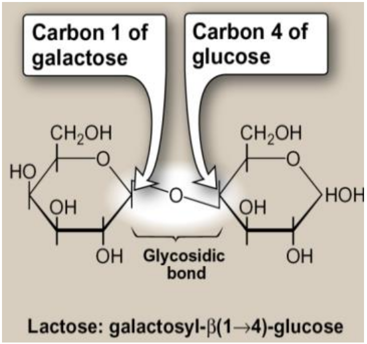
This phenomenon **only** occurs around carbon atoms that have **4 different** connections. The example below shows 4 different atoms, but chains of atoms, for instance a methyl group, could be substituted for these individual atoms. See the second image down.



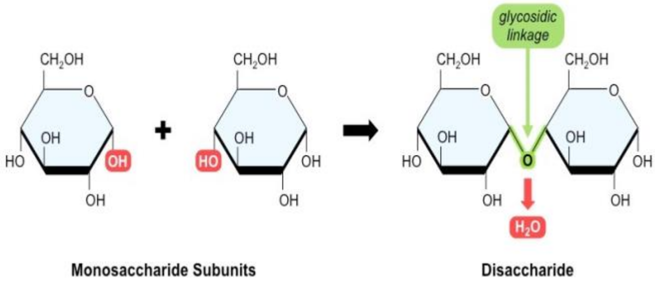


isomer

2. disaccharide



Lactose: galactosyl-β(1→4)-glucose

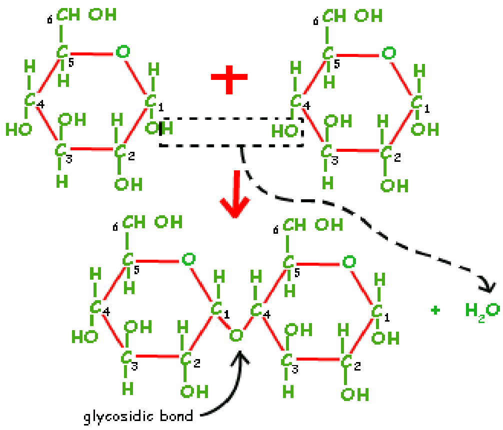


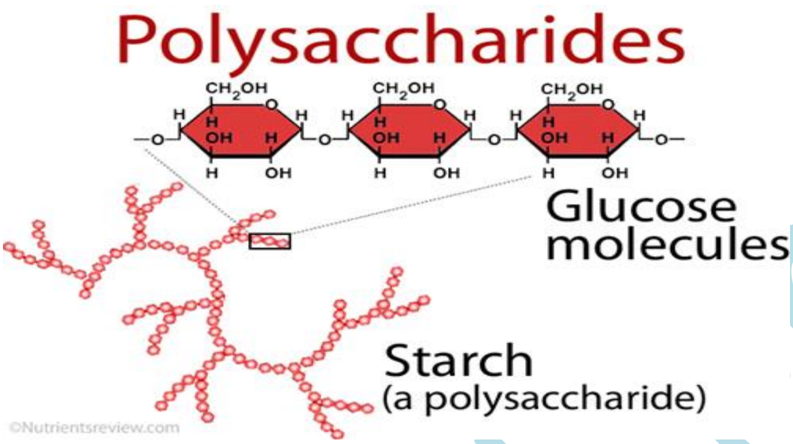
- contain two unit of monosaccharides
- water soluble – as they are short hydrocarbon chains
- are sweet to taste
- ex: sucrose (L+G), galactose(G+G) and lactose Gal+G)

3. polysaccharides

1. Starch

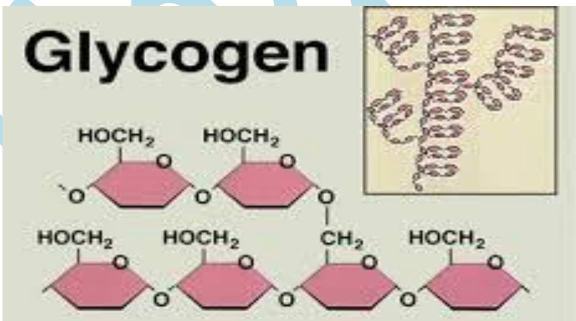
- most common storage polysaccharide in plants ,composed of 10 – 30% a-amylose (straight chain) and 70-90% amylopectin (branched) depending on the source.Common sources are grains , potatoes, peas, beans, wheat

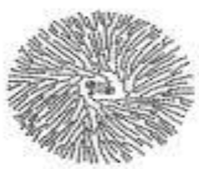




2. **glycogen**

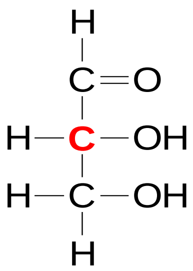
- also known as animal starch ,stored in muscle and liver ,contains both a(1,4) links and a(1,6) branches at every 8 to 12 glucose unit. complete hydrolysis yields glucose, its branched like amylopectin.





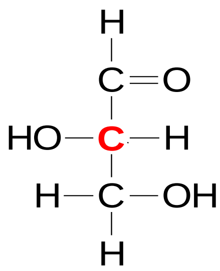
- 3. **cellulose** structure of plants It is not digested by the intestines in humans.

<u>**The D and L structures**. If the -OH group on the carbon before the terminal carbon is on the left it is designated with an L; if the -OH group on the carbon before the terminal carbon is on the right it is designated with an D</u>.



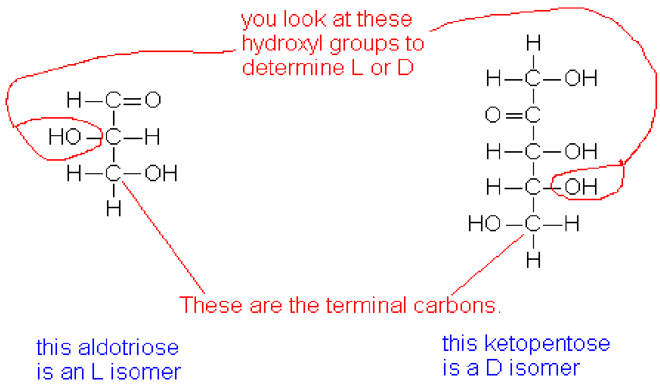
D-glycer aldehyde

D-2,3-dihydroxypropanal



L-glycer aldehyde

L-2,3-dihydroxypropana

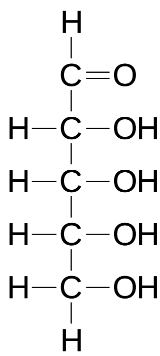


determine the number of isomers

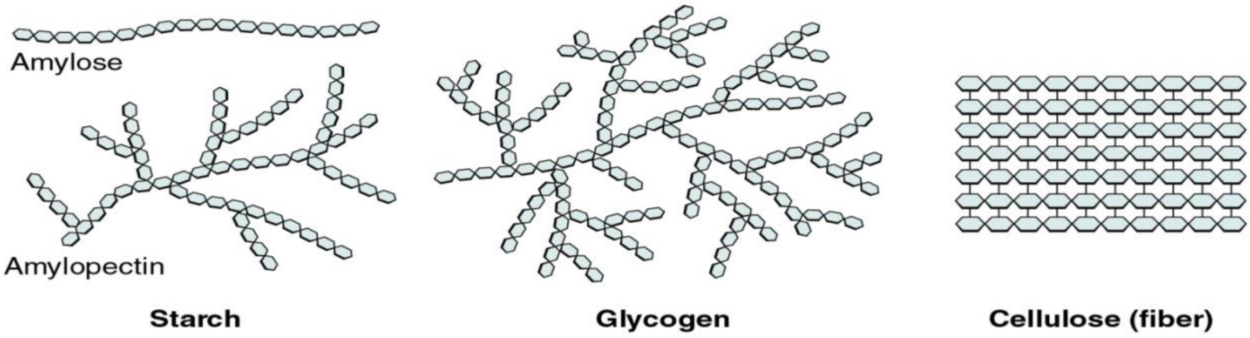
To determine the number of isomers a compound will form:

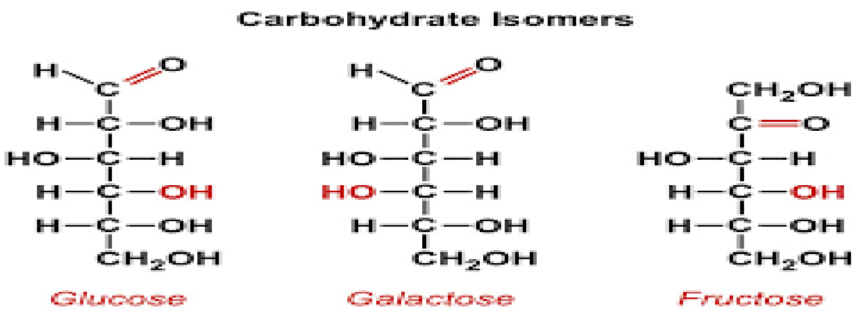
1. Count the number of stereocenters in the molecule
2. Take 2 to that power

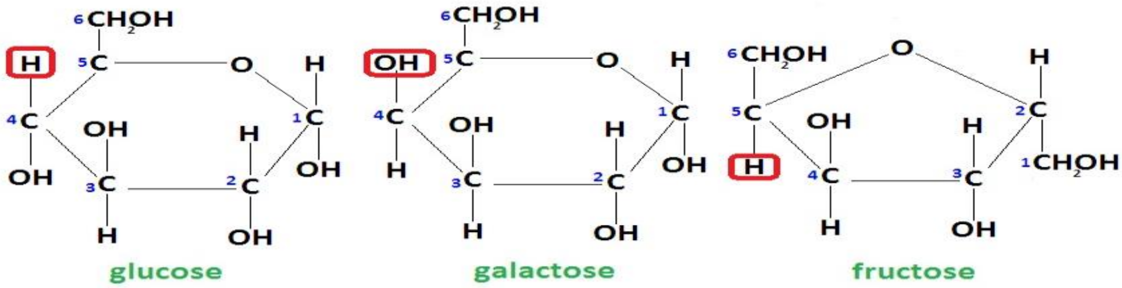
- The ribose molecule to the right has 3 stereocenters.
- $2^3 = 8$ Ribose will have 8 different isomers



Ribose



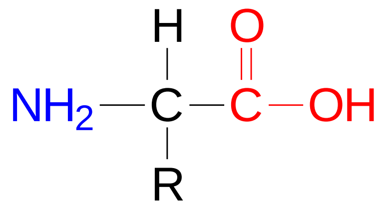




Lec :5

Stage I : Amino Acids and Proteins

Amino acids are named as such because each amino acid consists of an **amine** portion and a **carboxylic acid** part, as seen below.

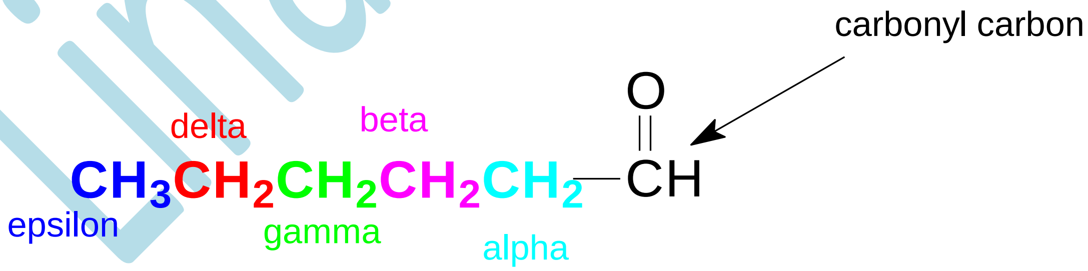


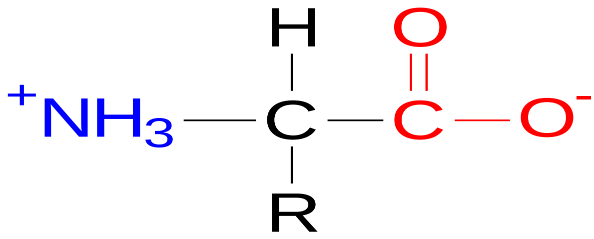
Compare this structure to the above structures of each of the amino acids. Each amino acid has this general structure.

The side chains are sometime shown as R-groups when illustrating the backbone.

In the approximately 20 amino acids found in our bodies, what varies is the side chain. Some side chains are hydrophilic while others are hydrophobic. These side chains help determine the properties of the protein made from them.

The amino acids in our bodies are referred to as alpha amino acids. The reason is that the central carbon is in an alpha position in relation to the carbonyl carbon. The carbon adjacent to the carbonyl carbon is designated the alpha carbon. Each carbon in the chain will be designated with a different letter of the Greek alphabet. See the example below.



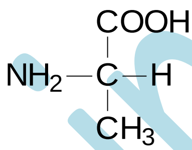


zwitter ion

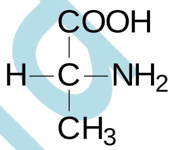
You may have noticed that the general form for the amino acid is often drawn with the acidic hydrogen attached to the amine group. This occurs because amine groups are basic. So, the amino acid has performed an acid-base reaction on itself. When the amino acid is in this form it is referred to as a Zwitter ion. When amino acids are in solution this is the form that they will be found.

Chirality:

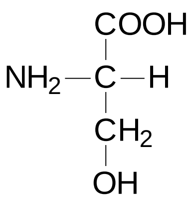
A chiral compound must contain a carbon that is bonded to four different atoms/groups with the exception of glycine,



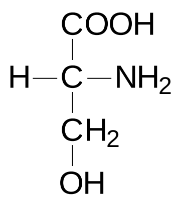
L-alanine



D-alanine



L-serine

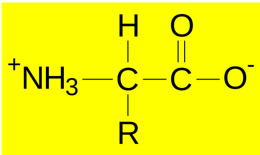


D-serine

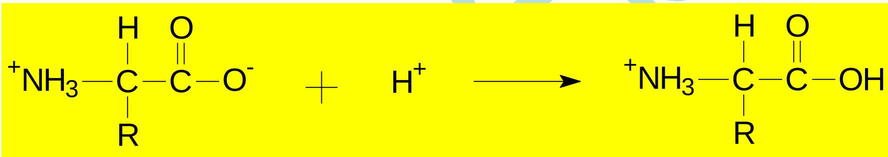
The importance of chiral compounds is that their chemical reactivity is different. we can consume both L and D amino acids, but our bodies will only metabolize the D form. The enzymes used in the metabolism of amino acids are built to fit this D form but not the L form. The L form will pass through your body unused.

Buffering:

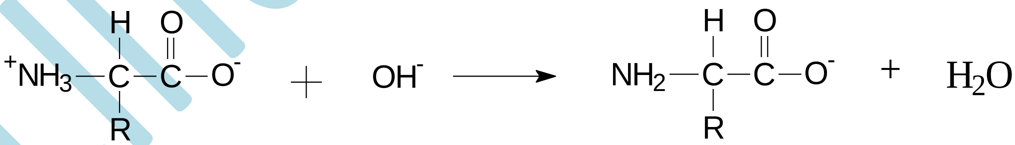
α-amino acids contain both acidic -COOH and the basic $–NH_2$ groups, these two functional groups allow them to act as a buffer. Unfortunately, though, the picture is not as simple as this. In the solid crystalline state the a-amino acids exist as Zwitter ions, as discussed before they are formed by the transfer of protons, H^+ from the -COOH to the $–NH_2$ groups. For α-amino acids without acidic or basic side chains these zwitter ions have charged groups but are neutral overall. Amino acids are found in the Zwitter form even as solids, they form an ionic matrix similar to salts.



Zwitter ions remain when the α-amino acid is dissolved in water at pH 7. Addition of an acid, supplying more protons, produces ions with an overall positive charge. The amino acid forms the below structure in an acid environment.



Addition of a base, removes the acidic hydrogens, producing ions with an overall negative charge. The amino acid forms the below structure in a basic environment.



We can describe α-amino acids as amphoteric as they can react with both acid and alkali. They are effective buffers in biological systems.

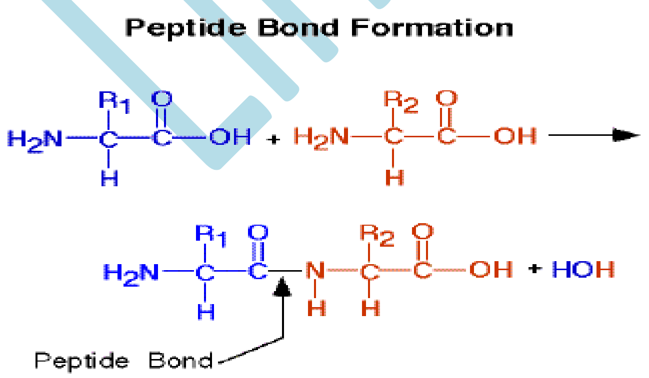
At very low pH all α-amino acids exist as ions with an overall positive charge, while at high pH they exist as ions with an overall negative charge. For each α-amino acid there is a pH between these extremes at which its molecules are neutral overall. This value is called the **isoelectric point** for the α-amino acid. At its isoelectric point the α-amino acid molecules will not move when placed in an electric field. The separation technique called electrophoresis relies on molecules with different isoelectric points moving at different speeds when kept at a fixed pH and placed in an electric field.

Protein Functions:

Type of Protein	Function	Examples
Structure	structural support	collagen in tendons and cartilage keratin in hair and nails
Contractile	muscle movement	actin, myosin, tubulin and kinesin proteins
Transportation	movement of compounds	hemoglobin carries O_2 and lipoproteins carry lipids
Storage	nutrient storage	ferritin stores iron is spleen and liver casein stores proteins in milk
Hormone	chemical communication	insulin regulates blood sugar
Enzyme	Catalyze biological reactions	lactase breaks down lactose trypsin breaks down proteins
Protection	Recognized and destroy foreign substances	immunoglobulins stimulate immune system

Reactions of Amino Acids:

To form protein, the amino acids are linked by dehydration synthesis to form peptide bonds. The chain of amino acids is also known as a polypeptide.



Destroying a Protein:

When a protein is destroyed it is said to be denatured. Remember that the purpose of a primary structure is so the secondary and tertiary structures will form. Certain conditions will cause the protein to unfold, leaving only the primary structure.

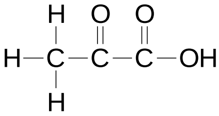
- heat – breaks hydrogen bonds by causing the atoms to vibrate too radically
- UV light – breaks hydrogen bonds by exciting bonding electrons
- organic solvents – breaks hydrogen bonds
- strong acids and bases – breaks hydrogen bonds and can hydrolyze the peptide bonds, breaking the primary structure
- detergents – disrupt hydrophobic interactions
- heavy metal ions – forms bonds to sulfur groups and can cause proteins to precipitate out of solution.

Essential and Non-Essential Amino Acids:

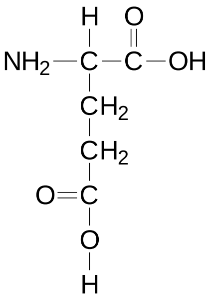
As far as your body is concerned, there are two different types of amino acids: essential and non-essential. Non-essential amino acids are amino acids that your body can create out of other chemicals found in your body. Essential amino acids cannot be created, and therefore the only way to get them is through food. Here are the different amino acids:

Non-Essential Amino Acids:

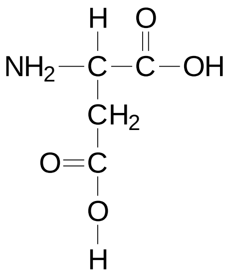
1. Alanine (synthesized from pyruvic acid)
2. Arginine (synthesized from glutamic acid)* essential for infants and young children
3. Asparagine (synthesized from aspartic acid)
4. Aspartic Acid (synthesized from oxaloacetic acid)
5. Cysteine (synthesized from homocysteine, which comes from methionine)
6. Glutamic Acid (synthesized from oxoglutaric acid)
7. Glutamine (synthesized from glutamic acid)
8. Glycine (synthesized from serine and threonine)
9. Proline (synthesized from glutamic acid)
10. Serine (synthesized from glucose)
11. Tryosine (synthesized from phenylalanine)



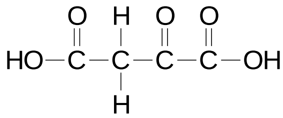
pyruvic acid



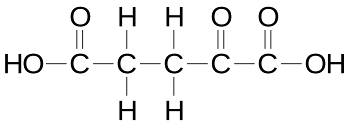
glutamic acid



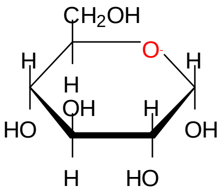
aspartic acid



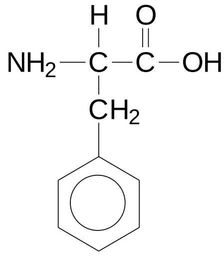
oxaloacetic acid



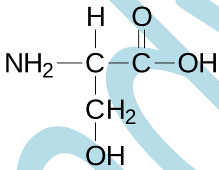
oxoglutaric acid



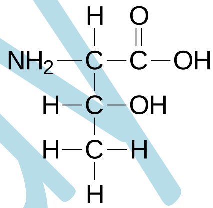
alpha -D-glucose



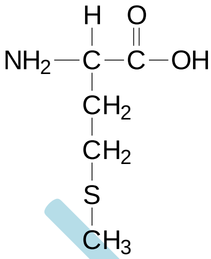
phenylalanine



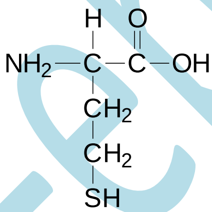
serine



threonine



methionine



homocysteine

Essential Amino Acids:

1. Histidine
2. Isoleucine
3. Leucine
4. Lysine
5. Methionine
6. Phenylalanine
7. Threonine
8. Tryptophan
9. Valine

must be consumed

Lec 6

Lipids

Definition of Lipid are a heterogeneous group of compounds, including fats, oils, or wax that dissolves in alcohol but not in water. Lipids contain carbon, hydrogen and oxygen but have far less oxygen proportionally than carbohydrates.

- LIPID describes a chemically varied group of organic fatty compound substances
- Lipids are highly concentrated energy stores.
- they are water-insoluble bio-molecules but soluble in organic solvents such as ether, benzene. Chloroform, etc.
- They are esters of long chain fatty acids and alcohols.
- Only a limited number of lipids are clinically important. This group includes fatty acids, triglycerides , cholesterol, and phospholipids.
- Lipids are important insulators against heat loss and organ damage and allows for nerve conduction in the central nervous system.
- When conjugated with proteins, lipids compounds are called *lipoproteins,* the transport form of lipids in aqueous substances such as blood.
-

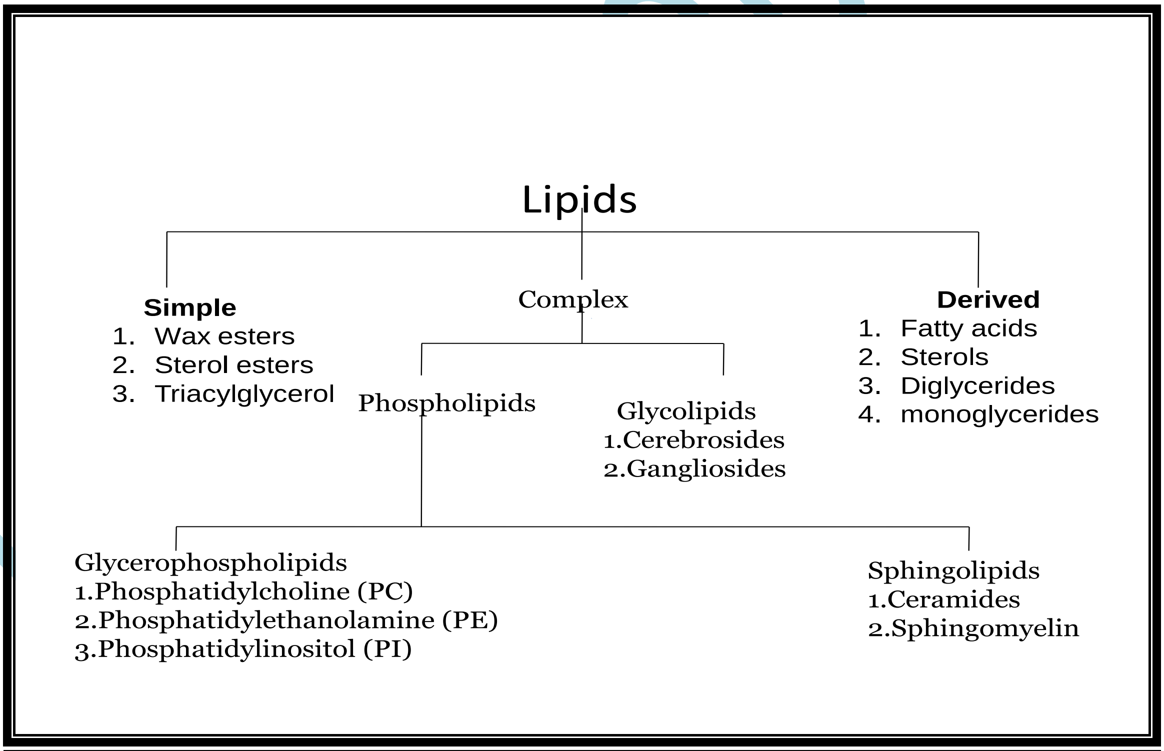
Classification Of Lipids:

LIPIDS are classified broadly according to their chemical composition into:

1- simple lipids
2- complex lipids
3- derived lipids

1. **SIMPLE LIPIDS:** These lipids are the esters of fatty acids with alcohols. They are of three types: Waxes, sterol esters and Triacylglycerol.
2. **COMPOUND/COMPLEX LIPIDS**: These lipids are esters of fatty acids with alcohols with additional groups such as phosphate, nitrogenous base, etc. They are again divided into 3 types: Phospholipids, Glycerophosphlipids, Sphingophospholipids.
3. **DERIVED LIPIDS:** These lipids are obtained on hydrolysis of simple and complex lipids. These lipids contain glycerol and other alcohols. This class of lipids include steroid hormones, ketone bodies, hydrocarbons, fatty acids, fatty alcohols, mono and diacylglycerides.

Classification Scheme:



Functions of Lipids:

1. Lipids are the constituents of cell membrane and regulate membrane permeability.

2. They protect internal organs, serve as insulating materials, give shape and smoothness to the body.
3. They serve as a source of fat soluble vitamins.
4. Essential fatty acids are useful for transport of cholesterol, formation of lipoproteins, etc.
5. Phospholipids in mitochondria are responsible for transport of electron transport chain components.
6. Accumulation of fat in liver is prevented by phospholipids.
7. Phospholipids help in removal of cholesterol from the body.
8. Cholesterol is a constituent of membrane structure and it synthesizes bile acids, hormones and vitamin D. It is the principal sterol of higher a nimals, abundant in nerve tissues and gallstones.

Classification Of Lipids:

Based on their Biological functions Lipids can be classified into:

- Storage Lipids—The principle stored form of energy
- Structural Lipids– The major structural elements of Biological Membranes
- Lipids are signals, cofactors and pigments

Storage Lipids:

Storage Lipids include fats and oils, and wax.

- Fats and oils are composed of 3 fatty acids each in ester linkage with a single glycerol (Triacylglycerols)

  3FA+Glycerol=Fats, Oils

- Waxes are esters of long-chain(C14-C36) saturated and unsaturated fatty acids with long chain alcohols FA + Alcohol = waxes

Functions of Wax:

- Chief storage fuels for some of the microorganisms.
- Protect skin and hair.
- Application in industries, pharmaceutical, and cosmetics

Triacylglycerols (TAG)

- Triacylglycerol(Triglyceride) is an ester of glycerol with three fatty acids.
- It is also called neutral fat.
- They are stored in adiposities tissue .
- A mammal contains 5% to 25% or more of its body weight as lipids,90%TAG

Fatty Acids:

- Fatty Acids are carboxylic acids with hydrocarbon chains ranging from 4-36.
- Fatty acids are of 2 types: **Saturated** and **Unsaturated** usually derived from triglycerides or phospholipids. It are important dietary sources of fuel for animals because, when metabolized, they yield large quantities of ATP.
- Non-essential fatty acids the body can synthesize it and the other cannot be synthesized in the body and must be obtained from food. this called essential fatty acids,ex(linoleic and alpha-linolenic),. These basic fats, found in plant foods, are used to build specialized fats called omega-3 and omega-6 fatty acids. Omega-3 and omega-6 fatty acids are important in the normal functioning of all tissues of the body.

Chemical Properties of Lipids:

1. Hydrolysis
2. Hydrogenation
3. Halogenation
4. Saponification
5. Oxidation

6. Rancidity (oxidation

& hydrolytic

Hydrogenation of the double bonds (adding H_2 across the C-C double bond) converts C-C double bonds to C-C single bonds.

Saponification:

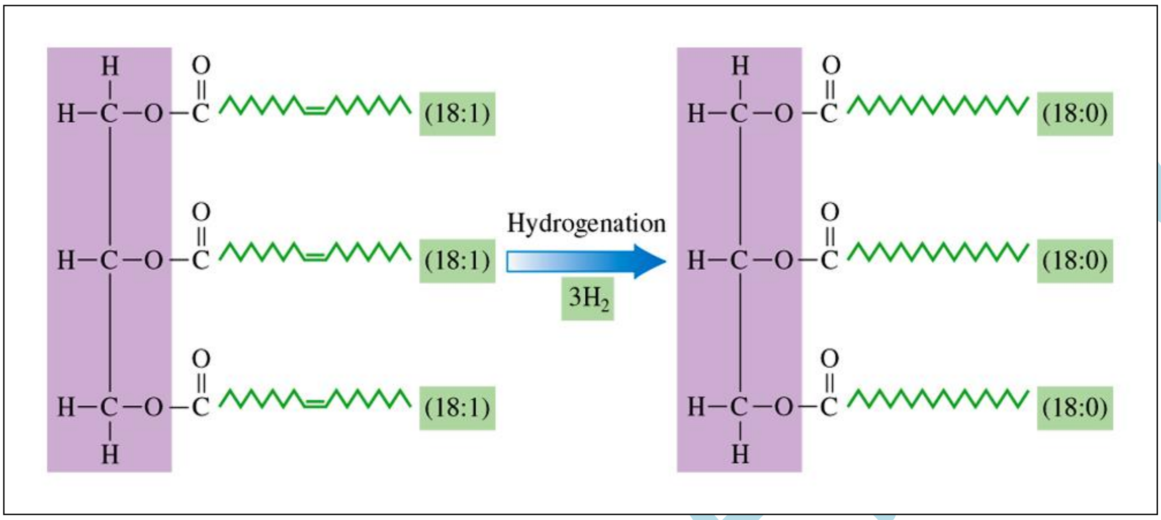
Hydrolysis of TAG with KOH or NaOH is called saponification or soap formation. These soaps are the household soaps. Sodium soaps are hard and potassium soaps are soft.

Iodine Number:

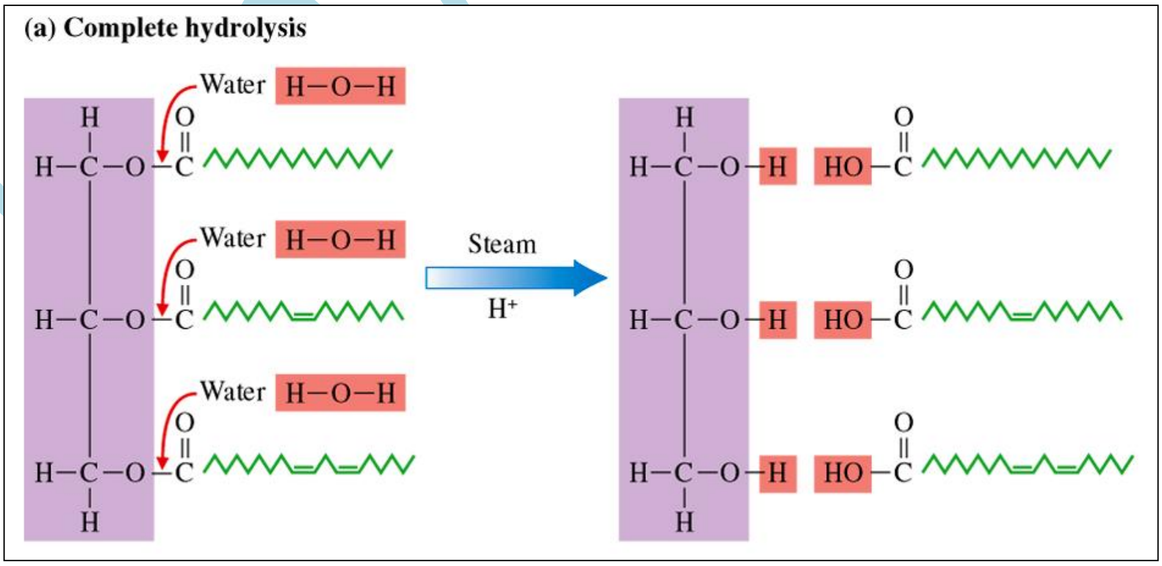
It is the grams of iodine required to saturate 100 grams of fat. It is an indication of unsaturation.

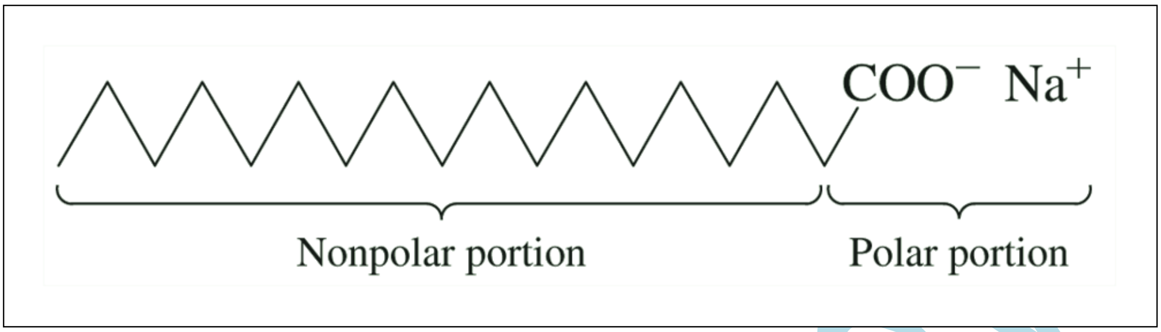
Rancidity:

Fats contaminated with enzymes like lipase undergo partial hydrolysis and oxidation of unsaturated fatty acids at the double bonds. This is even brought about by the atmospheric moisture and temperature. Due to this, there is release of hydrogen peroxide giving a bad odor and taste to the fat. This fat is said to be rancid and the process is known as rancidity. Rancidity can be prevented by antioxidants like vitamin E, vitamin C, phenols, etc.

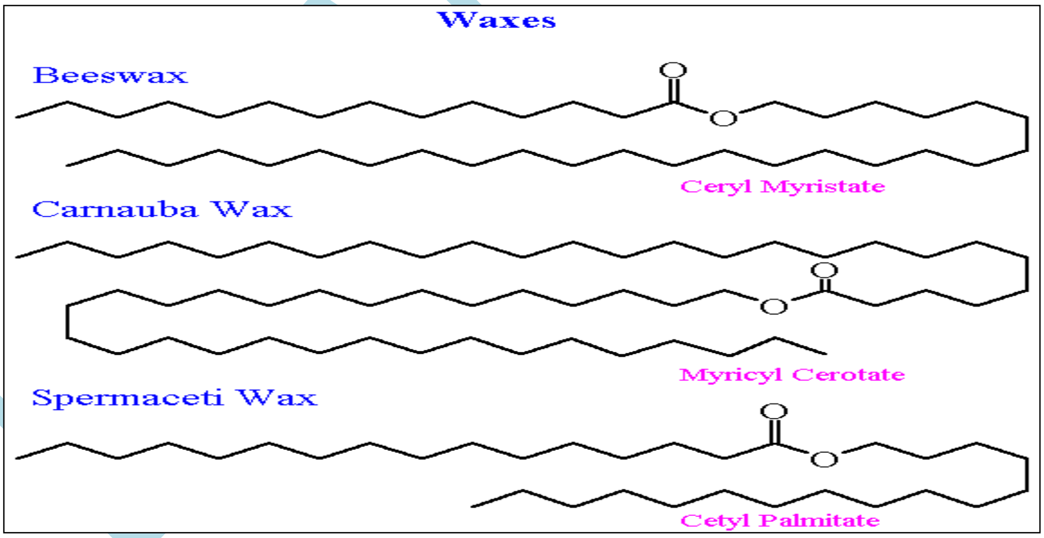


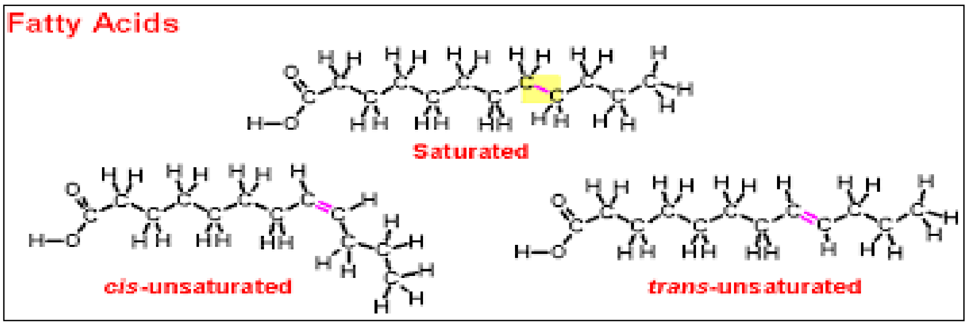
HYDROGENATION



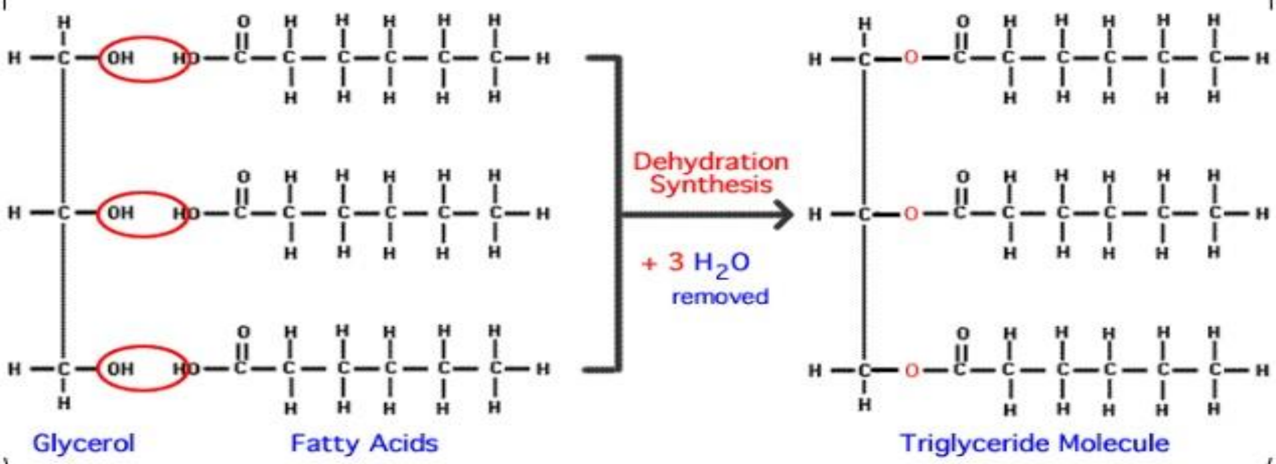


Saponification





- Triacylglycerol are esters of glycerol with fatty acids



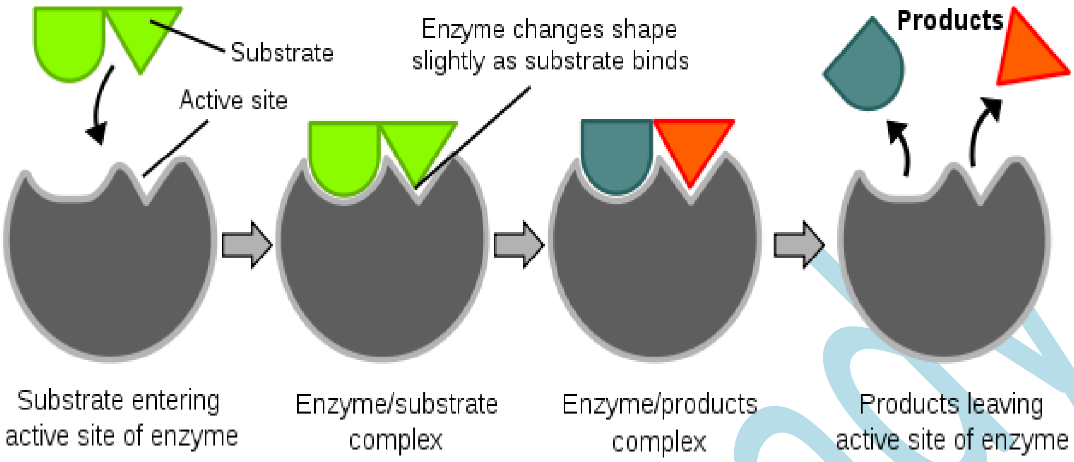
Lec 7

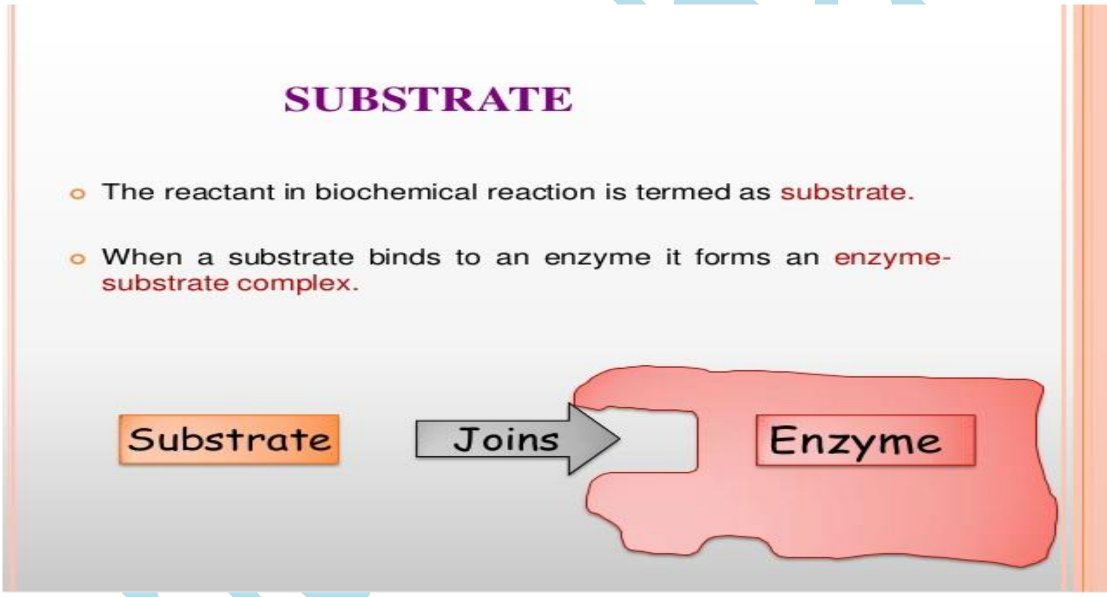
- **Enzyme Structure, classification**
  Enzymes play an important role in Metabolism, Diagnosis, and Therapeutics.
- All biochemical reactions are enzyme catalyzed in the living organism.
- Level of enzyme in blood are of diagnostic importance e.g. it is a good indicator in disease such as myocardial infarction.
- Enzyme can be used therapeutically such as digestive enzymes.

Define enzymes
(Enzymes as Biological Catalysts)

- **Enzymes** are proteins that increase the rate of reaction by lowering the energy of activation
- They catalyze nearly all the chemical reactions taking place in the cells of the body.
- Not altered or consumed during reaction.
- Reusable
- **<u>Active site:</u>**
  The area on the enzyme where the substrate attach to it is called the active site.
- Enzymes are usually very large proteins and the active site is just a small region of the enzyme molecule.
- **<u>ACTIVE SITES</u>**

- Enzyme molecules contain a special pocket or cleft called the active sites.

- 

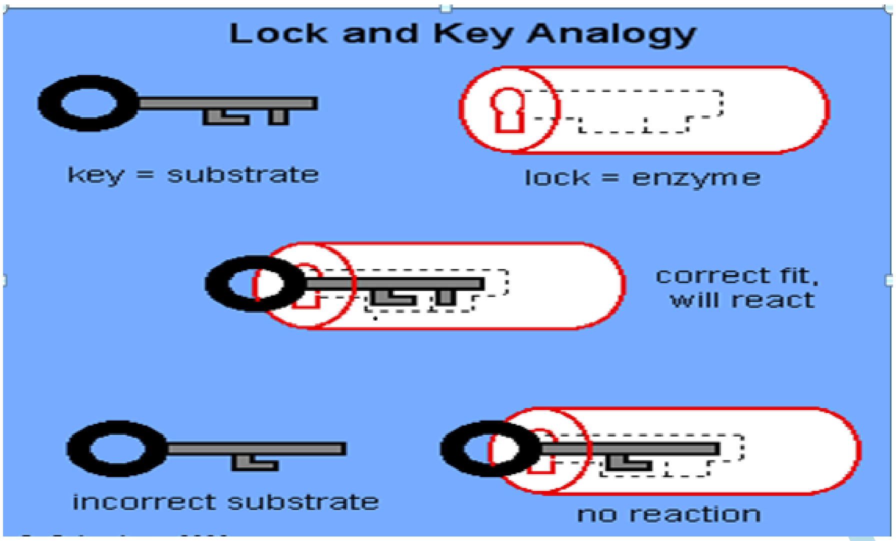
- 

- **In the lock-and-key model of enzyme action:**

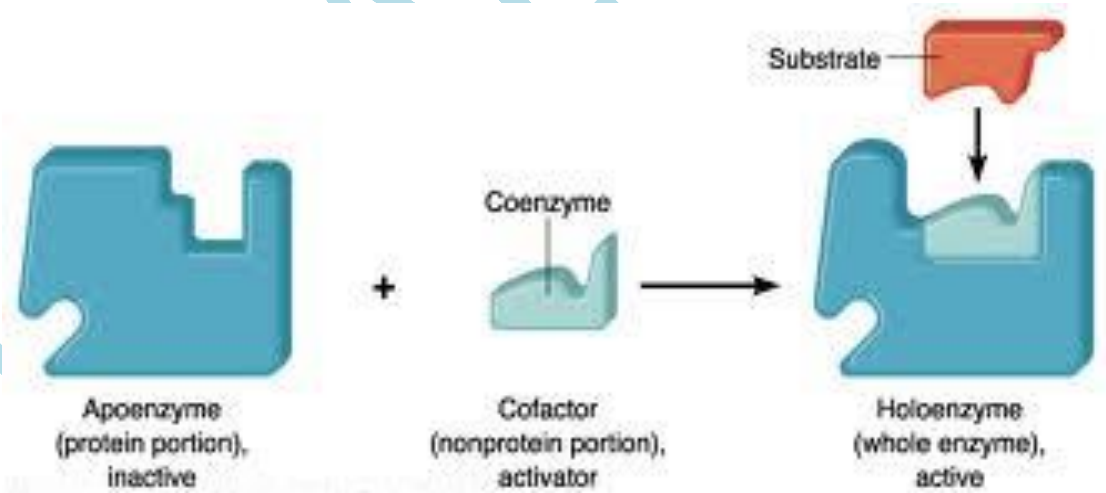
- the active site has a rigid shape

- only substrates with the matching shape can fit

- - the substrate is a key that fits the lock of the active site , Enzymes have varying degrees of specificity for substrates



<u>APOENZYME and HOLOENZYME</u>

- The enzyme without its non protein moiety is termed as apoenzyme and it is inactive.
- Holoenzyme is an active enzyme with its non protein component.
- 

- **Types of Cofactors**

<u>1. Cofactor</u>:

- **A cofactor is a non-protein chemical compound that is bound (either tightly or loosely) to an enzyme and is required for catalysis.**

- **2. <u>Coenzymes</u>.**
- **<u>Coenzyme:</u>**

  The non-protein component, loosely bound to apoenzyme by non-covalent bond.
- **Examples : vitamins or compound derived from vitamins.**
- **<u>3. Prosthetic groups.</u>**

  The non-protein component, tightly bound to the apoenzyme by covalent bonds is called a Prosthetic group.

- <u>The overall reaction for the conversion of substrate to product can be written as follows:</u>

$$E + S \leftrightarrows ES \rightarrow E + P$$

<u>What Affects Enzyme Activity?</u>

- Three factors:

1. Environmental Conditions

ex: temperature, pH, substrate concentration

2. Cofactors and Coenzymes
3. Enzyme Inhibitors

Lec:8

Vitamins

- Vitamins are essential organic nutrients, required in small amounts.
- They cannot be synthesized by the body. Must be obtained by outside sources like diet, rumen bacteria & sun.
- Required for growth, maintenance, reproduction and lactation.

Classes of Vitamins

Fat Soluble Vitamins: *stored in tissues*

Examples A ,D,E,K

Water Soluble Vitamins:

not stored in tissues, must have constant supply

Examples

B, B1, B2, B6 & B12 ,Niacin,Folic Acid,C

Function, Deficiency Signs & Sources

Vitamin A

Function: development healthy skin and nerve tissue. Aids in building up resistance to infection. Functions in eyesight and bone formation. It is important in the portion of pregnant females.

Deficiency signs: retarded growth in the young, the development of a condition around the eyes known as Xerophthalmia, night blindness and reproductive disorders.

Sources: whole milk, carotene, animal body oils (cod fish and tuna),and can be synthetically produced.

علامات النقص: تأخر النمو في الشباب، وتطوير حالة حول العينين المعروفة باسم جفاف العين، العمى الليلي واضطرابات الإنجاب.

مصادر: الحليب كامل الدسم، كاروتين، زيوت جسم الحيوان (الأسماك سمك القد والتونة)، ويمكن أن تنتج صناعيا.

Vitamin E

Function: normal reproduction.

Deficiency signs: poor growth, Muscular Dystrophy, "white muscle" disease , (affects the nerves and muscles).

Sources: synthetic for poultry and swine, cereal grains and wheat germ oil, protein concentrates, oil seeds (peanut and soybean oil).

مصادر: الاصطناعية للدواجن والخنازير، الحبوب وزيت جنين القمح ومركزات البروتين، والبذور الزيتية (الفول السوداني وزيت فول الصويا.

Vitamin E rapidly destroyed in rancid or spoiled fats. That is why these may cause white muscle disease. Utilization of Vitamin E is dependent on adequate selenium.

فيتامين E تدمر بسرعة في الدهون الزنخة أو الفاسدة. هذا هو السبب في أنها قد تسبب أمراض العضلات البيضاء. استخدام فيتامين E يعتمد على وجود السيلينيوم بشكل كاف.

Vitamin D

Function: is essential for the proper utilization of calcium and phosphorus to produce normal, healthy bones.

Deficiency signs: retarded growth, deformed bones (rickets), lameness and osteoporosis.

Sources: Whole milk, sun-light, fish liver oils, yeast.

علامات نقص: تأخر في النمو والعظام (الكساح)، العرج و هشاشة العظام.

مصادر: الحليب كامل الدسم، الشمس والمحاصيل العلفية وزيوت كبد السمك، الخميرة .

Vitamin K

Function: necessary for the maintenance of normal blood coagulation.

Deficiency signs: blood loses its power to clot or the time needed for clotting is longer and serious hemorrhages can result from slight wounds or bruises.

Sources: green leafy , fish , liver, soybeans, intestinal synthesis, and the synthetic compounds.

علامات نقص: الدم يفقد قوته على التجلط أو الوقت اللازم للتخثر يكون أطول، ويمكن حدوث نزيف خطير من جروح طفيفة أو كدمات.

مصادر: الورقية الخضراء، السمك، الكبد، وفول الصويا، والتصنيع من الأمعاء الدقيقة ، والمركبات

Vitamin C (Ascorbic acid)

Function: has an effect on the metabolism of calcium in the body.

Deficiency signs: scurvy (swollen and painful joints and bleeding gums) and brittleness of bones.

Sources: citrus fruits, tomatoes, leafy vegetables and potatoes..

علامات نقص: الاسقربوط (تورم وألم المفاصل ونزيف اللثة) وهشاشة العظام

مصادر: الحمضيات، والطماطم، والخضراوات الورقية والبطاطا.

Vitamin B1 (Thiamin)

Function: required for the normal metabolism of carbohydrates.

Deficiency signs: loss of appetite, muscular weakness, severe nervous disorders, general weakness and wasting (BeriBeri).

Sources: whole grains and especially their seed and embryos, yeast, milk and intestine synthesis.

علامات نقص: فقدان الشهية، ضعف العضلات، واضطرابات عصبية شديدة، والضعف العام والهزال (البري بري)

المصادر: الحبوب الكاملة وخصوصا من البذور والأجنة، والخميرة والحليب والتصنيع المعوي .

Minerals

- Essential inorganic nutrients, required in small amounts.
- As many as 20 minerals may be required!
- Required for growth, maintenance, reproduction and lactation.

  The Macrominerals

- Calcium Ca, Phosphorous P, Potassium K, Sulfur S, Sodium Na, Chlorine Cl, Magnesium Mg
- **Calcium (Ca)**

- Function: major component of bones and teeth and essential in blood coagulation, nerve and muscle function and milk and egg production.
-
- Deficiency signs: retarded growth, deformed bones (rickets), osteoporosis in older.
- Sources: milk, oyster shells and limestone

- علامات نقص: تأخر في النمو، تشوه في العظام (الكساح)، وهشاشة العظام في كبار السن.

مصادر: الحليب، اصداف المحار والحجر الجيري.

Sodium chloride

Considered together because of a close biochemical relationship and are provided as common salt (NaCl)

Function: required for the formation and maintenance, concentration and pH of body fluids, such as protoplasm, blood. Important in the formation of digestive juices and functions in nerve and muscle activity.

وظيفته: مطلوب لتشكيل وصيانة تركيز ودرجة حموضة سوائل الجسم، مثل البروتوبلام والدم. مهم في تشكيل عصائر الهضم ووظائفه في نشاط الأعصاب والعضلات

Phosphorus (P)

Function: essential for the formation of bones, teeth, and body fluids. Required for metabolism, cell respiration and normal reproduction.

وظيفته: ضروري لتكوين العظام والأسنان، وسوائل الجسم. اللازمة لعملية التمثيل الغذائي، تنفس الخلايا والتكاثر الطبيعي

The Microminerals

Iodine (I), Copper (Cu),Iron (Fe),Selenium (Se),Manganese (Mn)

Molybedenum (Mo),Zinc (Zn)

Lec:9

Nucleic acid

- Friedrich Miescher in 1869 Isolated what he called **nuclein** from the nuclei of pus cells
- Nuclein was shown to have acidic properties, hence it became called **nucleic acid**.

Two types of nucleic acid are found:

- Deoxyribonucleic acid (DNA)
- Ribonucleic acid (RNA)

- DNA is found in the nucleus

  with small amounts in mitochondria and chloroplasts

- RNA is found throughout the cell

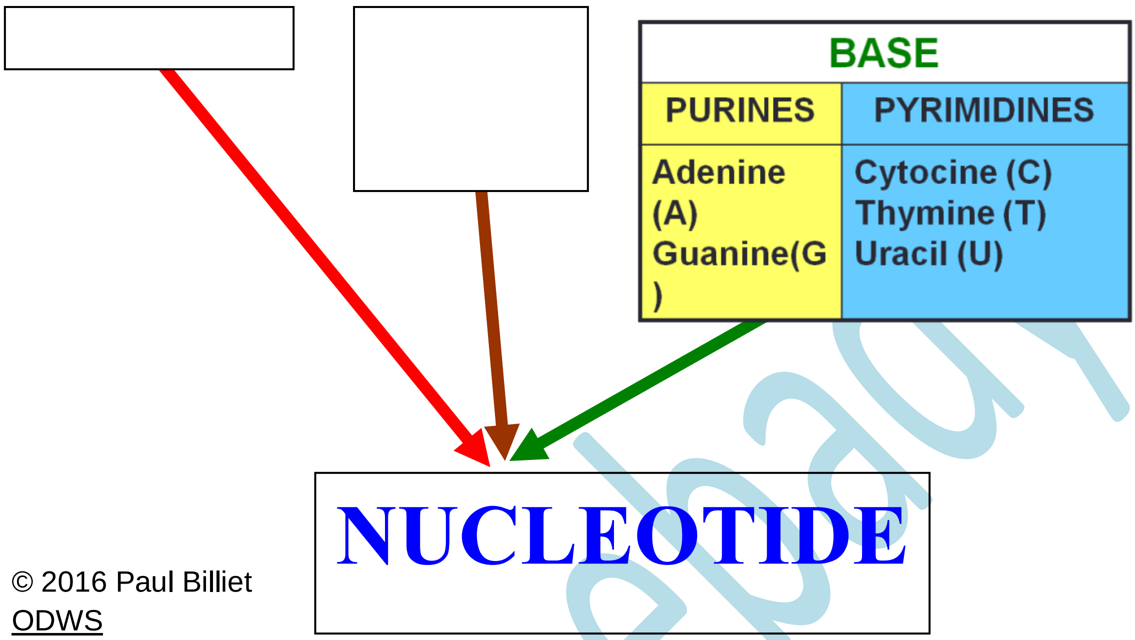
  DNA as genetic material:

1. Present in all cells and restricted to the nucleus
2. The amount of DNA in somatic cells (body cells) of any given species is constant (like the number of chromosomes)
3. The DNA content of gametes (sex cells) is half that of somatic cells.

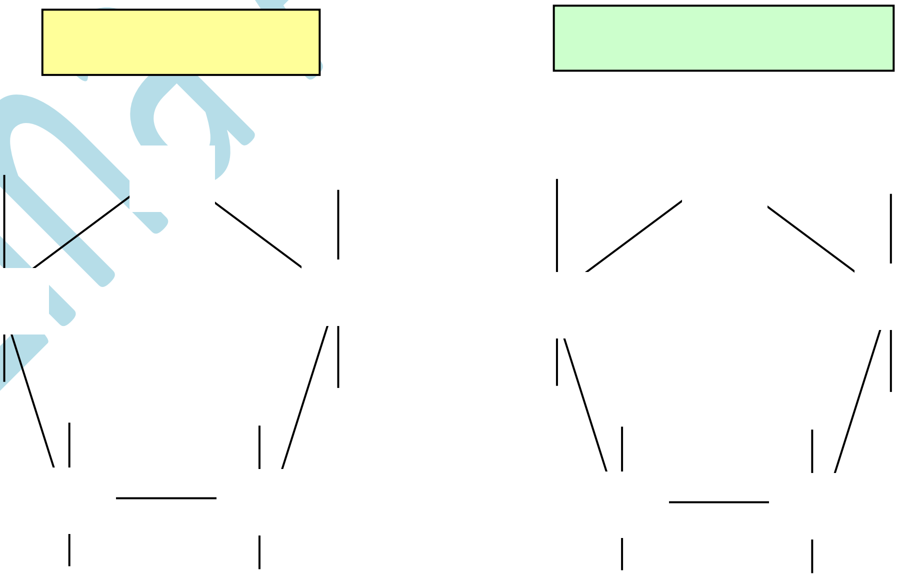
NUCLEIC ACID STRUCTURE

- Nucleic acids are **polynucleotides**
- Their building blocks are **nucleotides**

NUCLEOTIDE



Spot the difference



THE SUGAR-PHOSPHATE BACKBONE

- The nucleotides are all orientated in the same direction
- The phosphate group joins the 3^{rd}Carbon of one sugar to the 5^{th} Carbon of the next in line.
- The bases are attached to the 1^{st} Carbon
- Their order is important
  It determines the genetic information of the molecule

DNA IS MADE OF TWO STRANDS OF POLYNUCLEOTIDE

- The sister strands of the DNA molecule run in opposite directions (**antiparallel**)
- They are joined by the bases
- Each base is paired with a specific partner:

  A is always paired with **T**

  G is always paired with **C**

  Purine with Pyrimidine

- Thus the sister strands are **complementary** but **<u>not</u>** identical
- The bases are joined by **hydrogen bonds**, individually weak but collectively strong.

The difference between DNA and RNA

Ribonucleic Acid (RNA)

- Sugar + Phosphate Backbone
- Differs from DNA
  - Single Stranded
  - Ribose Sugar
  - Base Pairs A-U, G-C
- RNA assists DNA in built-up needed proteins

  - DNA – Double Helix, RNA – Single Stranded
  - DNA --- A-T, RNA ---A-U
  - DNA ---Deoxyribose Sugar, RNA---Ribose

- What is a similarity of DNA and RNA?
    - G binds with C in both DNA and RNA
    - Both have sugar and phosphate backbone

Hydrogen bonds