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An Initiative by अमर उजाला

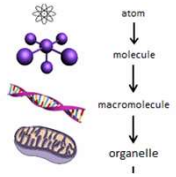
# BIOMOLECULES

# INTRODUCTION

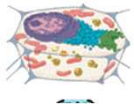
BIOMOLECULES

[redacted]

Celloorganelleses




Cell



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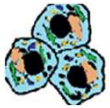
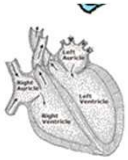
Tissues



tissue

Organs



organ

Living Organisn

organ system

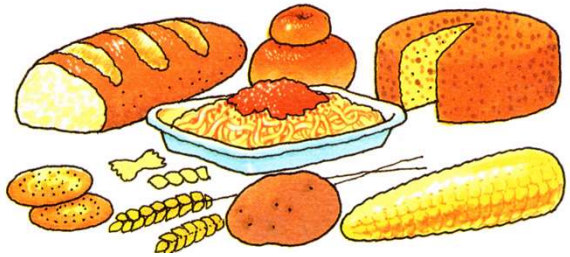
FOOD

# BIOMOLECULES

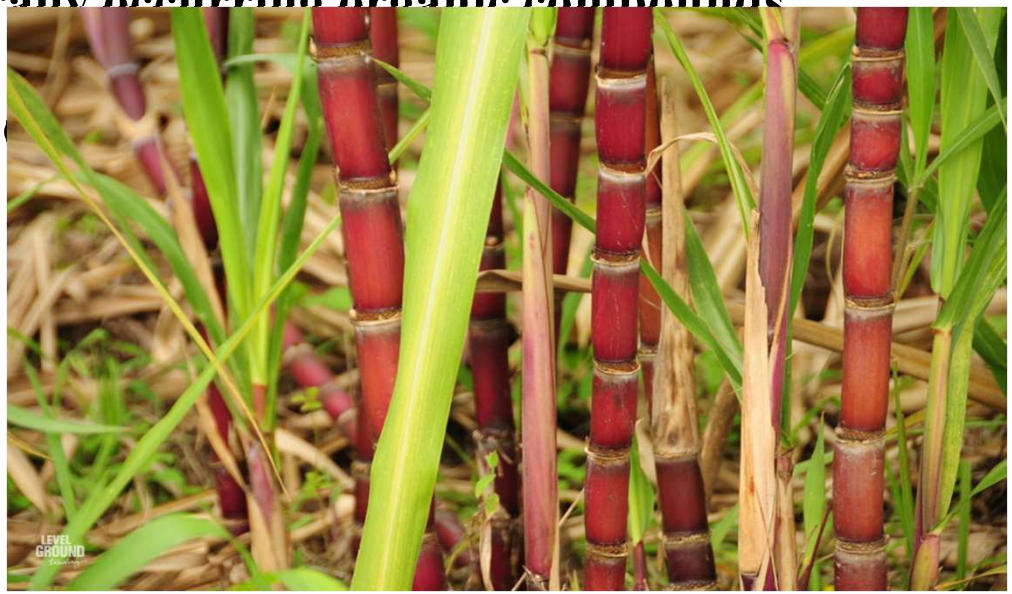
**The general bio - molecules that our food contains are :**

| | |
|---|---|
| i) | Carbohydrates. |
| ii) | Amino acids. |
| iii) | Proteins. |
| iv) | Nucleic acids. |
| v) | Vitamins. |
| vi) | Hormones. |

# Carbohydrates



- Carbohydrates are primarily produced by plants and form a very large group of naturally occurring organic compounds



- Some ( starch, etc.

**Carbohydrates**

**Carbo hydrates ⟹ Carbon + Water**

**Simplest ratio ⟹ C : H : O**

**1 : 2 : 1**

In terms of $H_2O$ we can write it as :-

1) **Glucose ⟶ Mol. Formula $(C_6H_{12}O_6)$**

**Glucose ⟶ $C_6(H_2O)_6$**

2) **Sucrose ⟶ Mol. Formula $(C_{12}H_{22}O_{11})$**

**S**

Hence these are called

**HYDR[illegible]S OF CARBON**

# Carbohydrates

**Thus General formula can be written as $C_x (H_2O)_y$**

**Here, x = y or x ≠ y**

## Carbohydrates

- The most common sugar, used in our homes is named as **sucrose.**
- The sugar present in milk is known as **lactose.**

# Carbohydrates

## Exception

**Acetic acid ($CH_3COOH$) is not a carbohydrate whereas,**

**Raffinose ($C_{18}H_{32}O_{16}$) is a carbohydrate.**

- **It indicates all the compounds which fit into this formula may not be classified as carbohydrates.**

# MCQs

1) **The compound that deviates from carbohydrates classification...**

a) glucose.

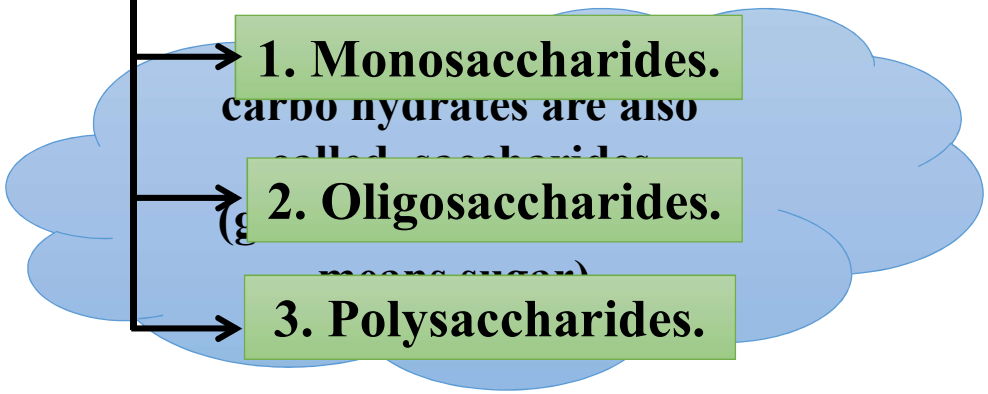
b) sucrose.

c) fructose.

✔ d) acetic acid.

# CLASSIFICATION OF CARBOHYDRATES (PART-I)

# Classification of Saccharides



## 1. Monosaccharides

- **A carbohydrate that cannot be hydrolysed further to give simpler unit of polyhydroxy aldehyde or ketone is called a *monosaccharide.***
- **About 20 monosaccharides are known to occur in nature.**

**Examples:**

**glucose, fructose, ribose, etc.**

## 2. Oligosaccharides

- **Carbohydrates that yield two to ten monosaccharide units, on hydrolysis, are called oligosaccharides.**
- **They are further classified as disaccharides, trisaccharides, tetrasaccharides etc, depending upon the number of monosaccharides which provide on hydrolysis.**

**Examples:**

**sucrose( glucose + fructose) , maltose( glucose + glucose)' etc.**

## 3. Polysaccharides

- **Carbohydrates which yield a large number of monosaccharide units on hydrolysis are called polysaccharides.**

**Examples:**

**starch, cellulose, glycogen, gums, etc.**

## Classification of Mono saccharides

| No.of C- atoms | General term | Aldehyde | Ketone |
|---|---|---|---|
| 3 | Triose | Aldotriose | Keto[illegible] |
| 4 | Tetrose | Aldotetrose | Ketotetrose |
| 5 | Pentose | Aldopentose | Ketopentose |
| 6 | Hexose | Aldohexose | Ketohexose |
| 7 | Heptose | Aldoheptose | Ketoheptose |

It is based on the number of carbon atoms and functional groups.

# MCQs

1) **Ribose is a...**

a) **Monosaccharide.**

b) **Disaccharide.**

c) **Oligosaccharide.**

d) **Polysaccharide.**

# MCQs

**2) Polysaccharide is...**

**a) Glucose.**

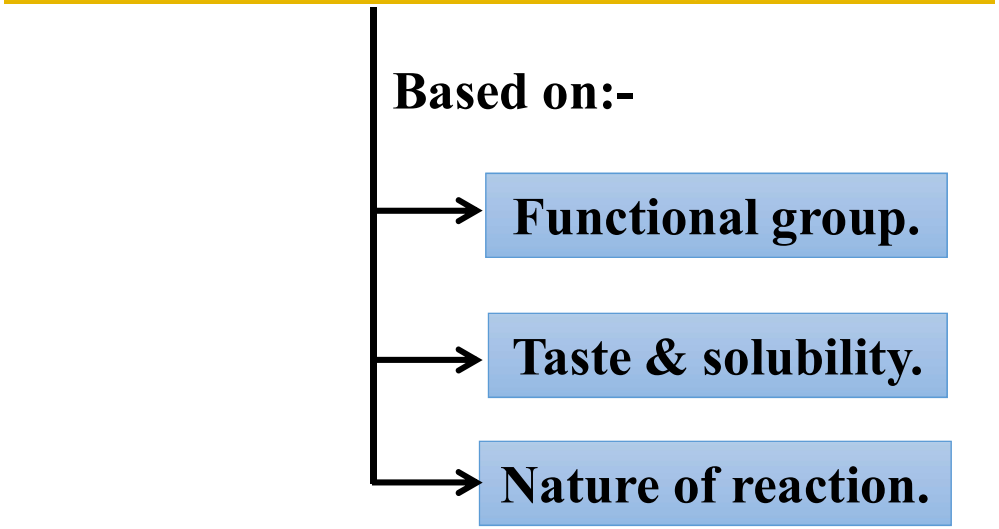
**b) Sucrose.**

**c) Starch.**

**d) fructose.**

# CLASSIFICATION OF CARBOHYDRATES (PART-II)

# Classification of Carbohydrates

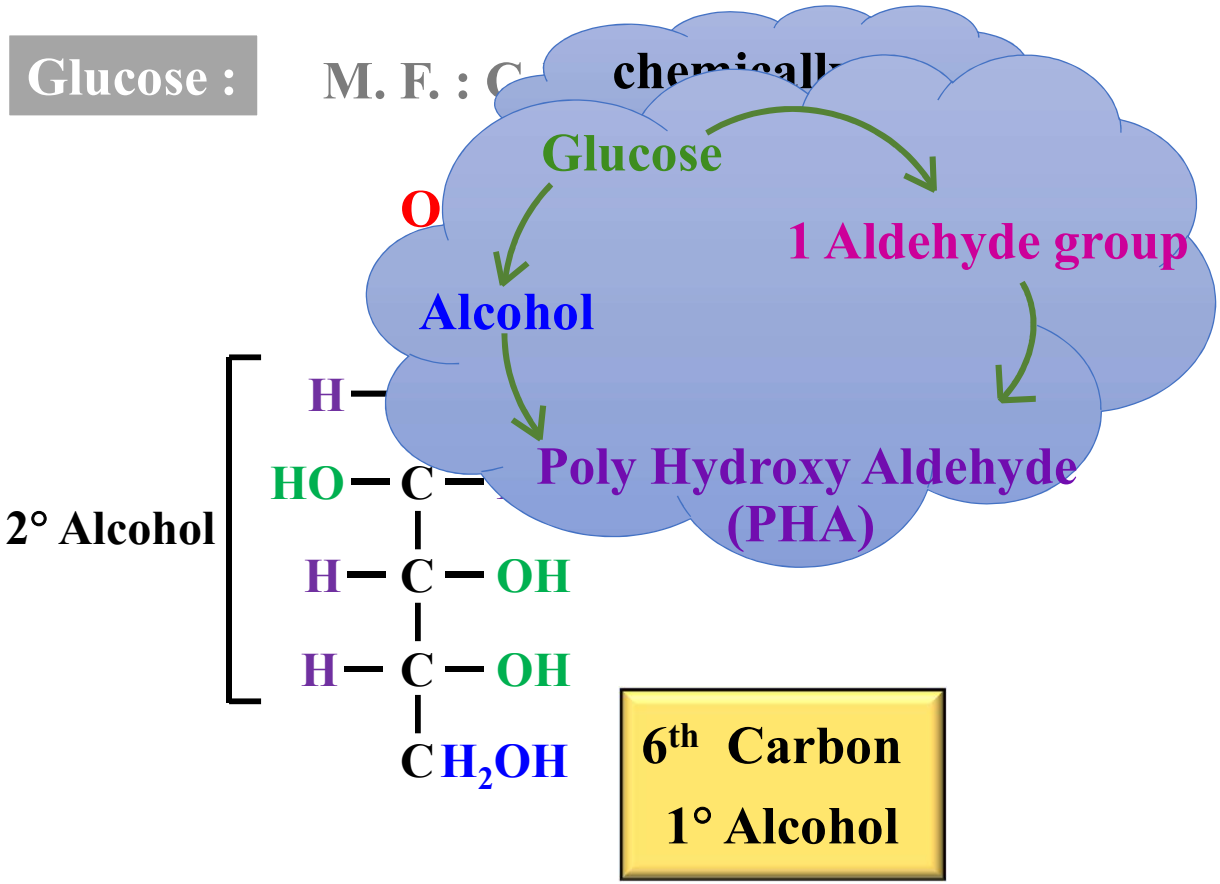


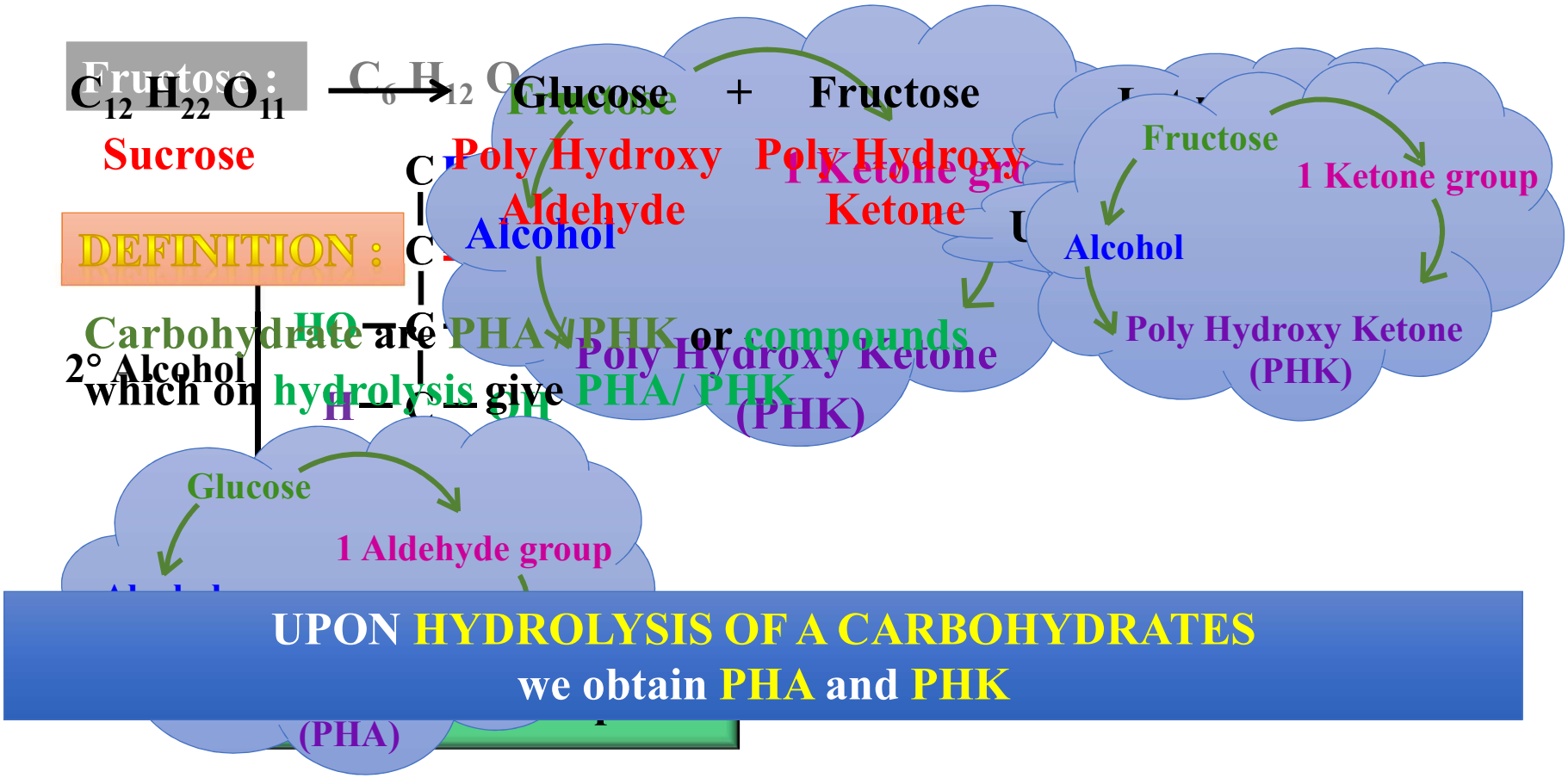
# Classification of Carbohydrates

## Based on functional group

- **Chemically the carbohydrates may be defined as optically active polyhydroxy aldehydes or ketones or the compounds which produce such units on hydrolysis.**

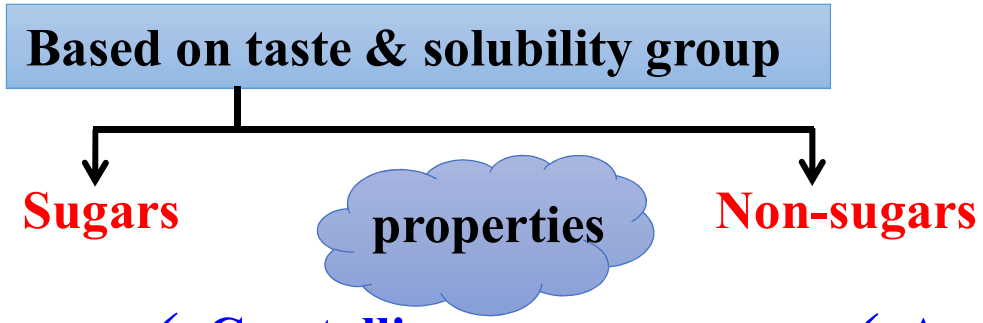
**Glucose :** M. F. : C chemicall




Fructose :
$C_{12}H_{22}O_{11}$
Sucrose
Glucose + Fructose
Poly Hydroxy Aldehyde
Poly Hydroxy Ketone
Alcohol
1 Ketone group
DEFINITION :
Carbohydrate are PHA/PHK or compounds
2° Alcohol
which on hydrolysis give
Poly Hydroxy Ketone (PHK)
PHA/ PHK
Glucose
1 Aldehyde group
(PHA)
UPON HYDROLYSIS OF A CARBOHYDRATES
we obtain PHA and PHK

# Classification of Carbohydrates

**Based on taste & solubility group**




- ✓ Crystalline.
- ✓ Sweet to taste and soluble in water.
- ✓ Eg. Monosaccharides & Oligosaccharides.
- ✓ Amorphous & tasteless.
- ✓ Insoluble in water.

# Classification of Carbohydrates

## Based on the nature of the reaction

### Reducing sugars

- ✓ They reduce Fehling solution and Tollen's reagent.
- ✓ All monosaccharides.
- ✓ Disaccharides in which aldehydic and ketonic groups are free.
- ✓ Eg: Maltose and lactose.

### Non-reducing sugars

- ✓ They do not reduce Fehling solution and Tollen's reagent.
- ✓ Dissacharides in which aldehydic or ketonic groups are bonded behave as non-reducing sugars.
- ✓ Eg: Sucrose.

# MCQs

1) **Chemically carbohydrates are ...**

a) hydroxy carbonyl compound.

b) carbonyl compound.

c) alcoholic compound.

d) Poly hydroxy carbonyl compound.

# MCQs

**2) The simplest ratio of carbon and hydrogen in carbohydrates...**

**a) 2 : 1**

**b) 3 : 1**

**c) 1 : 3**

**d) 1 : 2**

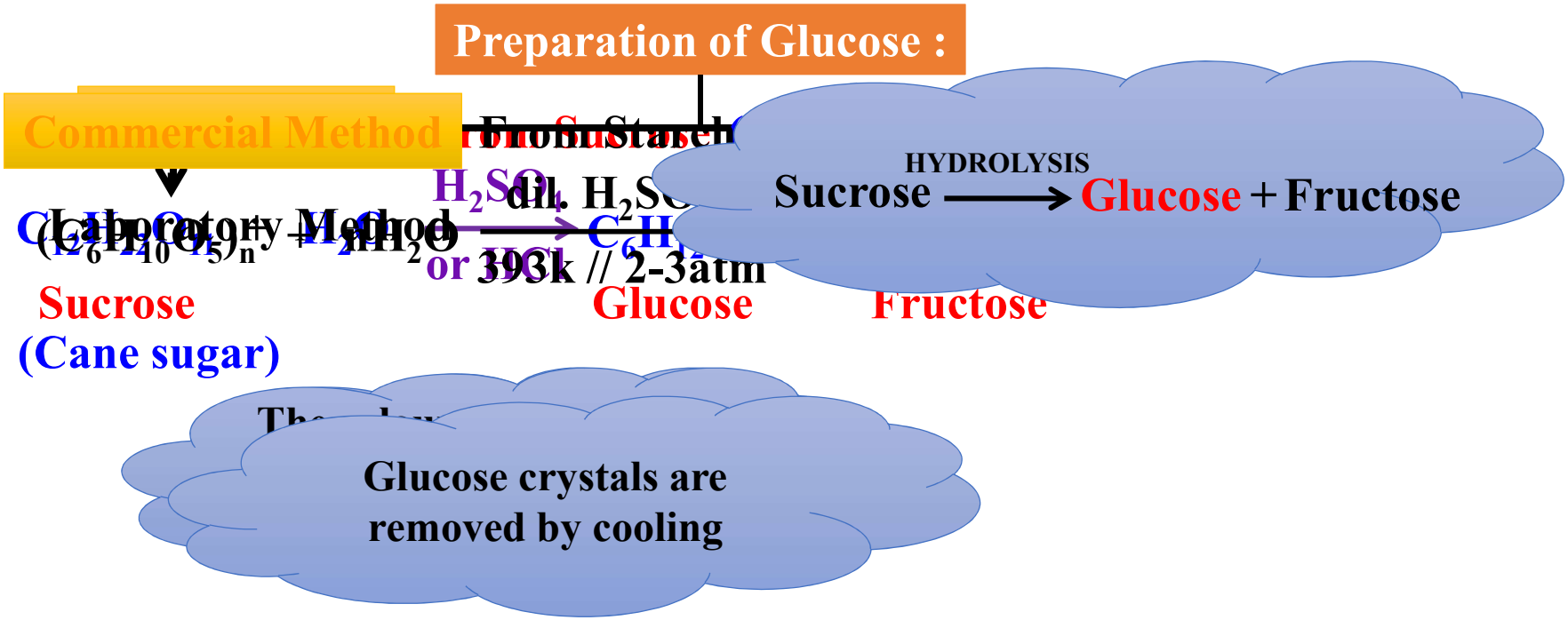
# PREPARATION & STRUCTURE OF GLUCOSE (PART-I)

## Glucose :


Human blood

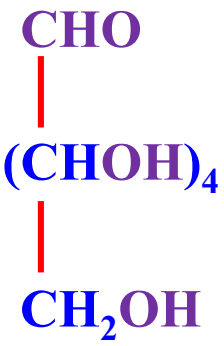
Most naturally abundant sugar.

Found in granes, honey and in human blood.


Preparation of Glucose :
Commercial Method
From Starch
Laboratory Method
$(C_6H_{10}O_5)_n + nH_2O$
$H_2SO_4$
dil. $H_2SO_4$
or HCl
393k // 2-3atm
HYDROLYSIS
Sucrose → Glucose + Fructose
Sucrose
(Cane sugar)
Glucose
Fructose
Glucose crystals are
removed by cooling

## Structure of Glucose

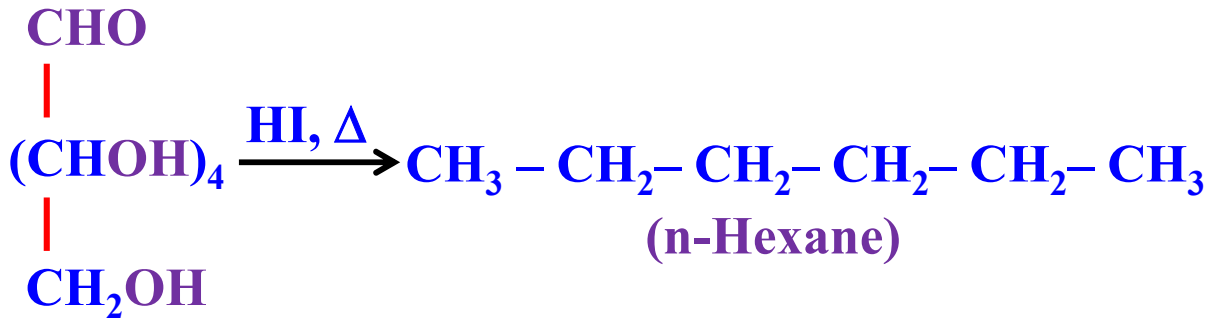
- **Glucose is an aldohexose and is also known as *dextrose.***




- **It is the monomer of many of the larger carbohydrates namely starch, cellulose.**
- **It is probably the most abundant organic compound on earth.**
- **It was assigned the structure given above on the basis of the following evidence:**

## Structure of Glucose

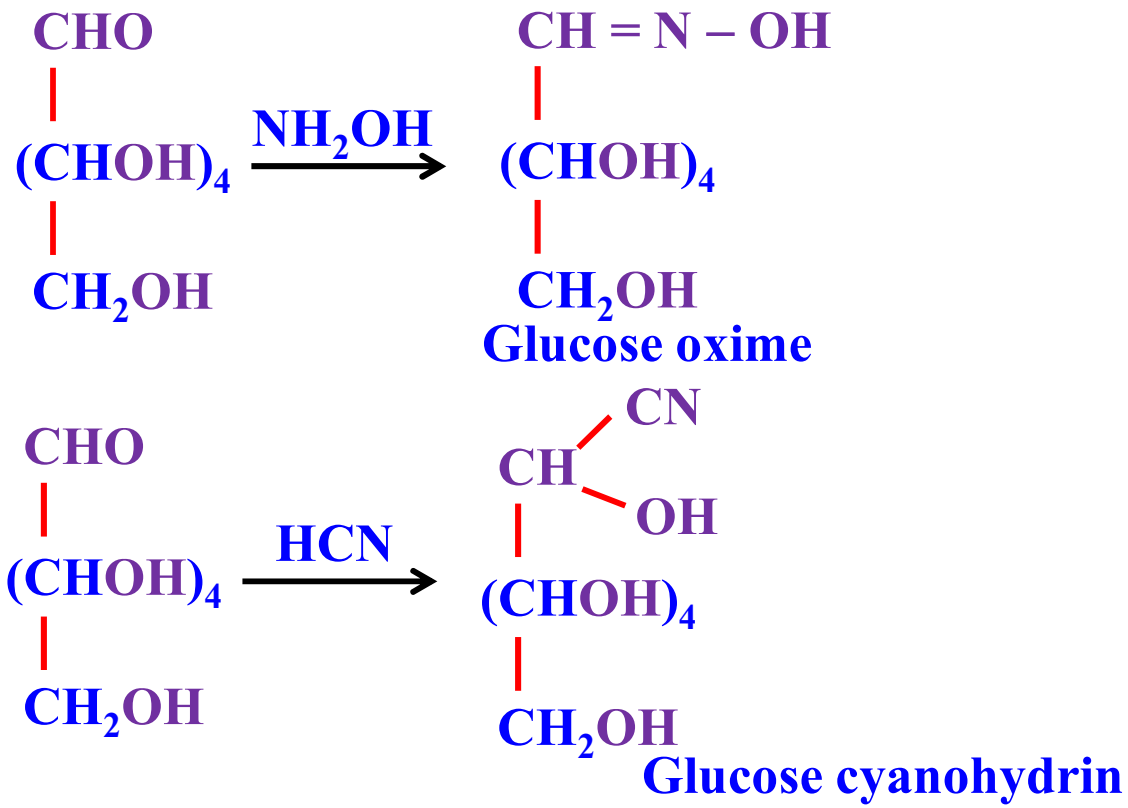
- Its molecular formula was found to be $C_6H_{12}O_6$.
- On prolonged heating with HI, it forms n-hexane, suggesting that all the six carbon atoms are linked in a straight chain.



## Structure of Glucose

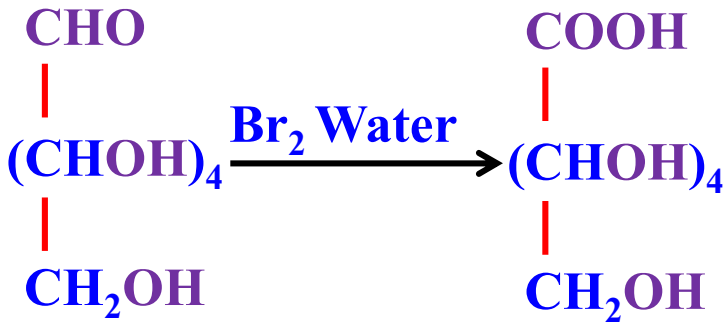
- **Glucose reacts with hydroxylamine to form an oxime and adds a molecule of hydrogencyanide to give cyanohydrin.**
  **These reactions confirm the presence of a carbonyl group ( >C=O ) in glucose.**

## Structure of Glucose



## Structure of Glucose

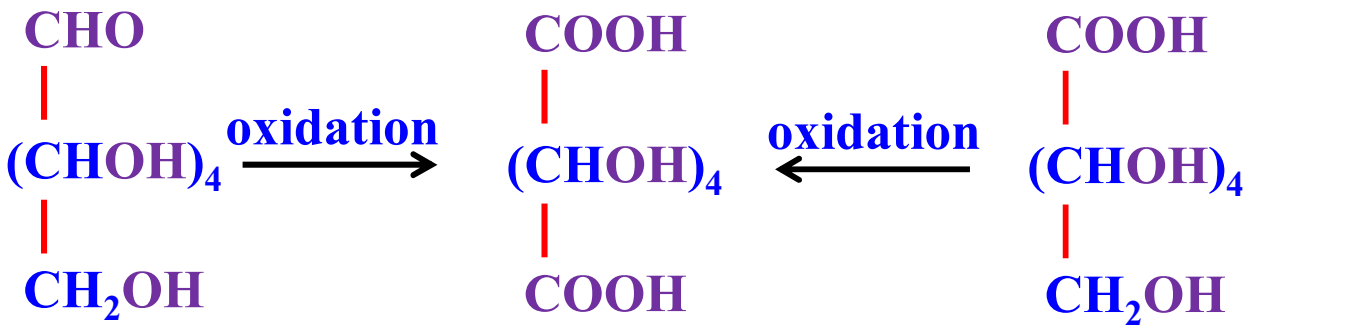
- Glucose gets oxidised to six carbon carboxylic acid (gluconic acid) on reaction with a mild oxidising agent like bromine water. This indicates that the carbonyl group is present as an aldehydic group.




Gluconic acid

## Structure of Glucose

- On oxidation with nitric acid, glucose as well as gluconic acid both yield a dicarboxylic acid, saccharic acid. This indicates the presence of a primary alcoholic (–OH) group in glucose.




Saccharic acid  Gluconic acid

# MCQs

1) **Glucose commercially prepared from...**

**a) sucrose.**

**b) cane sugar.**

**c) Both a & b.**

**d) starch.** ✔

# MCQs

**2) Hydrolysis of sucrose produces...**

**a) Glucose.**

**b) Fructose.**

**c) both a & b.**

**d) Maltose.**

MCQs

**3) Which of the following is not a sugar?**

**1) Sucrose**

**2) Glucose**

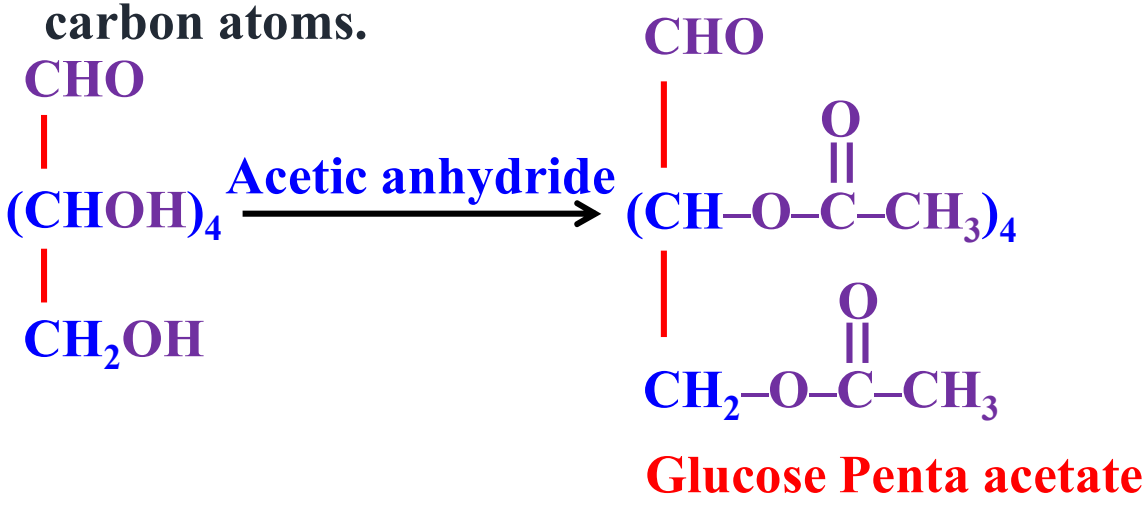
**3) Fructose**

**) Cellulose**

# PREPARATION & STRUCTURE OF GLUCOSE (PART-II)

## Structure of Glucose

- **Acetylation of glucose with acetic anhydride gives glucose penta acetate which confirms the presence of five –OH groups, since it exists as a stable compound, five –OH groups should be attached to different carbon atoms.**

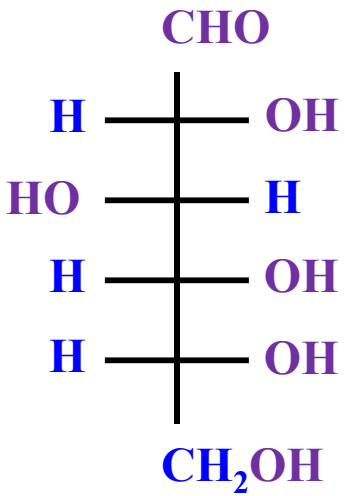



**Glucose Penta acetate**

## Structure of Glucose

- **The exact spatial arrangement of different –OH groups was given by Fischer after studying many other properties.**
- **Its configuration is correctly represented as I.**
- **So gluconic acid is represented as II and saccharic acid as III.**

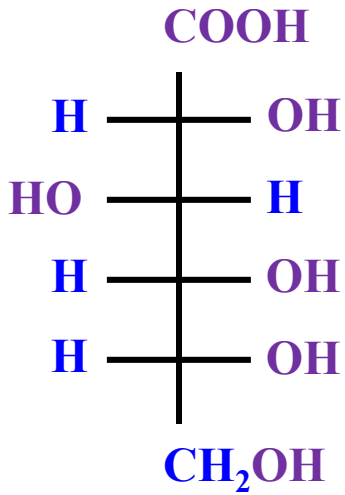
## Structure of Glucose




glucose

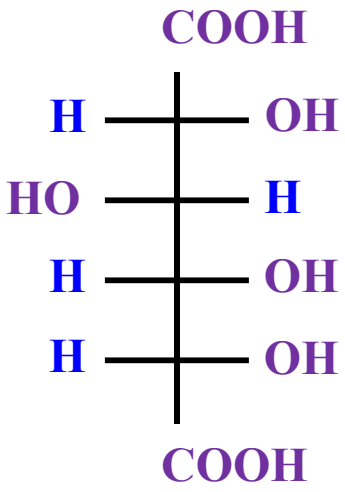
I

## Derivatives of glucose




gluconic acid

II




saccharic acid

III

## Structure of Glucose

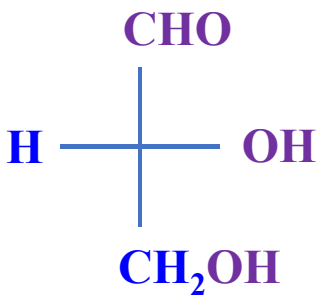
- **Glucose is correctly named as D(+)-glucose.**
- **'D' before the name of glucose represents the configuration whereas '(+)' represents dextrorotatory nature of the molecule.**
- **It may be remembered that 'D' and 'L' have no relation with the optical activity of the compound.**
- **The meaning of D– and L– notations is given as follows.**

## Structure of Glucose

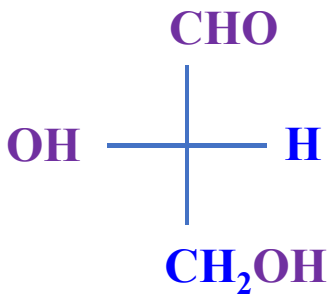
- **The letters ‘D’ or ‘L’ before the name of any compound indicate the relative configuration of a particular stereoisomer.**
- **This refers to their relation with a particular isomer of glyceraldehyde.**

## Structure of Glucose

- **Glyceraldehyde contains one asymmetric carbon atom and exists in two enantiomeric forms as shown below.**




(+) – Glyceraldehyde



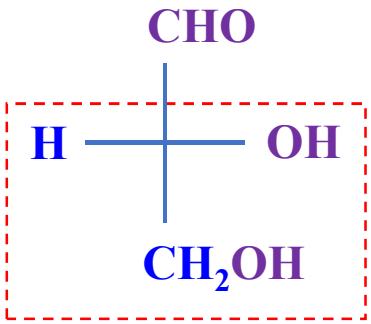

(–) – Glyceraldehyde

## Structure of Glucose

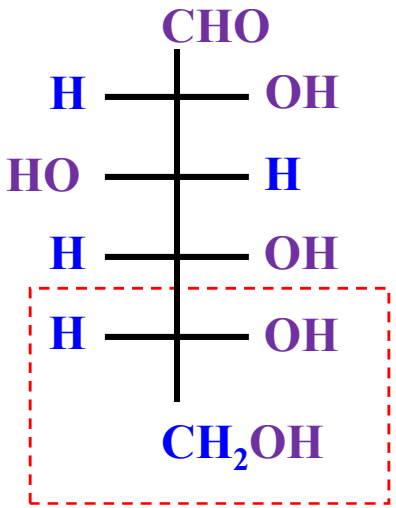
- **Glucose is correctly named as D(+) – glucose. 'D' before the name of glucose represents the configuration whereas '(+)' represents dextrorotatory nature of the molecule.**

**Remember that (D) & (L) have no relation with optical activity of the compound.**

# Structure of Glucose




D– (+) – Glyceraldehyde




D–(+) – Glucose

# MCQs

1) **Reaction of acetic anhydride with glucose indicates...**

a) 5 OH groups in glucose.

b) 4 OH groups in glucose.


c) 1 CHO group in glucose.

d) Linear structure.

# MCQs

**2) Correct representation of glucose is...**

**a) D(+)-glucose.**

**b) D(–)-glucose.**

**c) D -glucose.**

**d) L(+)-glucose.**

# PREPARATION & STRUCTURE OF GLUCOSE (PART-III)

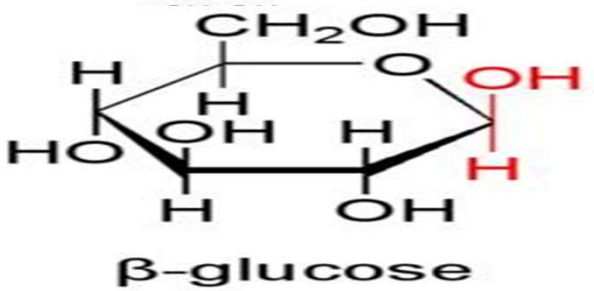
## Cyclic Structure of Glucose

***The structure (I) of glucose explained most of its properties but the following reactions and facts could not be explained by this structure.***

- **Despite having the aldehyde group, glucose does not give 2,4-DNP test, Schiff's test and it does not form the hydrogensulphite addition product with $NaHSO_3$.**

- **The penta acetate of glucose does not react with hydroxylamine indicating the absence of free —CHO group.**

## Cyclic Structure of Glucose



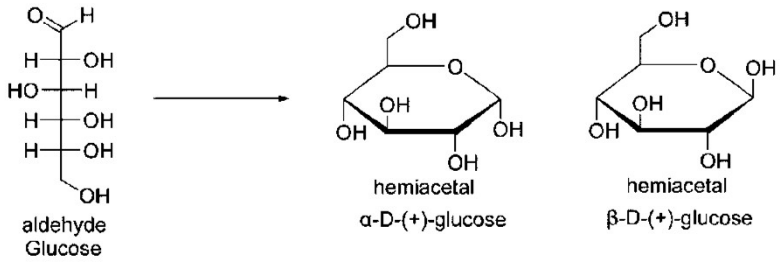
β-glucose

- Glucose is found to exist in two different crystalline forms which are named as α and β.
- The α-form of glucose (m.p. 419 K) is obtained by crystallization of concentrated solution of glucose at 303 K.
- while the β-form (m.p. 423 K) is obtained by crystallization of hot and saturated aqueous solution at 371 K.

# Cyclic Structure of Glucose

- It was proposed that one of the –OH groups may add to the –CHO group and form a cyclic hemi acetal structure.

This behaviour could not be explained by the open chain structure (I) for glucose.

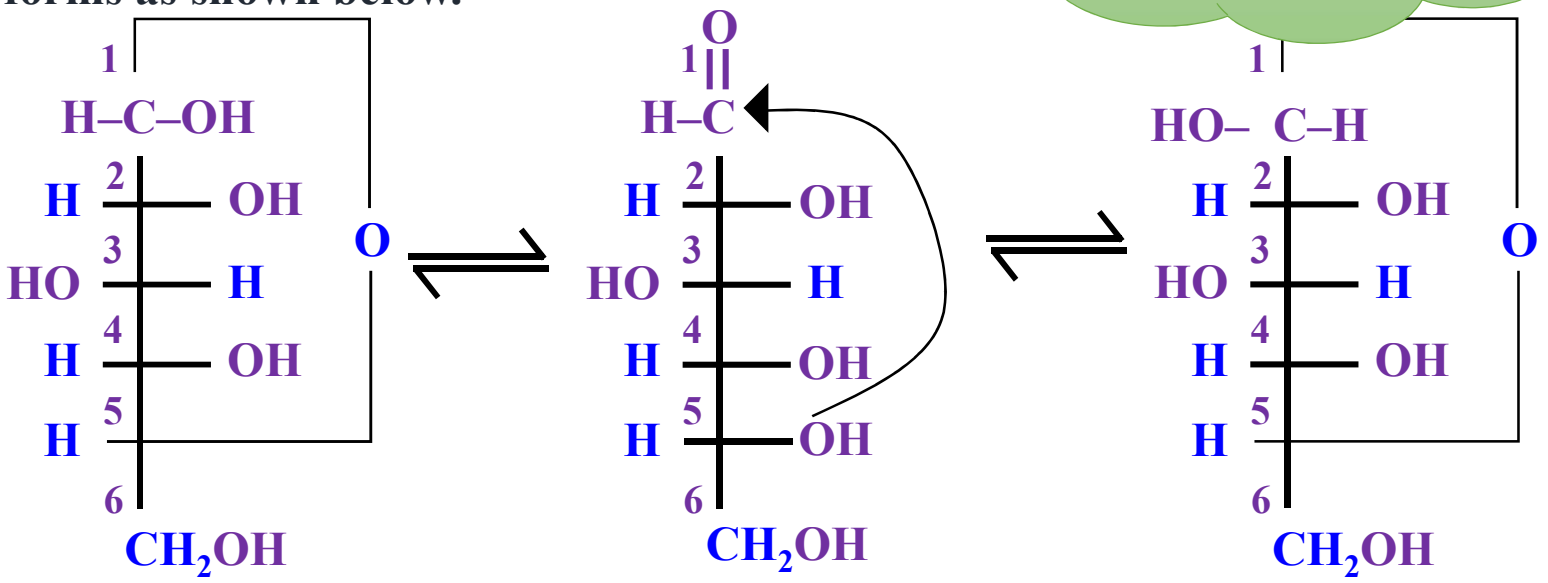



- It was found that glucose forms a six-membered ring in which —OH at C-5 is involved in ring formation.

# Cyclic Structure of Glucose

This explains the absence of –CHO group and ...o forms as shown below.

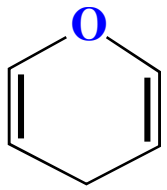
These two cyclic forms exist in equilibrium with open chain structure.



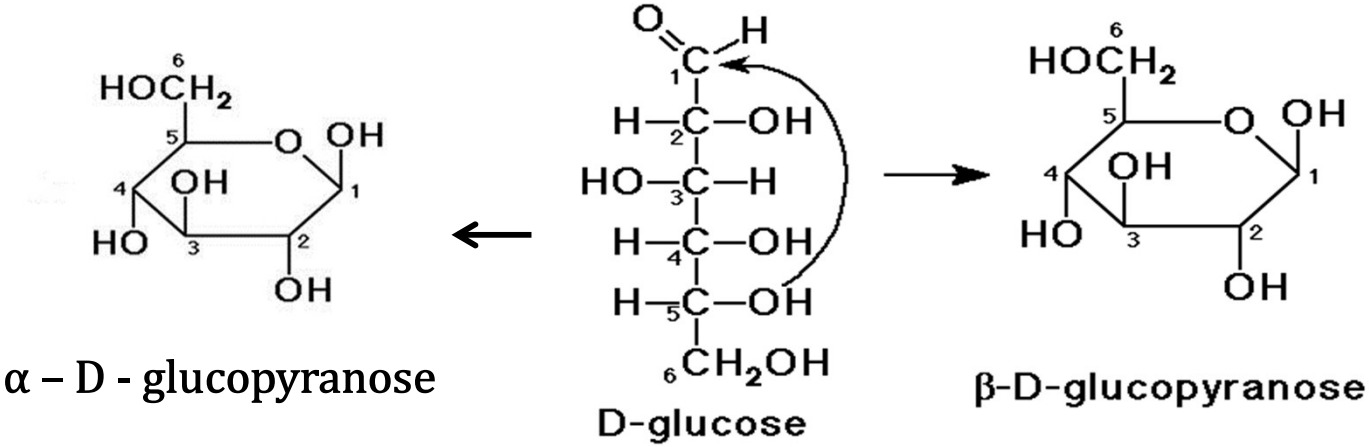

α – D – (+) – Glucose

β – D – (+) – Glucose

- **Pyran is a cyclic organic compound with one oxygen atom and five carbon atoms in the ring.**
- **The cyclic structure of glucose is more correctly represented by Haworth structure as given below.**




**Pyran**

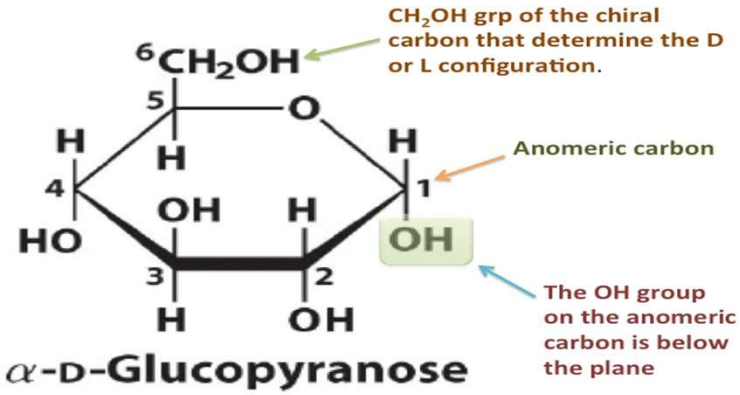



α – D - glucopyranose

**Haworth structure of glucose**

## Anomers

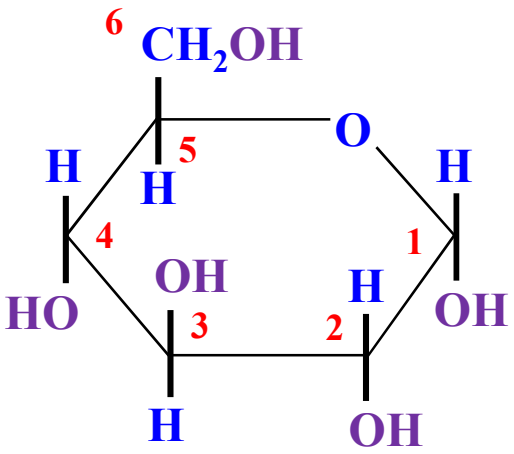
**The two cyclic hemiacetal forms of glucose differ only in the configuration of the hydroxyl group at $C_1$, called *anomeric carbon* (the aldehyde carbon before cyclisation).**

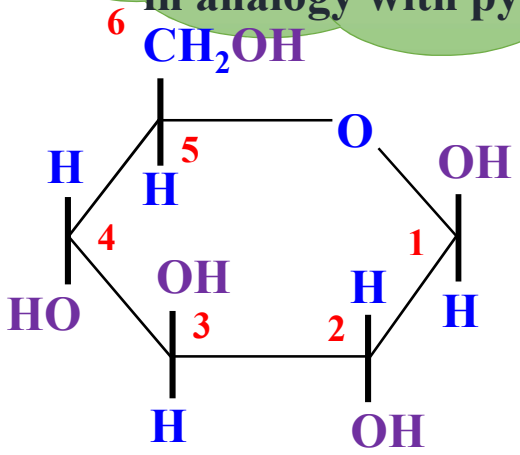


## Anomers

**Such isomers, i.e., α-form and β-form, a**

**The six membered cyclic structure of glucose is called pyranose structure (α– or β–), in analogy with pyran.**



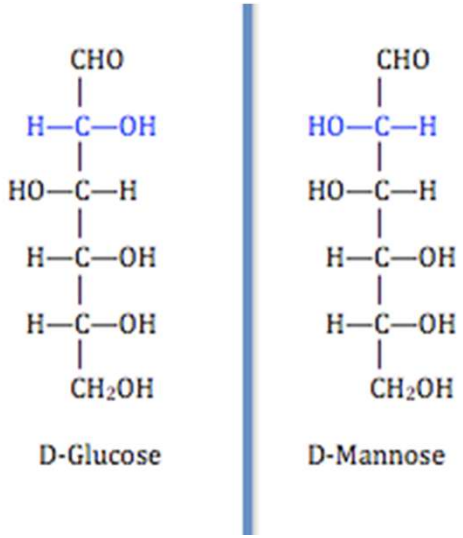




**α – D – (+) – Glucopyranose** **β – D – (+) – Glucopyranose**

## Epimers

**They are diastereomers that contain more than one chiral center but differ from each other in the absolute configuration at only one chiral center.**

**Example :**



# MCQs

**1) Anomers differ at...**

**a) 2nd Carbon.**

**b) 5th Carbon.**

**c) 1st Carbon.** ✓

**d) 3rd Carbon.**

# MCQs

**2) pyranose is a...**

**a) 6 membered ring with six Carbons**

**b) 5 membered ring with five C .**

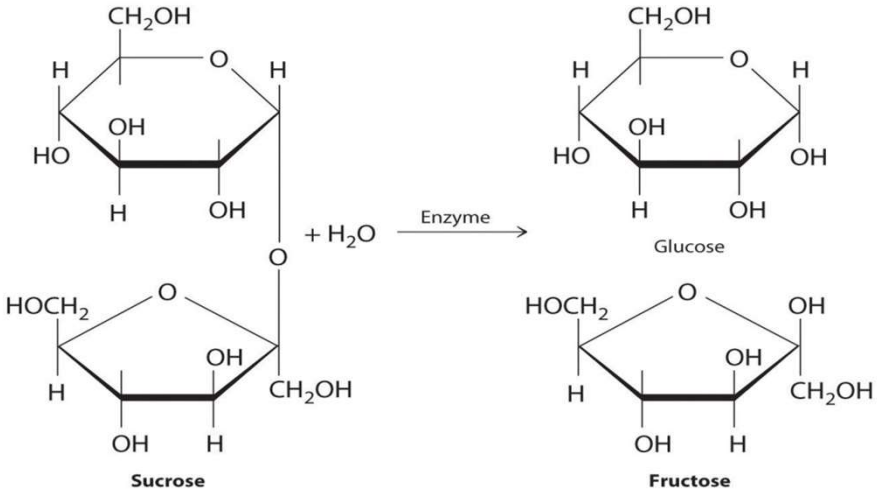
**c) 6 membered ring with five Carbons & one Oxygen.** ✓

**d) 5 membered ring with four C &one O .**

# STRUCTURE OF FRUCTOSE

# Fructose

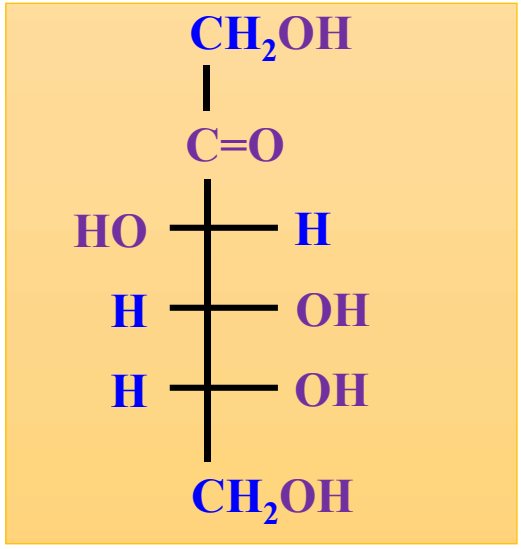
- **Fructose is an important ketohexose. It is obtained along with glucose by the hydrolysis of disaccharide,ex: sucrose.**




- **Molecular formula of fructose also found to be $C_6H_{12}O_6$ .**

## Fructose Structure

- On the basis of reaction, nature of it, in presence of plane polarisied light (optical activity) and position of hydroxyl group at chiral center, it can be represented as D – ( – ) – fructose.

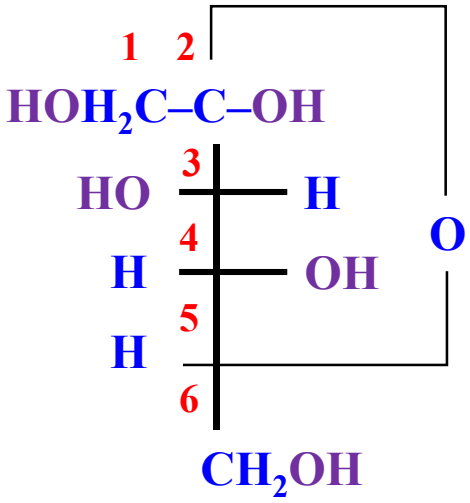



D– (–) –fructose

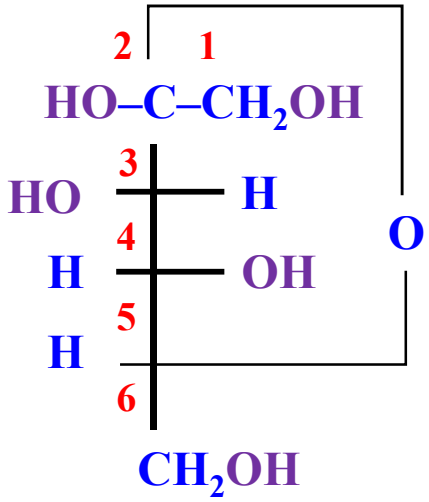
## Fructose Structure

It also exists in two cyclic forms which are obtai
$C_5$ to the $>C=O$ group.

These differ at $C_2$ - Carbon called epimers.



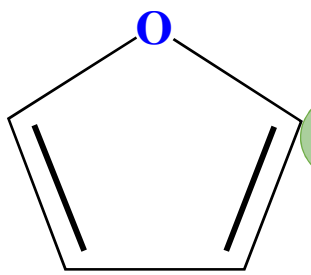

α – D – (–) –Fructofuranose




β – D – (–) –Fructofuranose

## Fructose Structure

**Furan is a five membered cyclic compound with one oxygen and four carbon atoms.**

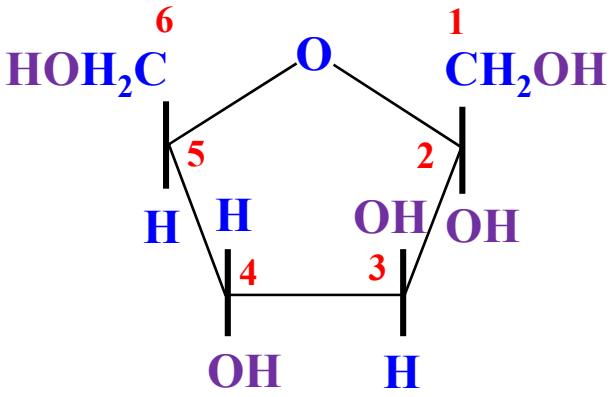



**Furan**

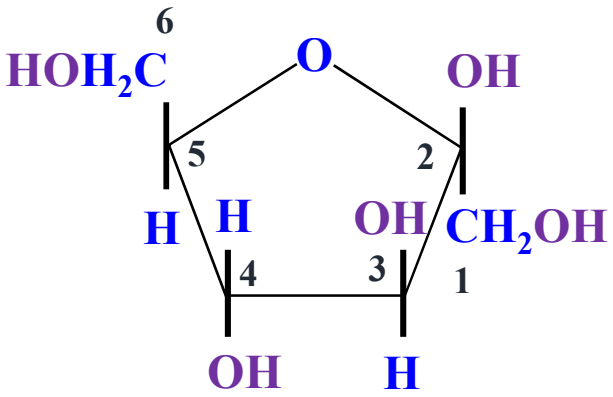
**The ring, thus formed is a five membered ring and is named as furanose with analogy to the compound furan.**

## Fructose Structure

**The cyclic structures of two anomers of fructose are represented by Haworth structures as given.**




α – D – (–) – Fructofuranose




β – D – (–) – Fructofuranose

MCQs

**1) Five membered ring structure of glucose is known as**

**1) Haworth structure**

**2) Furanose**

**3) Pyranose**

**4) Baeyer's structure**

MCQs

2) $\alpha$-D-glucose and $\beta$-D-glucose are examples of

1) Enantiomers

2) Tautomers

3) Anomers

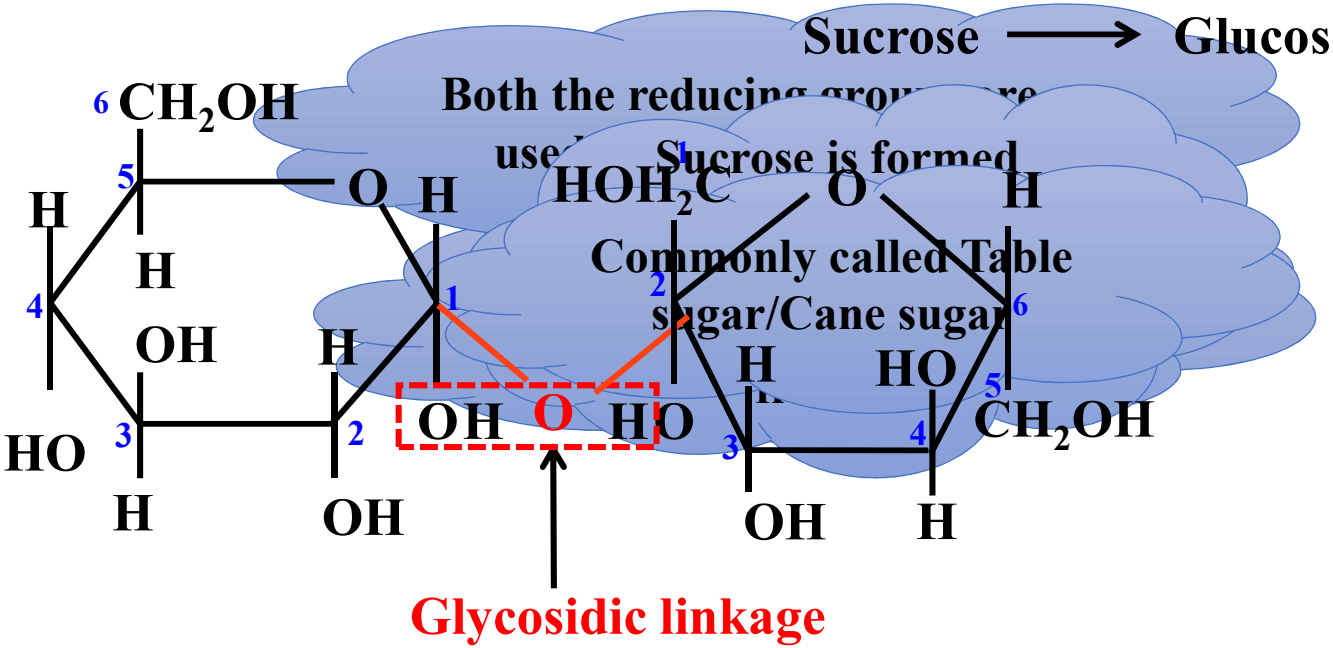
4) Epimers

# STRUCTURES OF SUCROSE & LACTOSE

## Structures of disaccharides

## Structure of sucrose

Sucrose ⟶ Glucose + Fructose



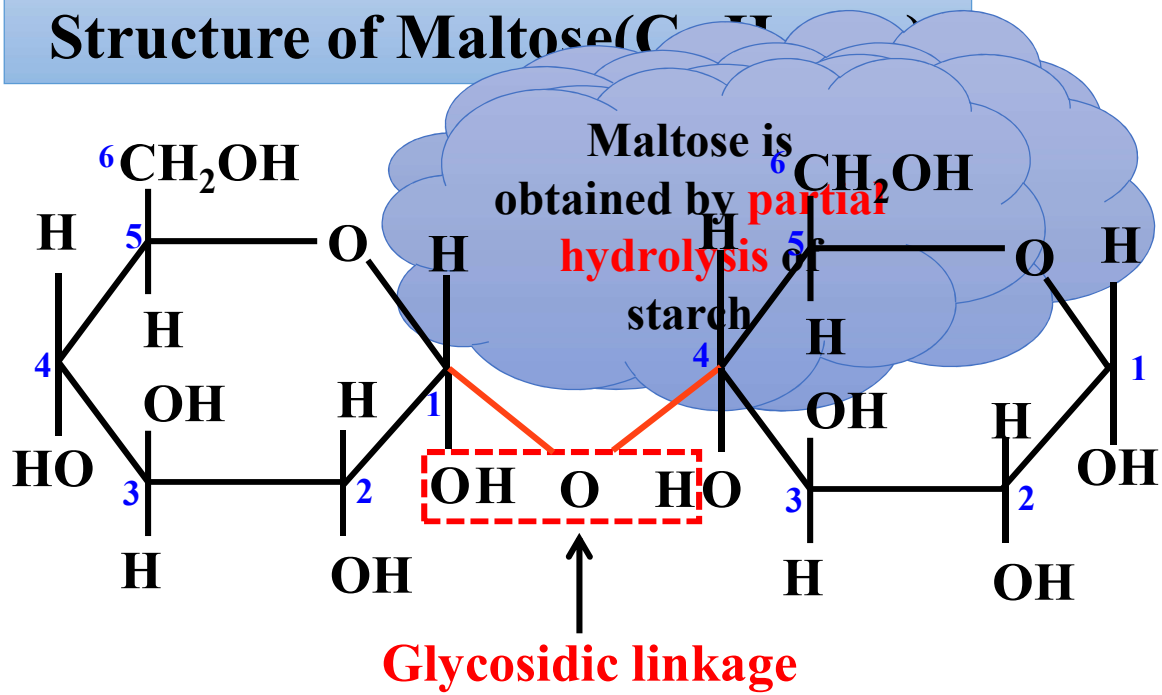

α – D – Glucopyranose

β – D – Fructofuranose

## Invert sugar:

- **Sucrose is dextrorotatory but after hydrolysis it gives dextrorotatory glucose ($+52.5^0$) and laevo rotatory fructose($-92.4^0$) .**
- **As a result sucrose brings about a change in the sign of rotation from dextro(+) to laevo(-) and the product is named as invert sugar.**

## Structure of Maltose($C_{12}H_{22}O_{11}$)

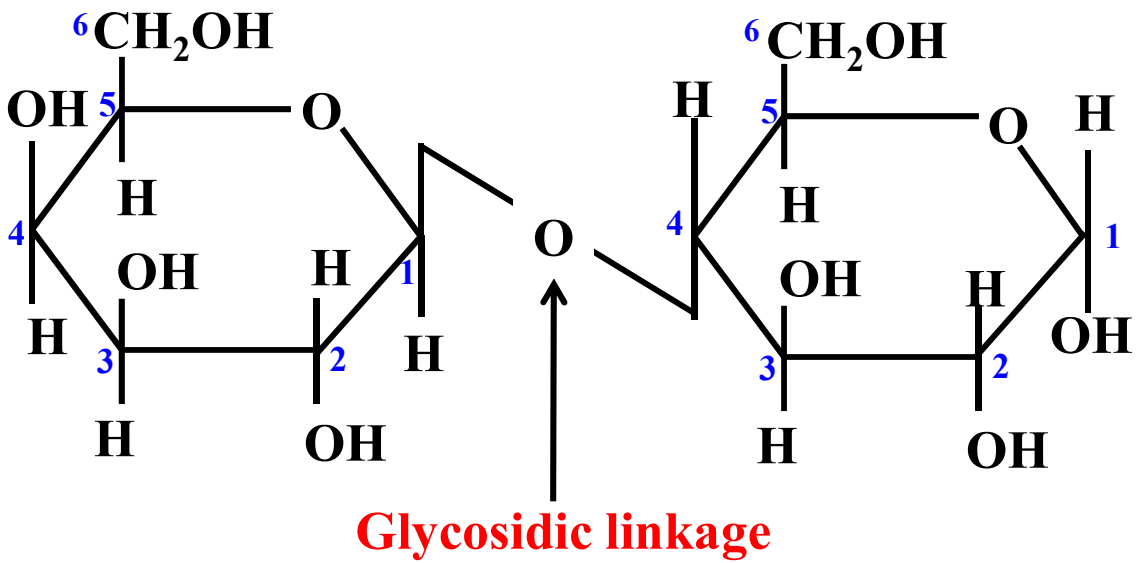



α – D – Glucopyranose α– D – Glucopyranose

## Structure of lactose

- **It is composed of β – D – galactose and β–D– glucose.**
- **the glycosidic linkage present between C – 1 of galactose and C – 4 of glucose .**
- **This is also known as milk sugar.**

## Structure of lactose



# MCQs

**1) Invert sugar is a mixture of...**

**a) d- glucose ($+52.5^0$) and l- fructose($-92.4^0$).**

**b) d- glucose ($+92.4^0$) and l- fructose($-52.5^0$).**

**c) l - glucose ($+52.5^0$) and d- fructose($-92.4^0$).**

**d) d- glucose ($-52.5^0$) and l- fructose($+92.4^0$).**

MCQs

**2) Glycosidic linkage between...**

**a) $C_1$ & $C_2$**

**b) $C_2$ & $C_4$**

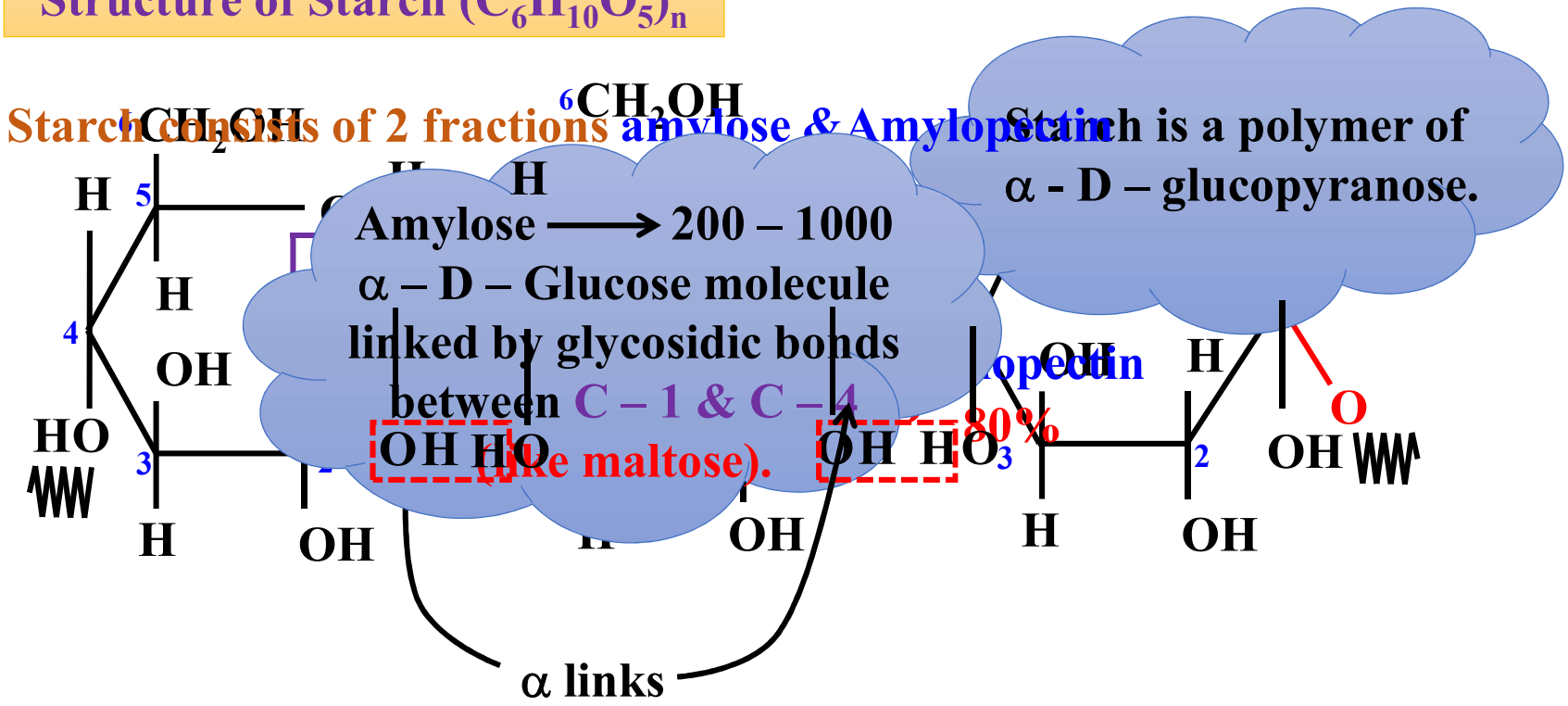
**c) $C_1$ & $C_4$** ✓

**d) $C_1$ & $C_5$**

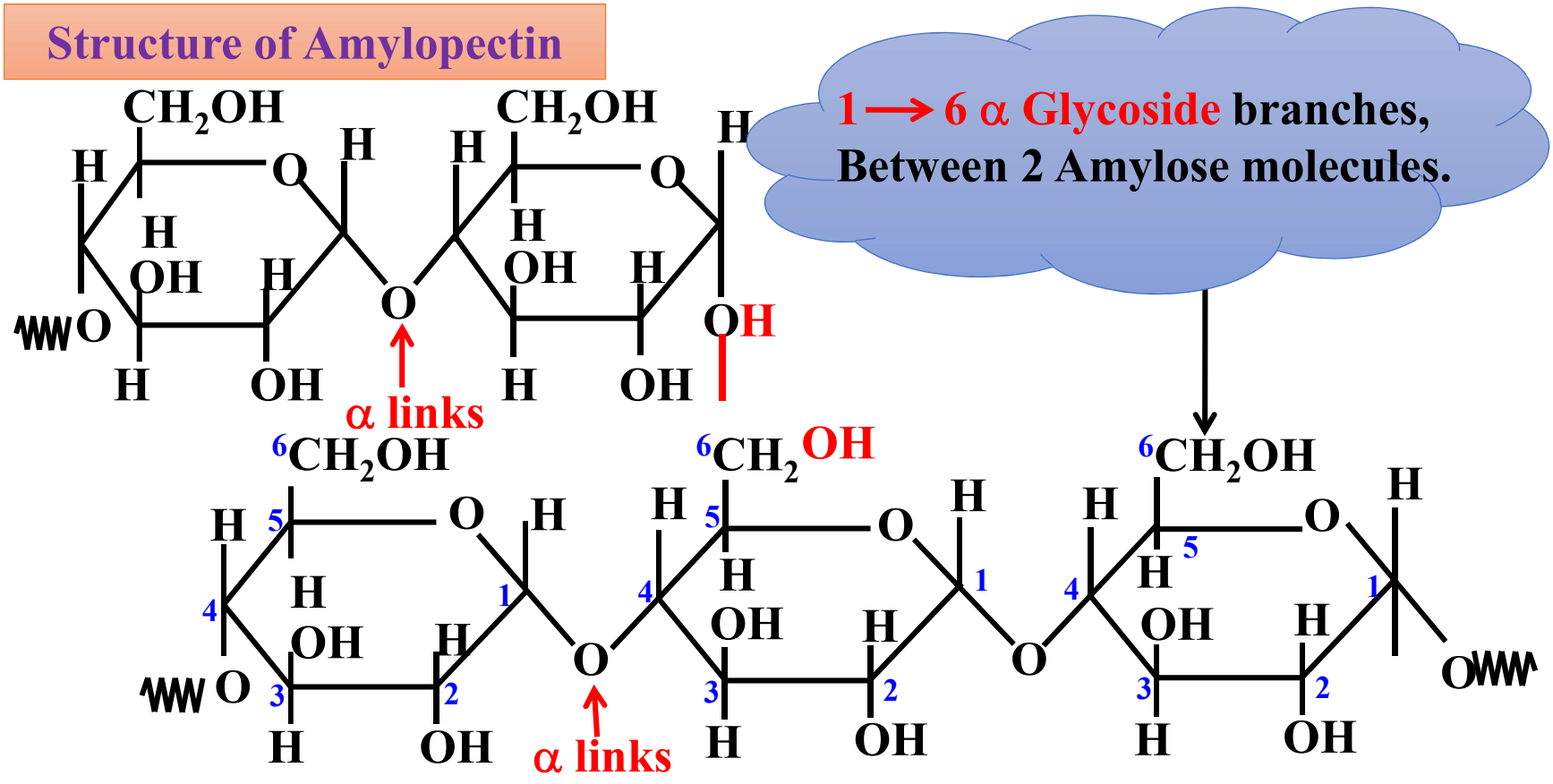
# STRUCTURE OF POLYSACCHARIDES & IMPORTANCE OF CARBOHYDRATES

## Structure of Starch $(C_6H_{10}O_5)_n$

Starch consists of 2 fractions amylose & Amylopectin



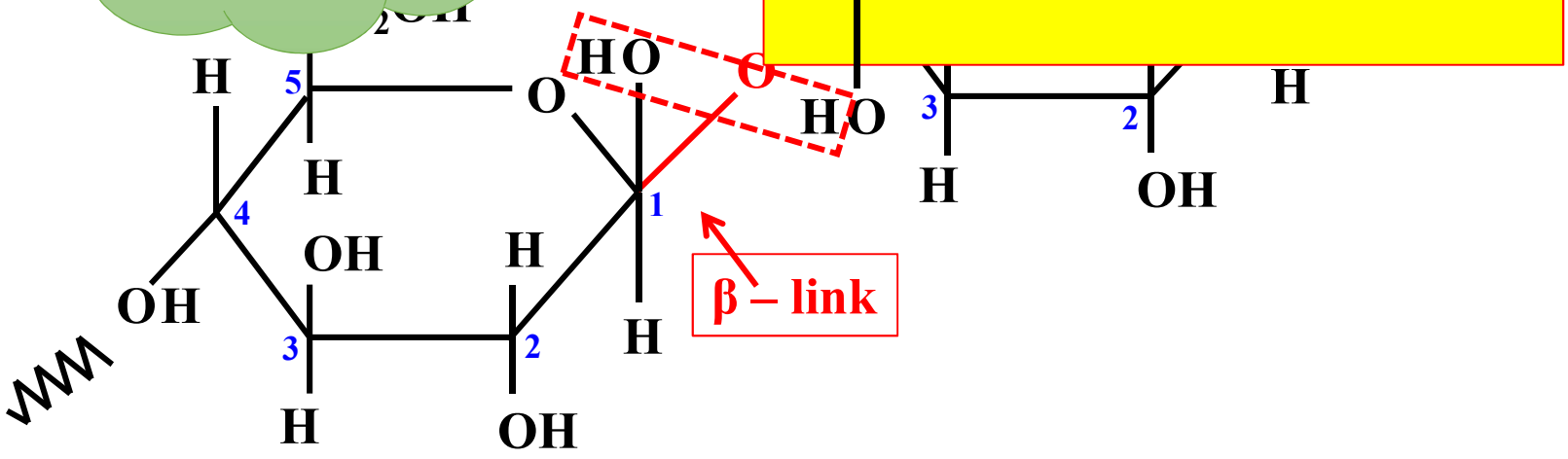
## Structure of Amylopectin



## Structure of Cellulose $(C_6H_{10}O_5)_n$

Long unbranched polymer

Cellulose consist of 2 glucose molecules joined by β – linkages thus, cellulose consist of 1 → 4 β glycoside linkages



## Glycogen

**The carbohydrates are stored in animal body as glycogen.**

## Sources:

**Liver, muscles, brain, yeast and fungi.**

## Structure of Glycogen

**Structurally similar to amylopectin and is rather more branched than amylopectin of starch.**

## Uses:

**When the body needs glucose enzymes break the glycogen down to glucose.**

## Importance of carbohydrates

- **Carbohydrates are essential for life in both plants and animals.**
- **Honey is carbohydrate used as an instant source of energy by ‘vaids’ in ayurvedic system of medicine.**
- **Carbohydrates are used as storage molecules.**
- **Carbohydrates are used to build furniture(wood).**

## Importance of carbohydrates

- **Carbohydrates used as raw materials for many important industries like textiles, paper, licquers and breweries.**
- **Carbohydrates in the form of D-ribose and 2-deoxy-D-ribose are present in nucleic acids.**
- **Carbohydrates are found in bio system in combination with many proteins and lipids.**

# MCQs

**1) The link between glucose units in starch is ...**

**a) β – link.**

**b) α – link.**

**c) α - glycosidic link.**

**d) α – peptide link.**

MCQs

**2. Amylopectin is a polymer of**

**1) Amylase**

**2) $\alpha - D -$ glucose**

**3) $\beta - D -$glucose**

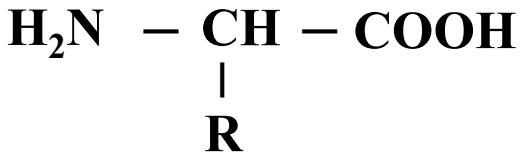
**4) Amino acid**

# AMINO ACIDS & CLASSIFICATIONS
# PART- I

## Amino Acids

- **The compounds which contain amino ($-NH_2$) and carboxyl (-COOH) functional groups are called amino acids.**

**On hydrolysis, proteins produce only α – amino acids.**

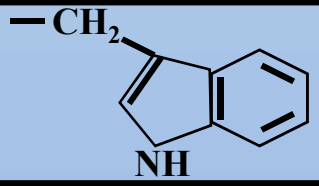
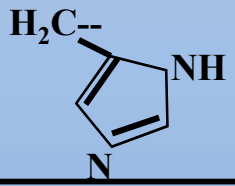
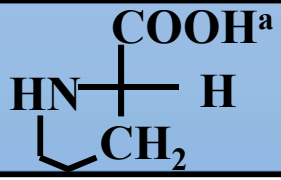


| Name of the amino acids | Characteristic feature of side chain, R | Three letter symbol | One letter Code |
|---|---|---|---|
| 1. Glycine | H | Gly | G |
| 2. Alanine | $-CH_3$ | Ala | A |
| 3. Valine* | $(H_3C)_2CH-$ | Val | V |
| 4. Leucine* | $(H_3C)_2CH-CH_2-$ | Leu | L |

| Name of the amino acids | Characteristic feature of side chain, R | Three letter symbol | One letter Code |
|---|---|---|---|
| 5. Isoleucine* | $H_3C-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2-$ | Ile | I |
| 6. Arginine * | $HN=\underset{\displaystyle NH_2}{\underset{|}{C}}-NH-(CH_2)_3-$ | Arg | R |
| 7. Lysine* | $H_2N-(CH_2)_4-$ | Lys | K |
| 8. Glutamic acid | $HOOC-CH_2-CH_2^-$ | Glu | E |

| Name of the amino acids | Characteristic feature of side chain, R | Three letter symbol | One letter Code |
|---|---|---|---|
| 9. Aspartic acid | $HOOC - CH_2-$ | Asp | D |
| 10.Glutamine | $H_2N-\overset{\overset{O}{\|\|}}{C}-CH_2 - CH_2-$ | Gln | Q |
| 11. Asparagine | $H_2N- \overset{\overset{O}{\|\|}}{C}-CH_2-$ | Asn | N |
| 12. Threonine * | $H_3C-CHOH^-$ | Thr | T |

| Name of the amino acids | Characteristic feature of side chain, R | Three letter symbol | One letter Code |
|---|---|---|---|
| 13. Serine | $HO - CH_2-$ | Ser | S |
| 14.Cysteine | $HS-CH_2-$ | Cys | C |
| 15. Methionine * | $H_3C- S-CH_2-CH_2-$ | Met | M |
| 16. Phenyalalanine* | $C_6H_5-CH_2^-$ | Phe | F |

| Name of the amino acids | Characteristic feature of side chain, R | Three letter symbol | One letter Code |
|---|---|---|---|
| 17. Tyrosine | (p)HO-$C_6H_4$-$CH_2$- | Tyr | Y |
| 18. Tryptophan * |  | Trp | W |
| 19. Histidine* |  | | H |
| 20. Proline |  | Pro | P |

a = entire structure

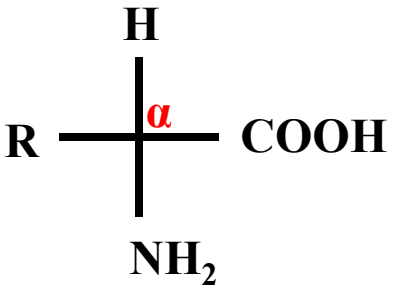
# Classification of Amino Acids

- Based on position of -$NH_2$ group.
- Based on nature.
- Based on importance.

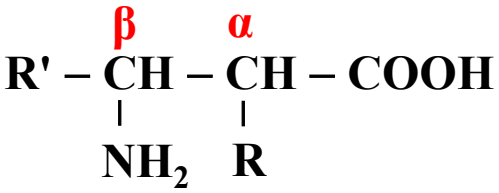
## Classification of Amino Acids

### Based on position of -$NH_2$ group

α – amino acid –




β – amino acid –



## Classification of Amino Acids

### Based on position of -$NH_2$ group

γ – amino acid → $R' - \overset{\gamma}{C}H(NH_2) - \overset{\beta}{C}H_2 - \overset{\alpha}{C}H(R) - COOH$

**Example: Glycine**

$NH_2 - \overset{\alpha}{C}H_2 - COOH$

α – amino acid

# MCQs

**1) Amino acids consist of...**

**a) $-NH_2$ group only.**

**b) – COOH group only.**

**c) Both – $NH_2$ & – COOH groups.**

**d) – $NH_2$ & – $SO_3H$.**

MCQs

**2) A sulphur containing amino acid is**

**1) Glycine**

**2) Cysteine**

**3) Alanine**

**4) Leucine**

# AMINO ACIDS & CLASSIFICATIONS
# PART- II

# Classification of Amino Acids

## Based on nature

**On the basis of number of $-NH_2$ and – COOH groups, amino acids are classified as :**

1. **Acidic.**
2. **Basic.**
3. **Neutral.**

## Classification of Amino Acids

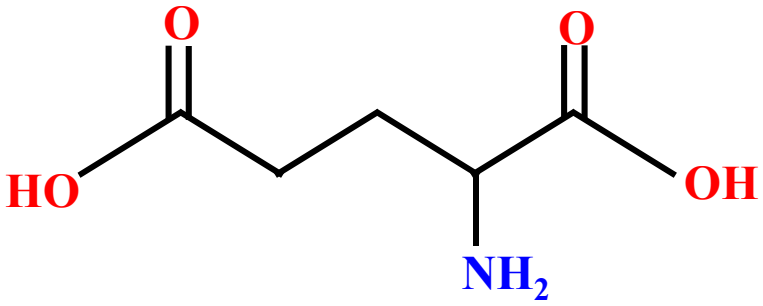
### Based on nature

### 1. Acidic 'Amino acids'

**These amino acids contain more '–COOH' groups than '– $NH_2$' groups and hence these are acidic.**

**Example:**

**Glutamic acid**



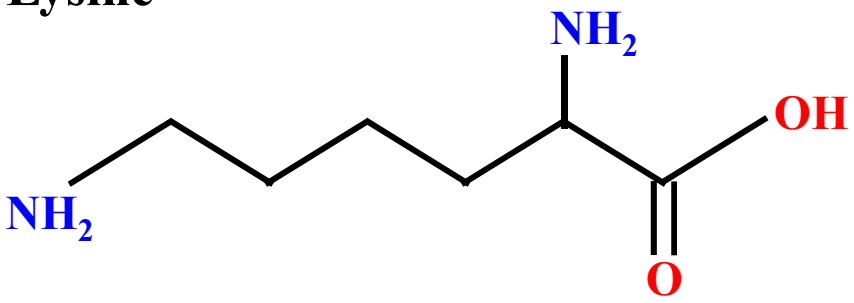
## Classification of Amino Acids

**Based on nature** | **2. Basic 'Amino acids'**

**These amino acids contain more amino groups than carboxyl group and hence these are basic.**

**Example :**

**Lysine**



## Classification of Amino Acids

**Based on nature** | **3. Neutral 'Amino acids'**

**Equal number of amino and carboxyl groups are neutral.**

**Example :**

**Glycine**

$$NH_2 - CH_2 - COOH$$

## Based on Importance

1. Essential amino acids.

2. Non- essential amino acids.

## Based on Importance

### 1. Essential amino acids

**The amino acids which cannot be synthesized in the body are called *essential amino acids.***

**Example :**

**Valine, leucine, Isoleucine etc..**

## Based on Importance

### 2. Non- Essential amino acids :

**The amino acids which can be synthesized in the body are called *non essential amino acids.***

**Example :**

**Glycine, alanine, glutamic acid etc…**

MCQs

**1) The essential amino acid is ...**

**a) Glycine.**

**b) alanine.**

**c) glutamic acid.**

**d) Isoleucine.**

**Hints & Solutions**

**The amino acids which cannot be synthesized in the body are called *essential amino acids***

MCQs

**2) The basic amino acids are**

**1) Lysine, arginine**

**2) Alanine,glutamic acid**

**3) Proline, valine**

**4) Alanine, cystein**

**Hints & Solutions**

**These amino acids contain more amino groups than carboxyl groups and hence these are basic**

MCQs

3) The acidic amino acid is

1) Aspartic acid

2) Alanine

3) Serine

4) Tyrosine

**Hints & Solutions**

Aspartic acid contain more '–COOH' groups than '– $NH_2$' groups

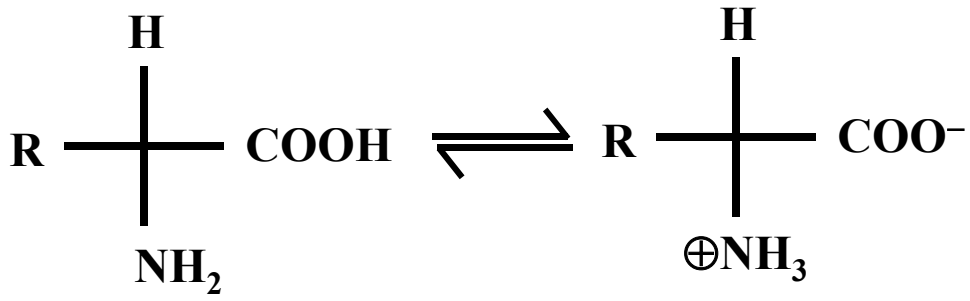
# CHARACTERISTIC PROPERTIES OF AMINO ACIDS & NOMENCLATURE

## Characteristic properties of amino acids:

- **Colourless, crystalline solids.**
- **Soluble in water.**
- **They have high melting point.**
- **Behave like  salts rather than simple amines or carboxylic acids .**

## Characteristic properties of amino acids:

- In aqueous solution, the carboxyl group can lose a proton and amino group can accept that proton, giving rise to a dipolar ion known as " **ZWITTER ion".**



## Nomenclature of amino acids:

- **All α – amino acids have trivial names.**

**Example :**

**Glycine ( In greek glykos means sweet).**

**Tyrocine ( In greek tyros means cheese).**

## Representation of α – amino acids:

- **Amino acids are represented by three letter symbol, sometimes one letter symbol.**

**Example :**

**Glycine ( Gly or G).**

**Alanine ( Ala or A).**

## Representation of α – amino acids:

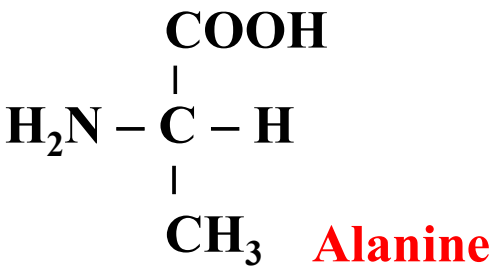
- **In zwitter ion form, amino acids show amphoteric behaviour as they react both with acids & bases.**

  **Except Glycine, all other naturally occurring amino acids are optically active.**

- **These exist both in D and L- forms.**

- **Most naturally occurring amino acids have L- configuration.**

## Representation of α – amino acids:



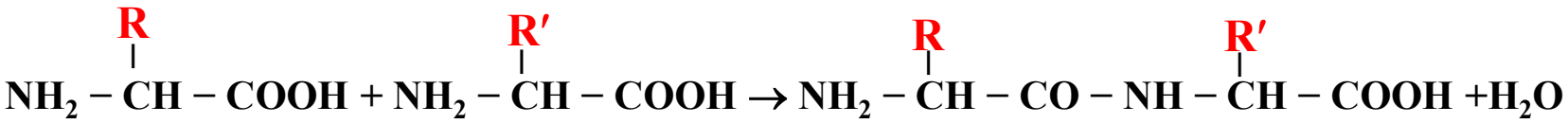

Alanine

## Isoelectric point:

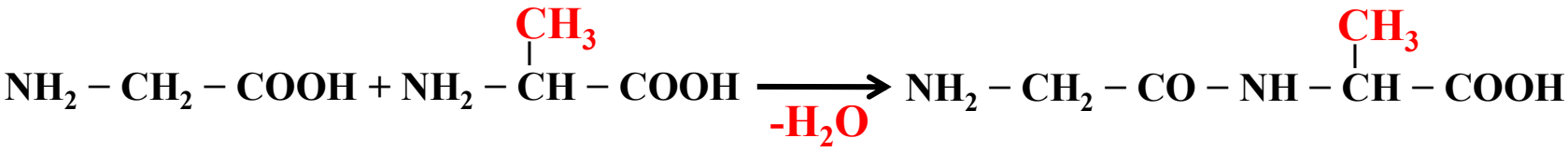
- **The $p^H$ at which the amino acid does not migrate to cathode or anode in an electric field is called *isoelectric point.***
- **In neutral amino acids, isoelectric point $p^H$ range is 5.5 to 6.3.**
- **In basic amino acids, isoelectric point $p^H$ range is7.6 to 10.8 .**
- **At isoelectric point, concentration of zwitter ion is maximum and the solubility of amino acids is minimum.**

**So different amino acids are separated at isoelectric point.**

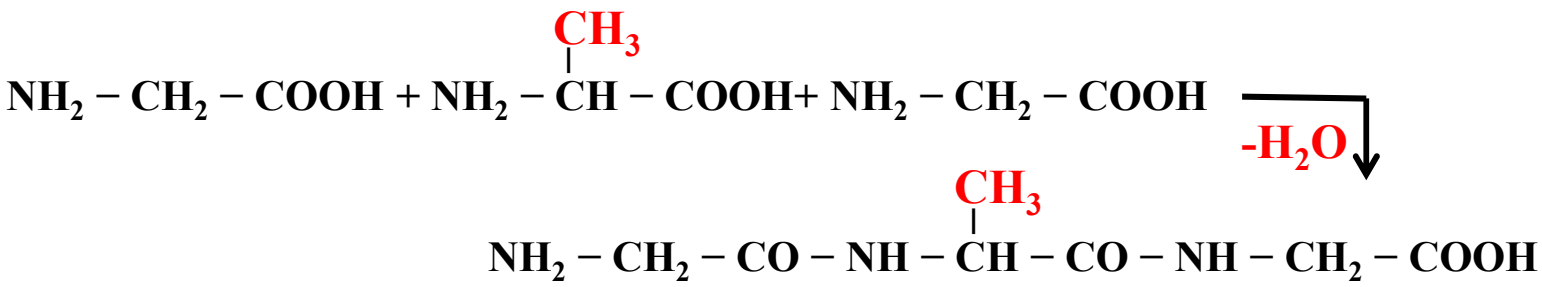
**The amide bond formed between the amino group of one amino acid and carboxyl group of another amino acid by the loss of water molecule is called peptide bond ( CO-NH) and the obtained product is called *peptide.***



**The product obtained when two amino acid molecules are combined with a peptide bond is called *dipeptide.***




**When three amino acids are combined with two peptide linkages, the obtained product is called *tripeptide.***



**Similarly when four, five or six amino acids are linked with peptide linkages, the respective products are known as tetrapeptide, pentapeptide or hexapeptide respectively.**

**The product obtained when a large number of amino acids are combined with peptide linkage is called polypeptide.**

**High molecular weight polypeptides are called proteins.**

# MCQs

**1) Which of the following molecules is capable of forming Zwitter ion**

1) $NH_2CH_2COOH$
2) $CH_3COOH$
3) $CH_3CH_2NH_2$
4) $CCl_3NO_2$

# MCQs

**2) Amino acids are...**

**a) Colourless, crystalline solids & insoluble in water.**

**b) Colourless, crystalline solids & Soluble in water.**

**c) Coloured, crystalline solids & Soluble in water.**

**d) Colourless, amorphous solids & Soluble in water.**

# MCQs

**3) Which of the following statements is not correct?**

**1) Proteins are poly amides formed from amino acids**

**2) Except glycine, all other amino acids show optical activity**

**3) Natural proteins are made up of L – isomers of amino acids**

**4) In $\alpha$–amino acids $-NH_2$ and –COOH groups are attached to different carbon atoms**

# PROTEINS
# &
# STRUCUTRE OF PROTEIN

## Proteins

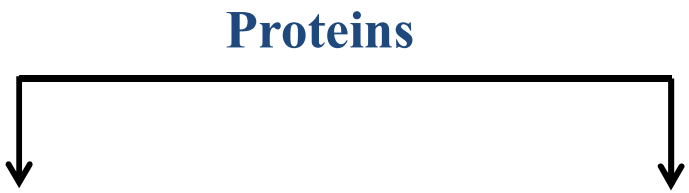
- **The word protein is derived from Greek word, "proteios" which means primary or prime importance.**
- **Proteins are the most abundant biomolecules of the living system.**
- **Chief sources of proteins are milk, cheese, pulses, peanuts, fish, meat etc.**

## Proteins

- They are present in every part of the body and form the fundamental basis of structure and functions of life.
- They are also required for growth and maintenance of body.

- All proteins are polymers of α-amino acids.

## Classification of proteins (On the basis of structure)

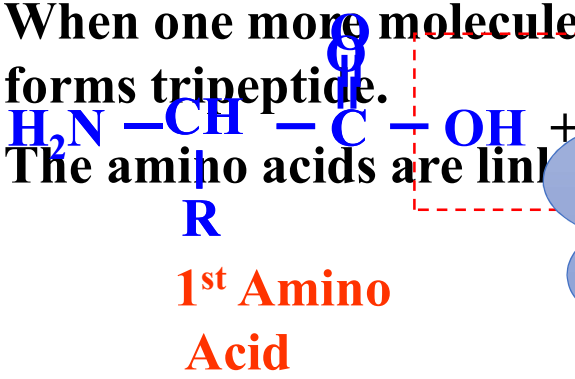



**(Chains of Amino acids lie side by side )**

**(Chains of Amino Acids fold to give a globular structure)**

## Structure of Peptide Bond in Proteins

When one more molecule of ami[illegible] it forms tripeptide.




The amino acids are linl[illegible]

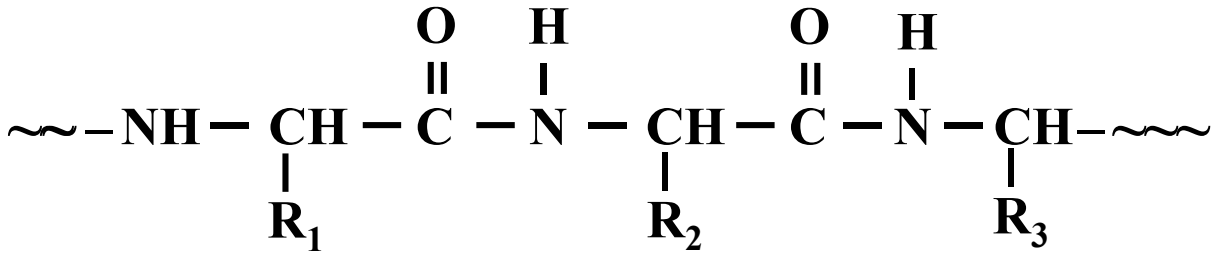
Peptide bond or peptide linkage is an amide formed between –COOH and – $NH_2$ group by elimination of a water molecule.

Amide bond

## Structure Of Protiens

### i) Primary structure :

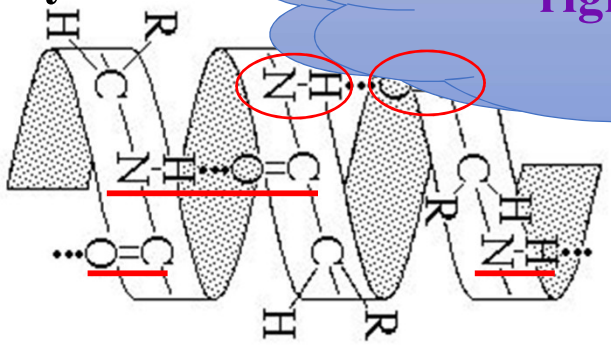
**The primary structure of proteins refers to the sequence of amino acids held together by peptide bonds .**



## Secondary Structure Of Protiens

**Long amino acid chains exist in [illegible] give a particular shape [illegible] secondary structure.**

**Chain gets coiled by twisting into right handed spiral known as α- helix.**



**Hydrogen bonding between –C(=O)– and –NH–**

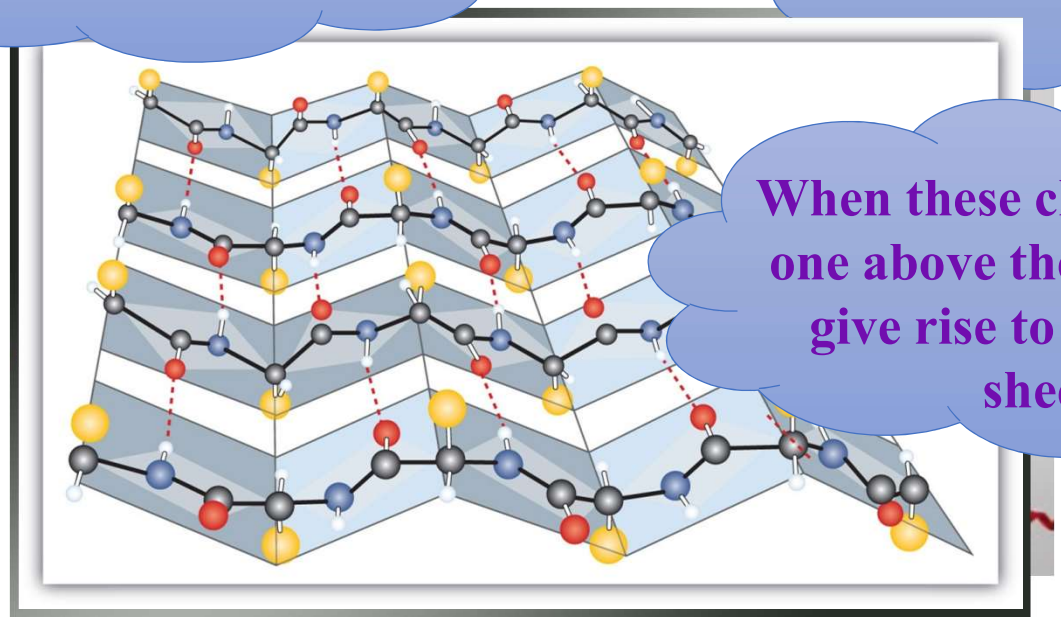
**occurs in different parts of same chain resulting in folding of polypeptides.**

These chains get fully stretched or extend sheet.

but they by

The pleats run from front to back.

Resulting into a sheet like structure.



When these chains are placed one above the other, they give rise to β pleated sheets.

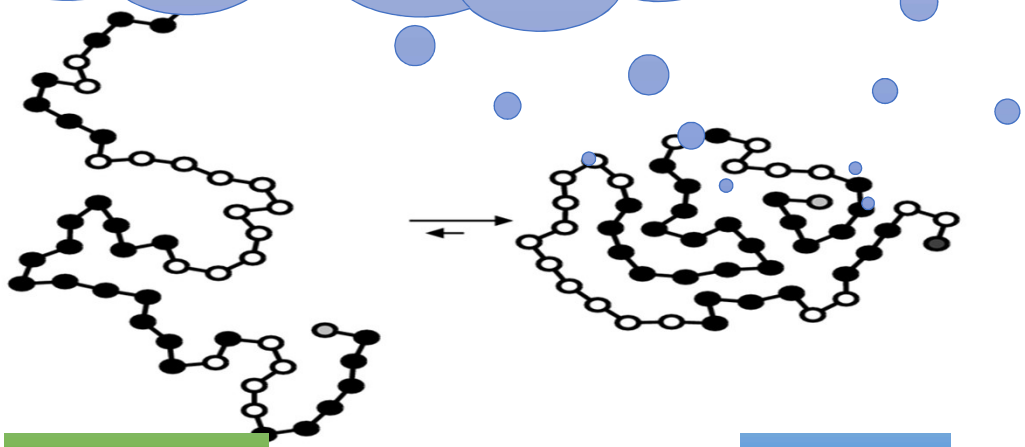
## Tertiary Structure Of Protiens

Electrostatic force of attraction.

er Waals forces.

Hydrogen bonds.

Disulphide linkage.



Unfolded

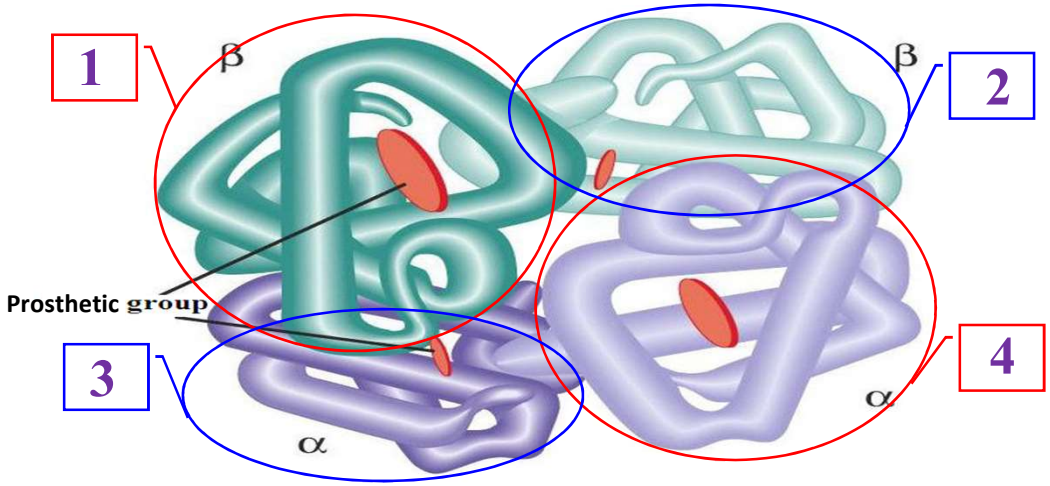
Folded

## Quaternary Structure Of Proteins

**The proteins composed of two or more polype red to as sub units.**

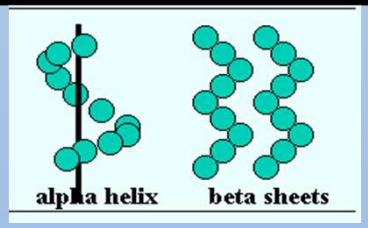
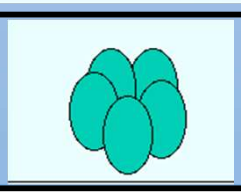
**Quaternary structure refers to the spatial ar sub units with respect to each other.**

**Here 4 sub units of proteins are arranged in a single unit.**




Primary structure
Folding
Secondary
Folding
Tertiary
Folding
Quaternary

# Protein Structure(summary)

| | Structure summary:- | |
|---|---|---|
| **Primary** | | **Glu-Arg-Phe-Gly** |
| **Secondary** | **Characteristic structures that occur in many proteins (E.g. alpha helix, beta sheets)** |   |
| **Tertiary** | **Three dimensional structure of proteins** |   |
| **Quaternary** | **Three dimensional structure of proteins composed of multiple sub units** |  |

# MCQs

**1) Which of the following contains nitrogen.**

**1) Fats**

**2) Proteins**

**3) Carbohydrates**

**4) None**

# MCQs

**2) Secondary strucure of protein is...**

**a) coiled structure.**

**b) linear structure.**

**c) zig-zag structure.**

**d) All the above.**

# USES OF PROTEIN , DENATURATION OF PROTEINS & ENZYMES

## Uses of Proteins

- They are found in living cell and are present in skin, hair, muscle, nerves, enzymes, antibodies and hormones.
- As hormones, protein regulate metabolic processes.
- Proteins form the major part in immune system.
- Proteins help in general wear and tear of body organs.
- Regulation of metabolism and body temperature.
- Proteins are major factors of growth.

## Denaturation of Proteins

- **Protein found in a biological system with a unique three-dimensional structure and biological activity is called *a native protein.***
- **When a protein in its native form, is subjected to physical change like in temperature, chemical change or change in *pH*, the hydrogen bonds are disturbed.**
- **Due to this, globules unfold and helix gets uncoiled and protein loses its biological activity.**

## Denaturation of Proteins

- **This is called *denaturation of protein*.**
- **During denaturation $2^0$ and $3^0$ structures are destroyed but $1^0$– structure remains intact.**
- **The coagulation of egg white on boiling is a common example of denaturation.**
- **Another example is curdling of milk which is caused due to the formation of lactic acid by the bacteria present in milk.**

## Enzymes

- **Life is possible due to the coordination of various chemical reactions in living organisms.**

- **An example is the digestion of food, absorption of appropriate molecules and ultimately production of energy.**
- **This process involves a sequence of reactions and all these reactions occur in the body under very mild conditions.**

## Enzymes

- **This occurs with the help of certain biocatalysts called *enzymes*.**
- **Almost all the enzymes are globular proteins.**
- **Enzymes are very specific for a particular reaction and for a particular substrate.**
- **The non- protein component of enzyme molecule is called a *"Prosthetic group".***

## Enzymes

- **The " prosthetic group" that is covalently bonded with the enzyme component is called *"CO-FACTOR".***
- **The "prosthetic groups attached to the enzyme at the time of reaction are called *"CO-ENZYME".***
- **They are generally named after the compound or class of compounds upon which they work.**

## Enzymes

- Some times enzymes also named after the reaction in which they are used.

**Example :**

**The enzymes which catalyse the oxidation of one substrate with simultaneous reduction of another substrate are named as oxidoreductase enzymes.**

**The enzyme name ends with – "ase".**

## Enzymes

- **Enzymes are needed only in small quantities for the progress of a reaction.**
- **Similar to the action of chemical catalysts, enzymes are said to reduce the magnitude of activation energy.**

**Example:**

**The activation energy for acid hydrolysis of sucrose is 6.22 kJ $mol^{-1}$, while the activation energy is only 2.15 kJ $mol^{-1}$ when hydrolyzed by the enzyme (sucrase).**

**Some examples of enzyme catalysed reactions are**

**Conversion of glucose to ethyl alcohol.**

**(i)** $C_{12}H_{22}O_{11(aq)} + H_2O_{(\ell)} \xrightarrow{\text{invertase}} C_6H_{12}O_{6(aq)} + C_6H_{12}O_{6(aq)}$

**Cane sugar** **glucose** **fructose**

**(ii)** $C_{12}H_{22}O_{6(aq)} \xrightarrow{\text{Zymase}} 2C_2H_5OH_{(aq)} + 2CO_{2(g)}$

**glucose** **Ethyl alcohol**

# MCQs

**1) Coagulation of egg is...**

**a) Denaturation of protein.**

**b) Formation of protein.**

**c) Formation of vitamin.**

**d) Denaturation of vitamin.**

**2) Enzyme used in conversion of glucose to ethyl alcohol...**

**a) Invertase.**

**b) zymase.** ✔

**c) diastase.**

**d) Maltase.**

# VITAMINS

# Vitamins

## Definition :

**Vitamins are the organic substances required in the diet in small amount to perform specific biological functions and for normal maintenance of optimum growth in living organisms.**

**Vitamins**

### Water soluble

- These Vitamins are Soluble in water.
- They have low toxicity.
- Cannot be stored in body.

**Eg : Vit B & Vit C**

### Fat soluble

- These Vitamins are Soluble in fats.
- They have high toxicity.
- Can be stored in body.

**Eg : Vit A,D, E & K**

## Some important Vitamins

| Sl. no: | Name of vitamins | Chemical name | Source | Deficiency disease |
|---|---|---|---|---|
| 1 | Vitamin-A | Retinol | Fish liver oil, carrots, butter milk, dark green leafy vegetables | 1. xerophthalmia<br>2. night-blindness |

## Some important Vitamins

| Sl. no: | Name of vitamins | Chemical name | Source | Deficiency disease |
|---|---|---|---|---|
| 2 | Vitamin-D | Calciferol | Fish oil, butter milk, egg, sun light | 1. Rickets in children<br>2. Osteo-malacia in adult |

## Some important Vitamins

| Sl. no: | Name of vitamins | Chemical name | Source | Deficiency disease |
|---|---|---|---|---|
| 3 | Vitamin-E | Tocopherol | Vegetable oils like wheat germ oil, sunflower oil, egg yolk. | 1. Sterility<br>2. Neurosis of heart muscles |

## Some important Vitamins

| Sl. no: | Name of vitamins | Chemical name | Source | Deficiency disease |
|---|---|---|---|---|
| 4 | Vitamin-K | Antiham-orrhagic | Vegetable oil, cauliflower, canola oil, olive oil, animal foods | 1. Increased blood clotting time |

## Some important Vitamins

| Sl. no: | Name of vitamins | Chemical name | Source | Deficiency disease |
|---|---|---|---|---|
| 5 | $B_1$ | Thiamine | Cereals, yeast milk, green vegetables | Beri-Beri |

## Some important Vitamins

| Sl. no: | Name of vitamins | Chemical name | Source | Deficiency disease |
|---|---|---|---|---|
| 6 | $B_2$ | Riboflavin | milk, egg white, liver, kidney | Redness of tongue, cheilosis dermatitis |

# MCQs

**1) Chief source of Vitamin-A is...**

**a) Fish liver oil, carrots, butter milk.**

**b) egg, sun light.**

**c) Vegetable oil.**

**d) seeds.**

# MCQs

**2) Chemical name of Vitamin-K is...**

**a) Retinol.**

**b) Riboflavin.**

**c) Antihaemorrhagic.**

**d) Thiamine.**

## Some important Vitamins

| Sl. no: | Name of vitamins | Chemical name | Source | Deficiency disease |
|---|---|---|---|---|
| 7 | $B_5$ | Niacin (or) Nicotinic acid | Green leafy vegetables, egg, milk, yeast meat | Pellagra (rough skin) dermatitis diarrhoea |

## Some important Vitamins

| Sl. no: | Name of vitamins | Chemical name | Source | Deficiency disease |
|---|---|---|---|---|
| 8 | $B_3$ | pentothenic acid | All food stuffs | Burning feet |

## Some important Vitamins

| Sl. no: | Name of vitamins | Chemical name | Source | Deficiency disease |
|---|---|---|---|---|
| 9 | $B_6$ | pyridoxine | cereals, grams, yeast, meat, egg yolk | Dermatitis, convulsions |

## Some important Vitamins

| Sl. no: | Name of vitamins | Chemical name | Source | Deficiency disease |
|---|---|---|---|---|
| 10 | $B_7$ | Biotin & vitamin H | Yeast, liver, kidney, milk | Blood cholesterol increases, Paralysis, loss of hair |

## Some important Vitamins

| Sl. no: | Name of vitamins | Chemical name | Source | Deficiency disease |
|---|---|---|---|---|
| 11 | $B_9$ | Folic acid | Spinach leaves, intestinal bacteria | Anaemia inflammation of tongue |

## Some important Vitamins

| Sl. no: | Name of vitamins | Chemical name | Source | Deficiency disease |
|---|---|---|---|---|
| 12 | $B_{12}$ | Cyano - cobalamine | meat, liver, kidney, fish, milk | Pernicious anaemia, hyper glycemia |

## Some important Vitamins

| Sl. no: | Name of vitamins | Chemical name | Source | Deficiency disease |
|---|---|---|---|---|
| 13 | Vitamin –C | Ascorbic acid | citrus fruits, green leafy vegetables | Scurvy, delay in wound healing |

# MCQs

**1) Disease caused by lack of Vitamin-C is...**

**a) Scurvy.**

**b) Pernicious anaemia.**

**c) Antihaemorrhagic.**

**d) Anaemia inflammation of tongue.**

# MCQs

**2) Cyano cobalamine is...**

**a) $B_1$ – Vitamin.**

**b) $B_2$ – Vitamin.**

**c) C – Vitamin.**

**d) $B_{12}$ – Vitamin.**

# NUCLEIC ACIDS

## Nucleic acids

Nucleic acids resemble proteins even thou ent.

These compounds are the substances of heredity.

The polynucleotide chain (polyester chain) i cleic acid molecule.

It is an ester of phosphoric acid with sugar.

In the nucleus of a cell, the chromosomes are made up of nucleoproteins which contain two types of nucleic acids, RNA and DNA.

## Nucleic acids

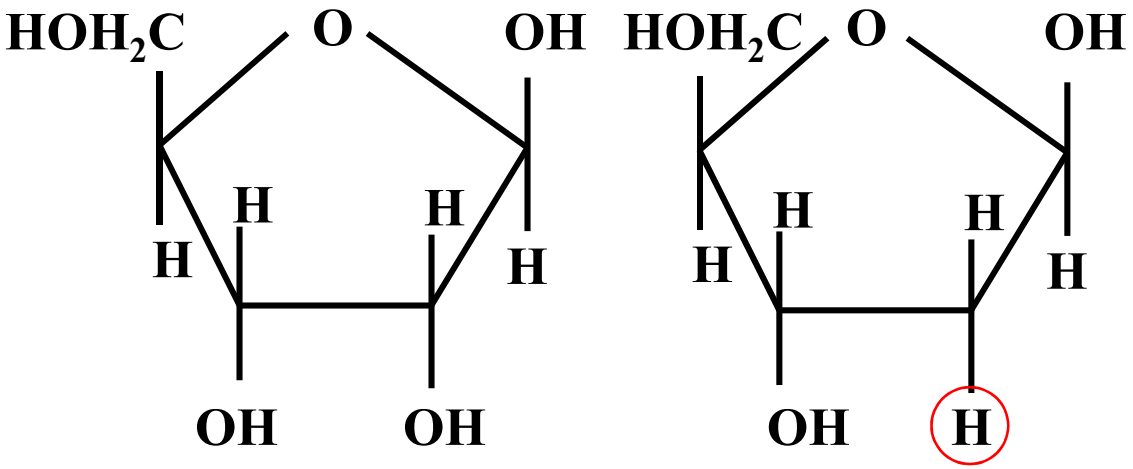
DNA ⟹ Deoxy ribose Nucleic acid

RNA ⟹ Ribose Nucleic acid

In DNA the oxygen is removed from the 2nd carbon atom.

β – D – ribose

β – D – 2 – de

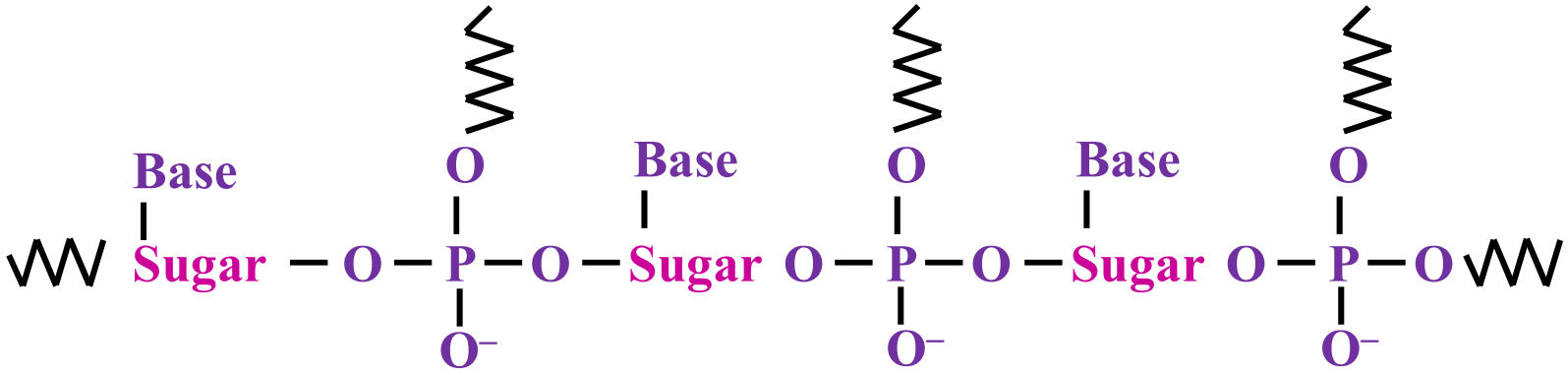


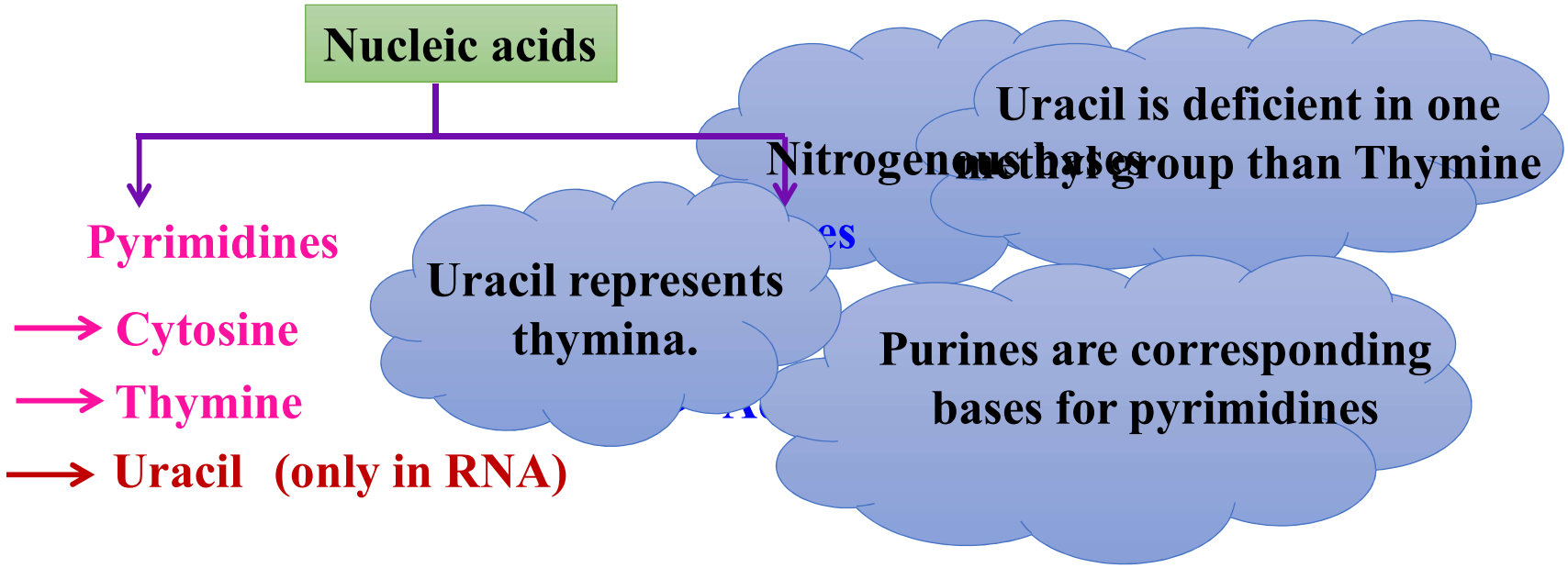
## Structure of nucleic acids

Polynucleotide chain

- A chain is made from many nucleotides
- Every Nucleic Acid is made out of **Sugar backbone (RIBOSE),**

**Nitrogenous base and phosphoric linkages**



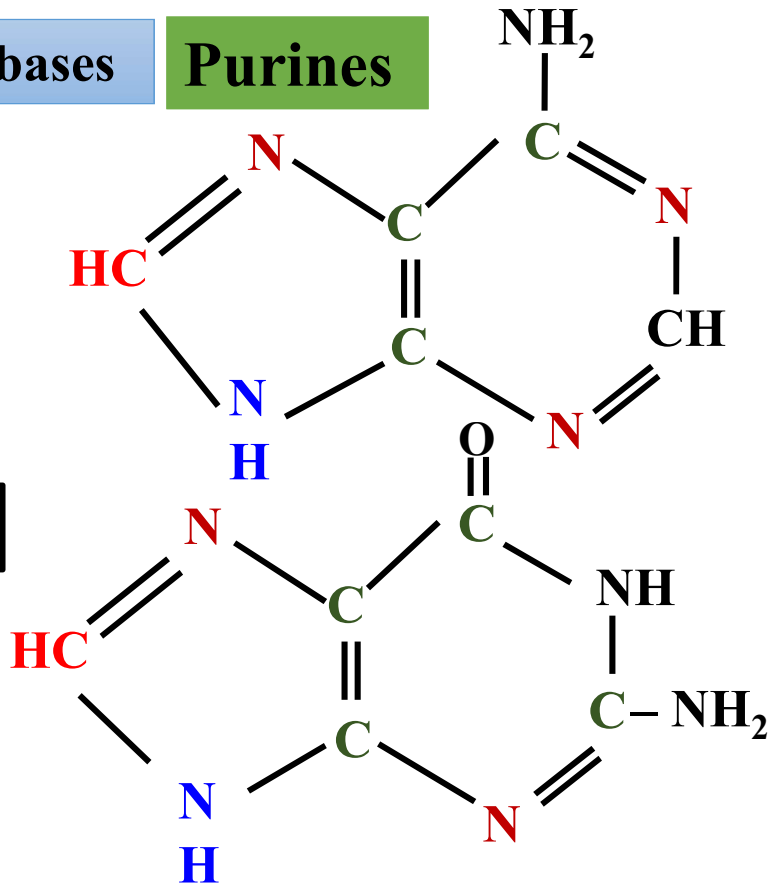

Nucleic acids
Pyrimidines
Cytosine
Thymine
Uracil (only in RNA)
Uracil represents thymina.
Uracil is deficient in one methyl group than Thymine
Purines are corresponding bases for pyrimidines

## Structure of Nitrogen bases

## Purines

i) **Adenine**

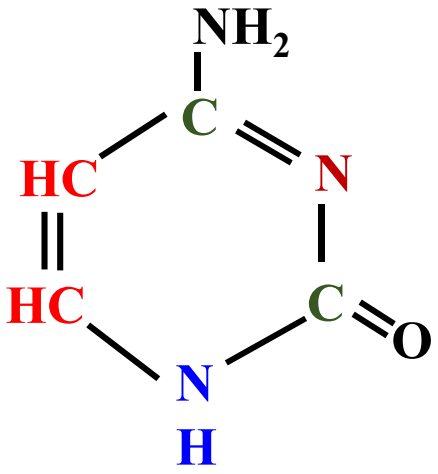
ii) **Guanine**



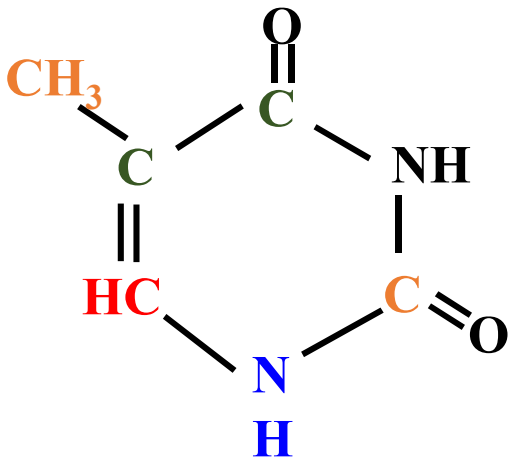
## Structure of Nitrogen bases

## Pyrimidines

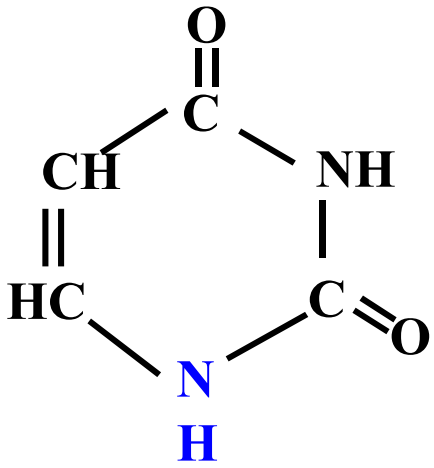
**Cytosine**




**Thymine**

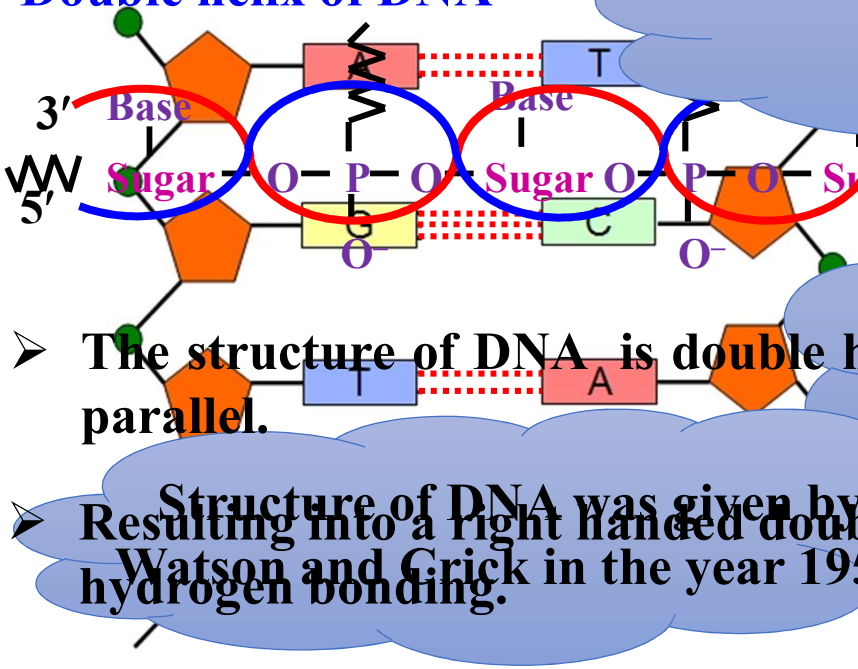



**Uracil**



## Structure of DNA and RNA

### Double helix of DNA




Due to hydrogen bonding, structure of DNA appeared as Helix structure.

DNA is a chain made up of nucleotides joined together through phosphodiester linkage.

- The structure of DNA is double helix with two strands running parallel.
- Resulting into a right handed double helix due to hydrogen bonding.

Structure of DNA was given by Watson and Crick in the year 1953

# MCQs

**1) DNA means...**

**a) Deoxy ribose Nucleic acid.**

**b) Oxy ribose Nucleic acid.**

**c) Ribose Nucleic acid.**

**d) Nucleic acid.**

# MCQs

**2) Uracil is...**

**a) Pyrimidines unit.** ✓

**b) Purine unit.**

**c) 5 membered ring.**

**d) Nucleic acid.**

# HORMONES

## Hormones

Name is derived from a Greek word 'Hormosin'

Hormones are the secretions of endocrine g

Hormones are easily diffusible, have low molecular weig d affect biological processes.

Hormones are normally derived from amino acids, Peptides, proteins and Steroids.

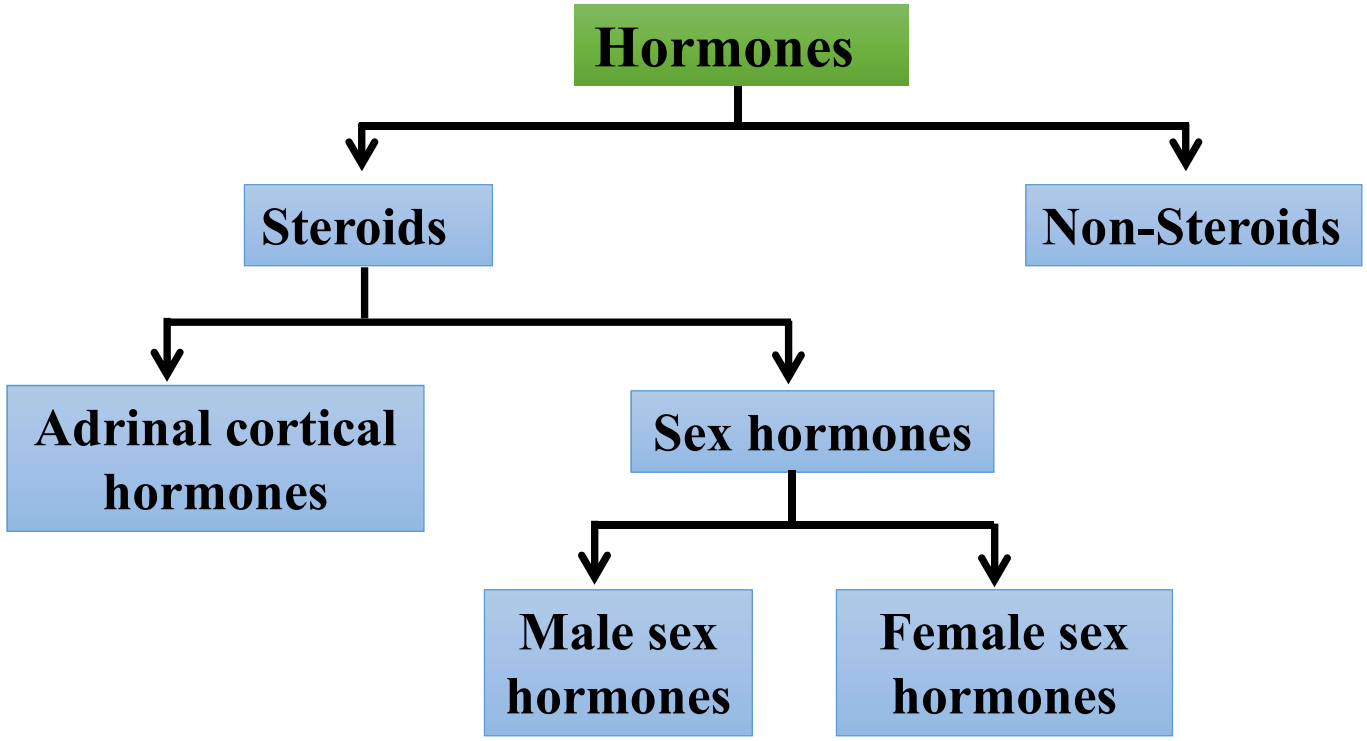
The mode of action of enzymes and hormones is similar.

They are produced in very small amounts and regulate vital body functions.

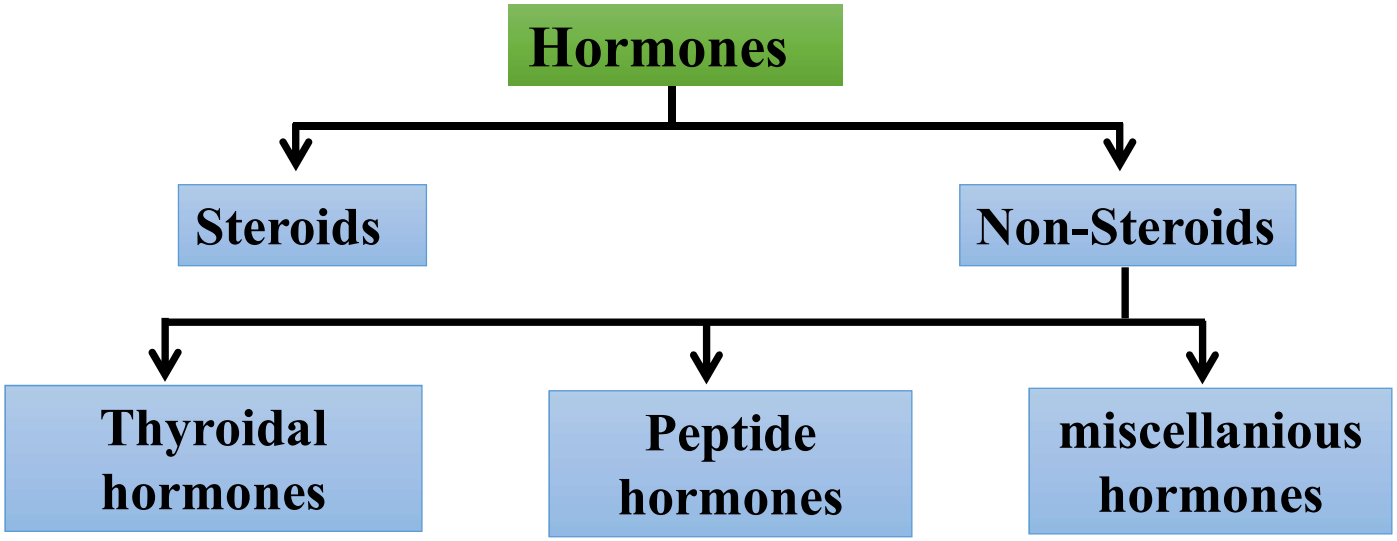
## Hormones

- **The hormones are molecules that act as inter cellular messengers.**
- **These are produced by endocrine glands in the body & are released directly into the blood stream.**
- **Hormones have several functions in the body.**
- **They help to maintain the balance of biological activities in the body.**
- **Plant hormones are also called *growth hormones.***
- **All hormones are generally proteins but not all of them are proteins.**

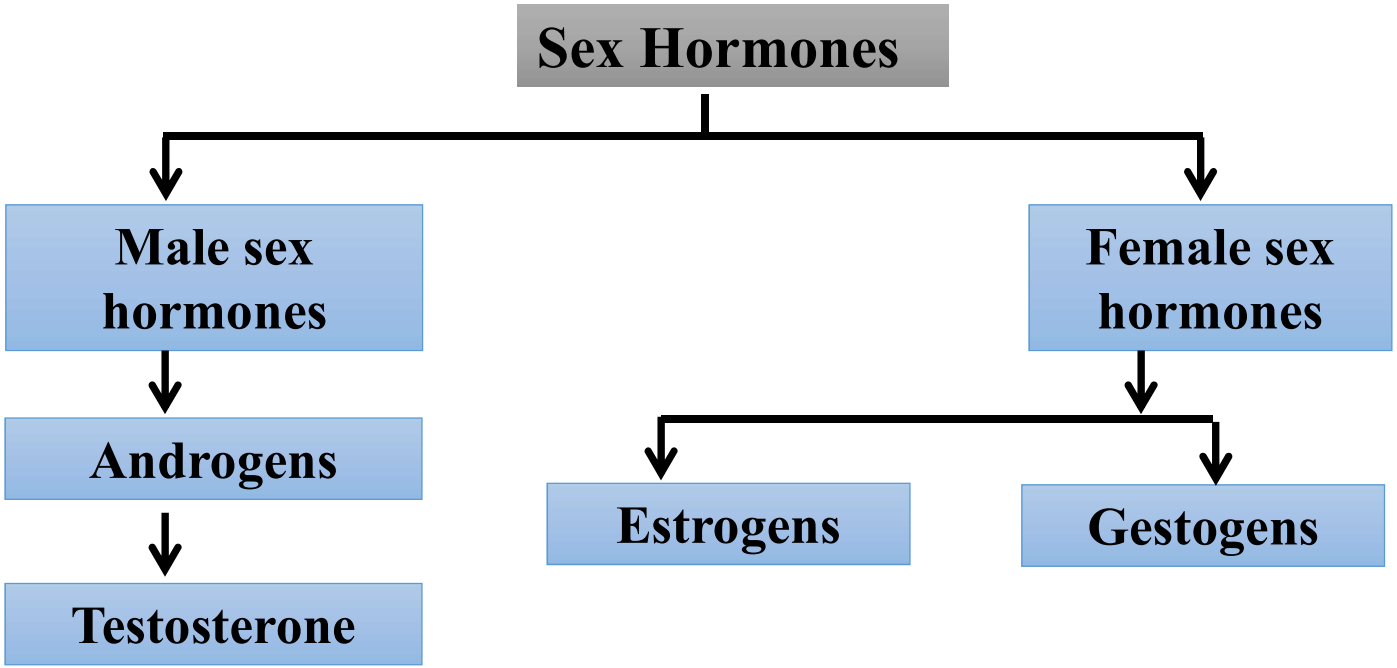
# Classification of hormones



# Classification of hormones



# Functions of hormones



| Sex hormones | organs of the secretion | Functions |
| --- | --- | --- |
| Androgens | Testes | Control the development & normal functioning of male sex organs |

| Sex hormones | organs of the secretion | Functions |
| --- | --- | --- |
| Estrogen | Ovary | Control the development & normal functioning of female sex organs |

| Sex hormones | organs of the secretion | Functions |
| --- | --- | --- |
| Oestrogens | Corpusluteum | Control the development & maintenance of pregnancy |

| Peptide hormones | organs of the secretion | Functions |
| --- | --- | --- |
| Adrenal corticoids | Adrenal cortex | Control the balance of water and minerals in the body<br><br>Regulate the metabolism of fats |

# MCQs

**1) Androgen is a...**

**a) Male hormone.**

**b) Female hormone.**

**c) Plant growth hormone.**

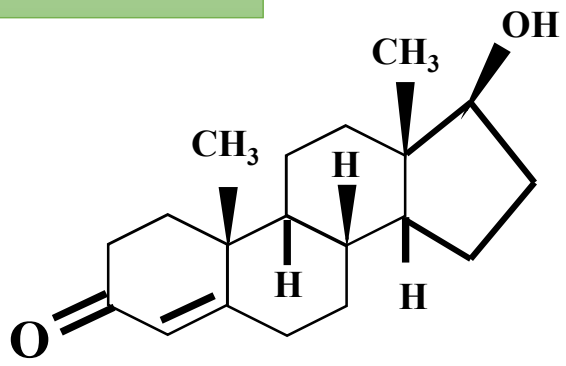
**d) both (a) & (b).**

## Testosterone

- **It is the principal male sex hormone produced by testis.**

- **This is responsible for the development of male secondary sexual characteristics such as deep voice, facial hair, sturdy physical nature.**

**Testosterone**



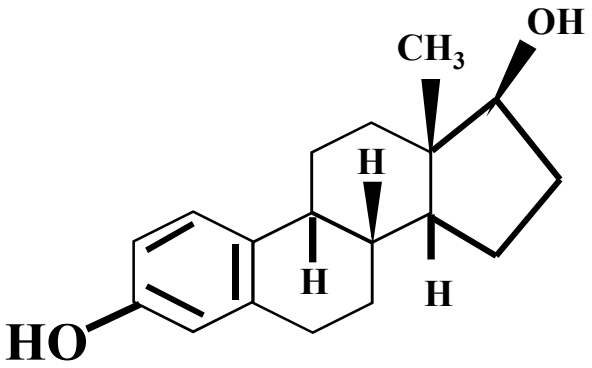

- **Synthetic testosterone is used to promote tissue and muscle growth.**

## Estradiol

- **It is main female sex hormone . It is responsible for the development of secondary female sex characteristics.**

- **These are breast development, shril voice and long hair.**
  **This also takes part in the control of menstrual cycle.**

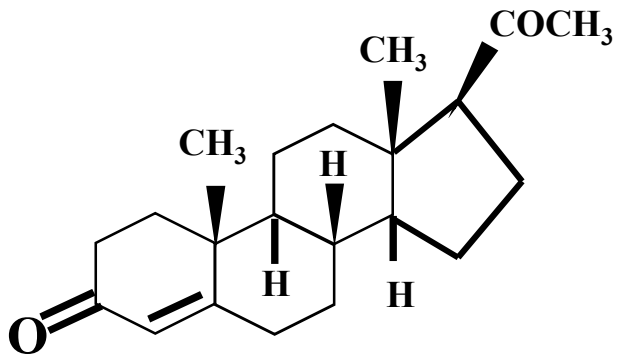
## Estradiol



## Progesterone

- **It is useful for preparing the uterus for the implantation of the fertilized egg.**

- **These are also useful as birth control agents.**



## Cortico steroids(adrenal cortical hormones):

- **These are of two types**

**Mineralo corticoids**

**Gluco corticoids**

## Cortico steroids(adrenal cortical hormones):

### Mineralo corticoids

- These are produced by different cells in the adrenal cortex. These are useful for water salt balance in the body.
- These controls the NaCl content of the blood. These cause the excretion of potassium in urine.

## Cortico steroids(adrenal cortical hormones):

### Gluco corticoids

- **These are made by adrenal cortex.**
  **These are useful to modify certain metabolic reactions.**
  **These have anti- inflammatory effect.**

# MCQs

1) The hormone responsible for the development of secondary female sex characteristics is ……

a) Testosterone.

b) Estradiol.

c) Progesterone.

d) Adrenal cortex.

# MCQs

2) The hormone responsible for the development of male secondary characteristics is ……..

a) Testosterone.

b) Estradiol.

c) Progesterone.

d) Adrenal cortex.

## Non-Steroid hormones:

- **Peptide hormones.**
- **Amino acid derivative hormones.**
- **The most important amongst these is insulin. It has great influence on carbohydrate metabolism.**
- **It is responsible for the entry of glucose and other sugars into the living cells. This helps in the decrease of glucose in the blood.**
- **This is therefore commonly called *hypoglycemic factor.***

## Non-Steroid hormones:

- **It promotes anabolic processes and inhibits catabolic processes.**
- **Its deficiency in human beings causes diabetes mellitus.**
- **Insulin isolated from islets tissue of pancreas (or) from islets of langerhans was the first hormone identified as protein.**
- **Sanger was awarded nobel prize in 1958 for determining the structure of "insulin".**

## Insulin

- **It is a dipeptide consisting of two peptide chains bound by three S-S bonds. One chain contained 21 amino acids (A- Chain) and the other chain contained 30 amino acids (B-chains). Sulphur bridges connect cysteine amino acids in the two chains.**

- **6-11 of A-chain 7 of A-chain**
- **-7 of B-chain -20 of A-chain**
- **19 of B-chain**

## Amino acid derivatives:

- **These are thyroidal hormones.**

**Example:**

**These affect the general metabolism regardless of the specific activity. So thyroid gland is known as pace setter of the endocrine systems**

## Site of activity:

- **The hormones, on the basis of the site of their activity, are divided into two categories.**

- **The first category affects the properties of the *"Plasma membrane".***

- **All peptide hormones belong to this category.**

## Site of activity:

**Example:**

- **Insulin and the hormones of pituitary gland.**
- **The hormones of other category are taken into the cell and carried to the cell nucleus. These influence the gene expression.**

# MCQs

**1) Non-Steriod hormones is...**

**a) Insulin.**

**b) Estradiol.**

**c) Progesteron.**

**d) adrenal cortex.**

# MCQs

**2) Deficiency of insulin in human beings cause...**

**a) Blood coagulation .**

**b) Beri beri.**

**c) Diabetes.**

**d) Dermatitis.**

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