BYJU'S Classes

Biomolecules

Biochemistry

A **living system** grows, sustains, & reproduces itself.

Amazing thing about a living system is that it is composed of **non-living** atoms and molecules.

Living systems are made up of various **complex biomolecules** like carbohydrates, proteins, nucleic acids, lipids, etc.

Biochemistry

These biomolecules **interact** with each other and constitute the **molecular logic** of life processes.

The **pursuit of knowledge** of what goes on chemically within a living system falls in the domain of **biochemistry.**

Carbohydrates

Carbohydrates are primarily produced by plants.

Carbohydrates

The **group of compounds** known as **carbohydrates** received their general name because of early observations that they often have the **formula $C_x(H_2O)_y$.**

They appeared to be "**hydrates of carbon**".

Example

The molecular formula of glucose **($C_6H_{12}O_6$)** fits into this general formula, **$C_x(H_2O)_y$.**

Carbohydrates

All the compounds that fit into this formula **may not** be classified as carbohydrates.

Example

1. Acetic acid (CH_3COOH) fits into this general formula, $C_2(H_2O)_2$ but is not a carbohydrate.
2. Rhamnose, $C_6H_{12}O_5$ is a carbohydrate but does not fit in this formula.

Carbohydrates

Carbohydrates are usually defined as **polyhydroxy aldehydes** and **ketones** or substances that **hydrolyse** to yield polyhydroxy aldehydes and ketones.

Note

Almost all carbohydrates are **chiral** and **optically active**. An **exception** of this is **1,3-dihydroxypropanone**.

Classification of Carbohydrates

Based on number of hydrolysed products

- Monosaccharides
- Oligosaccharides
- Polysaccharides

Monosaccharides

The simplest carbohydrates, that **cannot be hydrolysed** into simpler carbohydrates.

Examples

1. Glucose
2. Fructose
3. Ribose


Fructose

Oligosaccharides

Carbohydrates that hydrolyse to produce **2–10 molecules** of monosaccharide.

Disaccharides

Carbohydrates that undergo hydrolysis to produce only **2 molecules** of monosaccharide.

Trisaccharides

Carbohydrates that undergo hydrolysis to produce only **3 molecules** of monosaccharide..

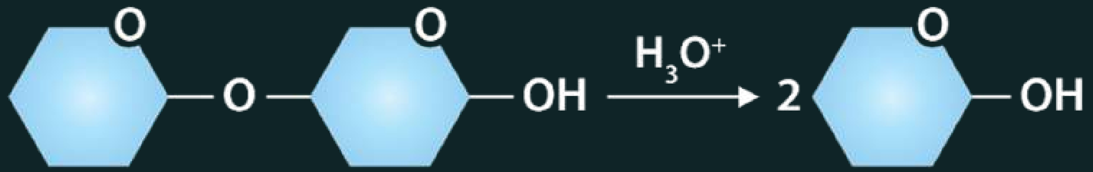
Oligosaccharides

Examples

One molecule of **sucrose** on hydrolysis gives one molecule of **glucose** and one molecule of **fructose.**

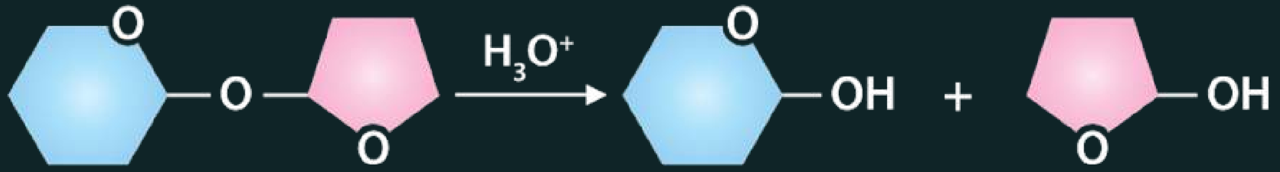
Maltose on hydrolysis gives two molecules of only **glucose**.

Oligosaccharides



1 mol of **maltose** (Disaccharide)

2 mol of **glucose** (Monosaccharide)



1 mol of **sucrose** (Disaccharide)

1 mol of **glucose** 1 mol of **fructose** (Monosaccharides)

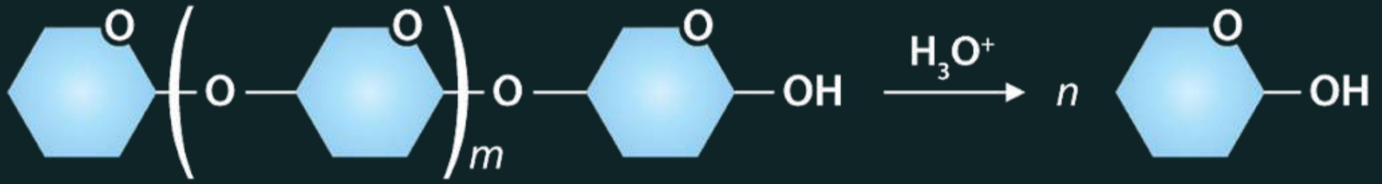
Polysaccharides

Carbohydrates that produce a large number of molecules of monosaccharides (>10) on hydrolysis.

Examples

1. Starch
2. Cellulose
3. Glycogen

Polysaccharides



1 mol of **starch** or
1 mol of **cellulose**
(Polysaccharide)

Many moles of
glucose
(Monosaccharides)

Summary

Carbohydrate	Number of units produced on hydrolysis	Examples
Monosaccharides	1	Glucose, Fructose, Galactose
Oligosaccharides	2 - 10 units	Sucrose, Maltose, Lactose
Polysaccharides	Many units (>10)	Starch, Cellulose

The two monosaccharide units obtained on hydrolysis of disaccharide may be:

a) Same

b) Different

c) Both a) and b)

d) None of these

Solution

The two monosaccharide units obtained on hydrolysis of disaccharide may be same or different.

Hence, option (c) is the correct answer.

Monosaccharides

Classification of monosaccharides according to

- **Number of carbon** atoms present in the molecule
- **Functional group** present in the molecule

Number of carbon atoms present in the molecule

Number of 'C' atoms	Monosaccharides
3	Triose
4	Tetrose
5	Pentose
6	Hexose
7	Heptose

Monosaccharides

Functional group present in the molecule

Monosaccharide containing

1. Aldehyde group → **Aldose**
2. Keto group → **Ketose**

Monosaccharides

Classification of monosaccharides according to

- **Number of carbon** atoms present in the molecule
- **Functional group** present in the molecule

These two classifications are frequently **combined.**

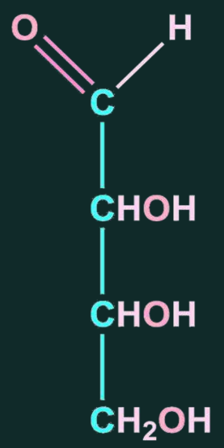
Monosaccharides

No. of 'C' atoms	General term	Aldehyde	Ketone
3	Triose	Aldotriose	Ketotriose
4	Tetrose	Aldotetrose	Ketotetrose
5	Pentose	Aldopentose	Ketopentose
6	Hexose	Aldohexose	Ketohexose
7	Heptose	Aldoheptose	Ketoheptose

Monosaccharides

Example

4 C aldose is called an **aldotetrose**, **5 C** ketose is called a **ketopentose**.



An aldotetrose

A ketopentose

Classification of Carbohydrates

Based on the ability to reduce Tollens' & Fehling's reagent

- Reducing sugar
- Non-reducing sugar

Reducing & Non-reducing Sugars

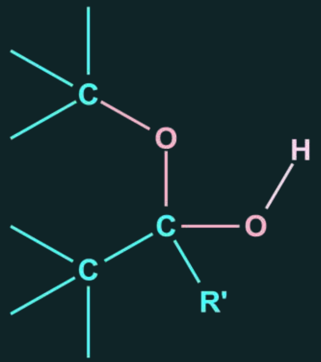
Reducing sugar	Non-reducing sugar
Reduces Tollens' & Fehling's reagent	Don't reduce Tollens' & Fehling's reagent.

Reducing sugar	Non-reducing sugar
Should have at least one **hemiacetal or hemiketal** functional group.	Should have acetal linkage.

Reducing & Non-reducing Sugars

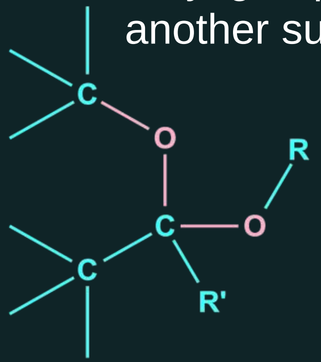
Reducing sugar

Non-reducing sugar



Hemiacetal
(R′ = H or CH_2OH)

Alkyl group or another sugar



Acetal
(R′ = H or CH_2OH)

Reducing sugar	Non-reducing sugar
Example: All monosaccharides and oligosaccharides except sucrose	Example: All polysaccharides and sucrose

Which of the following pairs give positive Tollen's Test?

a) Glucose, sucrose

b) Glucose, fructose

c) Hexanol, acetophenone

d) Fructose, sucrose

Solution

Since all monosaccharides and disaccharides except sucrose are reducing sugar, hence glucose and fructose are correct answers.

Hence, option (b) is the correct answer.

First member of aldose sugar is:

a) Aldohexose

b) Aldotetrose

c) Aldopentose

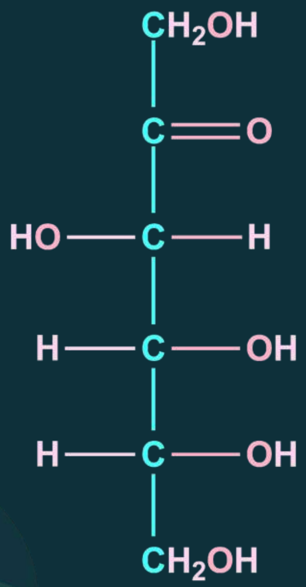
d) Aldotriose

Solution

First member of aldose sugar must contain at least three carbon atoms.

Hence, option (d) is the correct answer.

Given structure is:



a) Aldopentose

b) Ketohexose

c) Ketoheptose

d) Aldohexose

Solution

Since the given structure contain six carbon atom with ketone group. **Hence, option (b) is the correct answer.**

Glucose

1. It is the most common **monosaccharide**.

2. It is known as **dextrose** because it occurs in nature principally as the optically active **dextrorotatory isomers**.

3. It acts as a **reducing agent** (reduces both **Fehling's and Tollens' reagent**).

4. **Sources** of glucose are ripe grapes, honey, cane sugar, starch, & cellulose.

Preparation of Glucose

Preparation of glucose

- From sucrose (Cane sugar)
- From starch

From sucrose (Cane sugar)

By acid hydrolysis of **cane sugar** (a disaccharide)

If **sucrose** is boiled with dil. HCl or H_2SO_4 in alcoholic solution then glucose & fructose are obtained in **equal amount**.

Preparation of Glucose

$$\underset{\text{Sucrose}}{C_{12}H_{22}O_{11}} \xrightarrow{H_2O/H^+} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Fructose}}{C_6H_{12}O_6}$$

Preparation of Glucose

From starch

By enzymatic action over **starch**

Glucose is obtained by **hydrolysis of starch** by boiling it with dil. H_2SO_4 at 393 K under pressure.

$$\underset{\substack{\text{(Polysaccharides)}\\(C_6H_{10}O_5)_n}}{\text{Starch}} \xrightarrow{\text{Diastase}} \underset{\substack{\text{(Disaccharides)}\\(C_{12}H_{22}O_{11})}}{\text{Maltose}} \xrightarrow{\text{Maltase}} \underset{\substack{\text{(Monosaccharides)}\\(C_6H_{12}O_6)}}{\text{Glucose}}$$

On hydrolysis sucrose will give:

a) One molecule of glucose

b) Two molecules of glucose

c) One molecule of glucose and fructose

d) One molecule of glucose and maltose

Solution

On hydrolysis, sucrose will give one molecule of glucose and fructose.
Hence, option (c) is the correct answer.

Which of the following is correct regarding glucose?

a) The molecular formula of glucose is $C_6H_8O_6$

b) It can be obtained by acid hydrolysis of cane sugar

c) It is a disaccharide

d) It acts as an oxidising agent

Solution

The molecular formula of glucose is $C_6H_{12}O_6$ and it is a monosaccharide and a reducing agent. It is obtained by acid hydrolysis of acne sugar.

Hence, option (b) is the correct answer.

Starch is changed into disaccharide in presence of?

a) Diastase

b) Maltase

c) Lactase

d) Zymase

Solution

$$\underset{\substack{\text{(Polysaccharides)} \\ (C_6H_{10}O_5)_n}}{\text{Starch}} \xrightarrow{\text{Diastase}} \underset{\substack{\text{(Disaccharides)} \\ (C_{12}H_{22}O_{11})}}{\text{Maltose}}$$

Hence, option (a) is the correct answer.

Carbohydrates have not been classified on the basis of:

a) Sugars and non-sugars

b) Reducing character

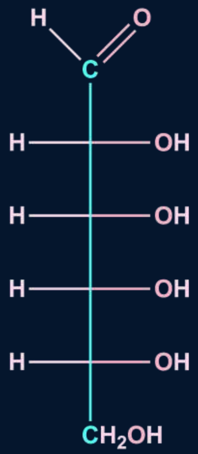
c) Optical activity

d) Hydrolysis (complexity of structure)

Solution

Carbohydrates have not been classified on the basis of optical activity.

Hence, option (c) is the correct answer.



Allose, given monosaccharide is a/an?

a) Aldopentose

b) Aldohexose

c) Ketopentose

d) Aldoheptose

Solution

Since the given structure contain six carbon atom with aldehyde group.

Hence, option (b) is the correct answer.

The two functional groups present in a typical carbohydrate are:

a) -CHO and -COOH

b) >C=O and –NH_2

c) -OH and -CHO

d) -OH and -COOH

Solution

The two functional groups present in a typical carbohydrate are -OH and -CHO.

Hence, option (c) is the correct answer.

"Carbohydrate that cannot be hydrolysed further to give simpler unit of polyhydroxy aldehyde or ketone." Name the type of carbohydrates.

a) Monosaccharide
b) Oligosaccharide
c) Polysaccharide
d) All of these

Solution

Carbohydrates that cannot be hydrolysed further to give a simpler unit of polyhydroxy aldehyde or ketone are known as monosaccharide.

Hence, option (a) is the correct answer.

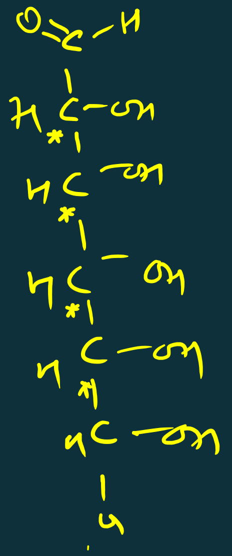
Structure of Glucose

CHO
|
$CHOH$
|
$CHOH$
|
$CHOH$
|
$CHOH$
|
CH_2OH

2° alcohols

1° alcohol

How was this structure derived?



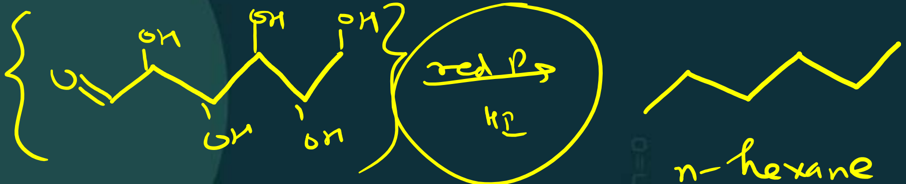
4C atoms: chiral

Structure of Glucose

all alcohols, all aldehydes, ketones $\xrightarrow{\text{red P/HI}}$ reduced to alkanes

1. Molecular formula: **$C_6H_{12}O_6$**

2. On prolonged heating with red P & HI, it forms **n-Hexane**, suggesting that all the six carbon atoms are linked in a **straight chain**.



Structure of Glucose

$$\begin{array}{c} CHO \\ | \\ (CHOH)_4 \\ | \\ CH_2OH \end{array} \xrightarrow[\Delta]{\text{Red P + HI}} CH_3CH_2CH_2CH_2CH_2CH_3$$

n-Hexane

Structure of Glucose

$C_6H_{12}O_6$ IHD = 1

1 π bond or 1 ring

$>C=O$

3 (a) Glucose reacts with **hydroxylamine** to form an **oxime** and adds a molecule of (b) hydrogen cyanide to give **cyanohydrin**.

$+CN^-$

These reactions confirm the presence of a carbonyl group (**>C = O**) in glucose.

Structure of Glucose

$$H{-}C{=}O \;+\; H_2N{-}OH \longrightarrow H{-}C{=}\ddot{N}{-}OH$$

oxime

$$\underset{\text{Glucose}}{\begin{array}{c} CHO \\ | \\ (CHOH)_4 \\ | \\ CH_2OH \end{array}} \xrightarrow{NH_2OH} \underset{\text{\sout{Gluco oxime}}}{\begin{array}{c} HC{=}N{-}OH \\ | \\ (CHOH)_4 \\ | \\ CH_2OH \end{array}}$$

glucoxime

$$\begin{array}{c} CHO \\ | \\ (CHOH)_4 \\ | \\ CH_2OH \end{array} \xrightarrow[CN^-]{HCN} \begin{array}{c} HC(CN)(OH) \\ | \\ (CHOH)_4 \\ | \\ CH_2OH \end{array}$$

(pH = 8-10)

Structure of Glucose

4

Glucose gets oxidised to six carbon carboxylic acid (**gluconic acid**) on reaction with a mild oxidising agent like bromine water.

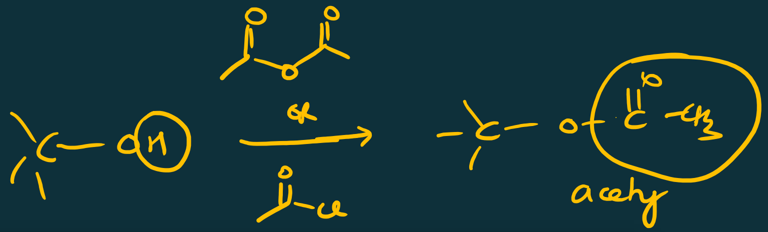
This indicates that the carbonyl group is present as an **aldehydic group**.

$$\begin{array}{c} CHO \\ | \\ (CHOH)_4 \\ | \\ CH_2OH \end{array} \xrightarrow{Br_2 \text{ water}} \begin{array}{c} COOH \\ | \\ (CHOH)_4 \\ | \\ CH_2OH \end{array}$$

Glucose → Gluconic acid

Structure of Glucose

$C_6H_{12}O_6$

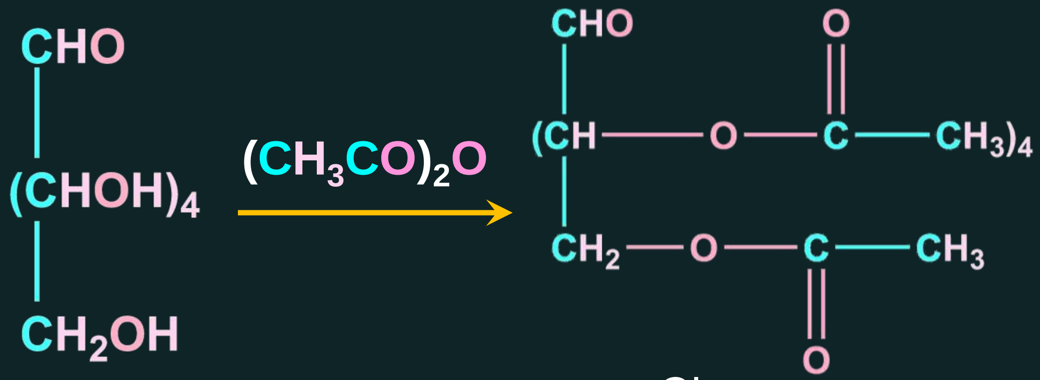


5

Acetylation of glucose with acetic anhydride gives **glucose pentaacetate** 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.

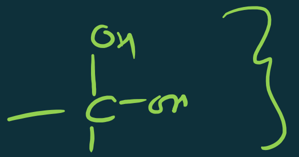
Structure of Glucose



Glucose

Glucose Pentaacetate

Structure of Glucose

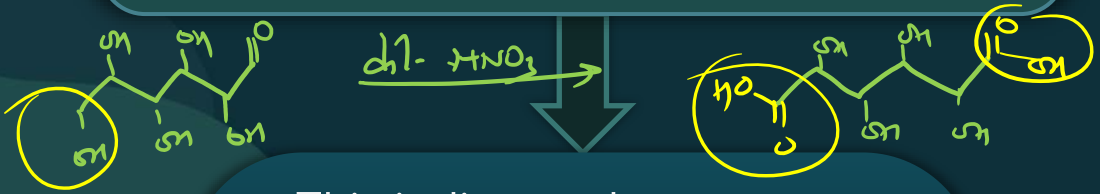


unstable

geminal diol

6

On oxidation with **dil. nitric acid**, glucose as well as, gluconic acid, both yield a **dicarboxylic acid i.e., saccharic acid**.



1° alcohol

This indicates the presence of a **primary alcoholic** (–OH) group in glucose.

Structure of Glucose

$$\underset{\text{Glucose}}{CHO-(CHOH)_4-CH_2OH} \xrightarrow[\text{dil. } HNO_3]{\text{Oxidation}} \underset{\text{Saccharic acid}}{COOH-(CHOH)_4-COOH} \xleftarrow[\text{dil. } HNO_3]{\text{Oxidation}} \underset{\text{Gluconic acid}}{COOH-(CHOH)_4-CH_2OH}$$

$$\underset{\text{Glucose}}{CHO-(CHOH)_4-CH_2OH} \xrightarrow{Br_2/H_2O \text{ or Tollen's}} \underset{\text{Gluconic acid}}{COOH-(CHOH)_4-CH_2OH}$$

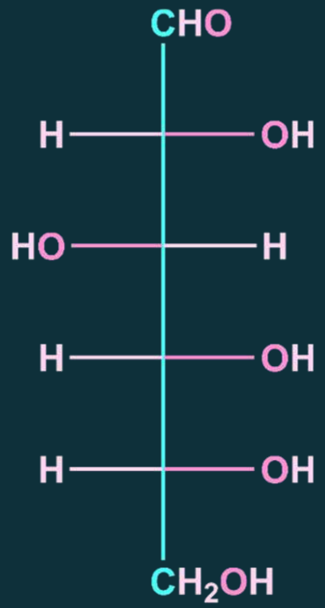
Remember

Dilute nitric acid

It is a stronger oxidising agent than bromine water, **oxidises** both the **-CHO group** and the **terminal -CH_2OH** group of an aldose **to -COOH groups**, forming dicarboxylic acids.

Structure of Glucose

Emil Fischer was able to establish the **stereochemical configuration** of the **glucose**, the most abundant monosaccharide.



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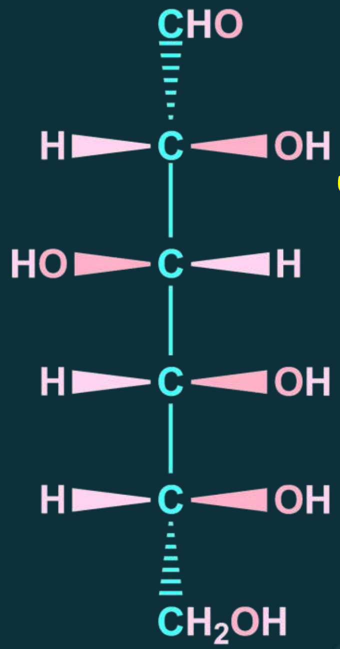
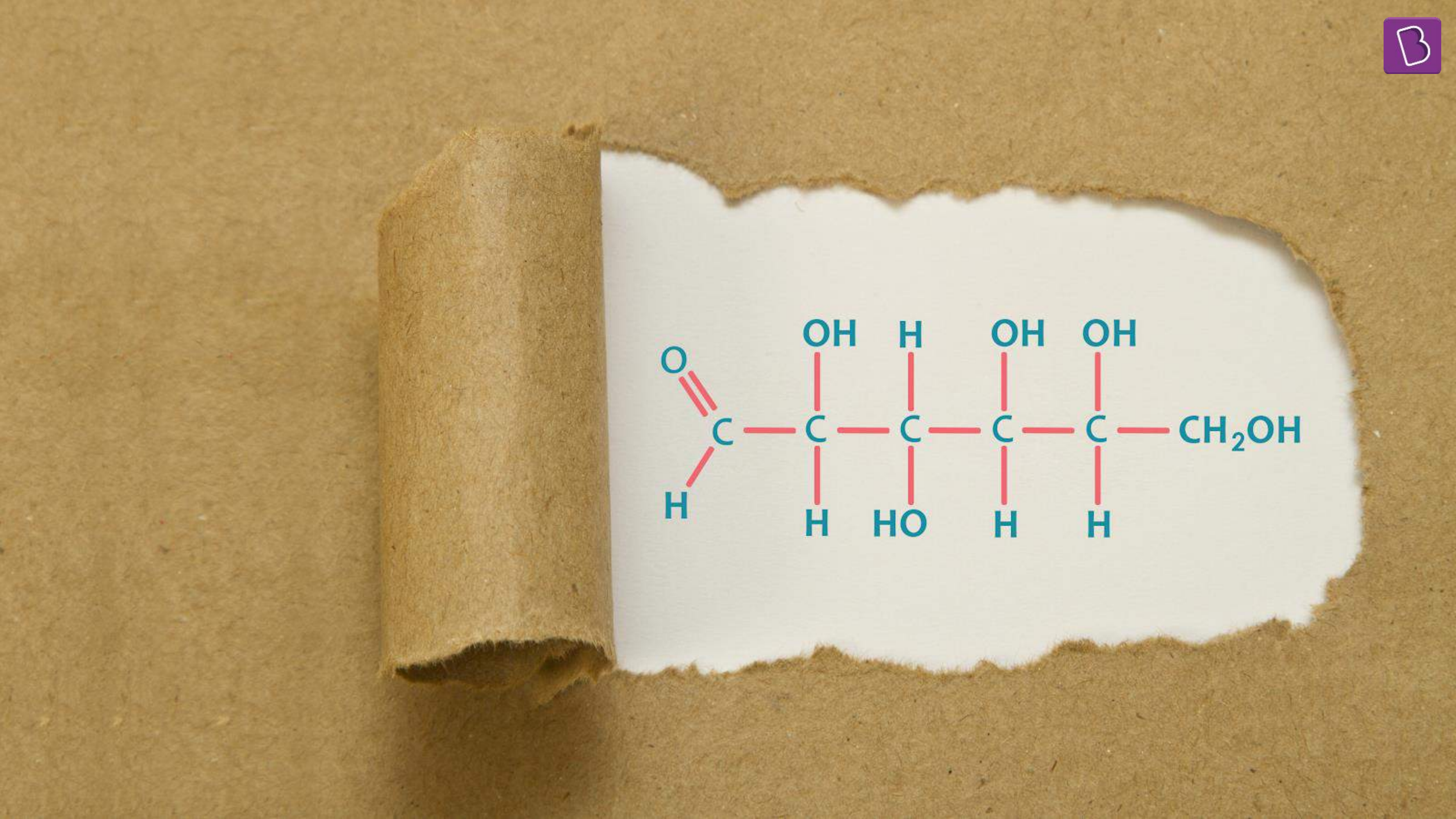
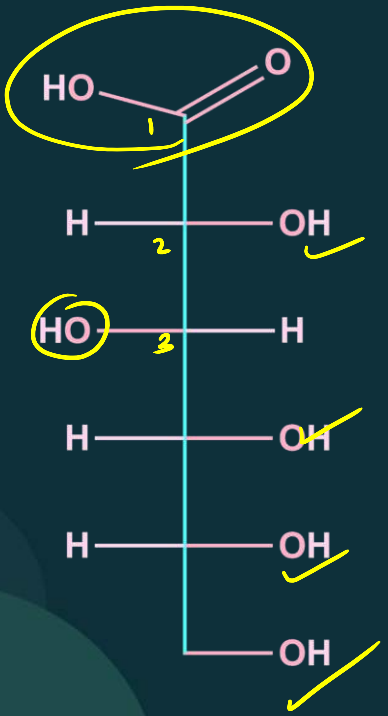


Fischer projection formula

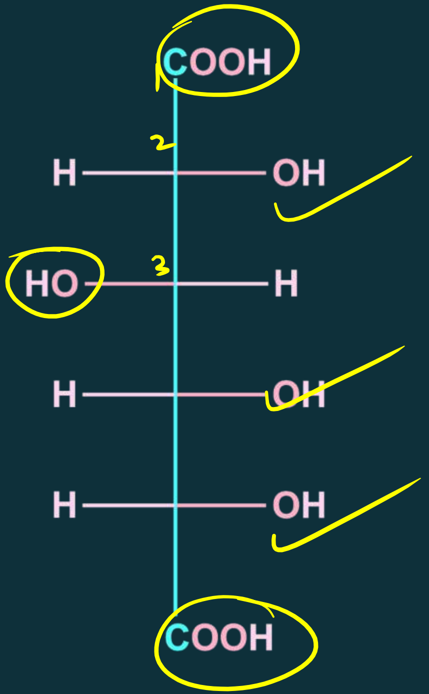
Wedge-dash formula



Gluconic and Saccharic Acids

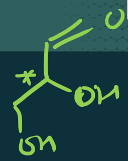


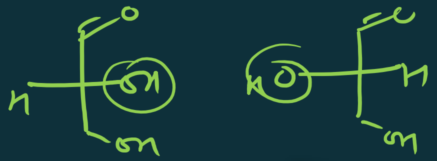
Gluconic acid



Saccharic acid

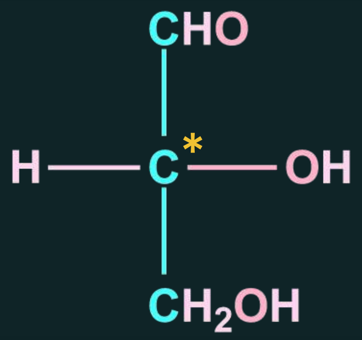
D and L Designations

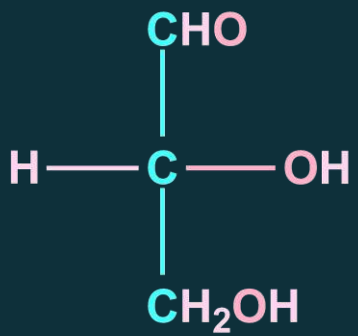




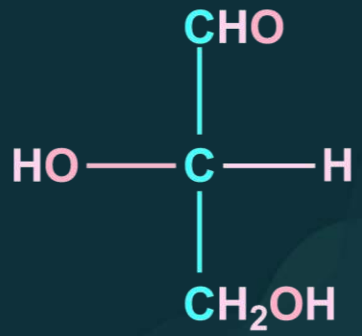
The simplest optically active monosaccharides is **glyceraldehyde**.

Glyceraldehyde exists in **two** enantiomeric forms that are known to have the **absolute configurations**.





(+)-Glyceraldehyde



(–)-Glyceraldehyde

D and L Designations

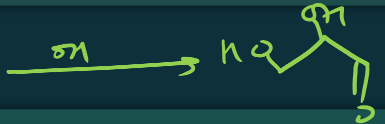
ONLY For glyceraldehyde

D-glyceraldehyde | L-glyceraldehyde

(+) = or d-

(l) =
(-) =

(+)-Glyceraldehyde is designated **D**-(+)-glyceraldehyde and (-)-glyceraldehyde is designated **L**-(-)-glyceraldehyde.

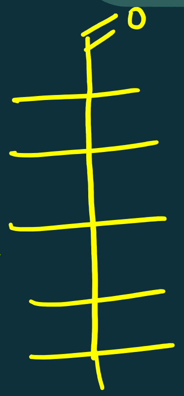


glyceraldehyde

glycerine or glycerol

These two compounds serve as **configurational standards** for all monosaccharides.

D and L Designations

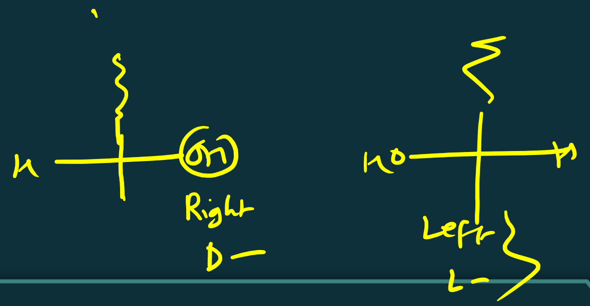


A monosaccharide whose **highest numbered chiral centre** (the penultimate carbon) has the **same** configuration as **D**-(**+**)-glyceraldehyde is designated as a **D sugar**.

One whose highest numbered chiral centre has the same configuration as **L**-(**-**)-glyceraldehyde is designated as a **L sugar**.

By convention, acyclic forms of monosaccharides are **drawn vertically** with the most oxidised carbon **at or nearest the top**.

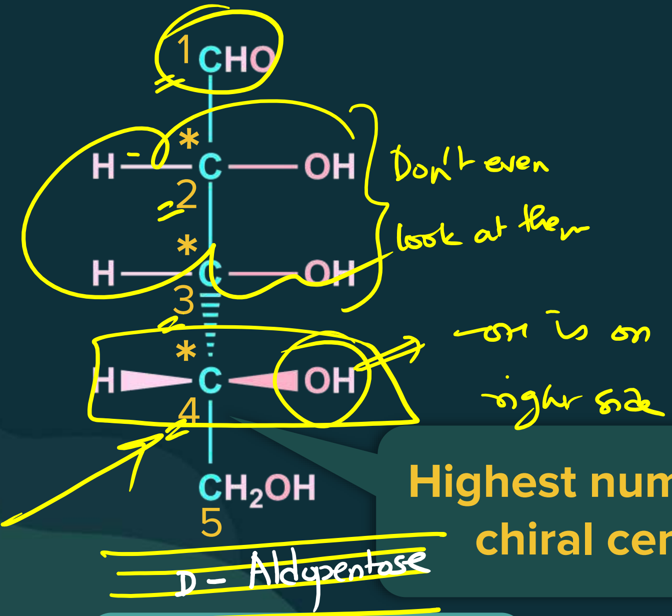
Remember



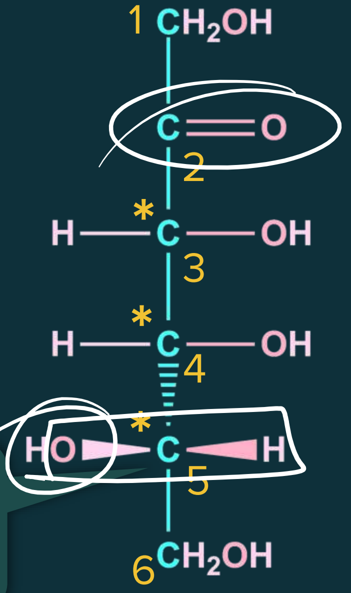
D sugars have the **-OH** on their **penultimate carbon** on the **right**.

L sugars have the **-OH** on their **penultimate carbon** on the **left**.

D and L Designations



Highest numbered chiral centre



D-aldopentose

(+) or (-)

L-ketohexose

Note

The D and L designations are **not** necessarily related to the **optical rotations** of the sugars.

Cyclic Structure of Glucose

1

Despite having aldehyde group, glucose **does not give Schiff's test** & it **does not form the hydrogen sulphite** (bisulphite) addition product with $NaHSO_3$.

Note

Schiff's reagent is a dilute solution of **rosaniline hydrochloride** whose pink colour has been discharged by passing SO_2.

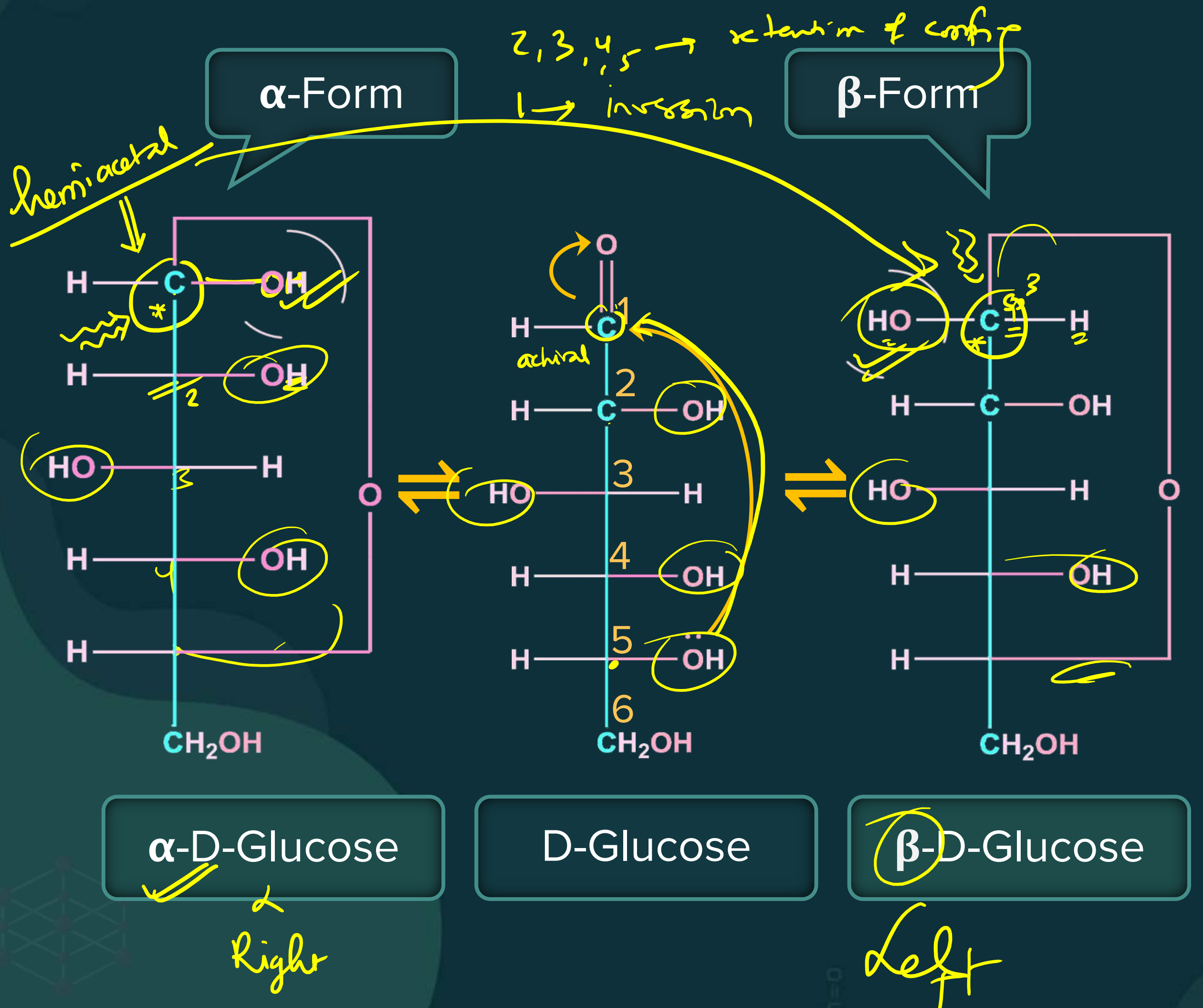
Aldehyde **restores** pink colour when treated with Schiff's reagent (Magenta solution in H_2SO_3).

Cyclic Structure of Glucose

2

The **pentaacetate** of glucose **does not react with hydroxylamine** indicating the **absence of free –CHO group**.

These behaviour **couldn't** be explained by **open chain structure.** It was proposed that one of –OH group may add to –CHO group to form a **cyclic structure**.

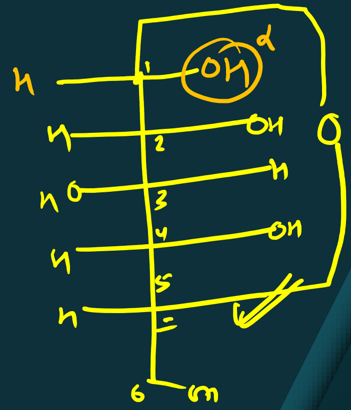

2,3,4,5 → retention of config
1 → inversion
α-Form
β-Form
hemiacetal
achiral
α-D-Glucose
D-Glucose
β-D-Glucose
Right
Left

Cyclic Structure of Glucose

In carbohydrate chemistry, diastereomers differing only at the hemiacetal or acetal carbon are called **anomers**, and the hemiacetal or acetal carbon atom is called the **anomeric carbon atom**.

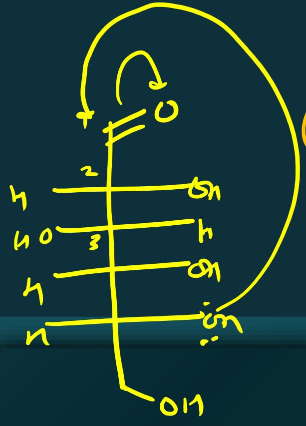
α-form & **β-form**, are called **anomers**.

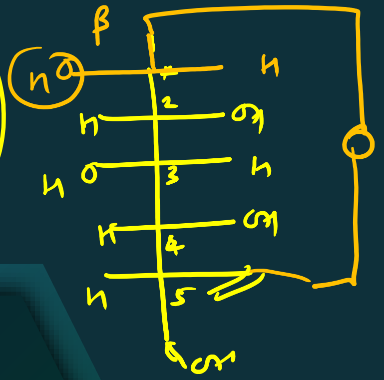
Note



α-D-glucose

α-D-Glucose



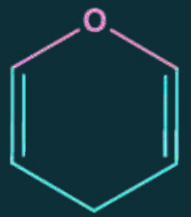


β-D-Glucose

β-D-glucose is **more stable** than α-D-Glucose.

Haworth Projection

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

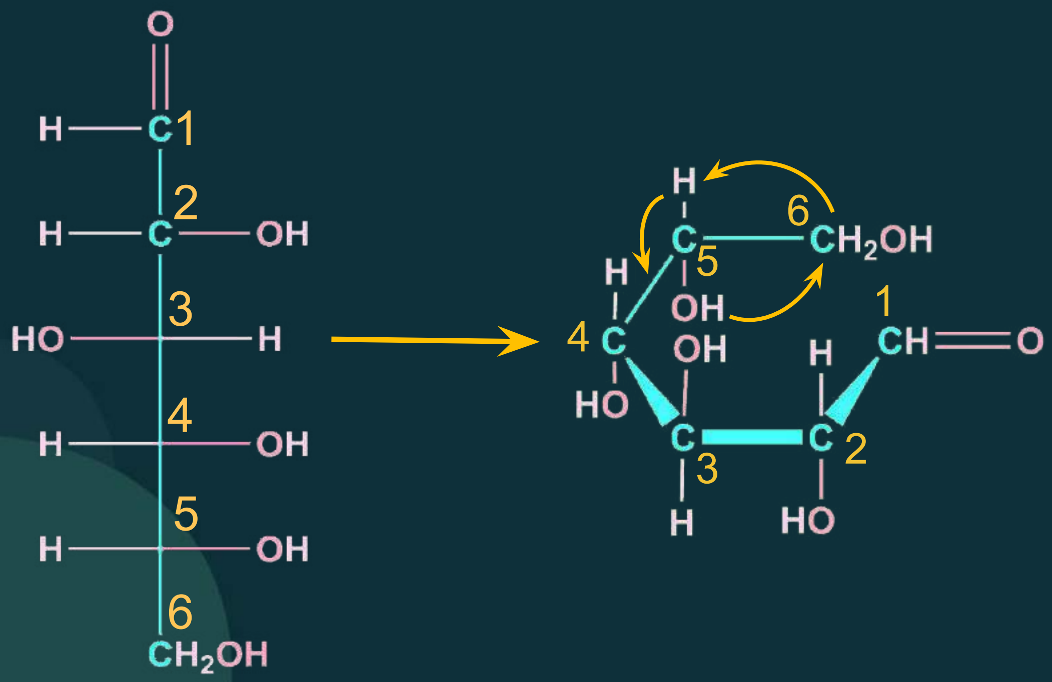


Pyran

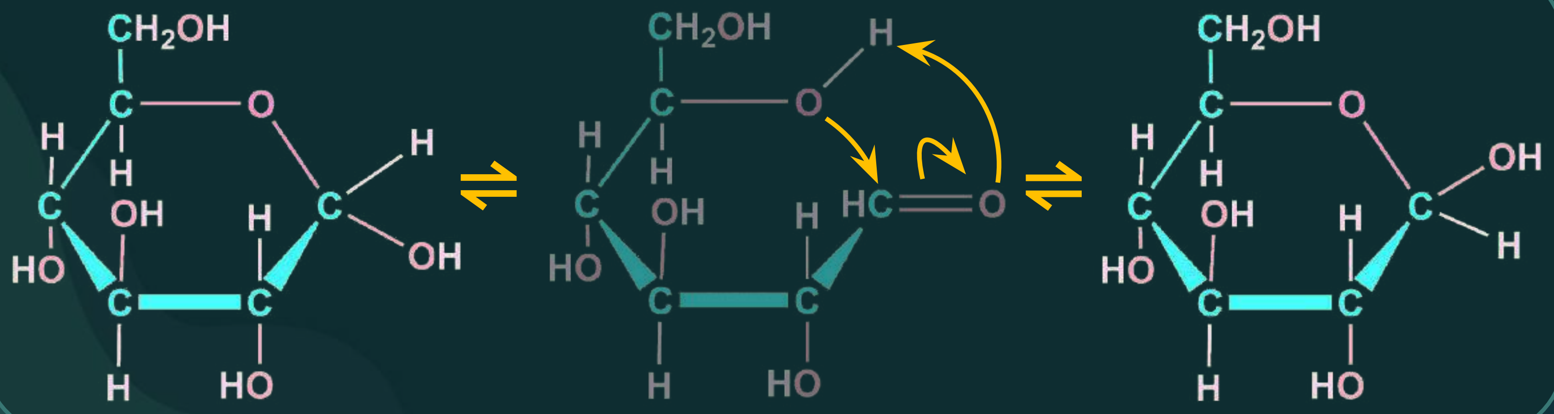
Groups on the **right** in a **Fischer projection** are **down** in a **Haworth** projection

Groups on the left in a **Fischer projection** are **up** in a **Haworth** projection

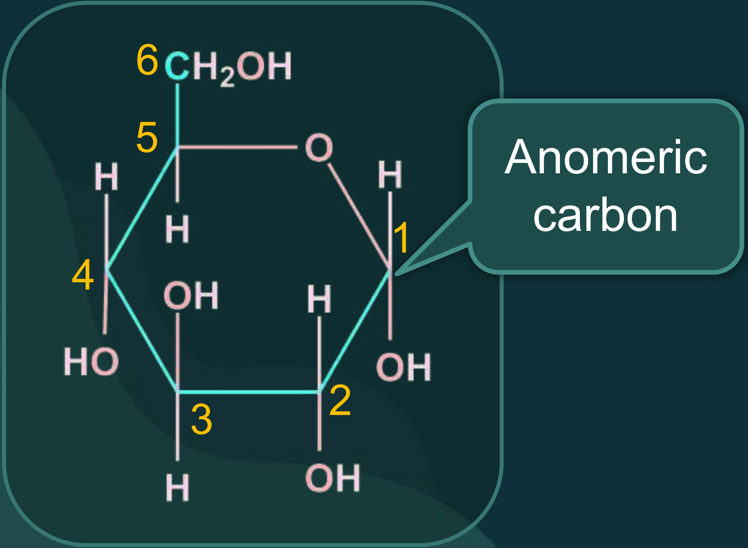
Haworth Projection



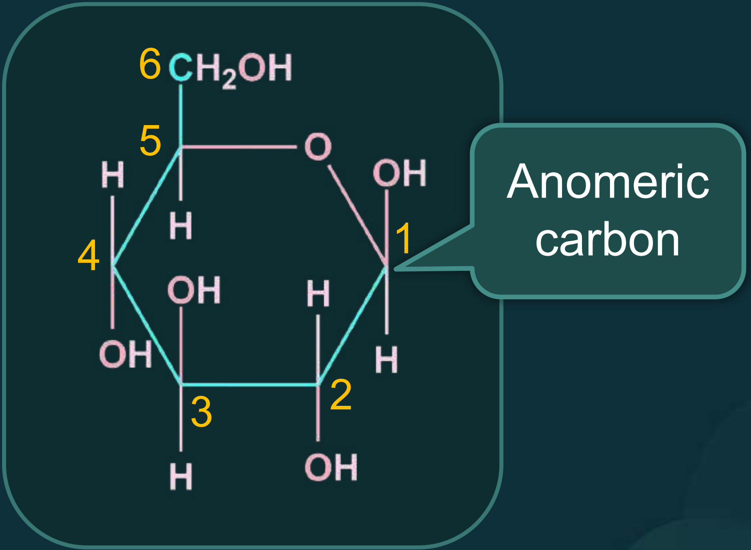
Haworth Projection



Haworth Projection

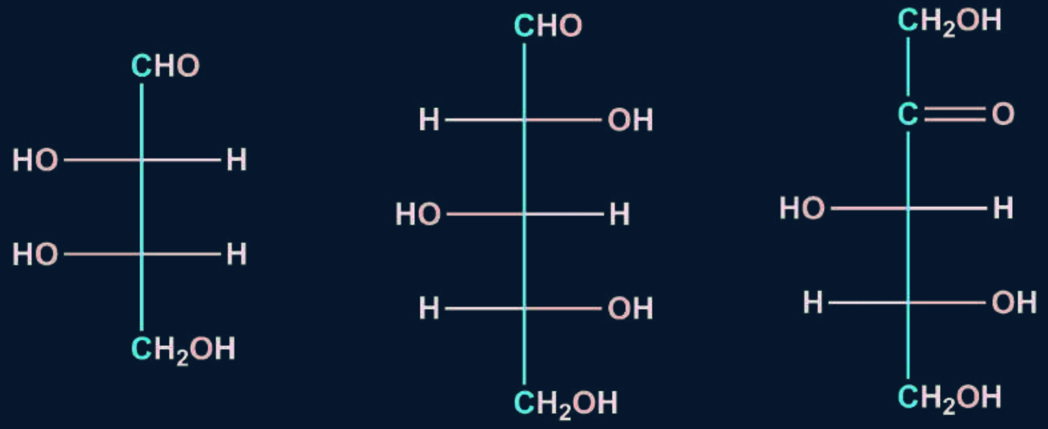


α-D-Glucose
α-D-glucopyranose



β-D-Glucose
β-D-glucopyranose

The **correct** statement about the **sugars** given above are:



I II III

a) I and II are L-Sugars

b) II and III are L-Sugar

c) I and III are D-sugars

d) I is a L-sugar

Solution

If -OH in the second last carbon (last stereogenic centre) is on left, then “L” and if on right then its “D”.

I is “L”

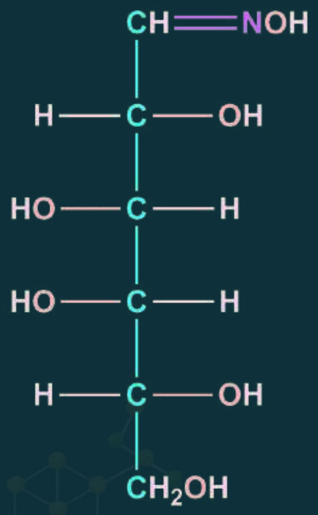
II is “D”

III is “D”

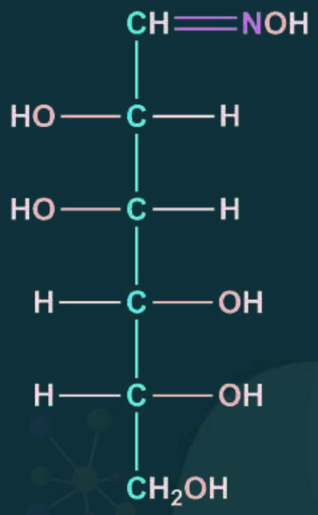
Hence, option (d) is the correct answer.

D-(+)-glucose reacts with **hydroxyl amine** and yields an oxime. The structure of the **oxime** would be:

a)

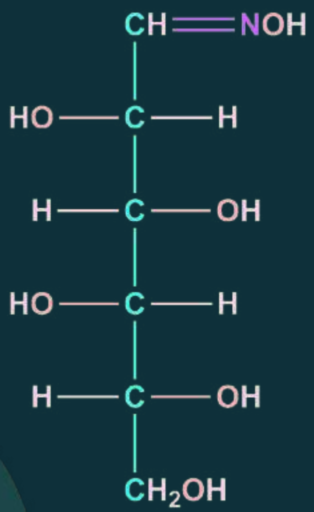


b)

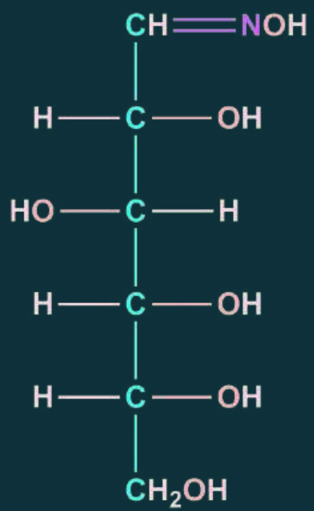


D-(+)-glucose reacts with hydroxyl amine and yields an oxime. The structure of the oxime would be:

c)

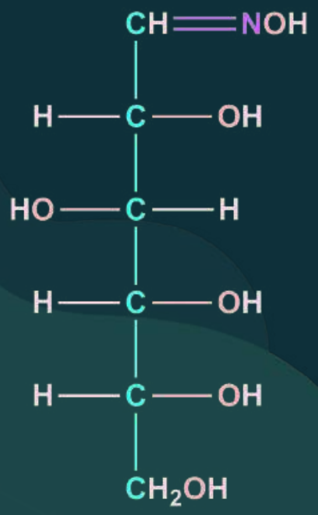


d)



Solution

D-(+)-glucose on reaction with hydroxylamine an oxime. The structure of the oxime is



Hence, option (d) is the correct answer.

Which of the following indicates the presence of five -OH groups in glucose?

BOARDS

a) Penta-acetyl derivative of glucose

b) Cyanohydrin formation of glucose

c) Reaction with Fehling's solution

d) Reaction with Tollens' reagent

Solution

Penta-acetyl derivative indicates the presence of five –OH groups in glucose.
Hence, option (a) is the correct answer.

Fructose

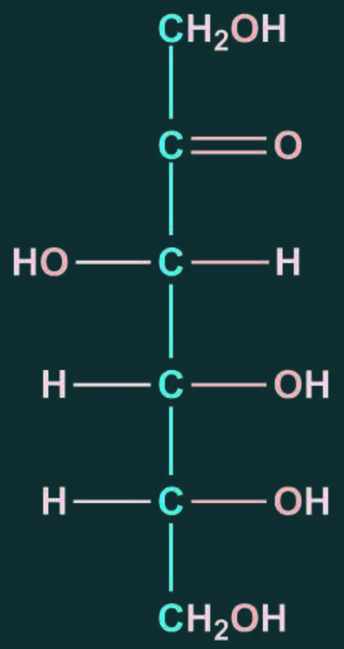
Fructose is an **important ketohexose**. It is obtained along with glucose by the **hydrolysis** of disaccharide, **sucrose**.

Molecular formula: $C_6H_{12}O_6$.

It is a natural monosaccharide found in **fruits**, **honey,** and **vegetables**. In its pure form, it is used as a **sweetener**.

It belongs to **D-series** and is a **laevorotatory** compound.

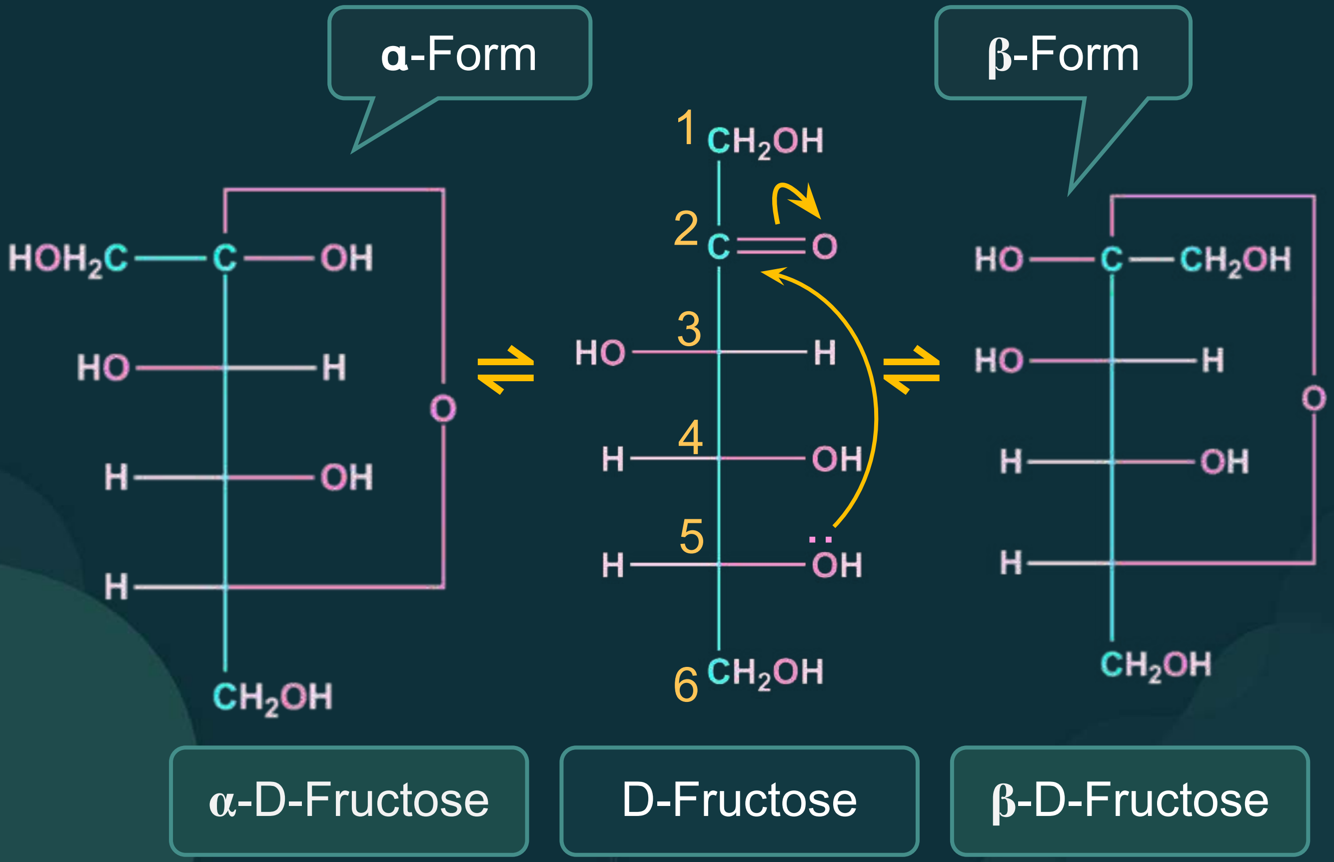
Structure of Fructose



D-(–)-Fructose

Structure of Fructose

It also exists in **two cyclic forms** that are obtained by the **addition of –OH at C_5** to the (>C=O) group.

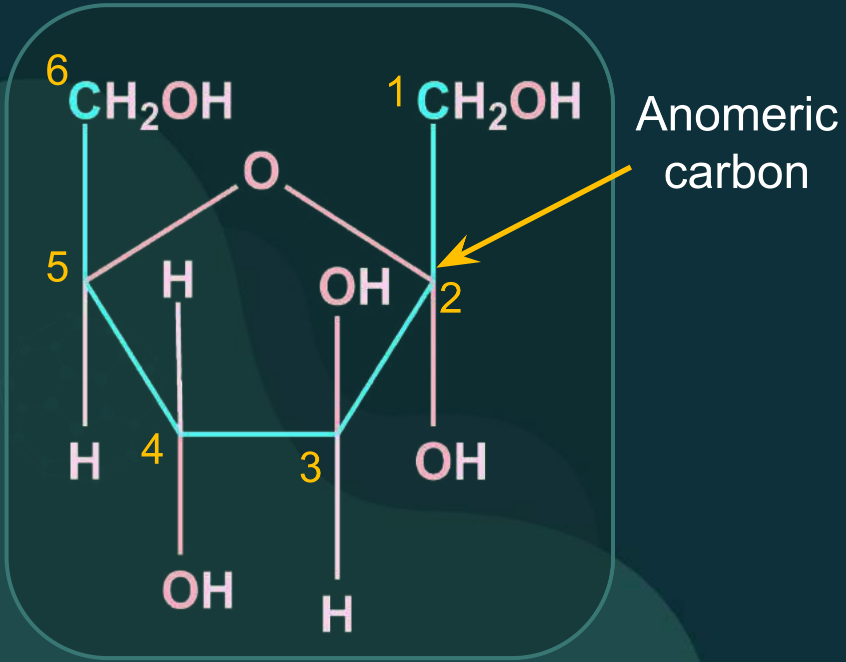


Structure of Fructose

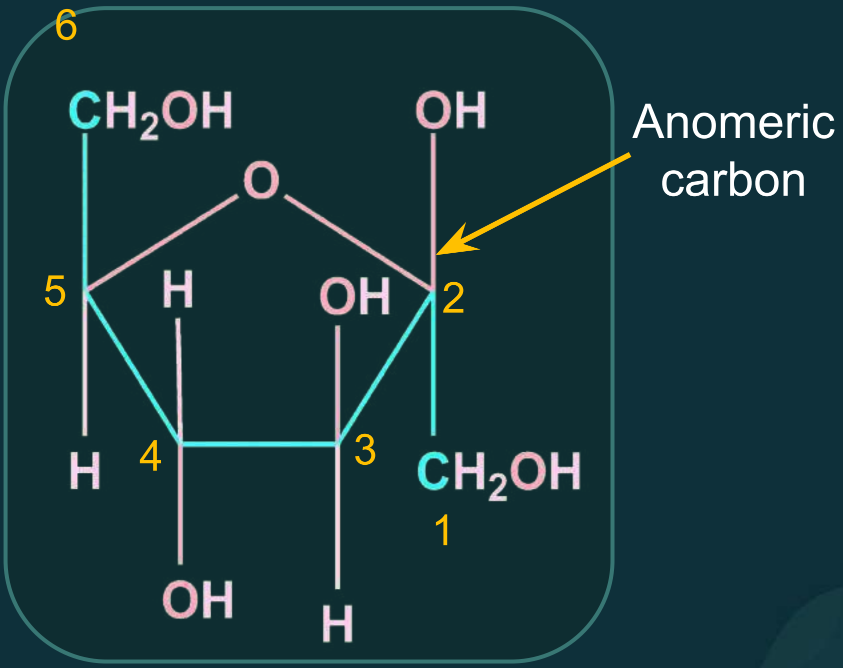
The **five** membered cyclic structure of monosaccharides is called **furanose** structure (α- or β-form) in analogy with **furan**.

Furan

Structure of Fructose



α-Fructose
α-Fructofuranose



β-Fructose
β-Fructofuranose

Disaccharides

Condensation of two molecules of either the **same or different monosaccharides** produces disaccharides.

Examples

Sucrose, maltose, lactose, cellobiose

Sucrose

1. Molecular formula: **$C_{12}H_{22}O_{11}$**
2. Sucrose is a **white crystalline solid**, **soluble** in water.
3. Sucrose is **dextrorotatory**.

Sucrose

4

On **hydrolysis** with dilute acids sucrose yields an **equimolar** mixture of **D-(+)-glucose** and **D-(–)-fructose**

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

D-(+)-glucose (+ 52.5°) D-(-)-fructose (- 92.4°)

Invert Sugar

Sucrose is **dextrorotatory** but after hydrolysis, it gives dextrorotatory glucose and laevorotatory fructose.

Since the **laevorotation of fructose (–92.4°)** is more than **dextrorotation of glucose (+ 52.5°)**, the mixture is **laevorotatory**.

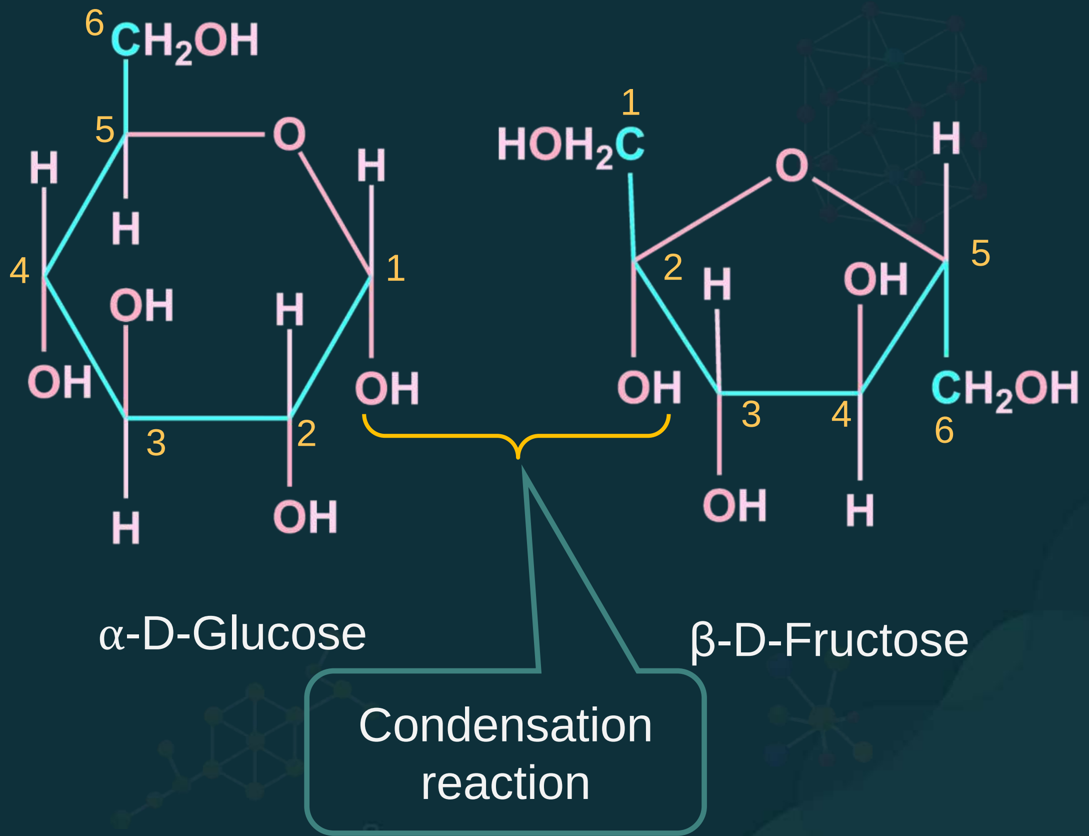
↓

Inversion of cane-sugar or inversion of sucrose

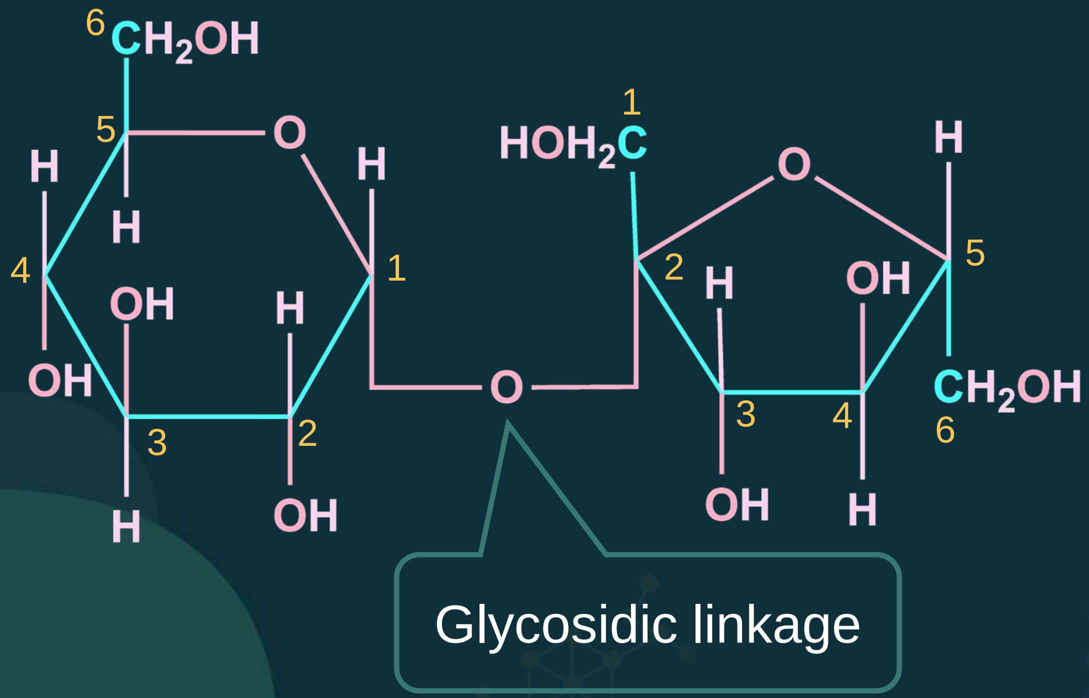
Mixture of glucose and fructose (1:1) is called **invert sugar**.

Sucrose

In sucrose, condensation reaction takes place between **C-1** of ***α*-D-glucose** and **C-2** of **β-D-fructose.**

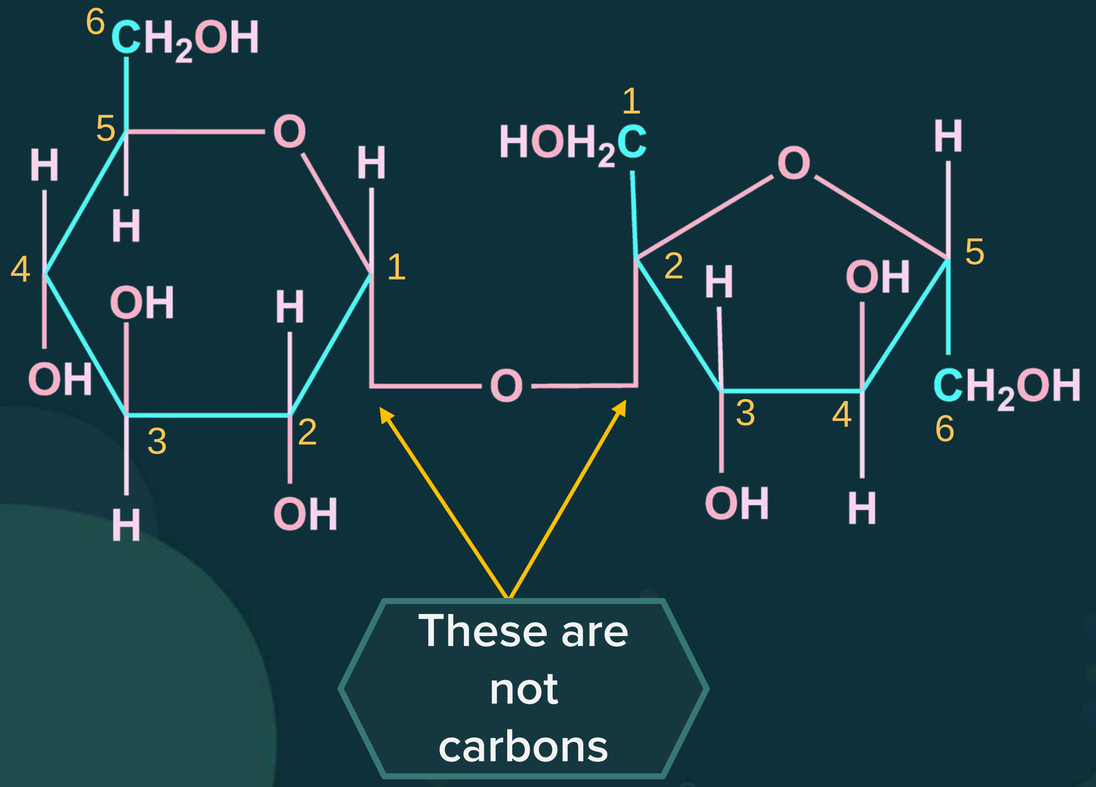


Sucrose



6
CH2OH
5
O
H
H
H
4
1
OH
H
OH
3
2
H
OH
1
HOH2C
O
H
2
H
OH
5
3
4
CH2OH
6
OH
H
O
Glycosidic linkage

Sucrose



6
CH_2OH
5
O
H
H
H
4
1
OH
H
OH
2
3
H
OH
O
1
HOH_2C
O
H
2
H
OH
5
3
4
OH
H
CH_2OH
6
These are not carbons

Glycosidic Linkage

The two monosaccharides are joined together by an **oxide linkage** formed by loss of water molecule. Such linkage through oxygen atom is called **glycosidic linkage**.

Sucrose is **not** a **reducing sugar** i.e., it will not reduce Fehling's or Tollens' reagent.

↓

Hemiacetal group is **absent.**

Which one of the following sets of monosaccharides forms sucrose?

BOARDS

a) α-D-galactopyranose and α-D-glucopyranose

b) α-D-glucopyranose and β -D-fructofuranose

c) β -D-glucopyranose and α -D-fructofuranose

d) α-D-glucopyranose and β -D-fructopyranose.

Solution

Sucrose is formed from α-D-glucopyranose and β -D-fructofuranose.
Hence, option (b) is the correct answer.

Assertion: Sucrose is a non-reducing sugar.
Reason: It has glycosidic linkage.

BOARDS

a) If both assertion & reason are correct and the reason is a correct explanation of the assertion.

b) If both assertion & reason are correct but the reason is not a correct explanation of the assertion.

c) If the assertion is correct but reason is incorrect.

d) If both the assertion and reason are incorrect.

Solution

1. All polysaccharides, disaccharides and monosaccharides has glycosidic linkage. Therefore, glucose has glycosidic linkage.
2. Sugar is non-reducing sugar because of the absence of hemiacetal group and not because of the glycosidic linkage.
Therefore, assertion and reason are correct, but the reason is not a correct explanation of the assertion.

Hence, option (b) is the correct answer.

The α–D-glucose and β–D-glucose differ from each other due to the difference in carbon atom with respect to its:

BOARDS

a) Number of -OH groups

b) Size of hemiacetal ring

c) Conformation

d) Configuration

Solution

The two pyranose form of glucose, i.e., α–D-glucose and β–D-glucose differs in its configuration.

Hence, option (d) is the correct answer.

Number of chiral carbons in β-D-(+) glucose is:

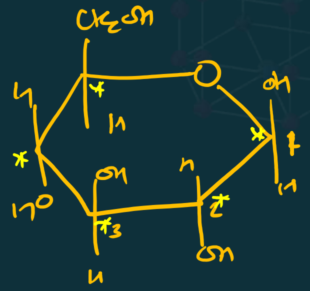
aldo

a) Five

b) Six

c) Three

d) Four



β-D-glucose

Solution

Total number of chiral carbons is 5.

Hence, option (a) is the correct answer.

Which of the following statement is not true about glucose?

BOARDS

a) It is an aldohexose.

b) It contains five hydroxyl groups.

c) It is a reducing sugar.

d) It is an aldopentose.

Solution

It is an aldohexose and not aldopentose.

Hence, option (d) is the correct answer.

α -D-(+)-glucose and β-D-(+)-glucose are:

BOARDS

a) Conformers

b) Epimers

c) Anomers

d) Enantiomers

Solution

α-D-(+)-glucose and β-D-(+)-glucose differ at one carbon in their configuration, so they are epimers. But the difference comes at first carbon, thus they are anomers.

Hence, option (c) is the correct answer.

Assertion: Hydrolysis of sucrose is known as inversion of cane sugar.
Reason: Sucrose is a disaccharide.

BOARDS

a) If both assertion & reason are correct and the reason is a correct explanation of the assertion.

b) If both assertion & reason are correct but the reason is not a correct explanation of the assertion.

c) If the Assertion is correct but Reason is incorrect.

d) If both the Assertion and Reason are incorrect.

Solution

Both the assertion & reason are correct, but the reason is not a correct explanation of the assertion.

Hence, option (b) is the correct answer.

Which of the following reactions could not be explained on the basis of the open chain structure of glucose?

BOARDS

a) Pentaacetate of glucose does not react with NH_2OH.

b) Glucose on prolonged heating with HI gives n-hexane.

c) Glucose on oxidation with bromine water forms gluconic acid.

d) With acetic anhydride glucose gives pentaacetate.

Solution

Penta-acetate of open chain structure of glucose does not react with NH_2OH. All other reactions i.e., heating with HI, oxidation with bromine water and With acetic anhydride, is possible.

Hence, option (a) is the correct answer.

The **incorrect** statements about above structure of **glucose** are:

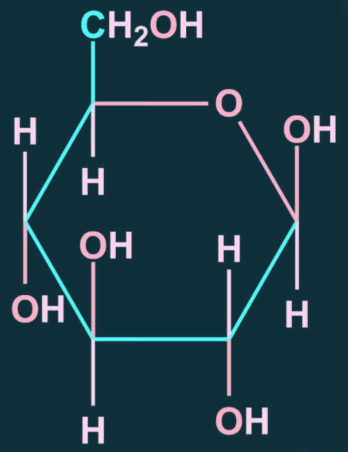
BOARDS

a) It is a pyranose form

b) It is a furanose form

c) It is a β-anomer

d) It is a D-sugar



Maltose: (Malt Sugar)

Maltose ($C_{12}H_{22}O_{11}$) is produced by the action of **malt** (which contains the enzyme **diastase**) on starch.

$$C_{12}H_{22}O_{11} \xrightarrow{H_3O^+} 2C_6H_{12}O_6$$

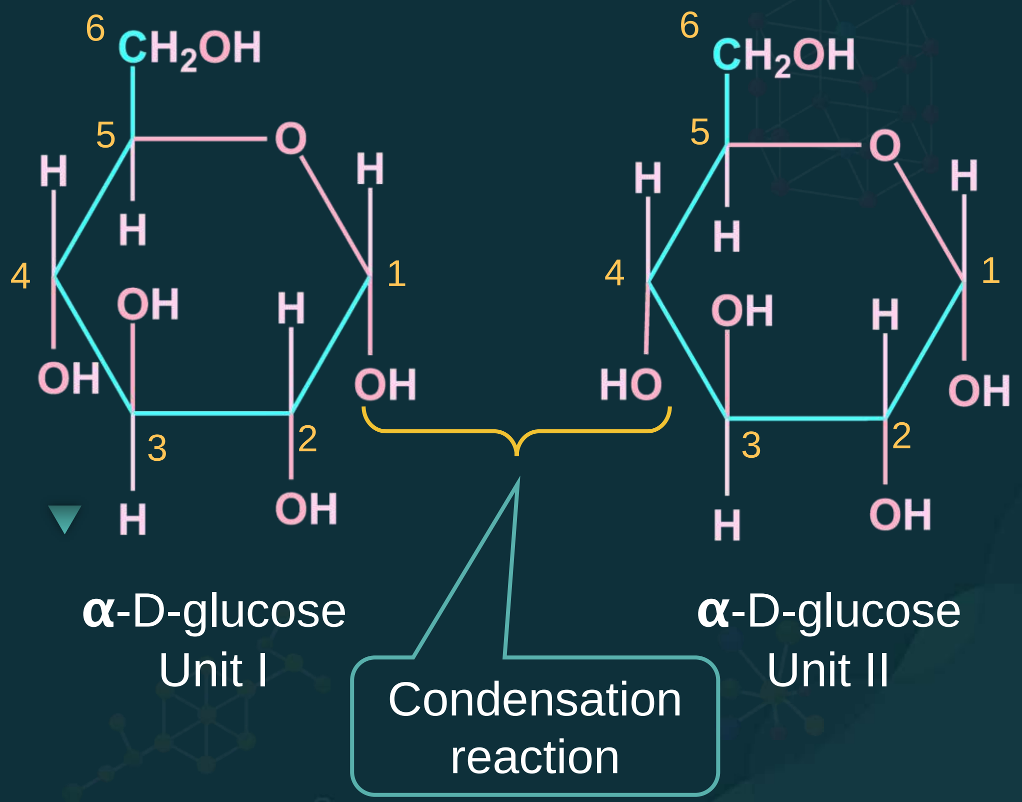
(α-D glucose)

$$\text{Starch} \xrightarrow{\text{Diastase}} \text{Maltose}$$

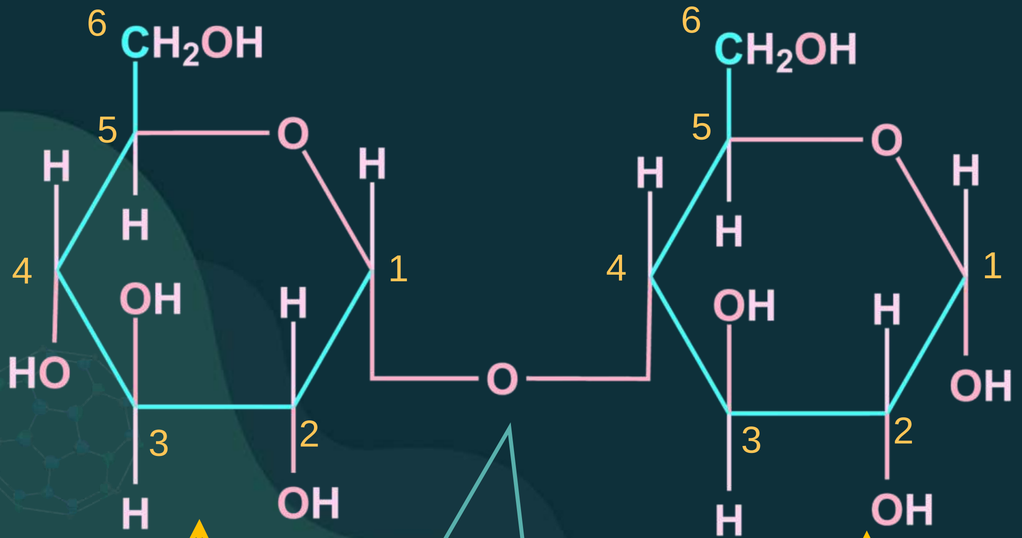
When it is **hydrolysed** with dilute acids or by the enzyme maltase, maltose yields two molecules of **D-(+)-glucose**.

Maltose: (Malt Sugar)

In maltose, glycosidic linkage is between **C1** of ***α*-D-glucose** and **C4** of ***α*-D-glucose.**



Maltose: (Malt Sugar)



Non reducing ring

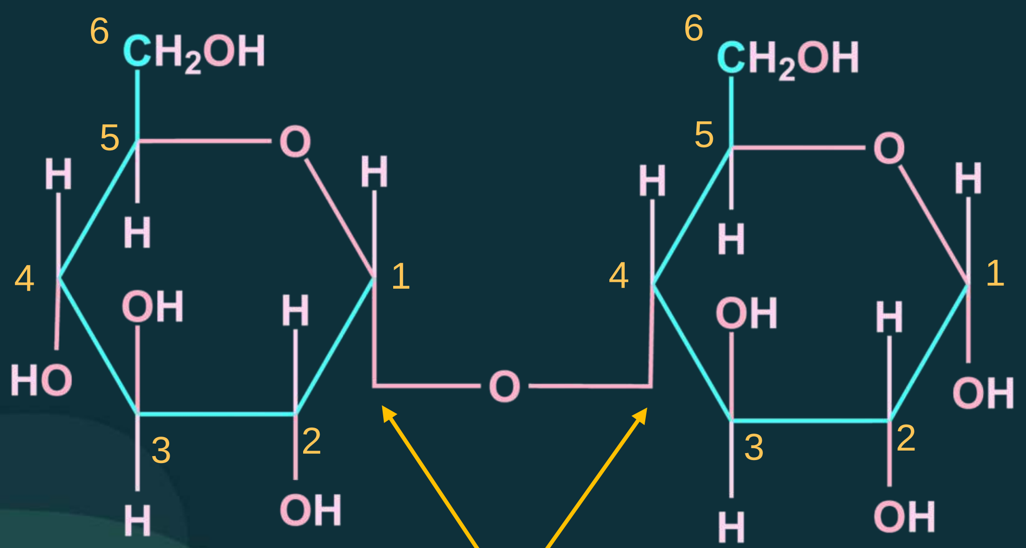
Glycosidic bond

Reducing ring

Maltose is a **reducing sugar** i.e., it reduces Fehling's or Tollens' reagent.

At least one **hemiacetal group** (of the two glucose molecules) is present.

Maltose: (Malt Sugar)



These are not carbons

Lactose (Milk Sugar)

Lactose ($C_{12}H_{22}O_{11}$) is a disaccharide present in the milk of humans, cows, and almost all other mammals.

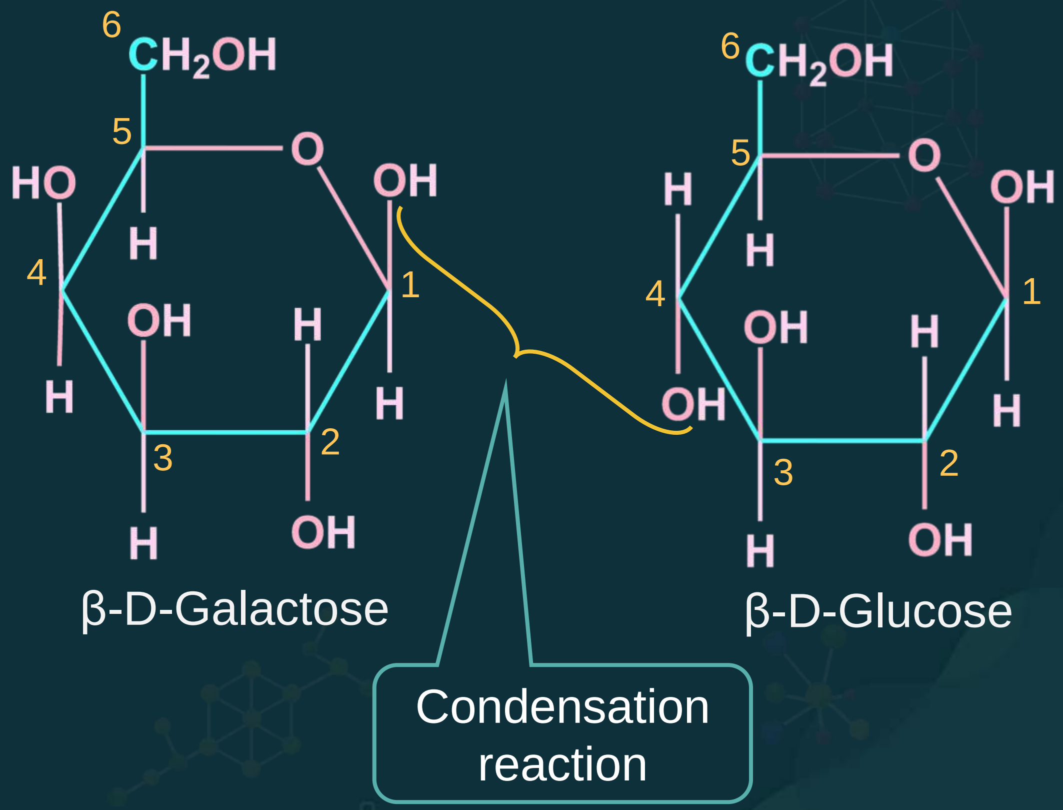
Lactose (Milk Sugar)

It is hydrolysed by dilute acids or by the **enzyme lactase**, to give an equimolar mixture of **D-(+)-glucose** and **D-(+)-galactose**.

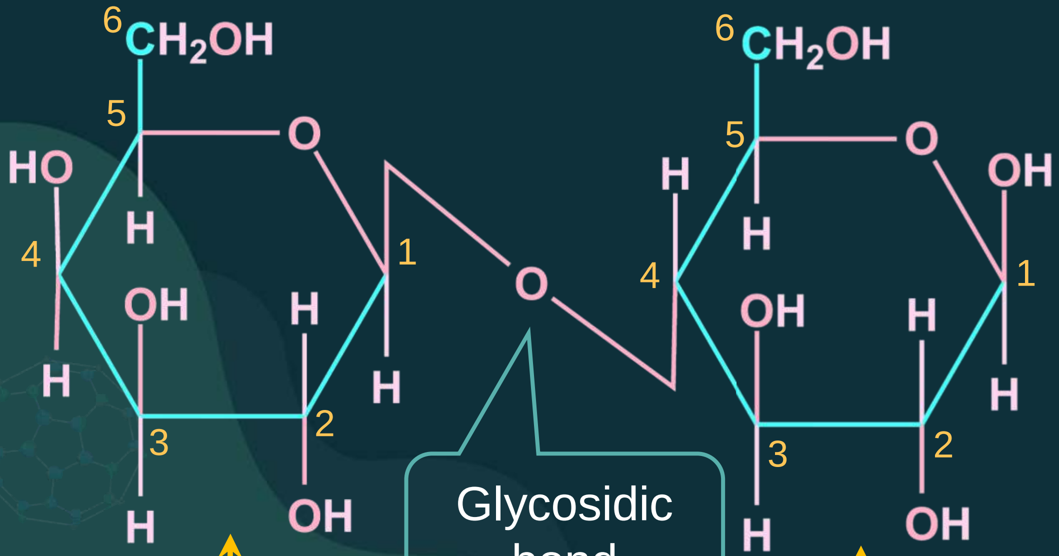
$$\text{Lactose} \xrightarrow{H_3O^+} \beta\text{-D-galactose} + \beta\text{-D-glucose}$$

Lactose (Milk Sugar)

In lactose, glycosidic linkage is between **C1** of **β-D-galactose** and **C4** of **β-D-glucose**.



Lactose (Milk Sugar)



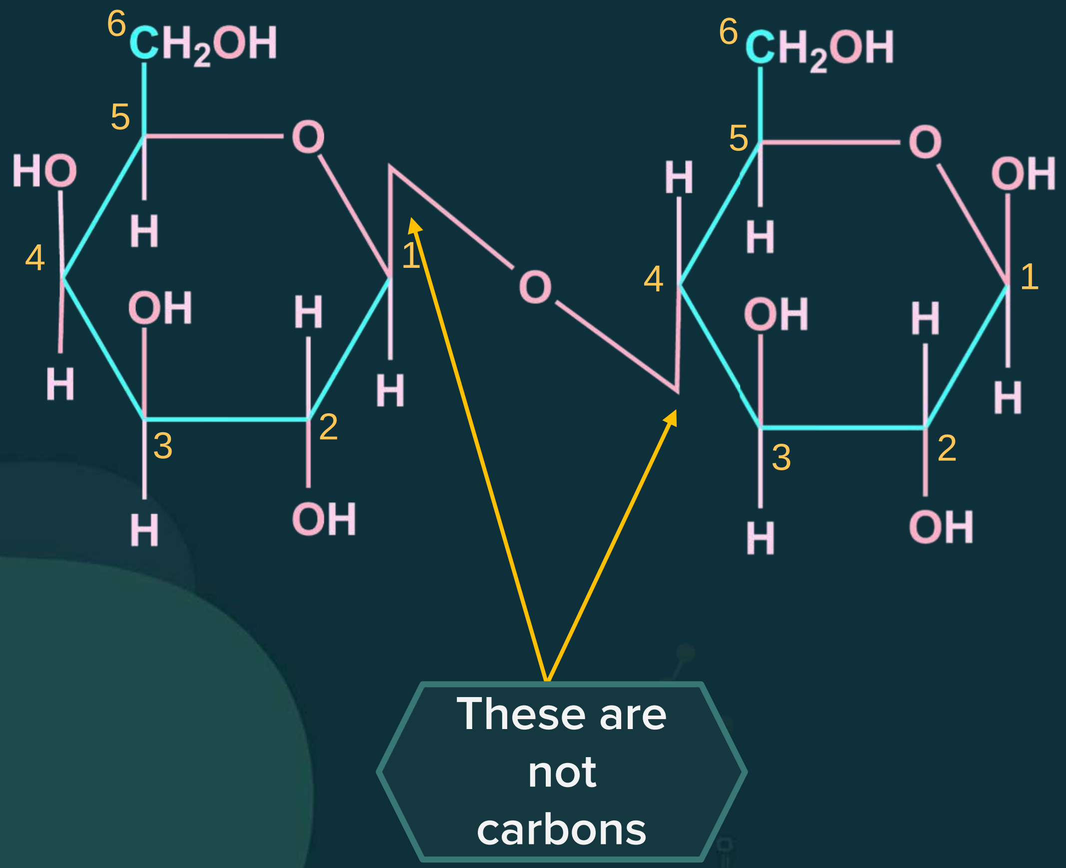
Glycosidic bond

Non reducing ring

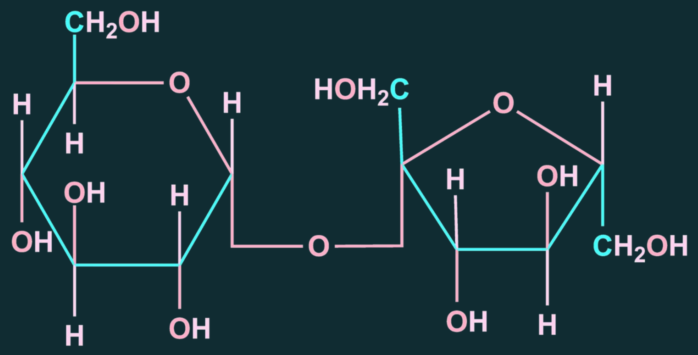
Reducing ring

Lactose is a **reducing sugar**, i.e., it **reduces Fehling's** or **Tollens' reagent**.

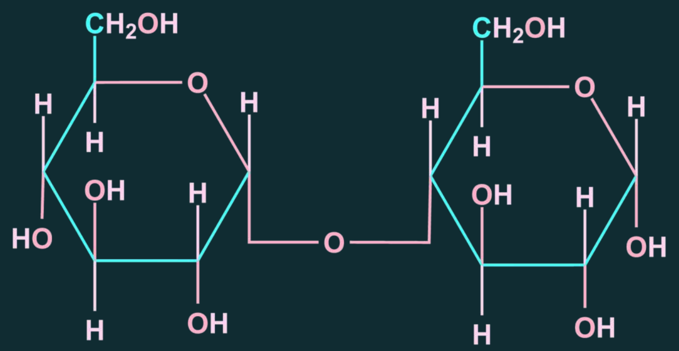
Lactose (Milk Sugar)



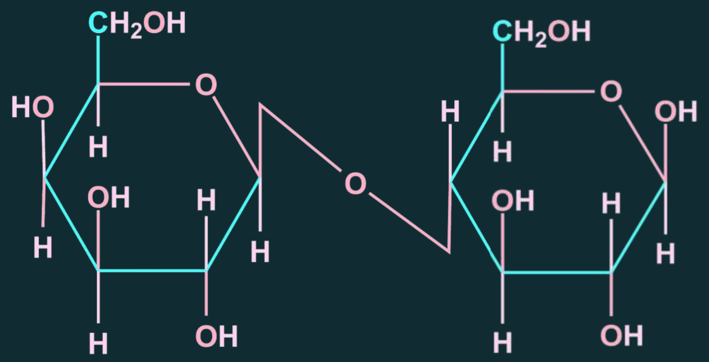
Summary

Disaccharide	**Sucrose**
Structure	
Monomeric unit linkage	C1 α-D-glucose + C2 β-D-fructose

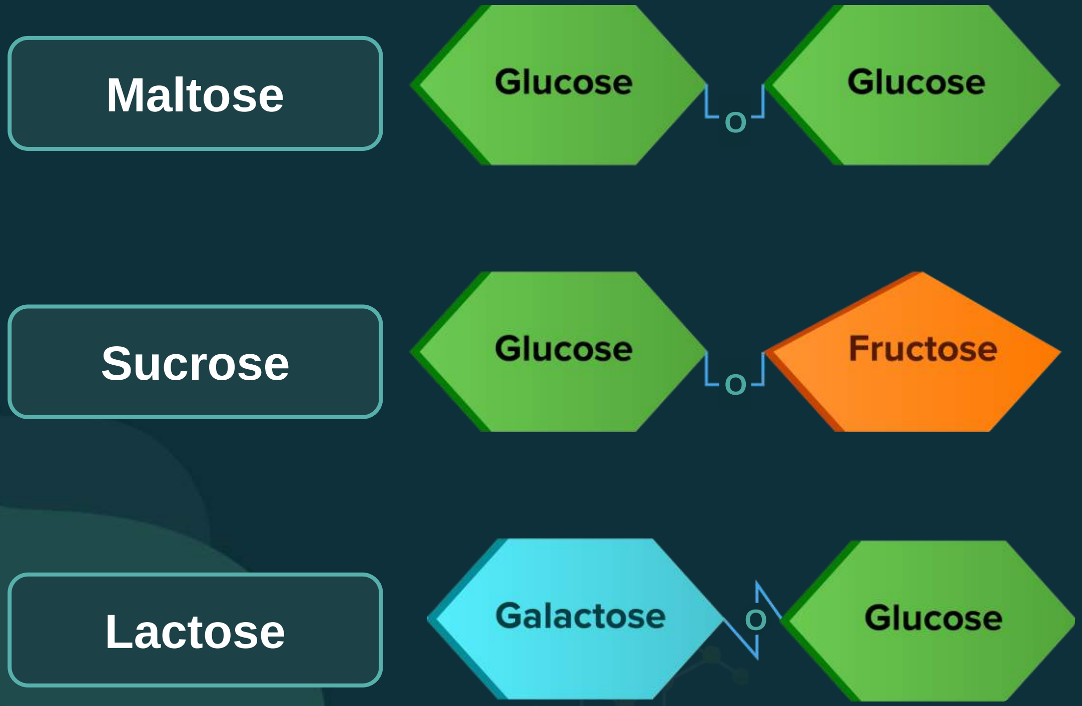
Summary

Disaccharide	**Maltose**
Structure	
Monomeric unit linkage	C1 α-D-glucose + C4 α-D-glucose

Summary

Disaccharide	**Lactose**
Structure	
Monomeric unit linkage	C1 β-D-galactose + C4 β-D glucose

Summary


Maltose
Glucose
O
Glucose
Sucrose
Glucose
O
Fructose
Lactose
Galactose
O
Glucose

Assertion: Maltose is a reducing sugar which gives two moles of D-glucose on hydrolysis.
Reason: Maltose has 1,4-β-glycosidic linkage.

BOARDS

a) If both assertion and reason are correct and the reason is a correct explanation of the assertion.

b) If both assertion and reason are correct but the reason is not a correct explanation of the assertion.

c) If the assertion is correct but reason is incorrect.

d) If both the assertion and reason are incorrect.

Solution

Assertion, i.e., Maltose is a reducing sugar which gives two moles of D-glucose on hydrolysis is a true statement, but Maltose do not have β-glycosidic linkage. So, the reason is wrong.

Hence, option (c) is the correct answer.

Polysaccharides

It contains large number of **monosaccharide units** joined together by **glycosidic linkage**. They mainly act as the **food storage** or **structural materials**.

Examples

Starch, cellulose, glycogen

Starch $(C_6H_{10}O_5)_n$

Starch is the main storage polysaccharide in **plants**.

Starch $(C_6H_{10}O_5)_n$

It is the most important **dietary source** for human beings.

Starch $(C_6H_{10}O_5)_n$

Starch Composition

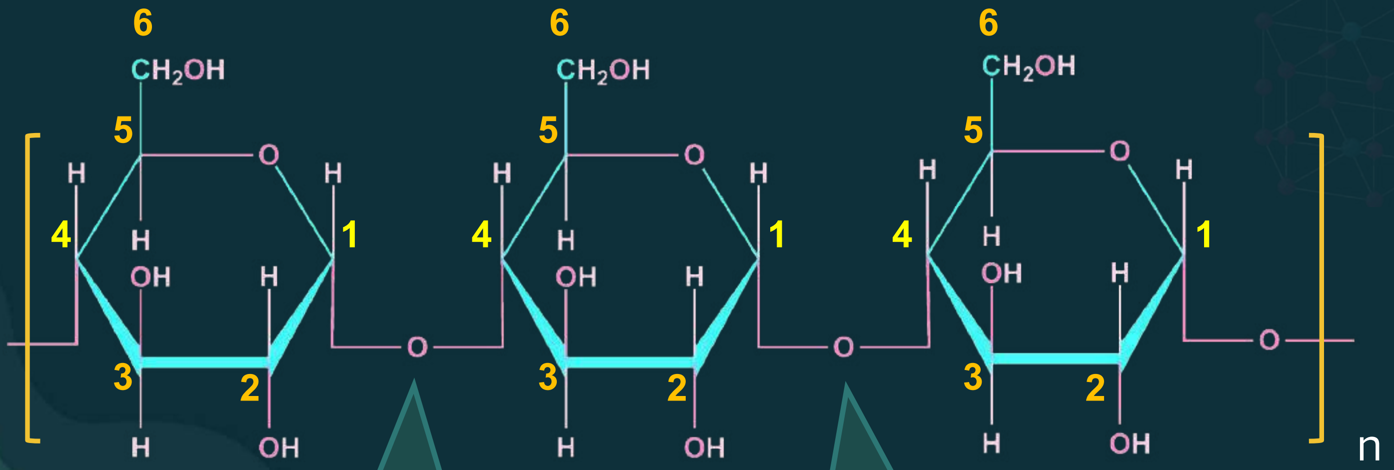
Amylose (15-20%)	Amylopectin (80-85%)
Water soluble	Water insoluble

Amylose

α-D-glucose units joined by **glycosidic linkages** between **C1** of one glucose unit and **C4** of the next glucose unit.

D-glucose units → 200 - 1000

Amylose



C1 – C4 glycosidic linkage

C1 – C4 glycosidic linkage

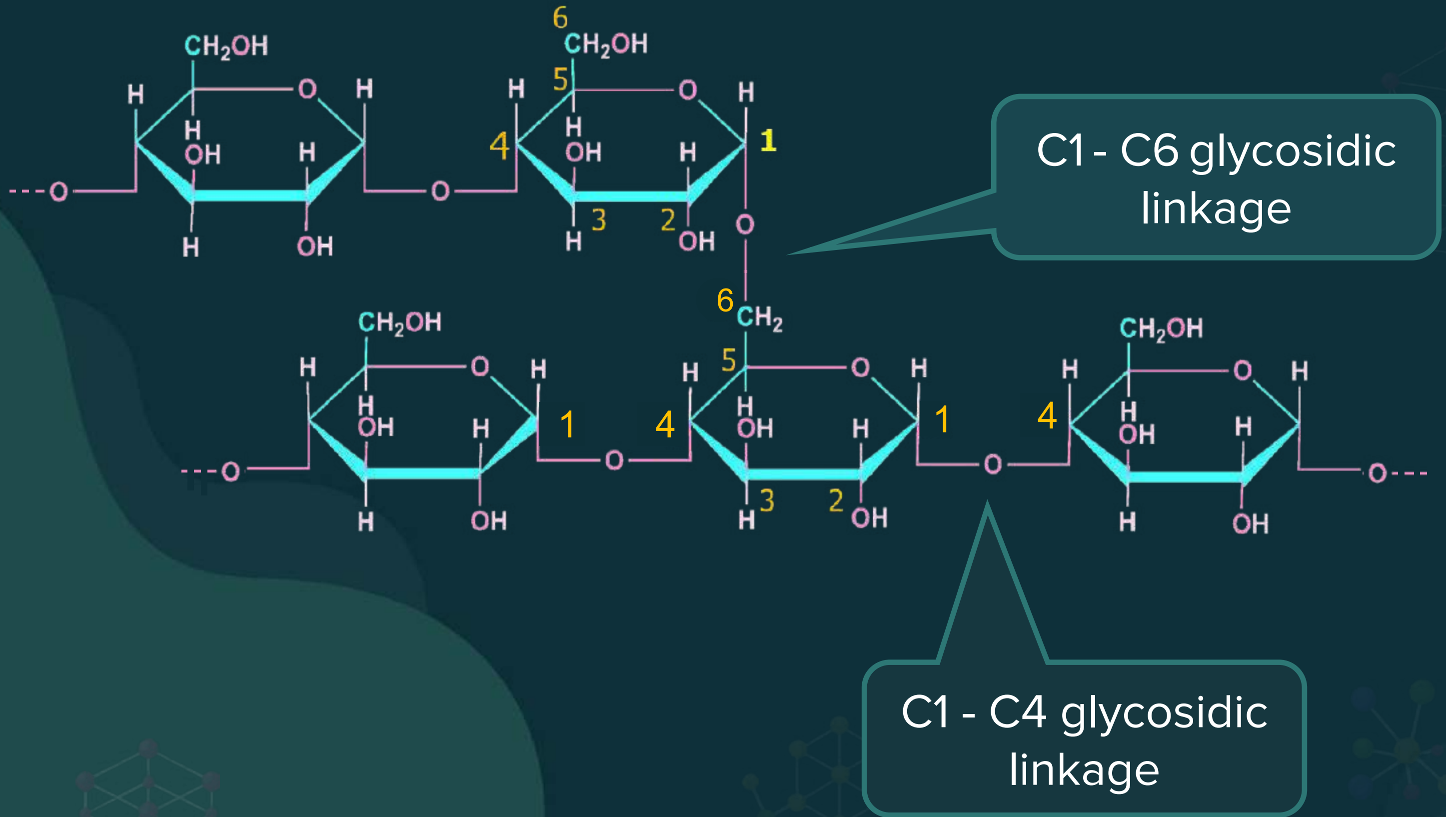
Amylopectin

Amylopectin has a **branched-chain structure**.

It is composed of chains of **25 to 30 α-D-glucose units** joined by **glycosidic linkages** between C1 of one glucose unit and C6 of the other glucose unit.

Glycosidic linkages between **C1** of one glucose unit and **C4** of the next glucose unit also exist.

Amylopectin



Cellulose $(C_6H_{10}O_5)_n$

The **food** of **termites** is mainly cellulose, which is obtained from wood, grass, leaves, humus, manure of herbivorous animals, and materials of vegetative origin (e.g., paper, cardboard, cotton).

Cellulose $(C_6H_{10}O_5)_n$

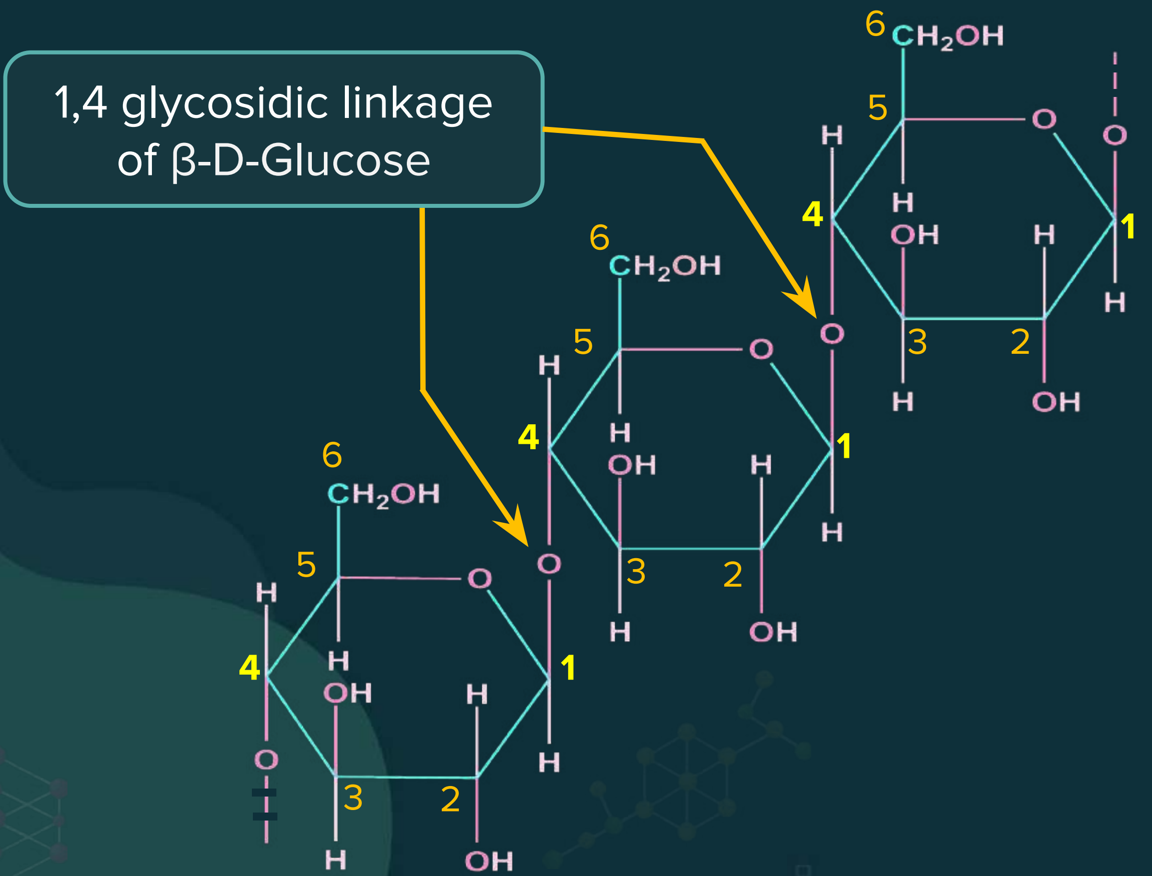
1 Cellulose occurs exclusively in **plants**.

2 It is a predominant constituent of **cell wall** of plant cells.

Linear chain natural polymers of ***β*-D-glucose** units joined by **1,4-glycosidic linkage.**

Natural linear polymers

Cellulose $(C_6H_{10}O_5)_n$



Glycogen (Animal Starch)

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

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

Structure is similar to amylopectin, but **branching** takes place after every **5-6 glucose units**.

Highly branched

Cellulose on hydrolysis yields:

BOARDS

a) β-D-Fructose

b) α-D-Glucose

c) β-D-Glucose

d) α-D-Fructose

Solution

Cellulose on hydrolysis yields β-D-Glucose.

Hence, option (c) is the correct answer.

On **hydrolysis** of **starch**, we finally get:

a) Glucose

b) Fructose

c) Both (a) & (b)

d) Sucrose

Solution

On hydrolysis of starch, we get amylose and amylopectin which are formed from the polymerisation of glucose.

Hence, option (a) is the correct answer.

Proteins

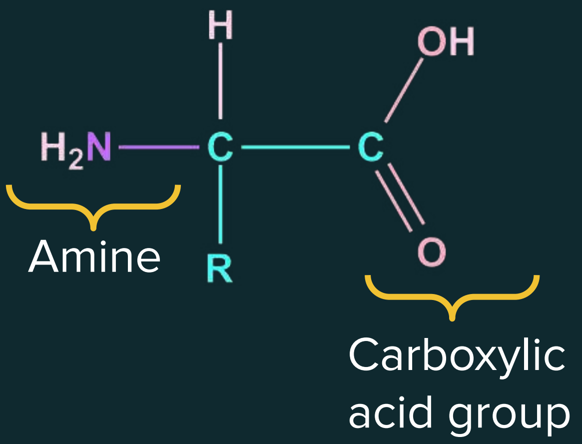
Proteins

Each **living cell** is made up of thousands of **different proteins**.

Proteins are **high molecular mass** complex, biopolymers of **amino acids**.

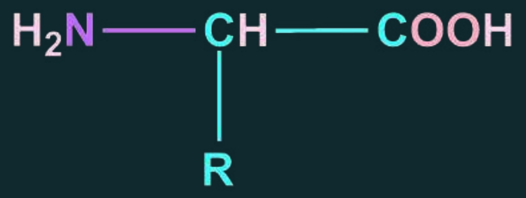
Amino Acids

The amino acids contain **amino** as well as **carboxylic acid** group.



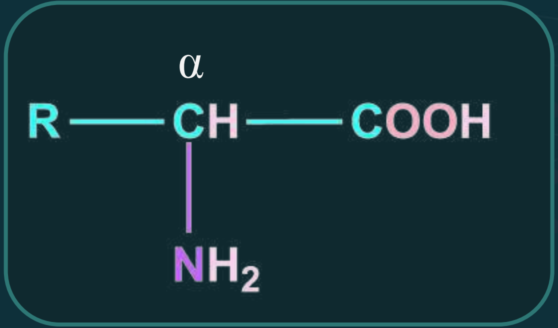
Amino Acids

R is alkyl, aryl group or any other group, but **never contain** unstable, strained cycles or functional groups.

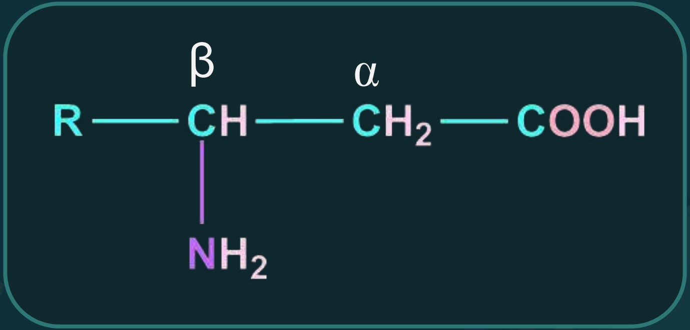


Amino Acids

On the basis of **position of amino** group in the chain, these are classified as ***α*, *β*, *γ*,** and so on.



α-amino acids



β-amino acids

Amino Acids

There are around **20 amino acids** in the living system.

Amino Acids

Neutral amino acid

Name of the amino acid	Three letter symbol	One letter code	Side chain (R)
Glycine	Gly	G	$-H$
Alanine	Ala	A	$-CH_3$
Valine	Val	V	$-CH(CH_3)_2$
Leucine	Leu	L	$-CH_2-CH-(CH_3)_2$

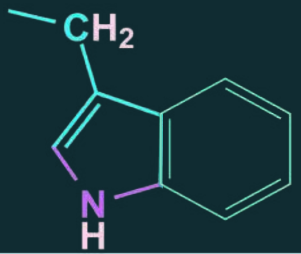
Amino Acids

Neutral amino acid

Name of the amino acid	Three letter symbol	One letter code	Side chain (R)
Isoleucine	Ile	I	$-\underset{\displaystyle CH_3}{\underset{\vert}{CH}}-C_2H_5$
Phenylalanine	Phe	F	$-CH_2-C_6H_5$
Cysteine	Cys	C	$-CH_2-SH$

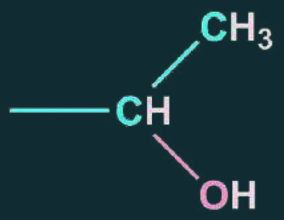
Amino Acids

Neutral amino acid

Name of the amino acid	Three letter symbol	One letter code	Side chain (R)
Methionine	Met	M	$-CH_2-CH_2-S-CH_3$
Tryptophan	Trp	W	
Serine	Ser	S	$-CH_2-OH$

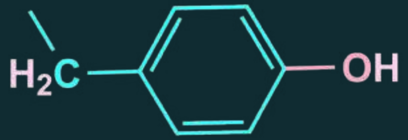
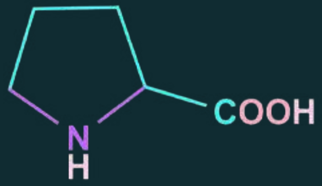
Amino Acids

Neutral amino acid

Name of the amino acid	Three letter symbol	One letter code	Side chain (R)
Asparagine	Asn	N	$-CH_2-CO-NH_2$
Glutamine	Gln	Q	$-CH_2-CH_2-CO-NH_2$
Threonine	Thr	T	

Amino Acids

Neutral amino acid

Name of the amino acid	**Three letter symbol**	**One letter code**	**Side chain (R)**
Tyrosine	Tyr	Y	
Proline	Pro	P	 (Complete structure)

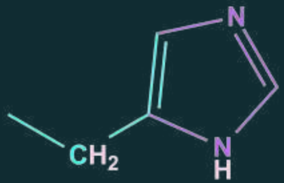
Amino Acids

Acidic amino acid

Name of the amino acid	Three letter symbol	One letter code	Side chain (R)
Aspartic acid	Asp	D	$-CH_2-COOH$
Glutamic acid	Glu	E	$-CH_2-CH_2-COOH$

Amino Acids

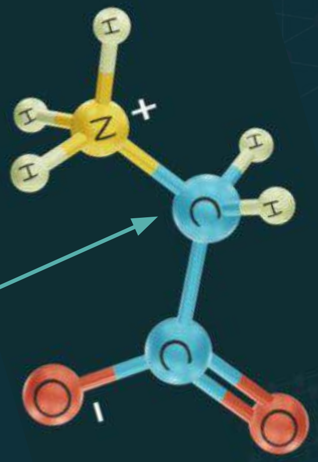
Basic amino acid

Name of the amino acid	Three letter symbol	One letter code	Side chain (R)
Arginine	Arg	R	$-CH_2-(CH_2)_2-NH-\underset{\underset{NH}{\Vert}}{C}-NH_2$
Histidine	His	H	
Lysine	Lys	K	$-CH_2-(CH_2)_3-NH_2$

Amino Acids

Almost all the naturally occurring amino acids have the **L configuration** at the **α carbon**, except **glycine.**

Glycine is **achiral.**



Classification of Amino Acids

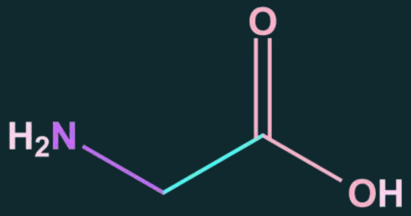
Based on Functional Groups Present

- Neutral amino acids
- Acidic amino acids
- Basic amino acids

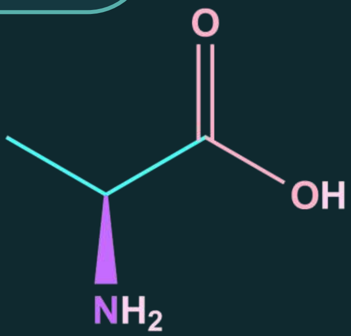
Neutral Amino Acids

If equal number of **– NH_2** and **– COOH** groups are present.

Examples



Glycine

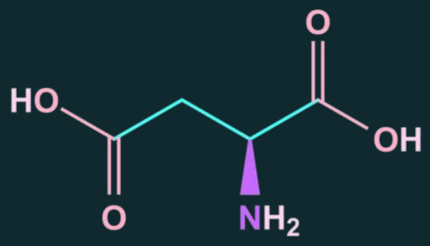


Alanine

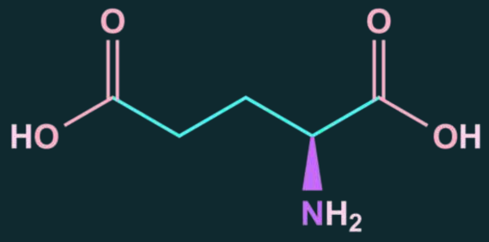
Acidic Amino Acids

If **more number of -COOH groups** are present as compared to $-NH_2$ groups.

Examples



Aspartic acid

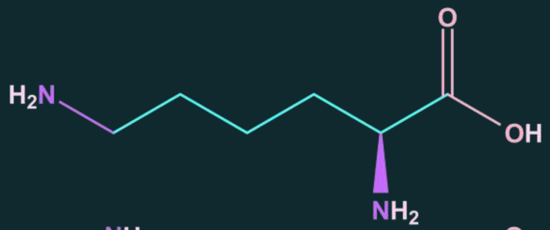


Glutamic acid

Basic Amino Acids

If **more number of -NH_2 groups** are present as compared to –COOH groups.

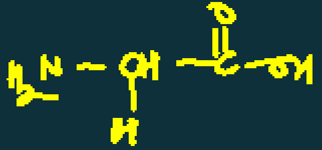
Examples

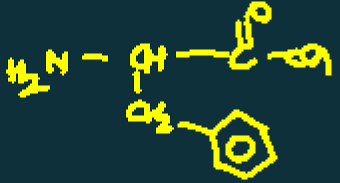


Lysine

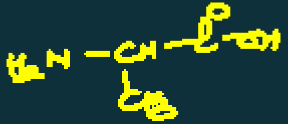
Arginine

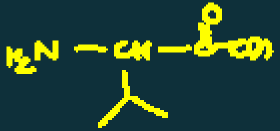
Amino Acids

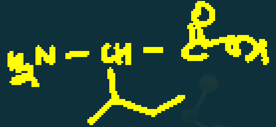
①  glycine Gly G

 Phenylalanine Phe F

if R– = alkyl, then 5 such amino acids exist.

R– = $-CH_3$  Alanine Ala A

isopropyl = $-\underset{CH_3}{CH}-CH_3$  Valine Val V

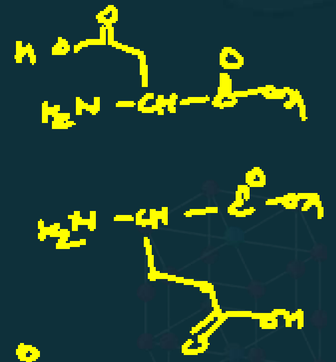
sec. butyl = $-\underset{CH_3}{CH}-CH_2-CH_3$  Isoleucine Ile I

Isobutyl = $-CH_2-\underset{CH_3}{CH}-CH_3$  Leucine Leu L

Amino Acids

Acidic Amino acids

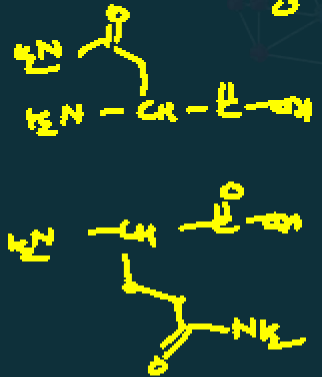
(2) Asp D $-CH_2-\overset{O}{\overset{\|}{C}}-OH$ Aspartic acid



Glu E $-CH_2-CH_2-\overset{O}{\overset{\|}{C}}-OH$ Glutamic acid

neutral amides

(3) N $-CH_2-\overset{O}{\overset{\|}{C}}-NH_2$ Asn Asparagine



Q $-CH_2-CH_2-\overset{O}{\overset{\|}{C}}-NH_2$ glutamine Gln

neutral 'S' containing amino acids

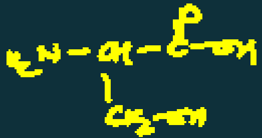
(4) $-CH_2-SH$ Cysteine Cys C

$-CH_2-CH_2-S-CH_3$ Methionine Met M

Amino Acids

③ —OH groups

$R-$ = $-CH_2-OH$



Serine Ser S

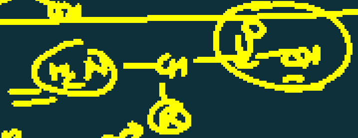
= $-CH(CH_3)-OH$

Threonine Thr T

= 

Tyrosine Tyr Y

④ nitrogenous bases



basic amino acid

$-CH_2-(CH_2)_3-NH_2$

Lysine Lys L

$-CH_2-CH_2-CH_2-NH-C(=NH)-NH_2$

Arginine Arg R

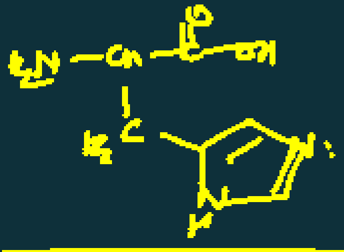
Amino Acids

Basic

Histidine

R- =

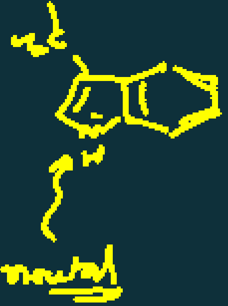
His H



Neutral

W

Tryptophan Trp

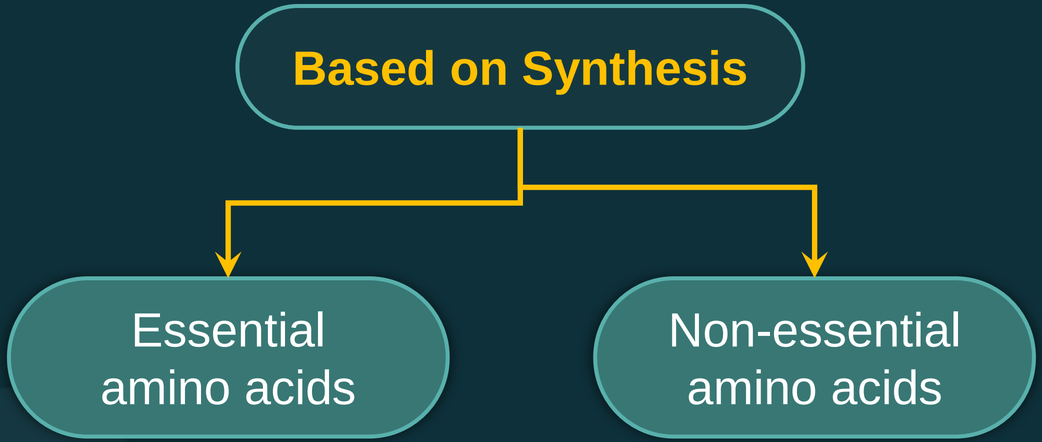


Note

Almost all the naturally occurring amino acids have the **L configuration** at the **α carbon**, except **glycine.**

Glycine is **achiral**

Classification of Amino Acids



Essential Amino Acids

10 amino acids that should **necessarily** be present in our diet.

Trick to Remember

PVT-TIM-HALL

Essential amino acids:
Phe, Val ,Thr, Trp, Ile,
Met, His, Arg, Leu, Lys,

PVT	TIM	HALL
Phenylalanine	Tryptophan	Histidine
Valine	Isoleucine	Arginine
		Lysine
Threonine	Methionine	Leucine

Non-Essential Amino Acids

10 amino acids that are **synthesised** in our **body**.

Trick to Remember

CAAATS-GGGP

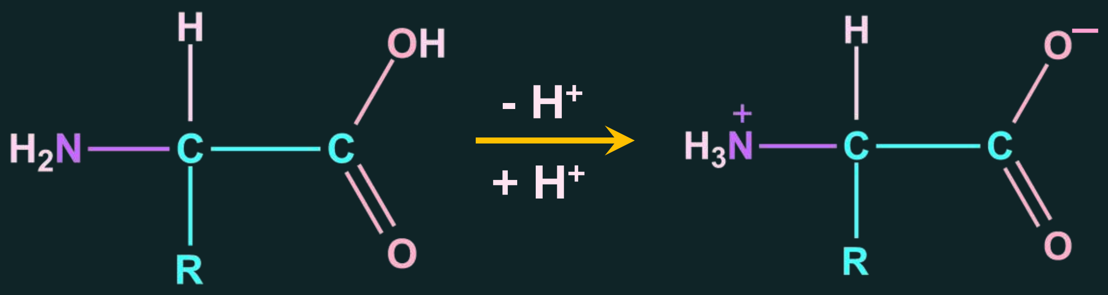
Non-essential amino acids:
Cys, Asn, Ala, Asp, Tyr,
Ser, Gln, Gly, Glu, Pro,

Note

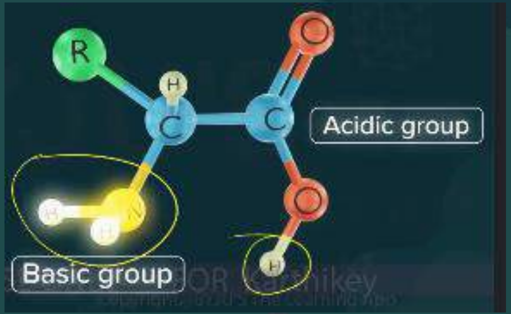
In a **neutral amino acid** solution, the **–COOH loses a proton** and the **$–NH_2$** of the same molecule **picks up the proton.**

The resulting ion is **dipolar**, charged but overall **electrically neutral**, is called **Zwitter ion.**

Zwitter Ion



Zwitter ion



Amino acids are **amphoteric** in nature

A substance forms zwitter ion. It can have functional group:

BOARDS

a) $–NH_2$, $– COOH$

b) $–NH_2$, $–SO_3H$

c) Both

d) None of these

Solution

One acidic and one basic group is required in a molecule to form a zwitter ion.

Hence, option (a) is the correct answer.

Assertion: **Alpha (α)-amino acids exist as internal salt in solution as they have amino and carboxylic acid groups in near vicinity.**

Reason: **H^+ ion given by carboxylic group (–COOH) is captured by amino group ($–NH_2$) having lone pair of electrons.**

BOARDS

a) If both assertion and reason are correct and the reason is a correct explanation of the assertion.

b) If both assertion and reason are correct but the reason is not a correct explanation of the assertion.

c) If the assertion is correct but the reason is incorrect.

d) If both the assertion and reason are incorrect.

Solution

Alpha (α)-amino acids exist as internal salt in solution as they have amino and carboxylic acid groups in near vicinity because H^+ ion given by carboxylic group (–COOH) is captured by amino group ($–NH_2$) having lone pair of electrons.

Hence, option (a) is the correct answer.

The incorrect statement (s) about starch:

a) It is a pure single compound.

b) It is a mixture of two polysaccharides of glucose.

c) It involves the (C1 – C4) glycosidic linkage between two α-D glucose units.

d) It involves branching by (C1 – C6) glycosidic linkage.

Solution

Starch is a mixture of two components - a water soluble component called Amylose(15-20%) and water insoluble component called Amylopectin (80-85%). Therefor, it is not a pure compound.

Hence, option (a) is the correct answer.

Which one of the following statements is correct?

BOARDS

a) All amino acids except lysine are optically active.

b) All amino acids are optically active.

c) All amino acids except glycine are optically active.

d) All amino acids except glutamic acids are optically active.

Solution

All amino acids except glycine are optically active, as glycine does not contain a chiral carbon.

Hence, option (c) is the correct answer.

Amongst the following, the **incorrect** statement is:

BOARDS

a) Cellulose and amylose has 1,4-glycosidic linkage.

b) Lactose contains β-D-galactose and β-D-glucose.

c) Maltose and lactose has 1,4-glycosidic linkage.

d) Sucrose and amylose has 1,2-glycosidic linkage.

Solution

α-D-glucose units are joined by glycosidic linkages between C1 of one glucose unit and C4 of the next glucose unit in amylose. Thus, amylose have 1,4-glycosidic linkage.

Hence, option (d) is the correct answer.

α-Amino acids are:

BOARDS

a) Acidic due to – COOH group and basic due to $-NH_2$ group.

b) Acidic due to $-NH_3^+$ group and basic due to $-COO^-$ group.

c) Neither acidic nor basic.

d) None is true.

Solution

They can either accept or donate H^+, so actually they are amphoteric in nature.

Hence, option (c) is the correct answer.

Peptides

Amino acids are **bifunctional** molecules with **$-NH_2$ group** at one end and **$-COOH$** at the other.

Compounds formed by **condensation** of amino group of one molecule of **α-amino acid** with the **carboxyl group** of the other molecule of same or different α–amino acid by elimination of **water**.

Amide linkages joining amino acids are called **peptide bonds or peptide linkages.**

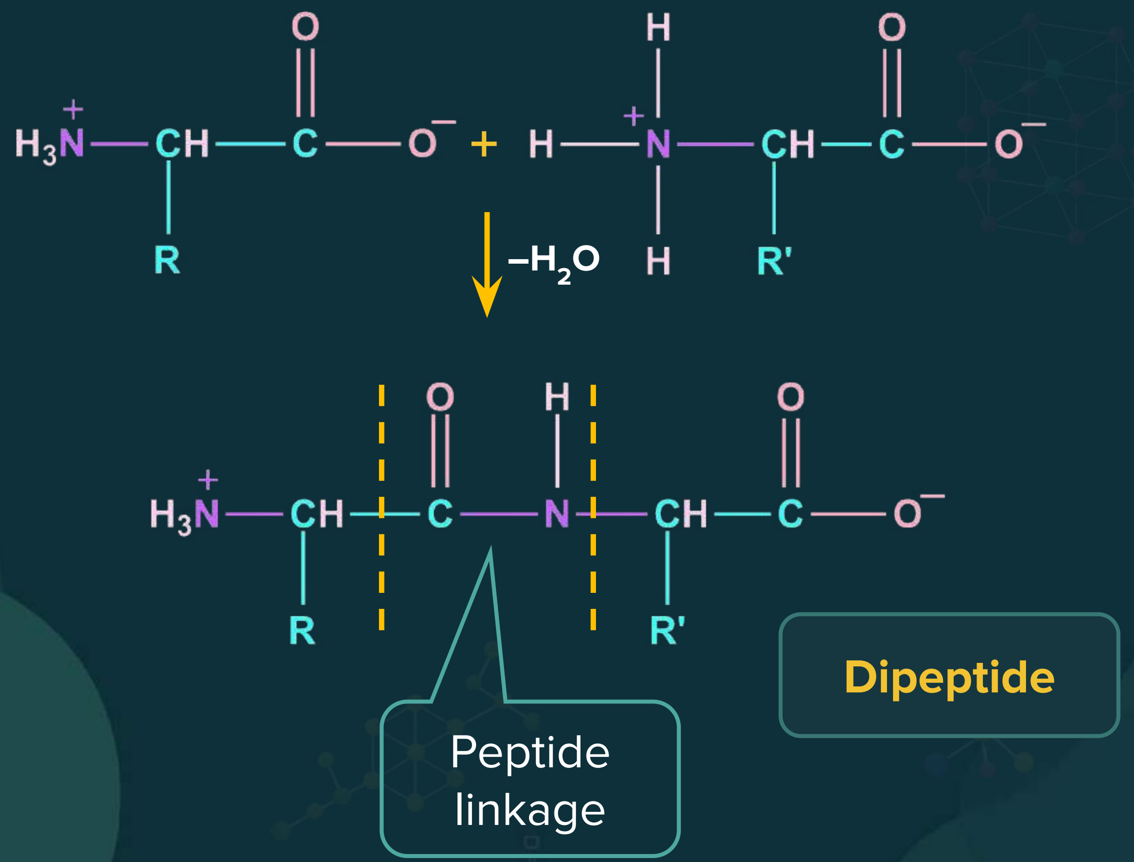
Peptides

Peptides that contain 2, 3, a few **(3–10)**, or many amino acids are called **dipeptides, tripeptides, oligopeptides, and polypeptides**, respectively.

Dipeptide

Amino acid

The amino acids may be same or different.

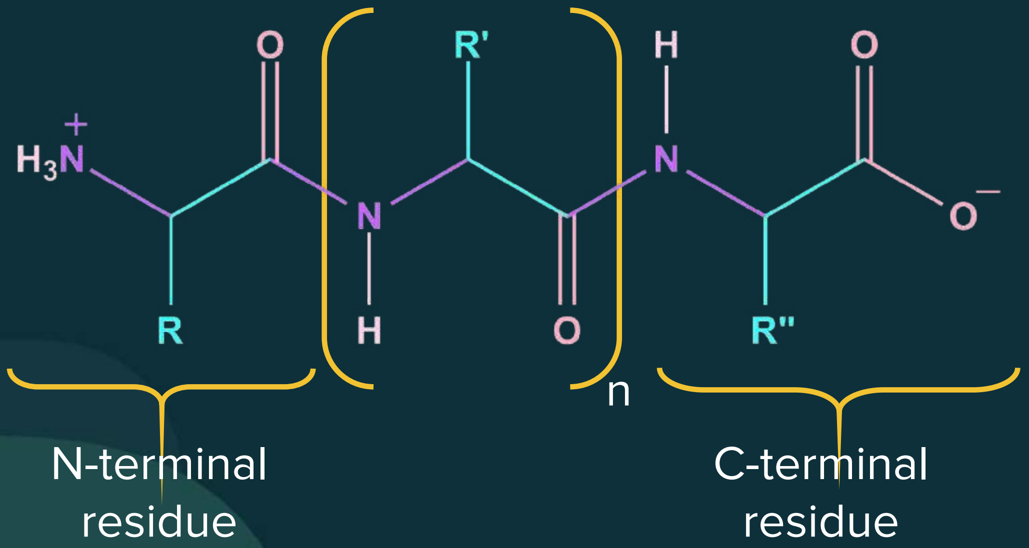


Peptides

The amino acid unit having free $-NH_2$ groups is called **N-terminal end** whereas, the amino acid unit with free $-COOH$ group is called **C-terminal end.**

The structure is written with **N-terminal end to the left** and **C-terminal end to the right**.

Peptides



$H_3\overset{+}{N}$
O
R
R'
N
H
O
n
H
N
O
O^-
R''
N-terminal residue
C-terminal residue

Peptides

At N-terminal or C-terminal further bond formation takes place and **tri, tetra, pentapeptides** are formed.

More than 10 amino acids joined together are called polypeptides.

Naming of Polypeptides

Starts from **–N-terminal residue**.

Suffix **-ine** of amino acids is replaced by **-yl** for all except amino acid of C-terminal residue.

Example:

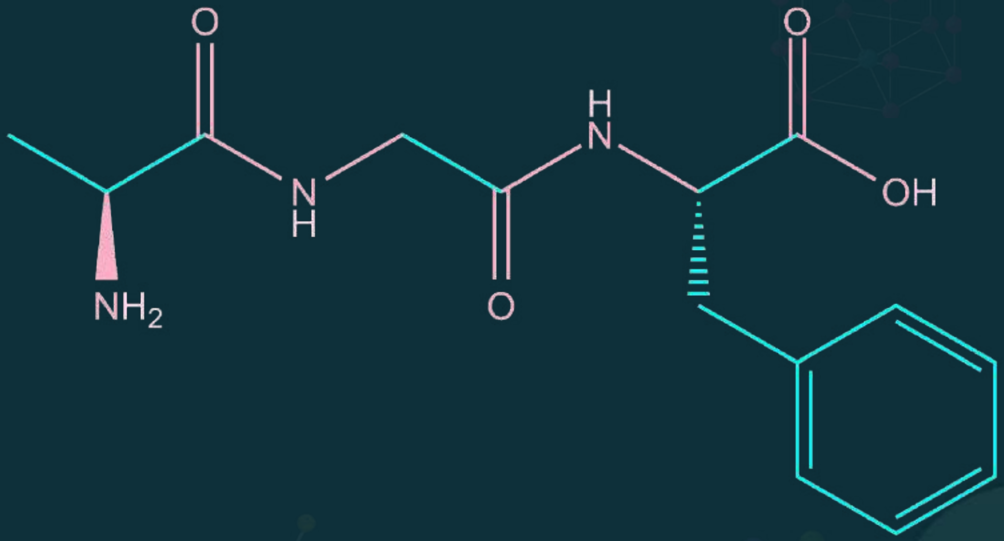
Glycine ⟶ Glycyl

Alanine ⟶ Alanyl

Lysine ⟶ Lysyl

Naming of Polypeptides

Alanylglycylphenylalanine means **Ala-Gly-Phe** or **A-G-F**.



Alanylglycylphenylalanine

Proteins

Generally, a **polypeptide** with more than **100 amino acid residues**.

Molecular mass > 10,000

Some polypeptides with **lesser number** of amino acids are also known as proteins.

Example

Insulin has 51 amino acids.

Proteins

Proteins on partial hydrolysis give peptides of varying molecular masses which upon complete hydrolysis give **α-amino acids**.

$$\text{Natural proteins} \xrightarrow{\text{Hydrolysis}} \text{Peptides} \xrightarrow{\text{Hydrolysis}} \alpha\text{-amino acids}$$

Classification of Proteins

Based on Molecular Structure

- Fibrous proteins
- Globular proteins

Fibrous Proteins

When polypeptide chain runs **parallel** to each other and has a **fibre like structure.**

Examples

Keratin(present in hair, wool, silk), myosin(present in muscles)

In fibrous protein, **chains** are held together by **hydrogen** & **disulphide bond.**

These are **insoluble** in water.

Globular Proteins

A **folded polypeptide** chain when forms a **spheroidal shape** is called a globular protein.

Soluble in water

Examples

Insulin and albumins

Structure and shape of proteins can be studied at **four different levels,** i.e., primary, secondary, tertiary, and quaternary.

Primary Structure of Proteins

Each polypeptide in a **protein** has **amino acids** linked with each other in a **specific sequence** known as the **primary structure.**

Any **change** in this **primary structure** i.e., sequence of amino acids creates a **different protein**.

Primary Structure of Proteins

Normal haemoglobin

-Val-His-Leu-Thr-Pro-***Glu***-Lys-

Sickle cell anemia haemoglobin

-Val-His-Leu-Thr-Pro-***Val***-Lys-

Secondary Structure of Proteins

The shape in which a **long polypeptide chain** can exist is called secondary structure.

Secondary Structure

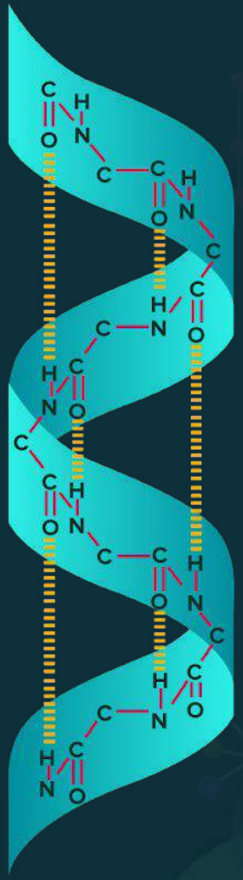
α-helix structure

β-pleated sheet structure

α-Helix Structure

In this structure, a polypeptide chain forms all possible **H–bonds** by twisting into a right-handed screw **helix**.

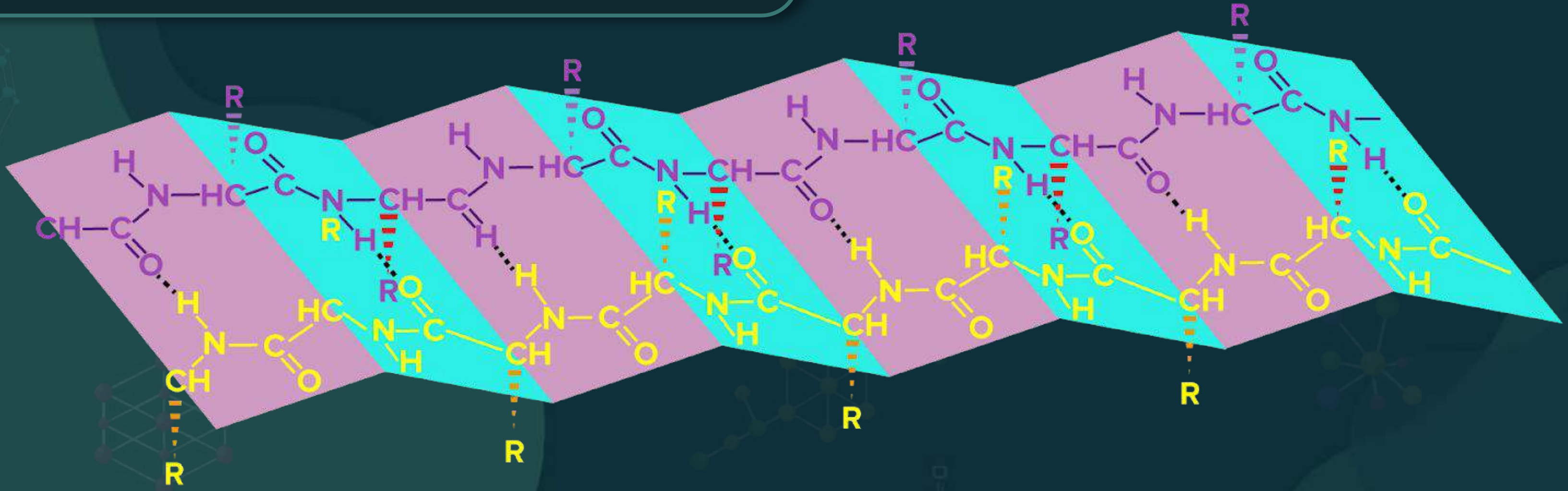
–NH– group of each amino acid residue forms **H–bond** with the **>C=O** of an adjacent turn of helix.



β-Pleated Sheet Structure

In this structure, **all peptide chains** are **stretched out** to a nearly maximum extension and then **laid side by side** that are held together by **intermolecular H-bond**.

The polypeptide chains can link together in **parallel and antiparallel sequence**.

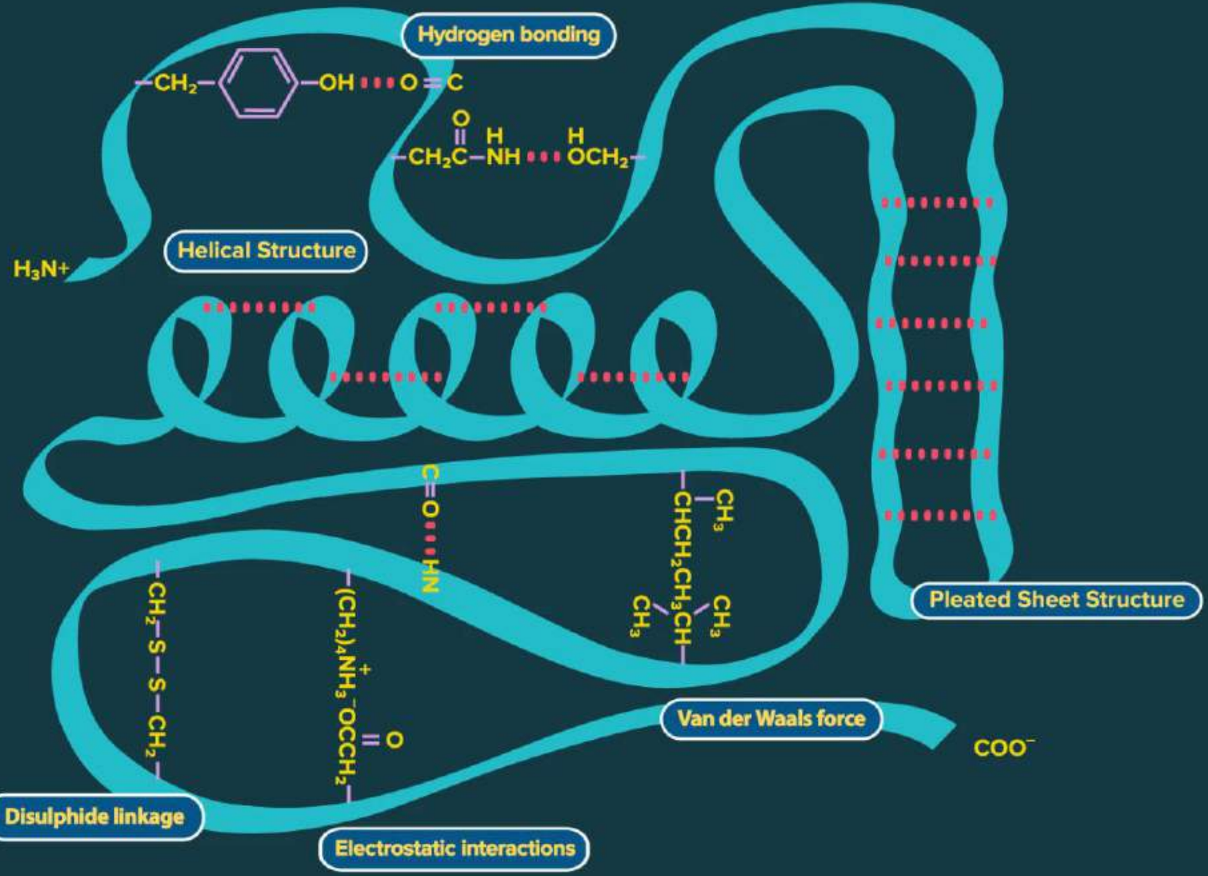


Tertiary Structure of Proteins

It represents **overall folding** of the polypeptide chains i.e., further folding of the secondary structure producing a **3D structure.**

It gives rise to two major **molecular shapes**

- Fibrous
- Globular

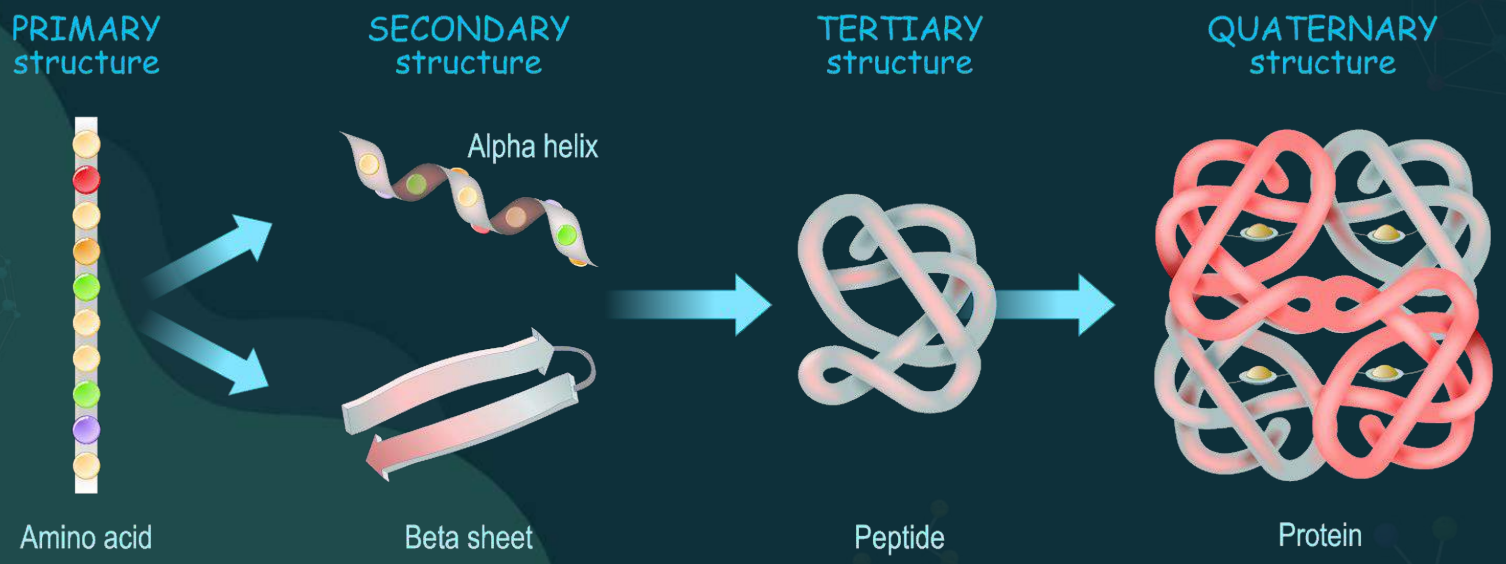

Hydrogen bonding
Helical Structure
H3N+
Pleated Sheet Structure
Van der Waals force
COO−
Disulphide linkage
Electrostatic interactions

Quaternary Structure of Proteins

Some of the proteins are composed of **two or more polypeptide chains** referred to as sub-units.

The spatial arrangement of these subunits with respect to each other is known as **quaternary structure**.

Structure of Proteins



Denaturation of Proteins

When protein in native form is subjected to a **physical change** like temperature or pH, the **hydrogen bonds** are **disturbed**.

As a result, globules get unfold and helices get uncoiled therefore, **proteins lose its activity**.

Denaturation of Proteins

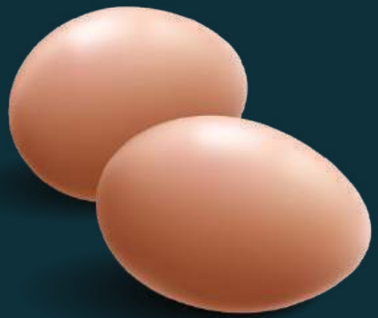
During denaturation **2° and 3°** structures get **destroyed** but **1°** structure **remains the same**.

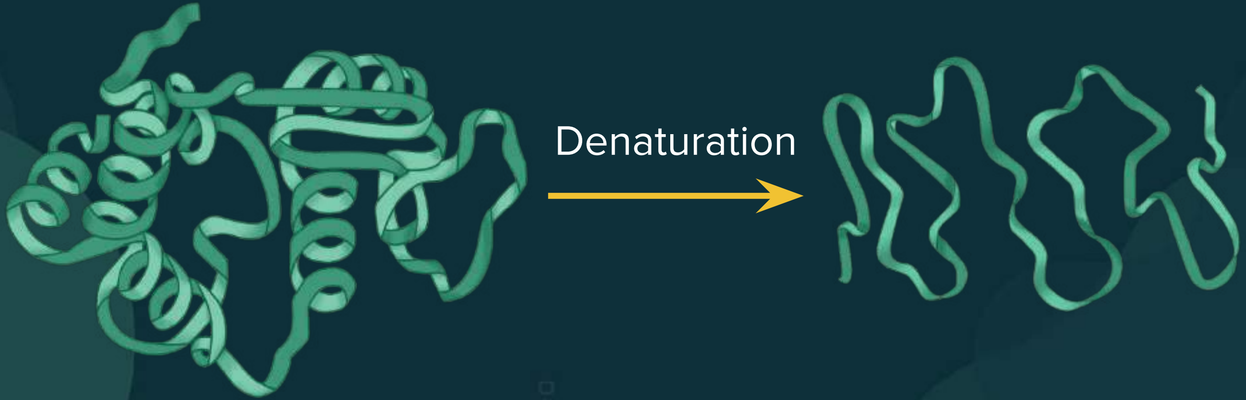
Example of denaturation:

1. **Coagulation** of egg while on boiling.
2. **Curdling** of milk caused by bacteria present in milk.

Denaturation of Proteins

Native protein i.e., folded structure of protein when heat is applied or some sort of temperature change take place then hydrogen bond present in protein get distrubed because of which folded structure become single chain of amino acid (this protein structure after unfolding is called as denatured protein).





Assertion: Disruption of the natural structure of a protein is called denaturation.

Reason: The change in colour and appearance of the egg during cooking is due to denaturation.

(a) If both assertion and reason are correct and the reason is a correct explanation of the assertion.

(b) If both assertion and reason are correct but the reason is not a correct explanation of the assertion.

(c) If the assertion is correct but the reason is incorrect.

(d) If both the assertion and reason are incorrect.

Solution

Assertion and reason statement is true, but when you add because after assertion (i.e., disruption of the natural structure of a protein is called denaturation, because The change in colour and appearance of the egg during cooking is due to denaturation.) Then reason is not the correct explanation of the assertion.

Hence, option (c) is the correct answer.

The force of **attraction** between the **neighboring peptide** chains is:

BOARDS

(a) van der Waals' force
(b) Covalent bond
(c) Hydrogen bond
(d) Peptide linkage

Solution

Here, quaternary structure is being discussed and in quaternary structure largely van der Waals' force of attraction is observed. In primary structure peptide linkage is observed, in secondary structure its hydrogen bonding, in tertiary structure almost every type of linkage contributes.

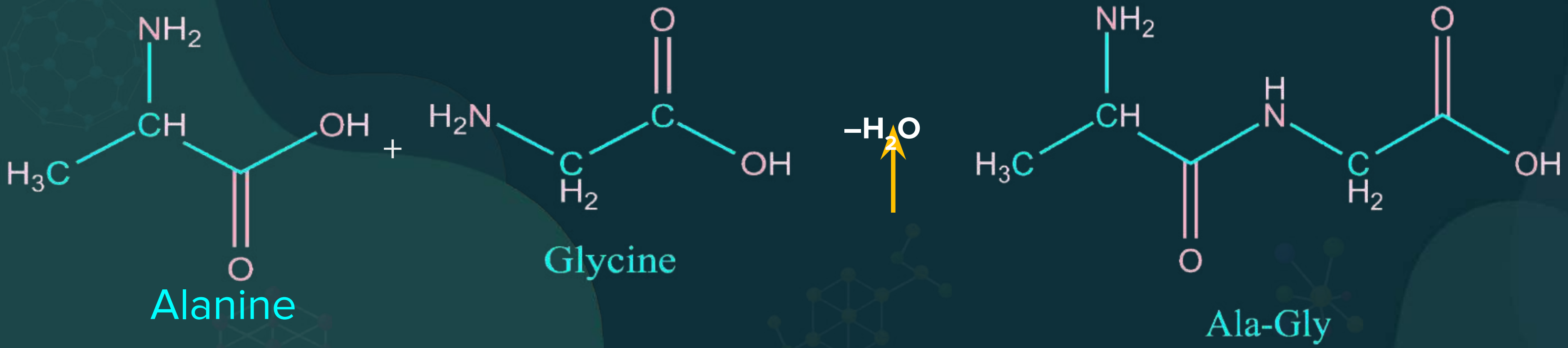
Hence, option (a) is the correct answer.

The **name** of the given **dipeptide** is:

$$NH_2\underset{\substack{|\\ CH_3}}{C}HCONHCH_2COOH$$

(a) Gly-Gly (b) Gly-Ala (c) Ala-Ala (d) Ala-Gly

Solution



Hence, option (d) is the correct answer.

Enzymes

Reactions of cellular metabolism are mediated by remarkable **biological catalysts** called enzymes.

Almost all the enzymes are **globular proteins**.

Enzymes are **very specific** for a particular reaction and for a particular substrate.

The ending of the name of an enzyme is **-ase**.

Enzyme

Maltose

The enzyme that **catalyses hydrolysis of maltose** into glucose is named as **maltase**.

$$\underset{\text{Maltose}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{\text{Maltase}} \underset{\text{Glucose}}{2C_6H_{12}O_6}$$

Oxidoreductase Enzymes

The enzymes that **catalyse the oxidation** of one substrate with **simultaneous reduction** of another substrate.

Mechanism of Enzyme Action

In an enzyme-catalysed reaction, the enzyme and the substrate combine to form an **enzyme–substrate complex**.

$$E + S \rightleftharpoons E\text{-}S \rightleftharpoons E + P$$

complex

Binding of the substrate can cause certain of its bonds to become **strained**, and therefore, more **easily broken**.

Mechanism of Enzyme Action

The product of the reaction usually has a **different shape** from the substrate.

This altered shape, or in some instances, the intervention of another molecule causes the complex to **dissociate**.

The enzyme can then accept another molecule of the substrate, and the whole process is **repeated**.

Mechanism of Enzyme Action

Thus, the enzyme-catalysed reactions may be considered to proceed in two steps.

Step 1: Binding of enzyme to substrate to form an activated complex.

$$E + S \rightleftharpoons ES^{\#}$$

Step 2: Decomposition of the activated complex to form product.

$$ES^{\#} \rightleftharpoons E + P$$

Enzymes take part in a reaction and:

(a) Decrease the rate of a chemical reaction

(b) Increase the rate of a chemical reaction

(c) Both (a) and (b)

(d) None of these.

Solution

Enzymes takes part in a reaction to decrease or increase the rate of a chemical reaction.

Hence, option (c) is the correct answer.

The function of enzymes in the living system is to:

(a) Catalyse biochemical reactions
(b) Provide energy
(c) Transport oxygen
(d) Provide immunity

Solution

The function of enzymes in the living system is to catalyse biochemical reactions.

Hence, option (a) is the correct answer.

Vitamins

Organic compounds required in the diet in **small amounts** to perform specific biological functions for normal maintenance of optimum growth and health of the organism.

Most of the vitamins **cannot** be synthesised in our body.

All the vitamins are generally available in our **diet**.

Vitamins

Classification of Vitamins

Based on solubility in water or fat

- Fat soluble vitamins
- Water soluble vitamins

Vitamins

Fat soluble vitamins

These are soluble in fat and oil but **insoluble in water**.

Examples: Vitamin A, D, E, and K

Water soluble vitamins

These are insoluble in fat and oil but **soluble in water**.

Examples: B group vitamins and vitamin C

Exception:

Biotin (Vitamin H) is neither soluble in fat nor in water.

Some Important Vitamins, Their Sources and Their Deficiency Diseases

Some Important Vitamins, Their Sources

Vitamins	Sources	Deficiency diseases
Vitamin A	Fish liver oil, carrots, butter, and milk.	**Xerophthalmia** (hardening of eye cornea), **night blindness**.
Vitamin B_1 **(Thiamine)**	Yeast, milk, green vegetables, and cereals.	**Beri beri** (loss of appetite and retarded growth).

Some Important Vitamins, Their Sources

Vitamins	Sources	Deficiency diseases
Vitamin B_2 (**Riboflavin**)	Milk, eggwhite, liver, and kidney.	**Cheilosis** (fissuring at corners of mouth and lips), **digestive disorders**, and **burning sensation** of the skin.
Vitamin B_6 (**Pyridoxine**)	Yeast, milk, egg yolk, cereals, and grams.	**Convulsions**

Some Important Vitamins, Their Sources

Vitamins	Sources	Deficiency diseases
Vitamin B_{12}	Milk, fish, egg, and curd.	**Pernicious anaemia** (RBC deficient in haemoglobin).
Vitamin C **(Ascorbic acid)**	Citrus fruits, amla, and green leafy vegetables.	**Scurvy** (bleeding gums).
Vitamin D	Exposure to sunlight, fish, and egg yolk.	**Rickets** (bone deformities in children) and **osteomalacia** (soft bones and joint pain in adults).

Some Important Vitamins, Their Sources

Vitamins	Sources	Deficiency diseases
Vitamin E	Vegetable oils like wheat germ oil, sunflower oil.	**Increased fragility** of RBCs and muscular weakness.
Vitamin K	Green leafy vegetables.	Increased blood clotting time.

Deficiency of which vitamin causes osteomalacia?

BOARDS

(a) Vitamin A

(b) Vitamin D

(c) Vitamin K

(d) Vitamin E

Solution

Deficiency of vitamin D causes osteomalacia.

Hence, option (b) is the correct answer.

Deficiency of vitamin B_1 causes the disease:

BOARDS

(a) Convulsions

(b) Beri-Beri

(c) Cheilosis

(d) Sterility

Solution

Deficiency of vitamin B_1 causes Beri-Beri (loss of appetite, retarded growth).

Hence, option (b) is the correct answer.

Assertion: Vitamin D cannot be stored in our body.

Reason: Vitamin D is a fat-soluble vitamin and is excreted from the body in urine.

(a) If both assertion and reason are correct and the reason is a correct explanation of the assertion.

(b) If both assertion and reason are correct but the reason is not a correct explanation of the assertion.

(c) If the assertion is correct but the reason is incorrect.

(d) If both the assertion and reason are incorrect.

Solution

Vitamin D can be stored in our body. Vitamin D is a fat-soluble vitamin and but it is not excreted from the body in urine. So, the assertion and reason are incorrect.

Hence, option (d) is the correct answer.

In a protein molecule, various amino acids are linked together by:

BOARDS

(a) Peptide bond
(b) Dative bond
(c) α-glycosidic bond
(d) β-glycosidic bond

Solution

Proteins are the polymers of α-amino acids and they are connected to each other by peptide bond or peptide linkage.

Hence, option (a) is the correct answer.

The **helical** structure of **protein** is stabilised by:

(a) Dipeptide bonds
(b) Hydrogen bonds
(c) Ether bonds
(d) Peptide bonds

Solution

The helical structure of protein is stabilised by hydrogen bonds.

Hence, option (b) is the correct answer.

Nucleic Acids

Nucleus of a living cell is **responsible** for this transmission of inherent characters, also called **heredity**.

The **particles** in nucleus of the cell, **responsible** for heredity, are called **chromosomes**.

They are made up of proteins and another type of biomolecules called **nucleic acids**.

Nucleic Acids

Chromosomes carry the basic genetic material DNA which is responsible to provide hereditary characteristics and genetic information to the various cells.

Nucleic Acids

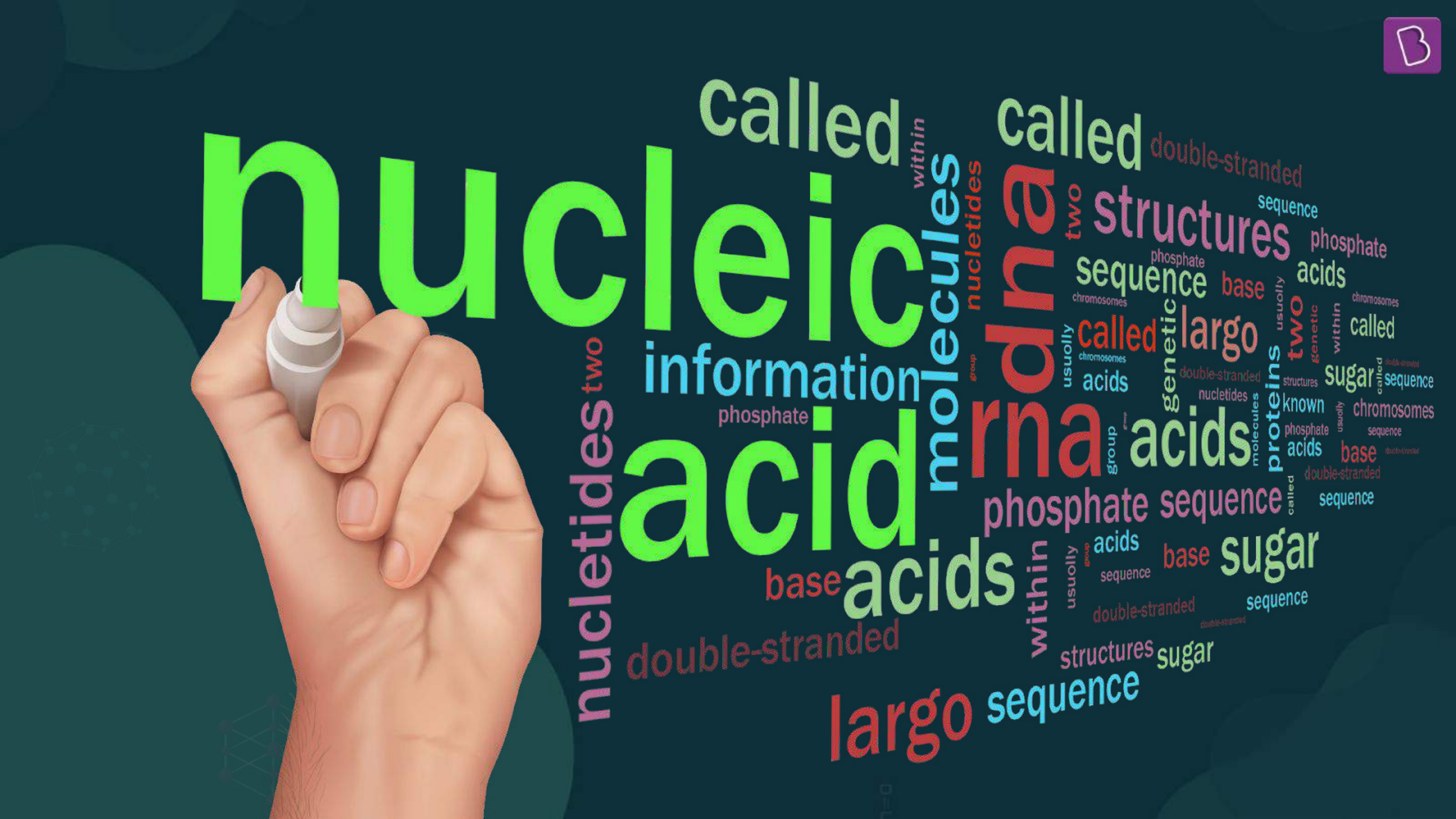
Types of nucleic acids

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

Nucleotides

Monomeric units of nucleic acids.

Nucleic acids are long chain polymers of nucleotides, so they are also called polynucleotides.



nucleic
acid
called
called
within
molecules
nucletides
dna
rna
two
structures
double-stranded
sequence
phosphate
acids
base
chromosomes
called
largo
genetic
usuolly
proteins
information
phosphate
two
nucleotides
acids
sugar
sequence
known
chromosomes
phosphate
sequence
base
within
base
acids
double-stranded
largo
sequence
structures
sugar

Nucleic Acids

Nucleotide

Five-carbon monosaccharide

+

A heterocyclic (nitrogen containing) base

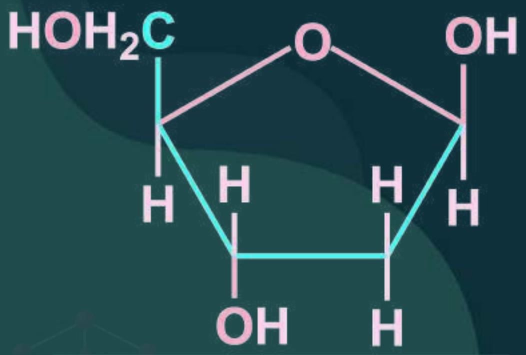
+

Phosphate ion

Nucleic Acids

DNA

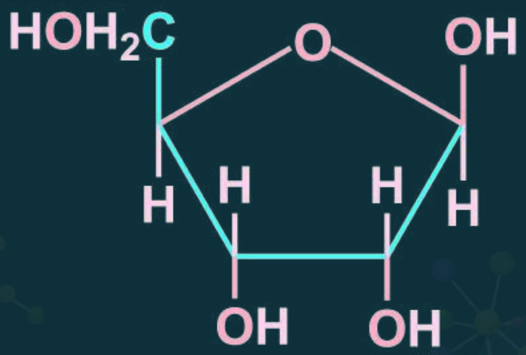
The sugar moiety is **β-D-2-deoxyribose**.



β-D-2-deoxyribose

RNA

The sugar moiety is **β-D-ribose**.



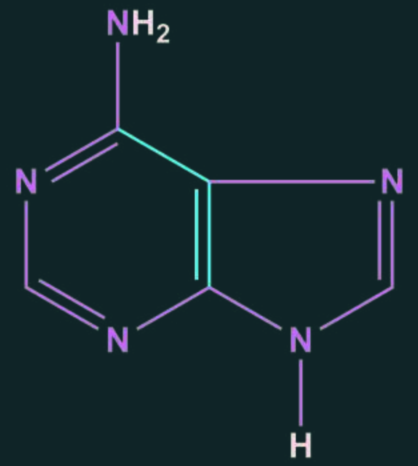
β-D-ribose

Nucleic Acids

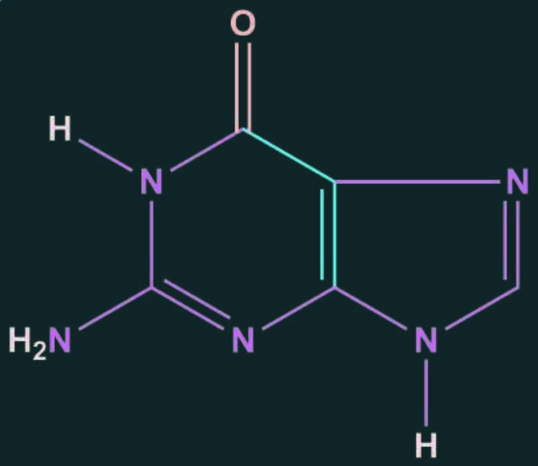
Four bases of DNA	Four bases of RNA
Adenine (A)	Adenine (A)
Guanine (G)	Guanine (G)
Cytosine (C)	Cytosine (C)
Thymine (T)	Uracil (U)

Nucleic Acids

Bases



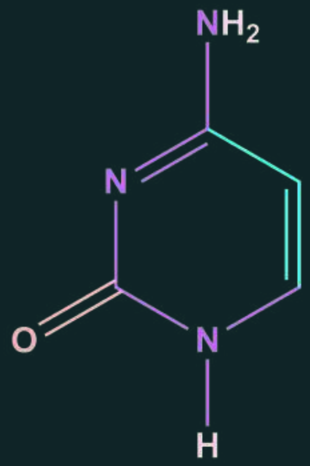
Adenine (A)



Guanine (G)

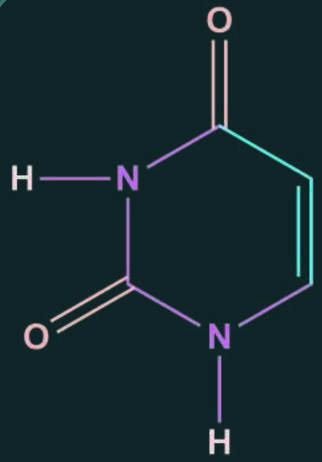
Nucleic Acids

Bases



Cytosine (C)

Thymine (T)



Uracil (U)

Nucleic Acids

Trick to remember bases:

(a) For DNA:

(i) Adenine (A) = Arrey

(ii) Guanine (G) = Gussa

(iii) Cytosine (C) = C(k)arega

(iv) Thymine (T) = Tu ; so together you can call it (A)rrey (G)ussa (C)karega (T)u

(b) For RNA:

(i) Adenine (A) = Arrey

(ii) Guanine (G) = Gussa

(iii) Cytosine (C) = C(k)arega

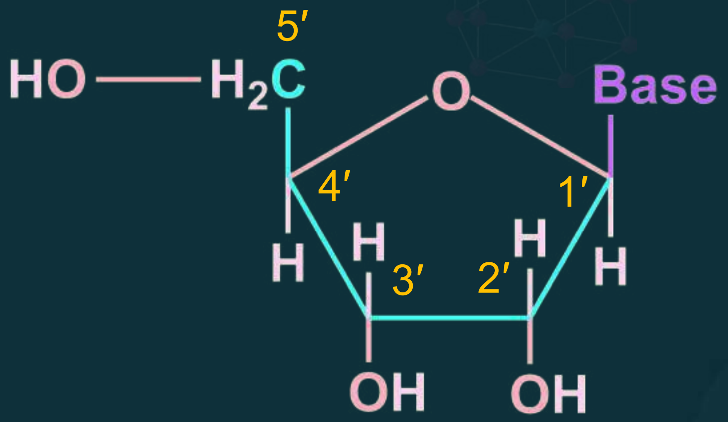
(iv) Uracil (U) = U; so together you can call it (A)rrey (G)ussa (C)karega (U)

Nucleic Acids

Nucleoside

A unit formed by the attachment of a **base** to **1′** position of **sugar** is known as **nucleoside.**

In nucleosides, the **sugar carbons** are numbered as **1′, 2′, 3′,** etc., in order to distinguish these from the bases.

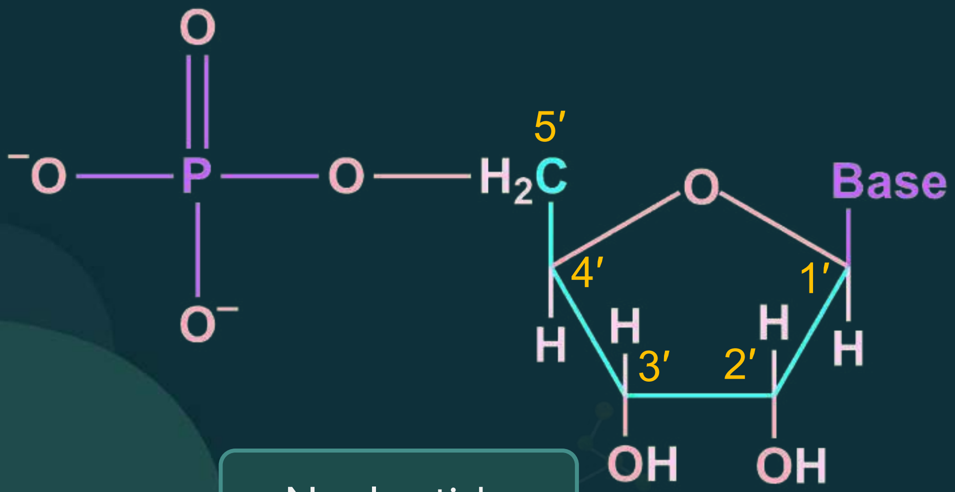


Nucleoside

Nucleic Acids

Nucleotide

When nucleoside is linked to phosphoric acid at 5′-position of sugar moiety, we get a nucleotide.

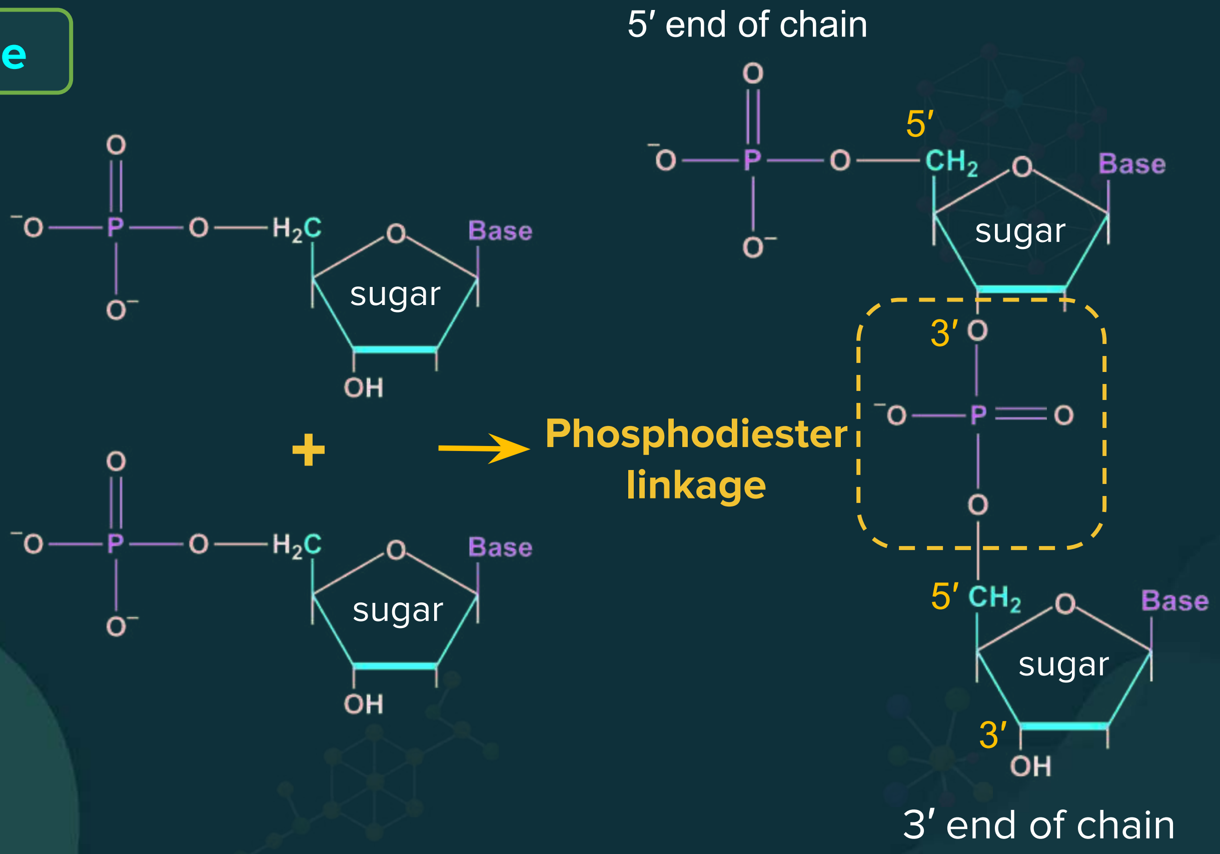


Nucleotide

Structure of Nucleic Acids

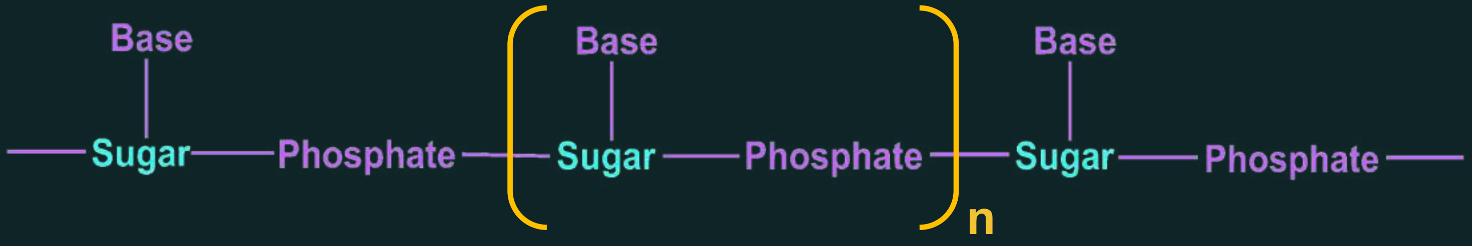
Formation of a dinucleotide

Nucleotides are joined together by **phosphodiester linkage** between **5′** and **3′** carbon atoms of the **pentose sugar**.



Nucleic Acids

Structure of nucleic acid



Simplified version of nucleic acid chain

Nucleic Acid

Nucleic acids are long chain polymers of **nucleotides**, so they are also called **polynucleotides.**

Nucleotides — **Monomeric** units of nucleic acids

Information regarding the sequence of nucleotides in the chain of a nucleic acid is called its **primary structure.** Nucleic acids have a **secondary structure** also.

DNA

James Watson and Francis Crick gave a **double strand helix structure** for DNA.

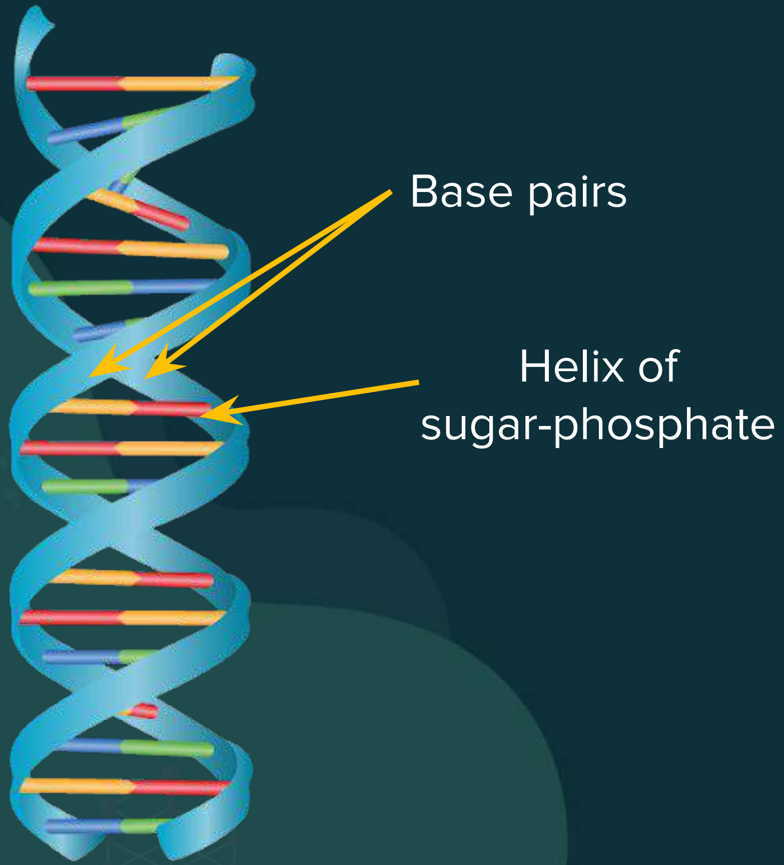
Two nucleic acid chains are wound about each other and held together by **hydrogen bonds** between pairs of bases.

DNA

The two strands are **complementary** to each other because the hydrogen bonds are formed between specific pairs of bases.

Adenine (A) forms hydrogen bonds **with thymine (T)** whereas, **cytosine (C)** forms hydrogen bonds **with guanine (G).**

DNA

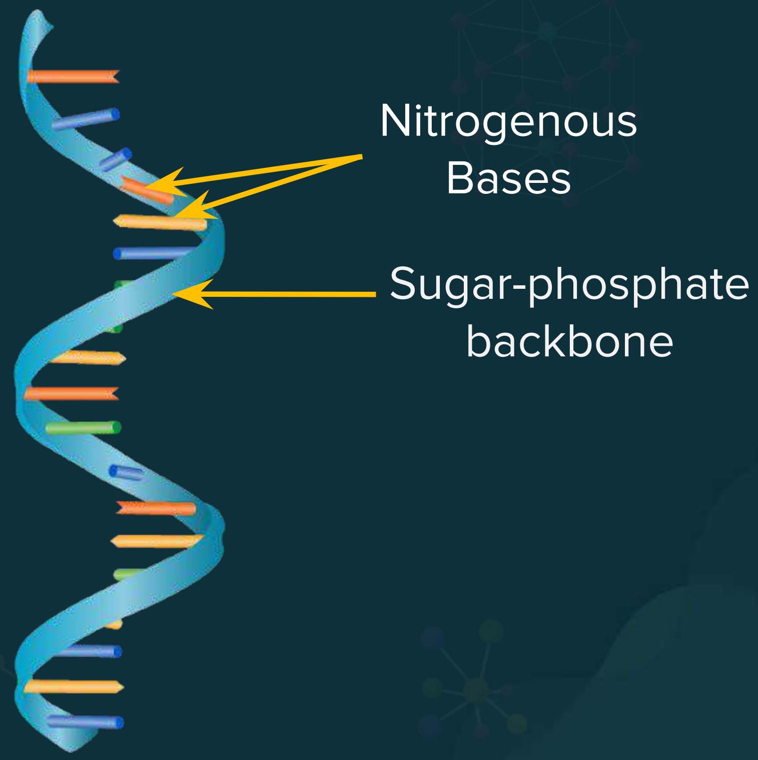


Base pairs
Helix of sugar-phosphate

5′
3′
G ≡ C
A = T
T=A
A = T
C ≡ G
G ≡ C
T=A
C ≡ G
T = A
G ≡ C
A=T
T = A
A=T
T = A
C≡G
G≡ C
5′
3′

RNA

In secondary structure of **RNA**, **helices** are present which are **only single stranded**. Sometimes they **fold back** on themselves to form a **double helix structure**.



RNA

RNA are of **three types**

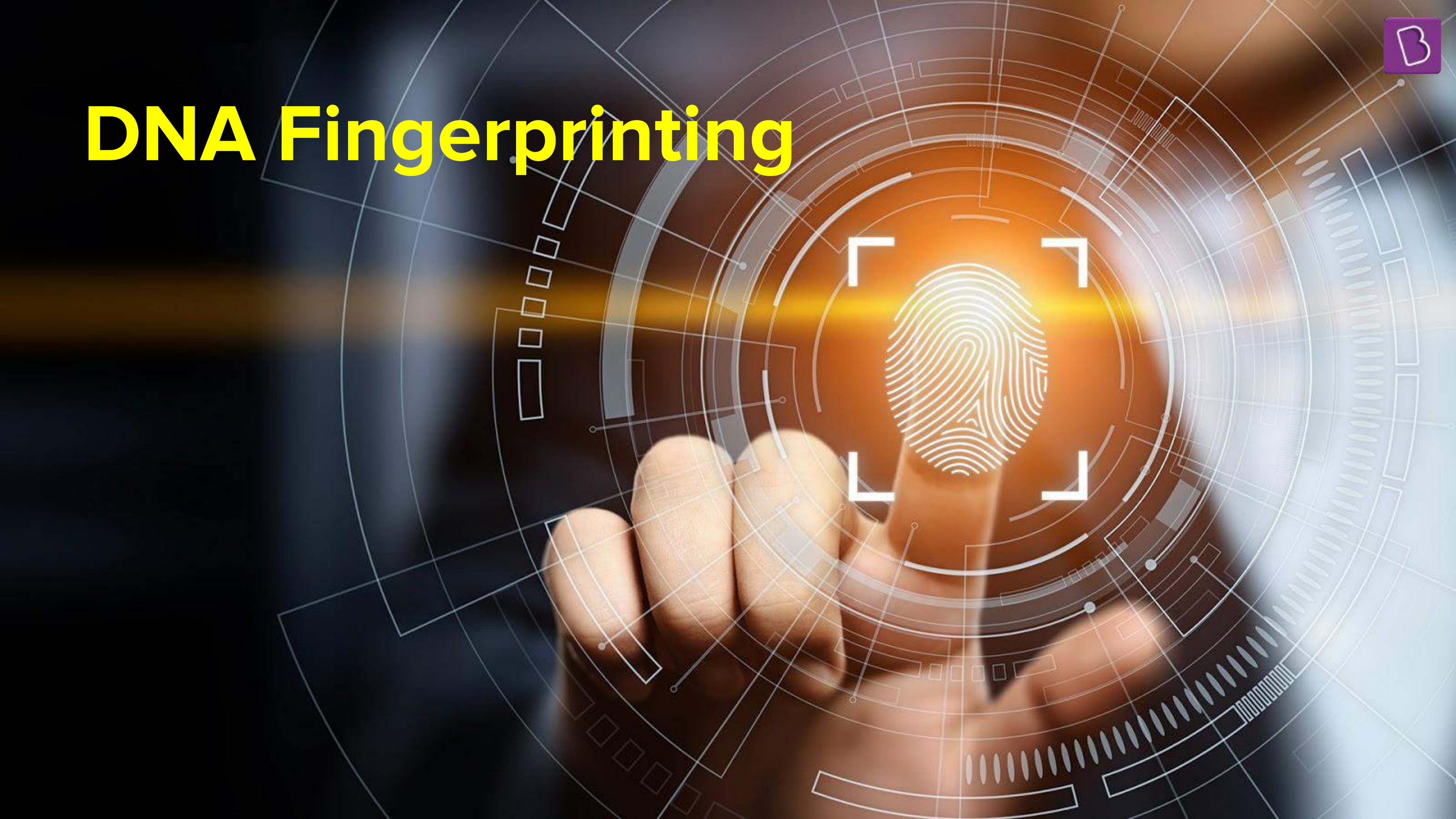
1. Messenger RNA (m-RNA)
2. Ribosomal RNA (r-RNA)
3. Transfer RNA (t-RNA)

Note

An important function of nucleic acids is the **protein synthesis** in the cell.

The proteins are **synthesised** by various **RNA molecules** in the cell but the **message for the synthesis** of a particular protein is present in **DNA.**

DNA Fingerprinting



DNA Fingerprinting

It is known that every individual has **unique fingerprints**.

These occur at the tips of the fingers and have been used for identification for a long time, but these can be altered by **surgery**.

DNA Fingerprinting

A **sequence of bases** on DNA is **unique** for a person, and information regarding this is called DNA fingerprinting. It is **same** for every cell & cannot be altered by any known treatment. DNA fingerprinting is now used:

a. Forensic laboratories for **identification of criminals**.

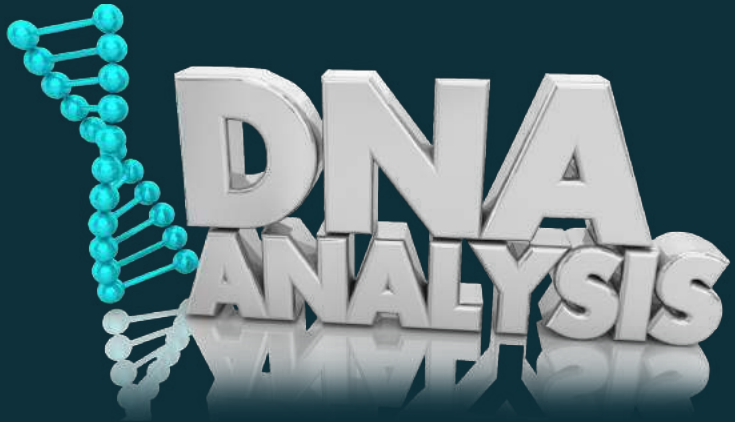
b. Determine **paternity** of an individual.

c. **Identify the dead bodies** in any accident by comparing the DNA's of parents or children.

d. **Identify racial groups** to rewrite biological evolution.

DNA Fingerprinting

Crime scene sample collection



Sample collected will go for DNA analysis and then criminals are identified with help of this.

The correct statement regarding RNA and DNA, respectively is:

BOARDS

(a) The sugar component in RNA is arabinose and the sugar component in DNA is ribose.

(b) The sugar component in RNA is 2′-deoxyribose and the sugar component in DNA is arabinose.

(c) The sugar component in RNA is arabinose and the sugar component in DNA is 2′-deoxyribose.

(d) The sugar component in RNA is ribose and the sugar component in DNA is 2′-deoxyribose.

Solution

In DNA molecules, the sugar moiety (carbohydrate part) is **β**-D-2-deoxyribose and in RNA, the sugar moiety is **β**-D-ribose.

Hence, option (d) is the correct answer.

Hormones

Hormone is derived from Greek language which means “that which sets in motion”.

Hormones are molecules that act as **intra-cellular messengers**.

These are produced by **endocrine glands** in the body and are poured directly in the bloodstream which transports them to the **site of action**.

Hormones

Chemical nature	Examples
Steroids	Estrogens and androgens
Poly peptides	Insulin and endorphins
Amino acid derivatives	Epinephrine and norepinephrine

Functions of Hormones

Hormones have several functions in the body. They help to maintain the **balance of biological activities** in the body.

Insulin & glucagon together regulate the glucose level in the blood

- Insulin keeps the blood glucose level within the **narrow limit**.
- Glucagon tends to **increase** the glucose level in the blood.

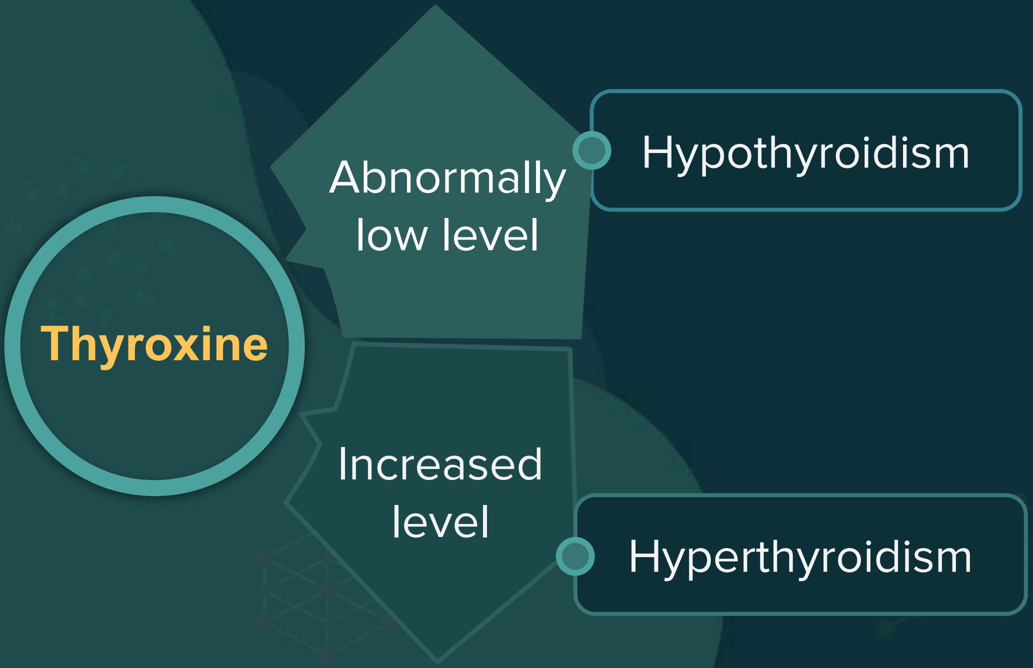
Functions of Hormones

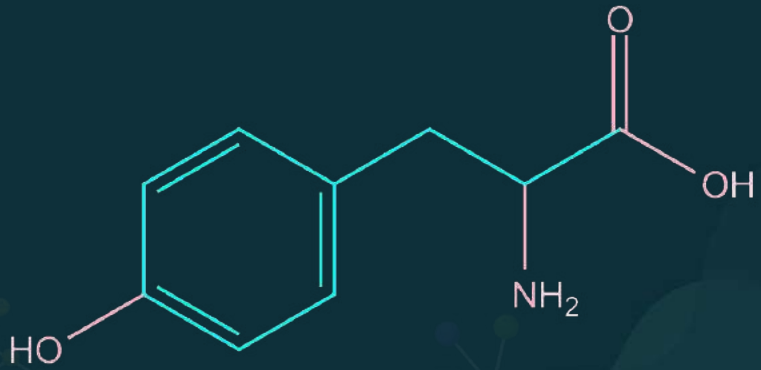
Epinephrine and norepinephrine mediate responses to external stimuli.

Growth hormones and sex hormones play role in **growth and development.**

Functions of Hormones

Thyroxine is an iodinated derivative of amino acid tyrosine which is produced in the thyroid gland.





Tyrosine

Functions of Hormones

Low level of iodine in the **diet** may lead to hypothyroidism and **enlargement** of the thyroid gland.

Hypothyroidism is characterised by **lethargyness** and **obesity**.

Hypothyroidism is largely being **controlled** by adding **sodium iodide (NaI)** to commercial table salt (**"iodised" salt**).

Steroid Hormones

Steroid hormones are produced by

- Adrenal cortex
- Gonads

Steroid Hormones

Hormone released by adrenal cortex	Function
Glucocorticoids	Controls the carbohydrate **metabolism**, modulate **inflammatory reactions**, and are involved in **reactions to stress**.
Mineralocorticoids	Control the **level of excretion** of **water and salt** by the kidney.

Steroid Hormones

Did You Know?

If adrenal cortex does not function properly then one of the results may be **Addison’s disease**.

It is **characterised by** hypoglycemia, weakness, and increased susceptibility to stress.

Steroid Hormones

Hormone released by gonads	Function
Testosterone (Male)	Responsible for development of **secondary male characteristics** (deep voice, facial hair, general physical constitution).
Estradiol (Female)	Responsible for development of **secondary female characteristics** and participates in the control of menstrual cycle.
Progesterone	Responsible for preparing the uterus for implantation of fertilised egg.

Insulin production and its action in human body are responsible for the level of diabetes. This compound belongs to which of the following categories?

BOARDS

(a) A co-enzyme

(b) A hormone

(c) An enzyme

(d) An antibiotic

Solution

Insulin is a hormone. Its production and its action in human body are responsible for the level of diabetes.

Hence, option (b) is the correct answer.

In DNA, the linkages between different nitrogenous bases are:

BOARDS

(a) Phosphate linkage
(b) H-bonding
(c) Glycosidic linkage
(d) Peptide linkage

Solution

In DNA, the linkages between different nitrogenous bases is hydrogen bonding.

Hence, option (b) is the correct answer.

Which of the following hormones contains iodine?

(a) Testosterone
(b) Adrenaline
(c) Thyroxine
(d) Insulin

Solution

Thyroxine hormone contains iodine.

Hence, option (c) is the correct answer.

In DNA, the complimentary bases are:

BOARDS

(a) Adenine and guanine; thymine and cytosine
(b) Uracil and adenine; cytosine and guanine
(c) Adenine and thymine; guanine and cytosine
(d) Adenine and thymine; guanine and uracil.

Solution

In DNA, the complimentary bases are adenine and thymine; guanine and cytosine.

Hence, option (c) is the correct answer.

RNA and DNA are chiral molecules, their chirality is due to:

BOARDS

(a) Chiral bases

(b) Chiral phosphate ester units

(c) D-sugar component

(d) L-sugar component

Solution

RNA and DNA are chiral molecules, their chirality is due to D-sugar component.

Hence, option (c) is the correct answer.

The couplings between base units of DNA is through:

(a) Hydrogen bonding
(b) Electrostatic bonding
(c) Covalent bonding
(d) van der Waals forces

Solution

The couplings between base units of DNA is through hydrogen bonding.

Hence, option (a) is the correct answer.

The sugar present in DNA is:

(a) Glucose

(b) Deoxyribose

(c) Ribose

(d) Fructose C-16

Solution

In DNA molecules, the sugar moiety is β-D-2-deoxyribose.

Hence, option (b) is the correct answer.

The pentose sugar in DNA and RNA has the:

(a) Open chain structure

(b) Pyranose structure

(c) Furanose structure

(d) None of the above

Solution

The pentose sugar in DNA and RNA has the furanose structure.

Hence, option (c) is the correct answer.

In both DNA and RNA, heterocyclic base and phosphate ester linkages are at:

BOARDS

(a) C_5' and C_2' respectively of the sugar molecule
(b) C_2' and C_5' respectively of the sugar molecule
(c) C_1' and C_5' respectively of the sugar molecule
(d) C_5' and C_1' respectively of the sugar molecule

Solution

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

Hence, option (c) is the correct answer.

Which of the statements about denaturation given below are correct?

BOARDS

(A) Denaturation of proteins causes loss of secondary and tertiary structure of protein.

(B) Denaturation leads to the conversion of double strand of DNA to single strand.

(C) Denaturation affects primary structure which gets distorted.

(a) (B) and (c)

(b) (A) and (c)

(c) (A) and (B)

(d) (A), (B) and (C)

Solution

During denaturation of proteins only the loss of secondary and tertiary structure takes place, since formation of double strand in DNA is secondary structure it also gets opened.

Hence, option (c) is the correct answer.

Practice Questions

Amongst the following amino acids, number of **essential amino acids** are:
Glycine, Alanine, Valine, Cysteine, Leucine, Isoleucine, Serine, Threonine

BOARDS

(a) 5 (b) 6 (c) 4 (d) 3

Solution

Essential amino acids cannot be synthesized by our body. They include Isoleucine, histidine, lysine, leucine, phenylalanine, tryptophan, methionine, threonine, and valine.

Hence, option (c) is the correct answer.

Which of the following is a basic amino acid?

(a) Alanine
(b) Glycine
(c) Arginine
(d) Glutamine

Solution

Arginine, Lysine and Histidine are basic amino acids.

Hence, option (c) is the correct answer.

The common disaccharide has the molecular formula:

BOARDS

(a) $C_{10}H_{18}O_9$

(b) $C_{10}H_{20}O_{11}$

(c) $C_{18}H_{22}O_{11}$

(d) $C_{12}H_{22}O_{11}$

Solution

Sucrose ($C_{12}H_{22}O_{11}$) is the most common disaccharide.

Hence, option (d) is the correct answer.

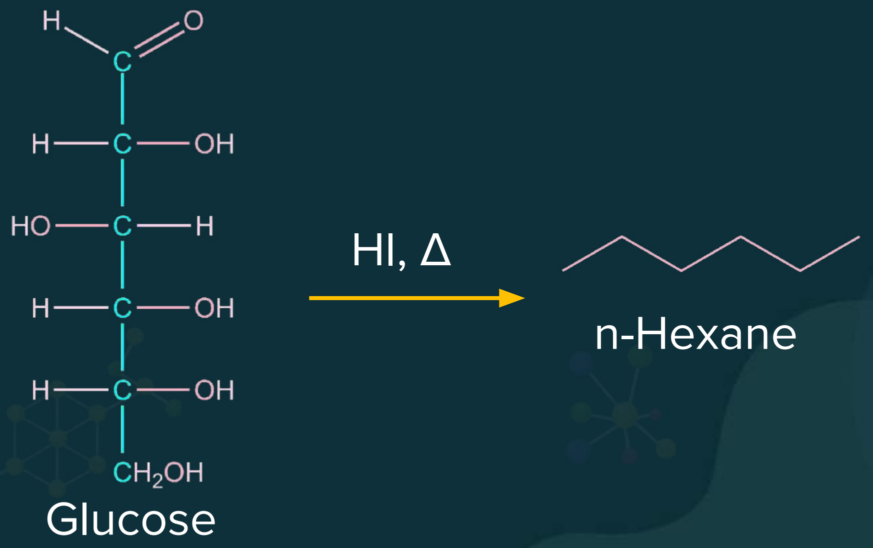
Glucose on prolonged heating with HI gives:

(a) Hexanoic acid
(b) 6-Iodohexanal
(c) Hex-1-ene
(d) n-Hexane

Solution

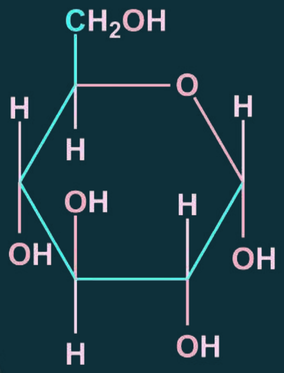
On prolonged heating glucose with HI, it forms n-hexane, suggesting that all the size carbon atoms are linked in a straight chain.

Hence, option (d) is the correct answer.

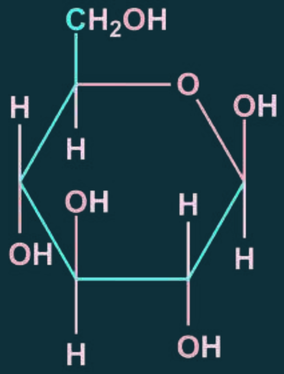


Haworth's projection of α-D-glucose is:

(a)



(b)

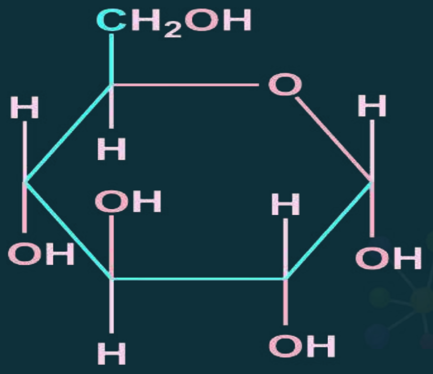


(c) Both (d) None of these

BOARDS

Solution

Haworth's projection of α-D-glucose is:



Hence, option (a) is the correct answer.

During acetylation of glucose, it needs x moles of acetic anhydride. The value of x would be:

(a) 3 (b) 5 (c) 4 (d) 1

BOARDS

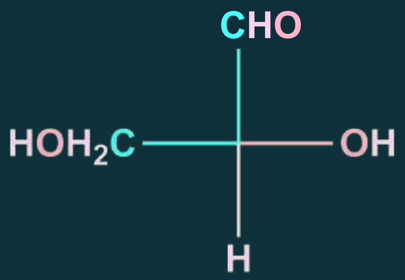
Solution

Acetylation of glucose with acetic anhydride gives glucose pentaacetate which confirms the presence of five –OH groups. So, 5 moles of acetic anhydride will be required.

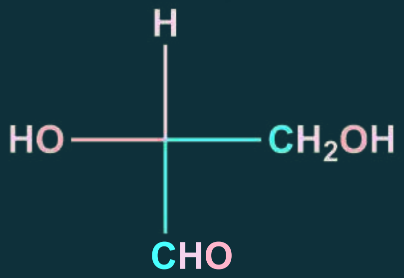
Hence, option (b) is the correct answer.

Which of the following is D-glyceraldehyde?

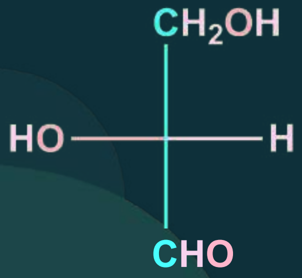
(a)



(b)



(c)



(d) Both a and b

Solution

Structure given in option (c) is D-glyceraldehyde.

Hence, option (c) is the correct answer.

Which reagent is used to convert glucose into saccharic acid?

BOARDS

(a) Br_2/H_2O

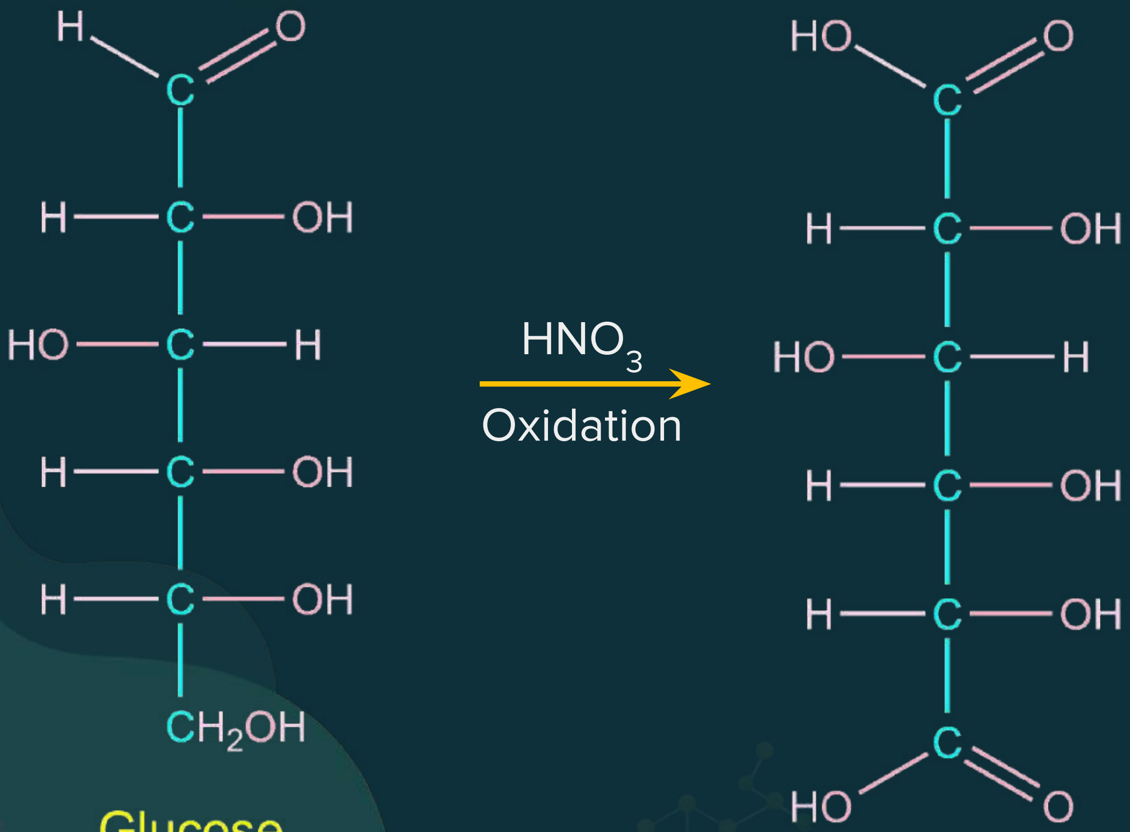
(b) Nitric acid

(c) Alkaline solution of iodine

(d) Ammonium hydroxide

Solution

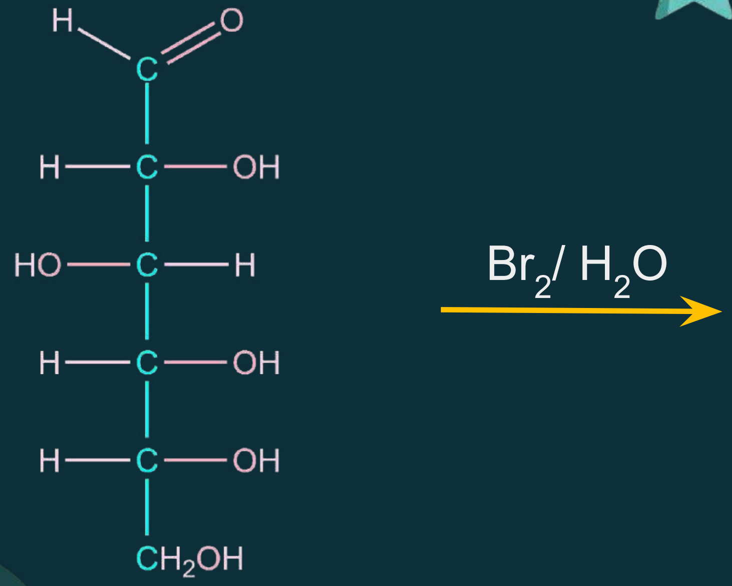
On oxidation with nitric acid, glucose yield a dicarboxylic acid, saccharic acid. This indicates the presence of a primary alcoholic (–OH) group in glucose.



Glucose

Hence, option (b) is the correct answer.

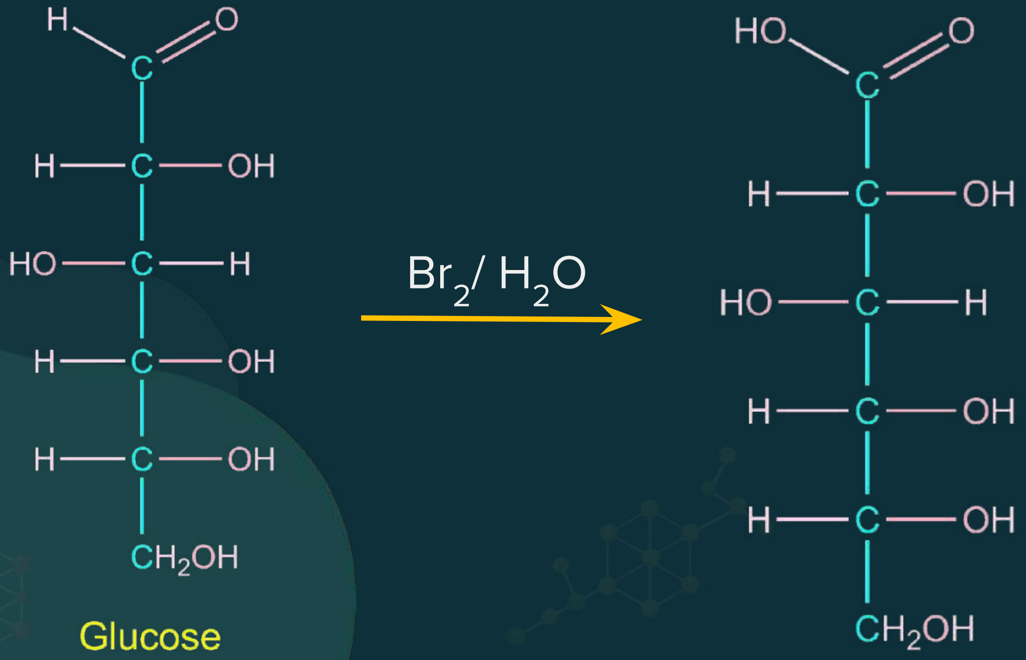
Predict the product of the following reaction:



Glucose

Solution

Glucose gets oxidised to six carbon carboxylic acid (gluconic acid) on reaction with a mild oxidising agent like bromine water.



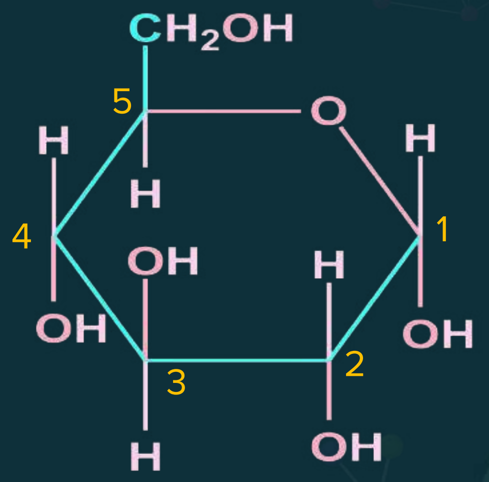
How many C-atoms are there in a pyranose ring?

(a) 3 (b) 5 (c) 6 (d) 7

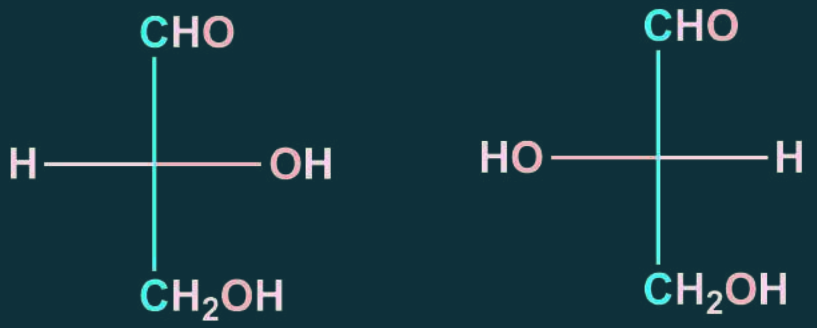
Solution

There are 5 C-atoms in a pyranose ring.

Hence, option (b) is the correct answer.



Which of the following statements is false about the given structure?



I II

(a) These are the isomers of glyceraldehyde.

(b) Both contain one chiral carbon atom.

(c) Both are enantiomer of each other

(d) I-(-)-glyceraldehyde said to have L configuration
II-(+)-glyceraldehyde said to have D configuration

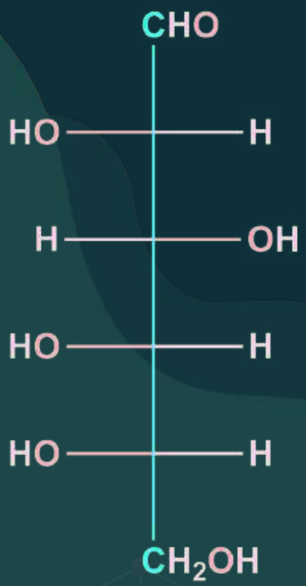
Solution

D-glyceraldehyde is dextrorotatory (+) and L-glyceraldehyde is laevorotatory (-). If the -OH group is on the right side it is D configuration otherwise it is L configuration.

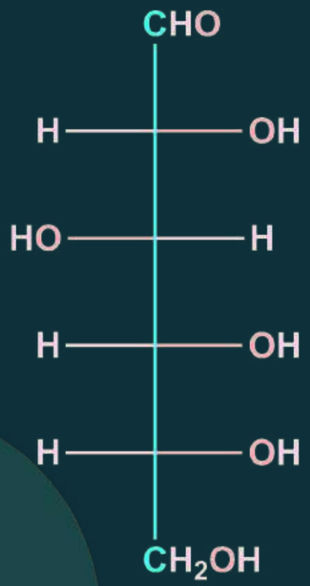
Hence, option (d) is the correct answer.

Which of the following is the structure of D-glucose?

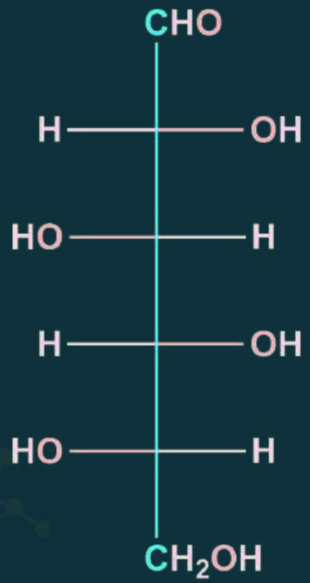
(a)



(b)



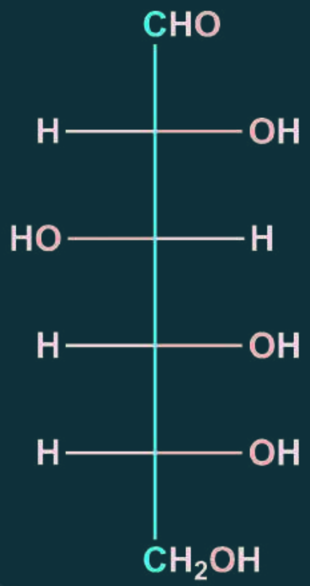
(c)



(d) None of these

Solution

The structure of D-glucose is:

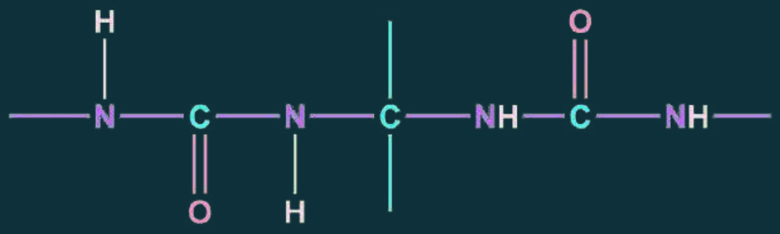


D-glucose

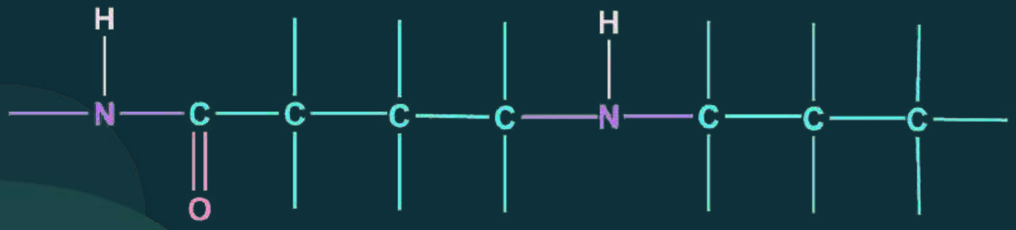
Hence, option (b) is the correct answer.

Which of the following structures represents the peptide chain?

(a)

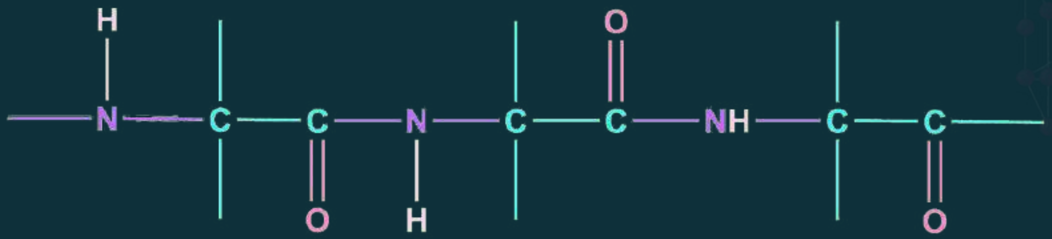


(b)

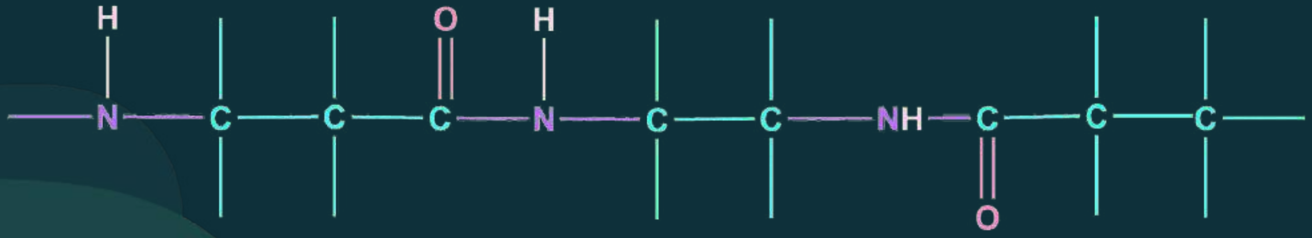


Which of the following structures represents the peptide chain?

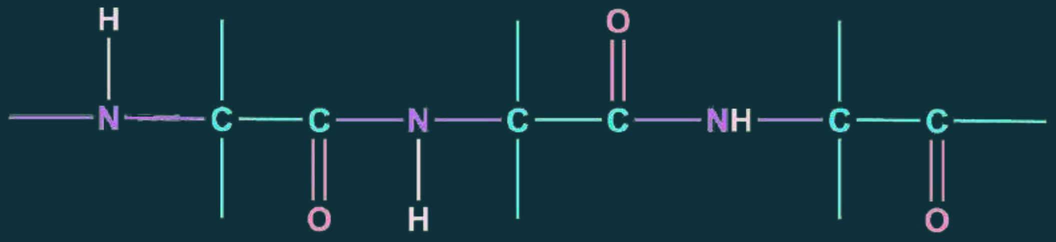
(c)



(d)



Solution



In peptide it contains amide linkage with one side end with N-terminal and other side end with C-terminal.

Hence, option (c) is the correct answer.

Denaturation of proteins leads to a loss of its biological activity by:

BOARDS

(a) Formation of amino acids

(b) Loss of primary structure

(c) Loss of both primary and secondary structures

(d) Loss of both secondary and tertiary structures

Solution

Denaturation of proteins leads to a loss of its biological activity by loss of both secondary and tertiary structures.

Hence, option (d) is the correct answer.

Assertion: Proteins on hydrolysis produce amino acids.

Reason: Amino acids contain $-NH_2$ and $-COOH$ groups.

BOARDS

(a) If both assertion and reason are correct and the reason is a correct explanation of the assertion.

(b) If both assertion and reason are correct but the reason is not a correct explanation of the assertion.

(c) If the assertion is correct but reason is incorrect.

(d) If both the assertion and reason are incorrect.

Solution

Amino acids contain the smallest unit as amino acid.

Hence, option (b) is the correct answer.

A decapeptide (Mol. wt. = 796 u) on complete hydrolysis gives glycine (Mol. wt. = 75 u), alanine and phenylalanine. Glycine contributes 47.0% to the total weight of the hydrolysed products. The number of glycine units present in the decapeptide is:

BOARDS

(a) 1 (b) 4 (c) 6 (d) 3

Solution

For the hydrolysis of decapeptide we need 9 molecules of H_2O. After hydrolysis, a mass of $9H_2O$ will be added to the mass of decapeptide.

Total mass after hydrolysis = Mass of decapeptide + Mass 9 H_2O molecules

= 796 + 162 = 958 u

$$\text{Mass of glycine} = (\text{Total mass after hydrolysis}) \times \frac{47}{100}$$

$$= 958 \times 0.47$$

$$= 450.26\ u$$

$$\text{Number of unit of glycine} = \frac{\text{Mass of glycine}}{\text{Molecular mass of glycine}}$$

$$\text{Number of unit of glycine} = \frac{450.26}{75}$$

$$\text{Number of unit of glycine} = 6$$

Hence, option (c) is the correct answer.

A tetrapeptide has −COOH group on alanine. This produces glycine (Gly), valine (Val), phenylalanine (Phe) and alanine (Ala), on complete hydrolysis. For this tetrapeptide, the number of possible sequences (primary structures) with $-NH_2$ group attached to a chiral center is:

(a) 24 (b) 4 (c) 16 (d) 18

Solution

While formation of tetrapeptide we have to write −COOH group on the right terminal i.e., alanine will always be on the right terminal. Since, we need $-NH_2$ group on chiral carbon => glycine can not be on left terminal (because glycine is optically inactive).

Solution

So the possible sequence we are left with:

- Val-Phe-Gly-Ala
- Val-Gly-Phe-Ala
- Phe-Val-Gly-Ala
- Phe-Gly-Val-Ala

Which base is present in RNA but not in DNA?

(a) Uracil (b) Cytosine

(c) Guanine (d) Thymine

Solution

DNA contains four bases viz. Adenine (A), Guanine (G), Cytosine (C) and Thymine (T). RNA also contains four bases, the first three bases are same as in DNA but the fourth one is Uracil (U).

Hence, option (a) is the correct answer.

The term **anomers of glucose** refers to:

BOARDS

(a) A mixture of (D)-glucose and (L)-glucose
(b) Enantiomers of glucose
(c) Isomers of glucose that differ in configuration at carbon one (C-1)
(d) Isomers of glucose that differ in configurations at carbons one & four (C-1 and C-4)

Solution

Anomers of glucose refers to isomers of glucose that differ in configuration at carbon one (C-1).

Hence, option (c) is the correct answer.

The secondary structure of protein refers to:

BOARDS

(a) α-helical backbone

(b) Hydrophobic interactions

(c) Sequence of α-amino acids

(d) Fixed configuration of the polypeptide backbone

Solution

The secondary structure of protein refers to the shape in which a long polypeptide chain can exist. They are found to exist in two different types of structures viz. α-helix and β-pleated sheet structure.

Hence, option (a) is the correct answer.

α-D-(+)-glucose and β-D-(+)-glucose are:

BOARDS

(a) Functional isomers
(b) Anomers
(c) Enantiomers
(d) Conformers

Solution

C-1 configuration in both are different (position of –OH). Hence they are anomers.

Hence, option (b) is the correct answer.

The presence or absence of hydroxy (–OH) group on **which carbon atom** of sugar **differentiates** RNA and DNA:

BOARDS

(a) 1^{st}

(b) 2^{nd}

(c) 3^{rd}

(d) 4^{th}

Solution

2^{nd} carbon will differentiate between RNA and DNA because of presence and absence of –OH group.

Hence, option (b) is the correct answer.

Which one of the following bases is not present in DNA?

(a) Quinoline

(b) Adenine

(c) Cytosine

(d) Thymine

Solution

DNA contains four bases viz. Adenine (A), Guanine (G), Cytosine (C) and Thymine (T).

Hence, option (a) is the correct answer.

Which of the vitamins given below is water soluble?

(a) Vitamin C

(b) Vitamin D

(c) Vitamin E

(d) Vitamin K

Solution

Vitamin C is soluble in water while vitamins A, D, E, and K are soluble in fat and oils.

Hence, option (a) is the correct answer.

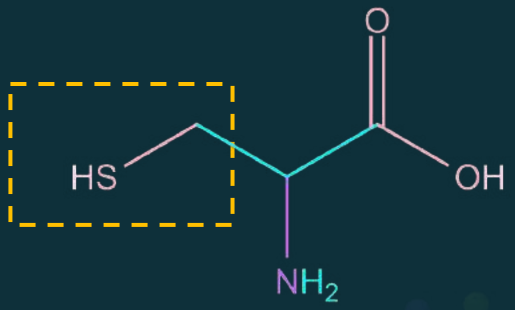
Thiol group is present in:

(a) Cystine
(b) Cysteine
(c) Methionine
(d) Cytosine

Solution

Thiol group is present in cysteine.

Thiol group



Cysteine

Hence, option (b) is the correct answer.

The **reason** for double helical structure of DNA is the operation of:

(a) Electrostatic attractions

(b) van der Waals forces

(c) Dipole-Dipole interactions

(d) Hydrogen bonding

Solution

Hydrogen bonding is responsible for double helical structure of DNA.

Hence, option (d) is the correct answer.

Complex hydrolysis of starch gives:

BOARDS

(a) Glucose only
(b) Glucose and fructose in equimolar amounts
(c) Galactose and fructose in equimolar amounts
(d) Glucose and galactose in equimolar amounts

Solution

Starch on hydrolysis gives only and only glucose.

Hence, option (a) is the correct answer.

Accumulation of which of the following molecules in the muscles occurs as a result of vigorous exercise?

BOARDS

(a) Glycogen

(b) Glucose

(c) Pyruvic acid

(d) L-lactic acid

Solution

L-lactic acid is responsible for cramps in muscles as a result of vigorous exercise.

Hence, option (d) is the correct answer.

Among the following, the essential amino acid is:

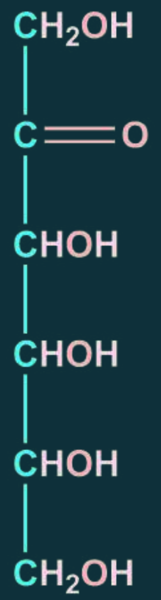
(a) Valine
(b) Aspartic acid
(c) Serine
(d) Alanine

Solution

Valine comes in essential amino acid.

Hence, option (a) is the correct answer.

For the structure, total number of **chiral centre** are:

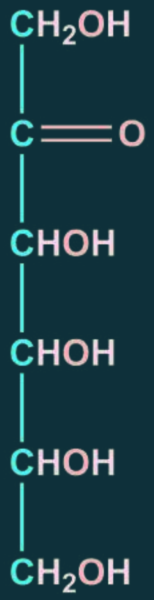


(a) 12 (b) 4 (c) 5 (d) 3

Solution

Chiral centres are carbon whose all 4 valency is satisfied by different groups. In this case there are 3 carbon whose all 4 valency is satisfied by different groups.

Hence, option (d) is the correct answer.



A hexapeptide with the composition **Arg, Gly, Leu, Pro** has proline at both **C-terminal** and **N-terminal** position. The partial hydrolysis of the hexapeptide gives

Gly–Pro–Arg, Arg–Pro, Pro–Leu–Gly

BOARDS

(a) Pro–Gly–Leu–Pro–Arg–Pro

(b) Pro–Leu–Gly–Pro–Arg–Pro

(c) Pro–Leu–Gly–Arg–Pro–Pro

(d) Pro–Arg–Pro–Leu–Gly–Pro

Solution

According to the arrangement given there will be 3 Pro in which 2 Pro will be on the ends. So option (b) satisfies the given arrangement in the question.

Hence, option (b) is the correct answer.

In a protein molecule various **amino acids** are linked together by:

(a) Dative bond

(b) α-glycosidic bond

(c) β-glycosidic bond

(d) Peptide bond

Solution

Amino acids are linked together by peptide bind to each other in protein molecules.

Hence, option (d) is the correct answer.

Formation of peptide bond is accompanied by release of one molecule of:

(a) Oxygen

(b) Hydrogen

(c) Water

(d) None of these

Solution

Formation of peptide bond is accompanied by release of one molecule of water.

Hence, option (c) is the correct answer.

The simplest carbohydrate capable of exhibiting optical isomerism is:

(a) Glucose

(b) Fructose

(c) Sucrose

(d) Glyceraldehyde

Solution

Glyceraldehyde is smallest of all and can exhibit optical isomerism.

Hence, option (d) is the correct answer.

In a nucleoside, nitrogen base is linked to pentose sugar by:

BOARDS

(a) Peptide linkage
(b) N-glycosidic linkage
(c) Phosphodiester bond
(d) H-bonds

Solution

In a nucleoside, nitrogen base is linked to pentose sugar by N-glycosidic linkage.

Hence, option (b) is the correct answer.

Ten DNA molecules undergo replication 2 times. The total number DNA molecules produced are:

BOARDS

(a) 10 (b) 20

(c) 30 (d) 40

Solution

1 DNA molecule if replicated 2 times it gives 4 molecules. So, 10 molecules will give 40 molecules.

Hence, option (d) is the correct answer.

In animals, the stored carbohydrates is:

(a) Starch

(b) Glycogen

(c) Fructan

(d) Sucrose

Solution

In animals, the stored carbohydrates is glycogen.

Hence, option (b) is the correct answer.

The sugars that are produced on hydrolysis of DNA and RNA are:

(a) Anomers
(b) Two different sugars
(c) Positional isomers
(d) Diastereomers

Solution

Two different sugars are produced on hydrolysis of DNA and RNA.

Hence, option (b) is the correct answer.