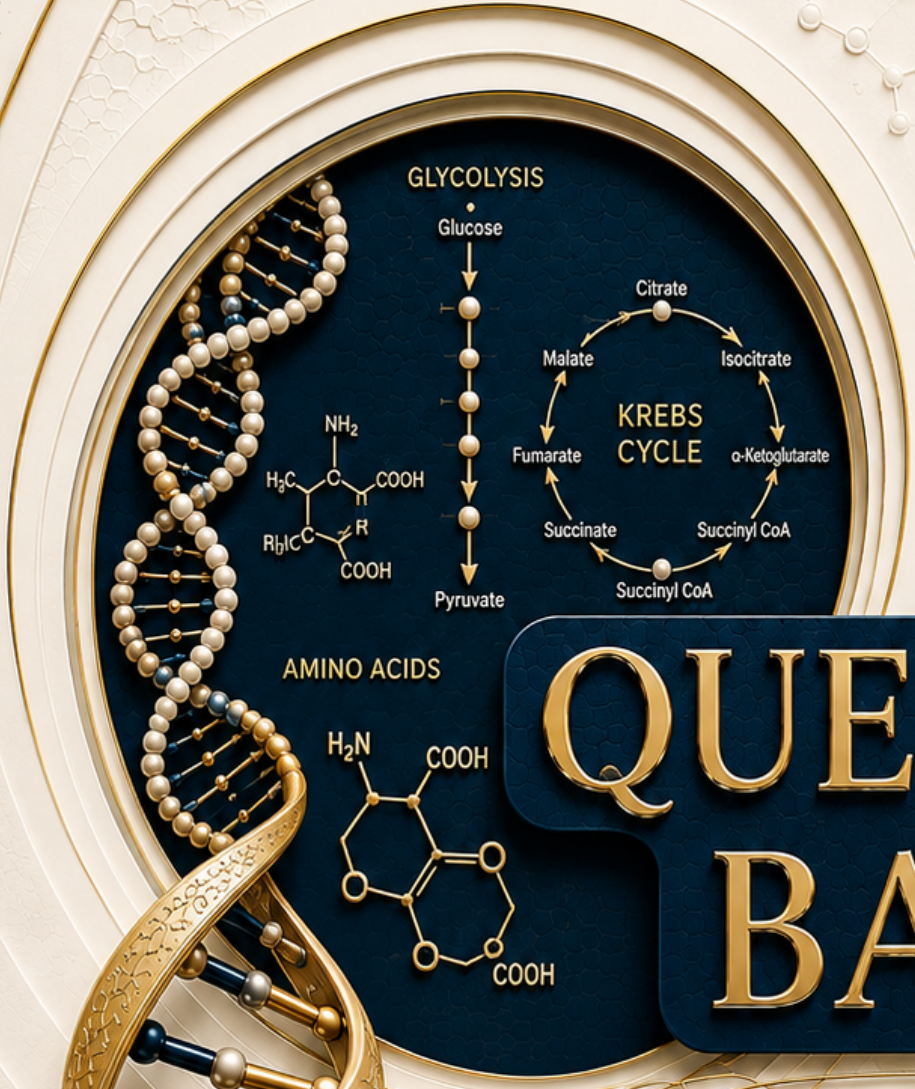
MEDWAY
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QUESTION BANK

• SEMESTER 1 •

BIOCHEMISTRY

Carbohydrates (part 1) - Monosaccharides

Part 1: MCQs (Choose the correct answer):

1. Which of the following best describes the chemical nature of carbohydrates?

A. Polyhydroxy fatty acids containing a carboxyl group
B. Polyamino compounds containing an amino and a carboxyl group
C. Polyhydroxy alcohols containing an aldehyde or a keto group
D. Nitrogenous bases linked to a pentose sugar
E. Long-chain hydrocarbons containing a glycerol backbone

2. All of the following are biomedical importance of carbohydrates EXCEPT:

A. They are the most abundant organic molecules in nature
B. They are a major source of dietary calories
C. They store energy in the body
D. They are components of cell membranes and share in intercellular communication
E. They are the main source of essential amino acids

3. Which of the following is an aldopentose?

A. D-Erythrose
B. D-Ribulose
C. D-Ribose
D. D-Xylulose
E. D-Fructose

4. Which of the following compounds is used as the reference for assigning the D- and L-configuration of sugars?

A. Dihydroxyacetone
B. Glyceraldehyde
C. Glycerol
D. Erythrose
E. Glucose

5. Which monosaccharide is known as grape sugar and is the main sugar present in the blood?

A. Fructose
B. Galactose
C. Mannose
D. Glucose
E. Ribose

6. The general formula of carbohydrates is:

A. C_nH_{2n+2}
B. $C_n(H_2O)_n$
C. $C_nH_{2n}O_2$
D. C_nH_nO
E. $C_nH_{2n+2}O_n$

7. Which of the following correctly describes the relationship between glucose and fructose?

A. Anomers
B. Epimers
C. Enantiomers
D. Functional group (aldose-ketose) isomers
E. Mirror-image isomers

8. A student draws the ring form of glucose and notes that cyclization has created a new asymmetric carbon responsible for the α and β forms. This carbon is:

A. Carbon 1
B. Carbon 2
C. Carbon 3
D. Carbon 5
E. Carbon 6

9. In the cyclic form of fructose, the anomeric carbon is:

A. Carbon 1
B. Carbon 2
C. Carbon 3
D. Carbon 5
E. Carbon 6

10. Semen provides spermatozoa with a monosaccharide that is also abundant in honey and fruits and is a component of sucrose and inulin. This sugar is:

A. Glucose
B. Galactose
C. Fructose
D. Mannose
E. Ribose

11. A breast-fed infant receives lactose with every feed. Besides glucose, which monosaccharide is a component of lactose?

A. Galactose
B. Fructose
C. Mannose
D. Ribose
E. Xylose

12. 2-Deoxyribose, the sugar present in DNA, is derived from ribose by:

A. Oxidation of the aldehyde group
B. Replacement of the OH group on carbon 2 by an amino group
C. Reduction of the aldehyde group
D. Phosphorylation of carbon 5
E. Replacement of the OH group on carbon 2 by a hydrogen atom

13. While studying the oxidation of glucose in living cells, a student identifies two phosphorylated trioses as intermediates. These are:

A. Erythrose 4-phosphate and ribose 5-phosphate
B. Glyceraldehyde 3-phosphate and dihydroxyacetone phosphate
C. Glucose 6-phosphate and fructose 6-phosphate
D. Xylulose 5-phosphate and ribulose 5-phosphate
E. Glucose 1-phosphate and galactose 1-phosphate

14. Which of the following correctly matches the type of sugar acid with the group that is oxidized?

A. Aldonic acid - the primary alcohol group
B. Uronic acid - the aldehyde group
C. Aldaric acid - the primary alcohol group only
D. Aldaric acid - both the aldehyde group and the primary alcohol group
E. Aldonic acid - the keto group

15. D-Ribose is a component of which of the following?

A. Triacylglycerols
B. Ribonucleic acid (RNA)
C. Deoxyribonucleic acid (DNA)
D. Glycogen
E. Phospholipids

16. Sugar alcohols are formed from monosaccharides by:

A. Reduction of the carbonyl group
B. Oxidation of the aldehyde group
C. Oxidation of the primary alcohol group
D. Replacement of an OH group by a hydrogen atom
E. Replacement of an OH group by an amino group

17. Oxidation of the primary alcohol group (C6) of glucose, with the aldehyde group left intact, produces:

A. Gluconic acid
B. Glucosaccharic acid
C. Sorbitol
D. Glucosamine
E. Glucuronic acid

18. Reduction of the keto group of fructose produces:

A. Sorbitol only
B. Mannitol only
C. A mixture of sorbitol and mannitol
D. Dulcitol
E. Ribitol

19. Glycerol, a component of triacylglycerols and most phospholipids, is the sugar alcohol obtained by reduction of:

A. Glyceraldehyde or dihydroxyacetone
B. Erythrose
C. Ribose
D. Glucose
E. Glyceric acid

20. Dulcitol is the sugar alcohol obtained by reduction of:

A. Glucose
B. Mannose
C. Galactose
D. Fructose
E. Ribose

21. A 58-year-old woman with osteoarthritis of the knee takes glucosamine supplements. Compared with glucose, glucosamine has an amino group in place of the hydroxyl group on:

A. Carbon 1
B. Carbon 2
C. Carbon 3
D. Carbon 4
E. Carbon 6

22. Aminosugars such as galactosamine are important constituents of:

A. Triacylglycerols
B. Bile salts
C. Ketone bodies
D. Glycosaminoglycans, glycolipids and glycoproteins
E. Cholesterol esters

23. Glucose 1-phosphate and glucose 6-phosphate are examples of which type of monosaccharide derivatives?

A. Sugar acids
B. Sugar alcohols
C. Aminosugars
D. Glycosides
E. Phosphate esters

24. In a glycoside, the non-carbohydrate group attached to the anomeric carbon is called:

A. Glycon
B. Aglycon
C. Epimer
D. Anomer
E. Ester

25. A nucleoside is an example of a glycoside in which the aglycon is a:

A. Phenol
B. Alcohol
C. Nitrogenous base
D. Phosphate group
E. Fatty acid

26. Maltose is formed by condensation of two α-D-glucose molecules with the loss of one molecule of water. The bond between them is:

A. α-1,4 glycosidic bond
B. β-1,4 glycosidic bond
C. α-1,6 glycosidic bond
D. α-1,2 glycosidic bond
E. β-1,2 glycosidic bond

27. D-Glucose and L-glucose are mirror images of each other. This type of isomerism is called:

A. Anomerism
B. Epimerism
C. Aldose-ketose isomerism
D. Optical isomerism (enantiomers)
E. Functional group isomerism

28. Which of the following pairs of sugars are C2 epimers?

A. Glucose and galactose
B. Galactose and mannose
C. Glucose and fructose
D. Ribose and xylose
E. Glucose and mannose

29. The five-membered ring form of fructose is called:

A. Fructofuranose
B. Fructopyranose
C. Fructosamine
D. Fructitol
E. Fructonic acid

30. Which of the following is a ketose containing seven carbon atoms?

A. D-Ribulose
B. D-Xylulose
C. D-Fructose
D. D-Sedoheptulose
E. D-Erythrulose

Part 2: Short-Answer & Essay Questions:

1. List the following:

A. Four biomedical importance of carbohydrates.

a.

b.

c.

d.

B. Three important aldohexoses.

a.

b.

c.

C. Three biologically important ketoses.

a.

b.

c.

2. On biochemical basis explain each of the following:

a. Sorbitol accumulation in the lens of a diabetic patient may lead to cataract.

b. Fructose is an isomer of glucose but it is not its epimer.

c. Glycerol is classified as a sugar alcohol.

3. Enumerate:

a. The three types of sugar acids, mentioning the group that is oxidized in each.

1.

2.

3.

b. Three structures that contain aminosugars.

1.

2.

3.

4. What is the product of each of the following?

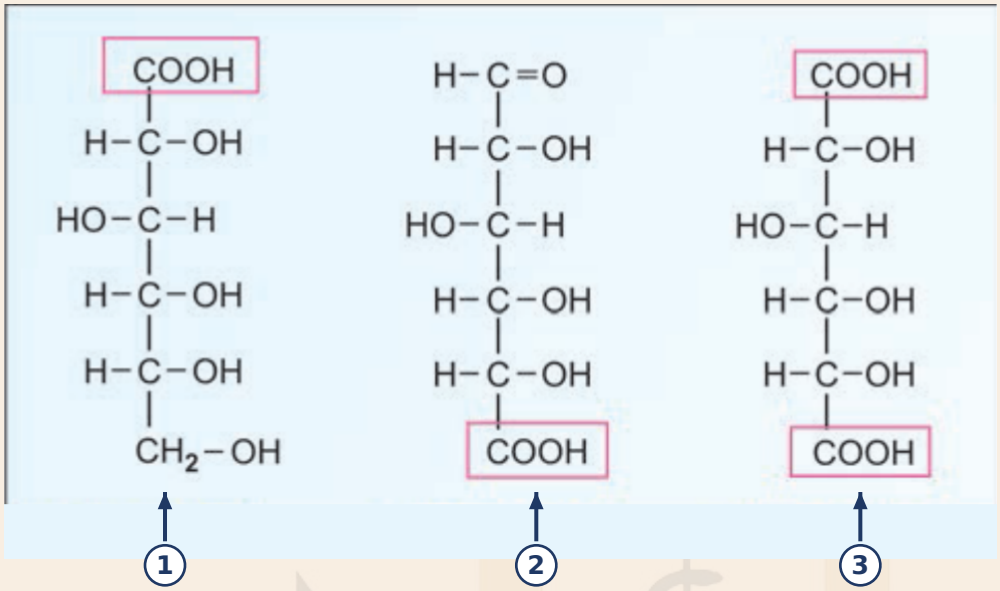
a. Oxidation of the aldehyde group of glucose:

b. Reduction of the aldehyde group of galactose:

c. Reduction of the keto group of fructose:

d. Replacement of the hydroxyl group on carbon 2 of glucose by an amino group:

5. Label the following diagram, mentioning the type of each sugar acid:

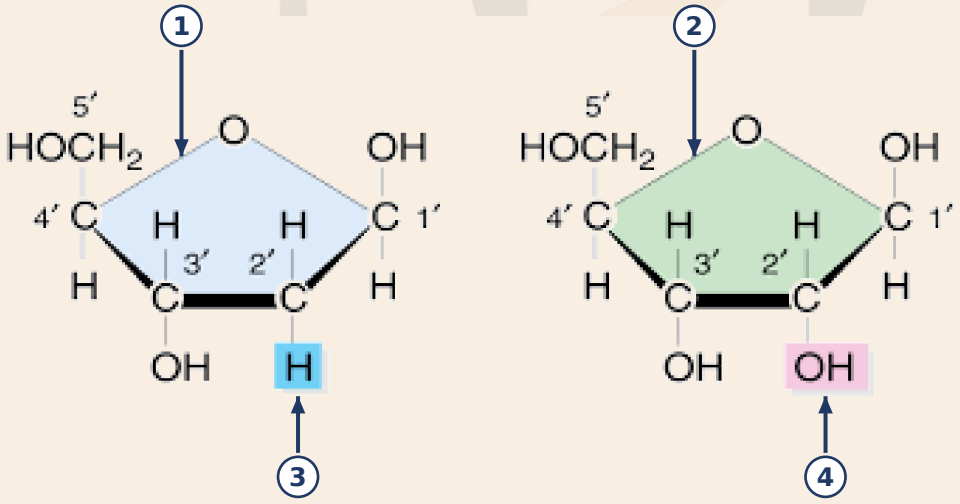


1.

2.

3.

6. Label the following diagram:



1.

2.

3.

4.

7. Enumerate:

a. The four types of isomerism of monosaccharides.

1.

2.

3.

4.

b. Three examples of the non-carbohydrate (aglycon) part of glycosides.

1.

2.

3.

8. On biochemical basis explain each of the following:

a. Glucose and mannose are epimers, whereas α-D-glucose and β-D-glucose are anomers.

b. Vitamin C must be supplied in the diet although it is a sugar acid.

Part 1: MCQ Answer Key (with slide references)

1. C – Polyhydroxy alcohols containing an aldehyde or a keto group Slide 2 (general formula Cn(H2O)n)
2. E – They are the main source of essential amino acids Slide 3 (the other four statements are listed importance of carbohydrates)
3. C – D-Ribose Slide 10 (D-erythrose is an aldotetrose; ribulose and xylulose are ketopentoses; fructose is a ketohexose)
4. B – Glyceraldehyde Slide 8 (the mother compound of the aldoses)
5. D – Glucose Slide 24 (present in all animal and plant cells, honey and fruits)
6. B – Cn(H2O)n Slide 2
7. D – Functional group (aldose-ketose) isomers Slide 22 (same molecular formula, different functional group)
8. A – Carbon 1 Slides 19 & 20 (the anomeric carbon of an aldose)
9. B – Carbon 2 Slides 20 & 21 (anomers are epimers at C1 of cyclic aldoses and at C2 of cyclic ketoses)
10. C – Fructose Slide 24 (fruit sugar)
11. A – Galactose Slide 24 (galactose is also present in GAGs, glycolipids and glycoproteins)
12. E – Replacement of the OH group on carbon 2 by a hydrogen atom Slide 34 (deoxysugar)
13. B – Glyceraldehyde 3-phosphate and dihydroxyacetone phosphate Slide 23 (erythrose 4-phosphate is a tetrose phosphate)
14. D – Aldaric acid - both the aldehyde group and the primary alcohol group Slides 27-29 (aldonic = aldehyde; uronic = primary alcohol)
15. B – Ribonucleic acid (RNA) Slide 23 (also a component of many nucleosides and nucleotides)
16. A – Reduction of the carbonyl group Slide 30 (the carbonyl group is reduced to an alcohol group)
17. E – Glucuronic acid Slides 27 & 28 (a uronic acid)
18. C – A mixture of sorbitol and mannitol Slide 32 (reduction of ketones produces 2 alcohols)
19. A – Glyceraldehyde or dihydroxyacetone Slides 31 & 33
20. C – Galactose Slide 30 (sorbitol = glucose; mannitol = mannose)
21. B – Carbon 2 Slide 35 (aminosugar)
22. D – Glycosaminoglycans, glycolipids and glycoproteins Slide 35 (several antibiotics also contain aminosugars)
23. E – Phosphate esters Slide 36
24. B – Aglycon Slide 37 (the glycon is the sugar part)
25. C – Nitrogenous base Slide 37 (aglycons: alcohols, phenols or nitrogenous bases)
26. A – α-1,4 glycosidic bond Slide 38
27. D – Optical isomerism (enantiomers) Slides 17 & 18
28. E – Glucose and mannose Slides 11 & 18 (glucose and galactose are C4 epimers)
29. A – Fructofuranose Slide 21
30. D – D-Sedoheptulose Slides 13-15 (ribulose/xylulose = C5; fructose = C6; erythrulose = C4)

Part 2: Short-Answer & Essay Answer Key (with slide references)

1. Importance, aldohexoses and ketoses — Slides 3, 11 & 13–15

- A. Most abundant organic molecules in nature; major dietary source of calories; storage of energy; components of cell membranes and intercellular communication (Slide 3).
- B. D-Glucose, D-mannose and D-galactose (Slide 11).
- C. Dihydroxyacetone, D-ribulose and D-fructose (also D-erythrulose, D-xylulose, D-sedoheptulose) (Slides 12–15).

2. Sorbitol, isomerism and glycerol — Slides 18, 22, 30–31 & 33

- a. Aldose reductase reduces the carbonyl group of the excess glucose to sorbitol (a sugar alcohol), which accumulates in the lens and leads to cataract (Slides 30–31).
- b. Fructose is a ketose (keto group on C2) while glucose is an aldose (aldehyde group on C1): same molecular formula but different functional group, so they are aldose-ketose isomers. Epimers differ in the configuration around only one asymmetric carbon (Slides 18 & 22).
- c. It is formed by reduction of the carbonyl group of glyceraldehyde or dihydroxyacetone to an alcohol group (Slides 31 & 33).

3. Sugar acids and aminosugars — Slides 27–29 & 35

- a. Aldonic acid: the aldehyde group is oxidized (e.g. gluconic acid). Uronic acid: the primary alcohol group is oxidized (e.g. glucuronic acid). Aldaric acid: both groups are oxidized (e.g. glucosaccharic acid).
- b. Glycosaminoglycans (GAGs), glycolipids and glycoproteins (also several antibiotics).

4. Products — Slides 27–29, 30, 32 & 35

- a. Gluconic acid (aldonic acid). b. Dulcitol (galactitol). c. Sorbitol and mannitol. d. Glucosamine.

5. Label the diagram (sugar acids) — Slides 27–29

- 1. Gluconic acid – an aldonic acid (C1 oxidized). 2. Glucuronic acid – a uronic acid (C6 oxidized). 3. Glucosaccharic acid – an aldaric acid (C1 and C6 oxidized).

6. Label the diagram (deoxyribose and ribose) — Slides 23 & 34

- 1. 2-Deoxyribose (present in DNA). 2. Ribose (present in RNA and nucleotides). 3. Hydrogen atom (replaces the OH group on C2). 4. Hydroxyl (OH) group on C2.

7. Isomerism and aglycons — Slides 18 & 37

- a. Optical isomers, anomers, epimers, and aldose-ketose (functional group) isomers.
- b. Alcohols, phenols and nitrogenous bases (e.g. in nucleosides).

8. Epimers/anomers and vitamin C — Slides 18–20 & 27–29

- a. Glucose and mannose differ only in the configuration around C2 (epimers). α- and β-D-glucose differ only in the configuration around the anomeric carbon (C1) created by ring closure (anomers).
- b. Humans cannot synthesize L-ascorbic acid (vitamin C) from glucose, so it must be obtained from the diet.