

# Exam Review: Organic Chemistry & Biochemistry

## Question 1 (Exam Review)

### The Question:

"Regarding the asymmetric carbon (C\*), choose the **incorrect** statement:

- A. It carries four different substituents.
- B. It creates a center of chirality in the molecule.
- C. A substance containing an asymmetric carbon is inactive on polarized light.
- D. The number of possible isomers is  $2^n$ .
- E. A chiral molecule is not superimposable on its mirror image.

**Correct Answer: "C"**

### Professional Explanation:

The defining characteristic of an asymmetric or **chiral carbon** is that it imparts **optical activity** to a molecule, meaning it will rotate the plane of polarized light. A substance with a chiral center is therefore **optically active**, not **inactive**. Statements A, B, and E are the core definitions of chirality. Statement D refers to the Van't Hoff rule, where 'n' is the number of chiral centers, correctly calculating the maximum number of stereoisomers.



**Memory Trick:** Asymmetric makes light **swim**. It actively changes the direction of polarized light; it doesn't let it sit still (**inactive**).

## Question 2 (Exam Review)

### The Question:

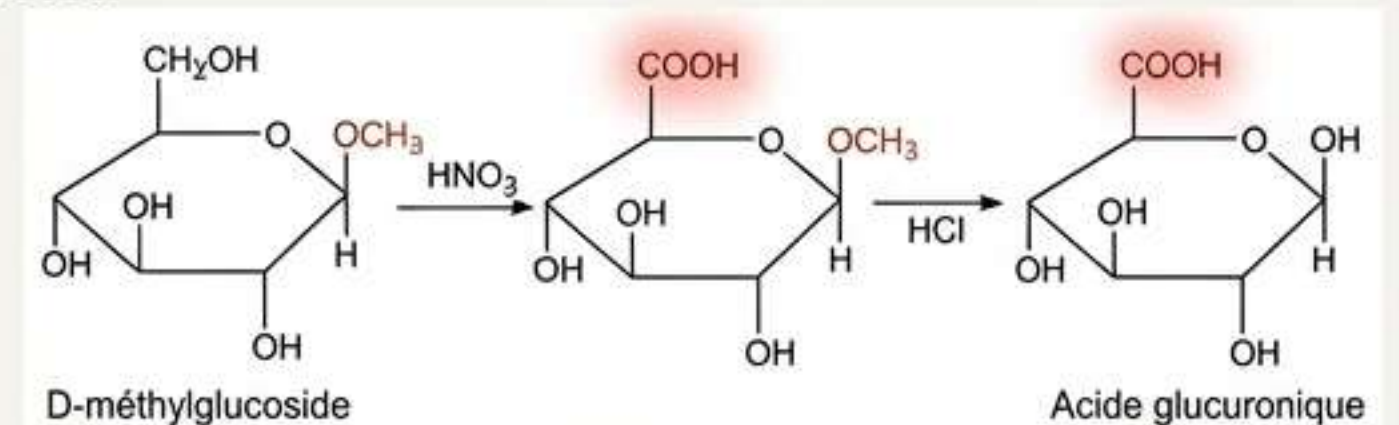
"What is the name of this acid, which is derived from the oxidation of D-glucose?"

- A.  $\beta$ -D-galacturonic acid
- B.  $\alpha$ -L-gulonic acid
- C.  $\beta$ -D-glucuronic acid
- D.  $\beta$ -D-mannuronic acid
- E.  $\beta$ -D-alononic acid

**Correct Answer: "C"**

### Professional Explanation:

This question tests your knowledge of sugar acid nomenclature. **Uronic acids** are formed by the selective oxidation of the primary alcohol group (C6) of an aldose while the aldehyde group (C1) is protected. Since the parent sugar is **glucose**, the resulting acid is **glucuronic acid**. The '**D**' configuration is determined by the orientation of the -OH on the subterminal carbon, which remains unchanged from D-glucose.



**Memory Trick:** Think **U** for **Uronic** and **Upstairs**. The oxidation happens 'upstairs' at the **highest numbered carbon** (C6), not downstairs at C1.

## Question 3 (Exam Review)

Concerning the cyclic form of sugars, choose the correct statement:

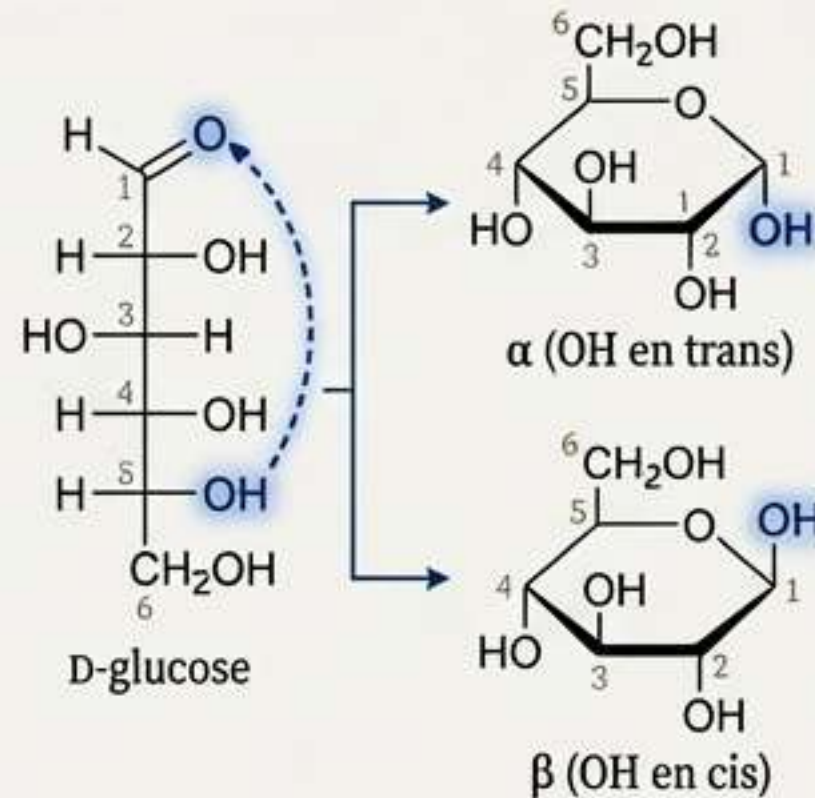
- A. A new center of asymmetry is formed at position 1.
- B. The most common rings in nature are furanoses (5 atoms) and pyranoses (6 atoms).
- C. The -OH groups on the right in Fischer projection appear below the plane of the ring.
- D. The hemiacetal hydroxyl group determines the  $\alpha$  and  $\beta$  forms of sugars.
- E. All statements are correct.

Correct answer: **E**

## Professional Explanation (Teacher Mode)

- \* (A) Cyclization involves the C1 aldehyde reacting with an OH group, turning the previously planar **C1** into a new chiral center, the **anomeric carbon**.
- \* (B) Six-membered **pyranose** rings and five-membered **furanose** rings are indeed the most stable and common forms.
- \* (C) This is the fundamental rule for converting a **Fischer projection to a Haworth projection**: groups on the **right go down**.
- \* (D) The orientation of the new hydroxyl on C1 defines the anomer:  **$\alpha$  (alpha)** if it's trans to the CH<sub>2</sub>OH group,  **$\beta$  (beta)** if it's cis.

Since all statements are true, E is correct.



**Memory Trick:** For Fischer to Haworth conversion: "Right Down, Left Up!" (Right groups go Down, Left groups go Up).

## Question 4 (Exam Review)

The reduction of the aldehyde group of glucose leads to:

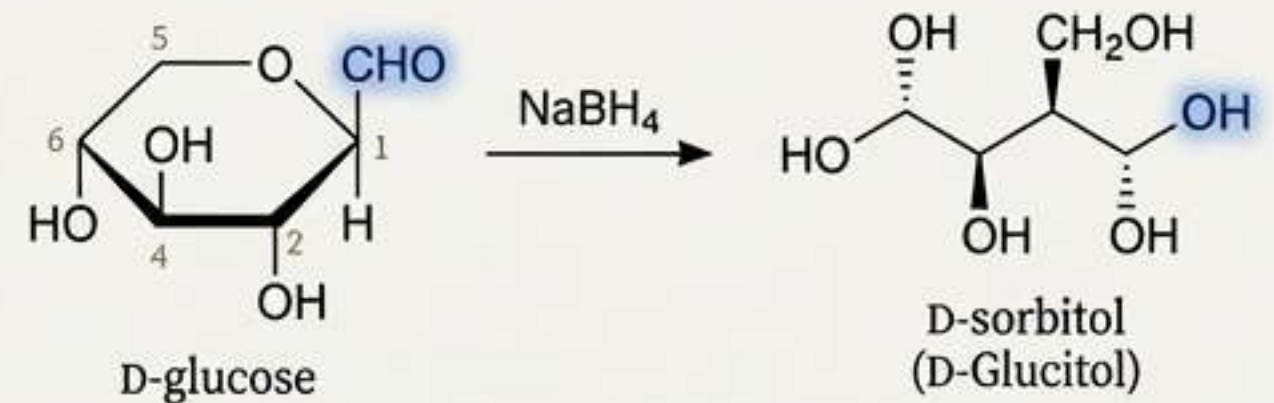
- A. The formation of sorbitol.
- B. The formation of mannitol.
- C. The formation of glucaric acid.
- D. The formation of gluconic acid.
- E. The formation of glucuronic acid.

Correct answer: **A**

## Professional Explanation (Teacher Mode)

The key term here is **reduction**. Reducing the carbonyl group of a sugar yields a polyol, or sugar alcohol. The acids listed in options C, D, and E are all products of **oxidation**.

The reduction of D-glucose's aldehyde group at C1 specifically produces the alditol **D-sorbitol** (also called D-glucitol). Mannitol is an epimer of sorbitol and is formed from the reduction of fructose.



**Memory Trick:** Glucose gets **reduced** to a **SOR**-bit less complex structure (Sorbitol).

## Question 5 (Exam Review)

The Question: "Which of the following structures represent the same hexose?"

- A. Structures I and II
- B. Structures I and III
- C. Structures I and IV
- D. Structures II and III
- E. Structures III and IV

Correct answer: **E**

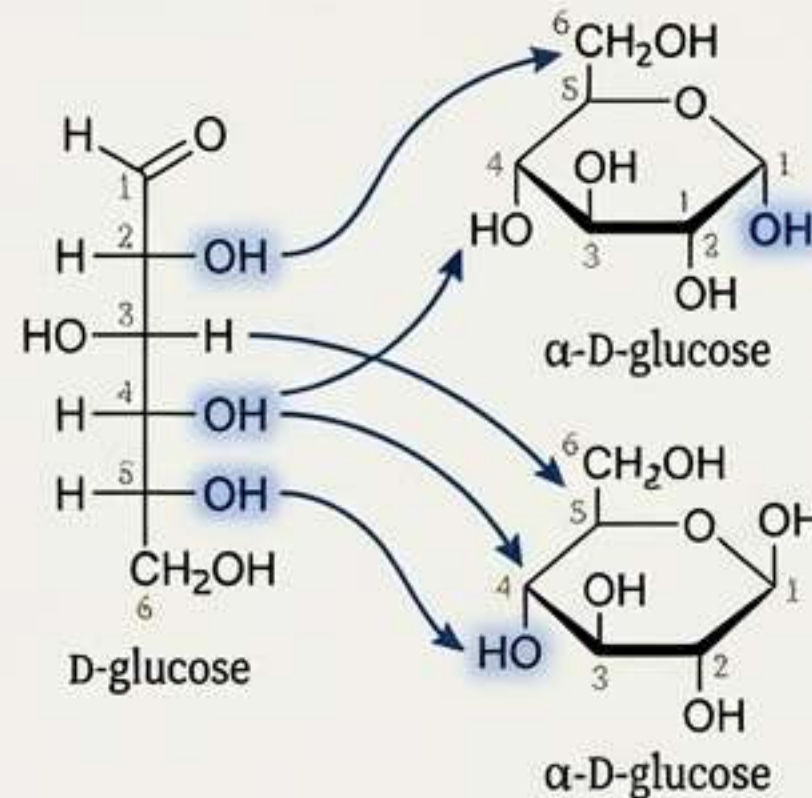
### Professional Explanation (Teacher Mode)

This question tests the ability to interconvert between Fischer and Haworth projections.

To represent the **same hexose**, the configuration of all chiral centers must match.

The rule is that hydroxyl groups on the **right** in the linear **Fischer** projection point **down** in the cyclic **Haworth** projection.

By applying this "Right Down, Left Up" rule, one can determine which Haworth structures correctly represent the same parent sugar.



**Memory Trick:** To check if they're the same sugar, mentally say "Down-Right, Up-Left" as you compare the Haworth structure to its implied Fischer original.

## Question 6 (Exam Review)

The Question: "Regarding osamines (amino sugars), choose the **incorrect** statement:"

- A. They are sugars where one -OH group has been replaced by an amine (-NH<sub>2</sub>) group.
- B. They are sugars where one -OH group has been replaced by an acid (-COOH) group.
- C. They exist in acetylated form.
- D. They are major components of glycopeptides and glycosaminoglycans.
- E. N-acetylmuramic acid belongs to this family.

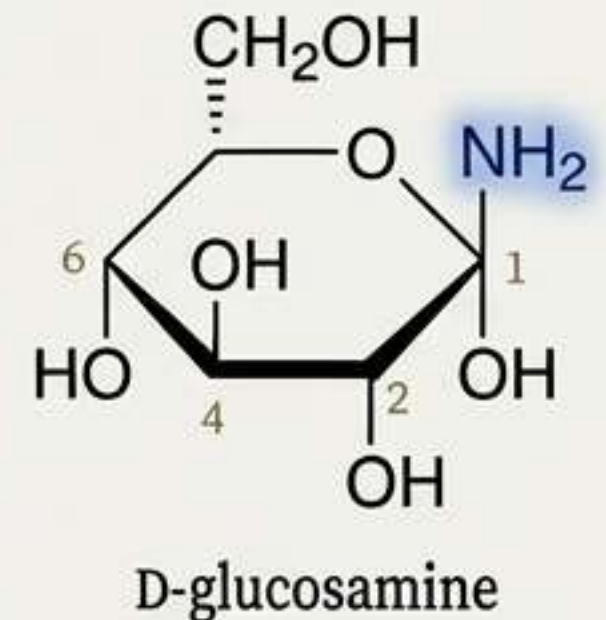
Correct answer: **B**

### Professional Explanation (Teacher Mode)

The name itself gives a strong clue: **osamine** is a combination of ose (sugar) and *amine*. These are monosaccharide derivatives where a hydroxyl (-OH) group is replaced by an **amino (-NH<sub>2</sub>) group**.

Statement B is **incorrect**; replacing an -OH with a carboxyl (-COOH) group creates a sugar **acid**, not an amino sugar.

Statements C, D, and E are all true; amino sugars are frequently acetylated and are fundamental building blocks of complex carbohydrates.



**Memory Trick:** "OsAMINE has an AMINE inside." Don't confuse it with an acid!

## Question 7-1 (Exam Review)

### The Question:

"Raffinose is:"

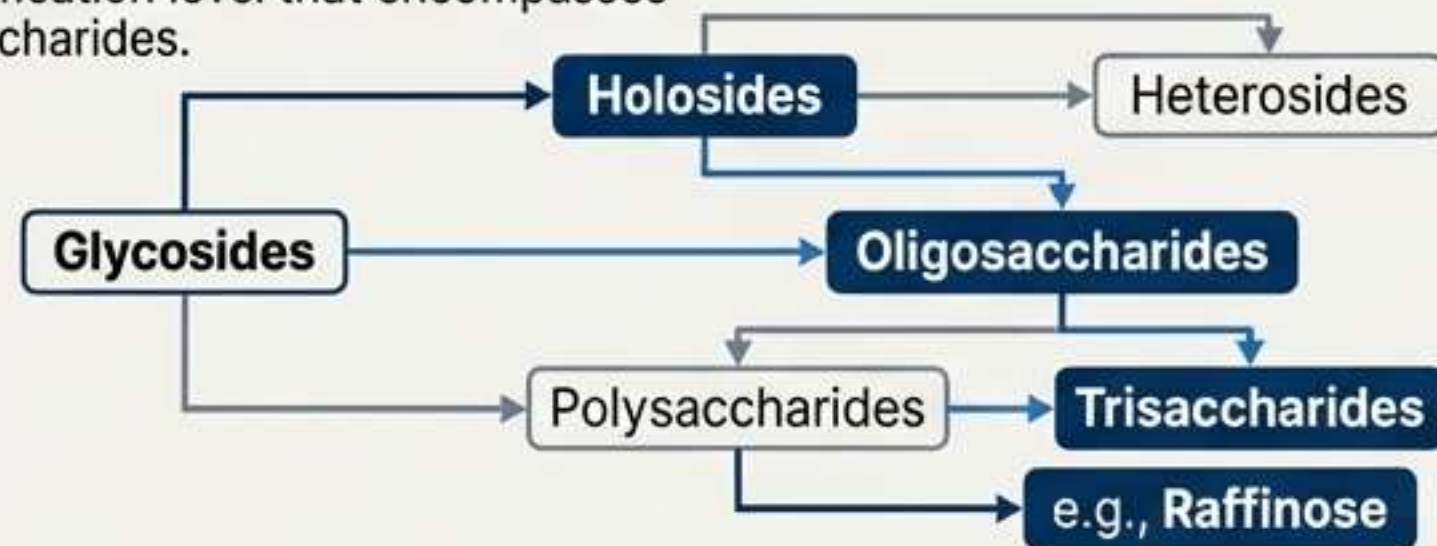
- A. A holoside.
- B. A heteroside.
- C. An oligosaccharide.
- D. A polyoside.
- E. A trisaccharide.

**Correct Answer: C**

### Professional Explanation (Teacher Mode):

This question tests carbohydrate classification.

- **Holoside:** A carbohydrate composed *only* of sugar units. Raffinose is a holoside.
- **Oligosaccharide:** A holoside with 2-10 sugar units. Raffinose has **three**, so it is an oligosaccharide.
- **Trisaccharide:** A specific type of oligosaccharide with **three** sugar units. While A, C, and E are all technically correct, **Oligosaccharide** is the correct classification level that encompasses trisaccharides.



**Memory Trick:** "Oligo" means "a few". Think of an oil rig with just a few workers (2-10), not a whole poly-nesian island of them.

## Question 7-2 (Exam Review)

### The Question:

"The chemical name of raffinose is:"

- A. [Various systematic names]
- B. [Various systematic names]
- C.  $\alpha$ -D-galactopyranosyl(1 $\rightarrow$ 6) $\alpha$ -D-glucopyranosyl(1 $\rightarrow$ 2) $\beta$ -D-fructofuranoside
- D. [Various systematic names]
- E. [Various systematic names]

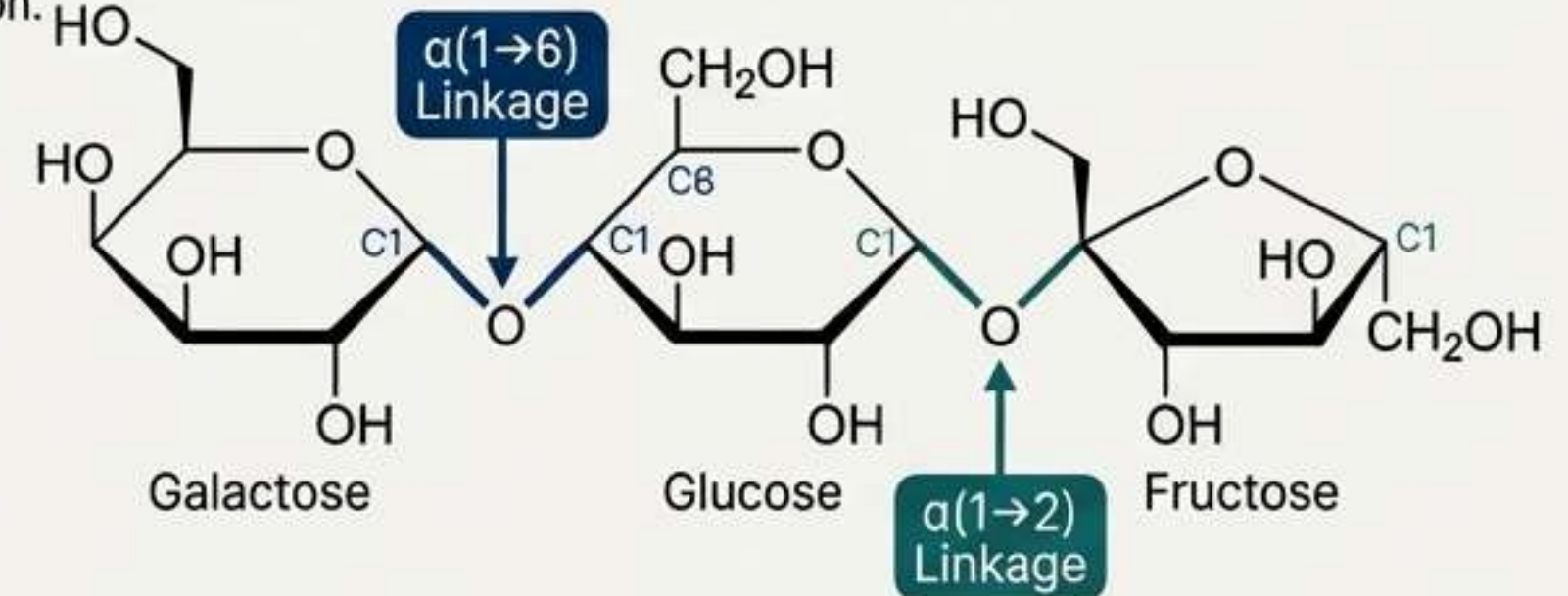
**Correct Answer: C**

### Professional Explanation (Teacher Mode):

The systematic name for an oligosaccharide precisely describes its components and linkages. For **raffinose**, we read the structure from left to right:

1. **Galactose** is linked to **Glucose**: An  $\alpha(1\rightarrow6)$  bond connects C1 of galactose to C6 of glucose.
2. **Glucose** is linked to **Fructose**: An  $\alpha(1\rightarrow2)$  bond connects C1 of glucose to C2 of fructose.

This structure is essentially **sucrose** (glucose-fructose) with a galactose added on.



**Memory Trick:** Remember the components **GaG-F** (Galactose-Glucose-Fructose) and the links **6** and **2**. "Give GaGs to Frogs at 6 and 2 o'clock".

# Exam Review: Raffinose and Fehling's Test

## Question 7-3 (Exam Review)

What is the result of the reaction of raffinose with Fehling's reagent?

- A. Gives a red precipitate.
- B. Reduces the reagent to  $\text{Cu}_2\text{O}$ .
- C. It is oxidized to aldobionic acid.
- D. No reaction occurs.
- E. It is converted to glucose.

Correct Answer: **D**

## Professional Explanation (Teacher Mode)

The **Fehling's test** is a chemical test for **reducing sugars**, which requires a **free hemiacetal group**. In raffinose, the anomeric carbon of galactose is linked ( $\text{C1} \rightarrow \text{C6}$ ), and the anomeric carbons of glucose ( $\text{C1}$ ) and fructose ( $\text{C2}$ ) are also linked. Since **all anomeric carbons are locked** in glycosidic bonds, raffinose is a non-reducing sugar and therefore gives no reaction.



**Memory Trick:** "No free anomer, no fun." For Fehling's test to work, you need a free anomeric carbon to open up and react. Raffinose has all its reactive ends tied up.

## Question 7-4 (Exam Review)

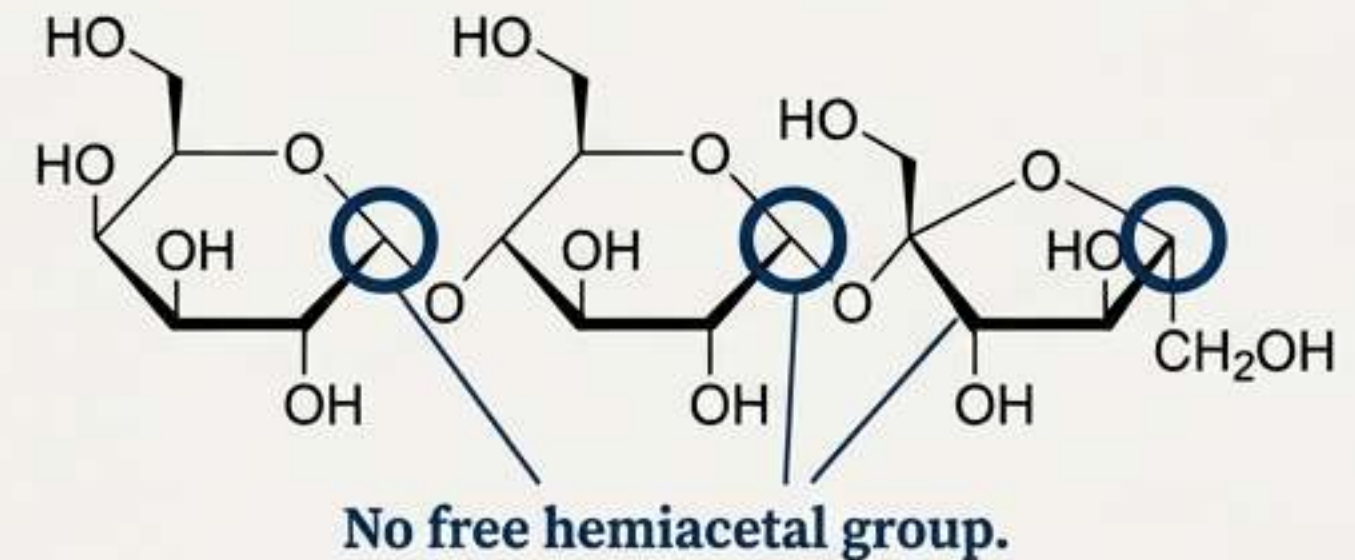
Why does raffinose not react with Fehling's reagent?

- A. Presence of a free alcohol function.
- B. Presence of a free hemiacetal function.
- C. Because raffinose is a reducing sugar.
- D. Because all anomeric hydroxyls are engaged in bonds.
- E. The nature of the constituent sugars.

Correct Answer: **D**

## Professional Explanation (Teacher Mode)

This question directly asks for the rationale behind the previous result. A sugar's ability to act as a **reducing agent** depends on the equilibrium between its cyclic **hemiacetal** form and its open-chain **aldehyde** form. This is only possible if the **anomeric hydroxyl group is free**. Because all of raffinose's **anomeric hydroxyls are engaged** in glycosidic bonds, the rings cannot open, and the sugar cannot reduce the  $\text{Cu}^{2+}$  in Fehling's reagent.



**Memory Trick:** 'Think of anomeric carbons as "hands." If all the sugars are holding hands in a circle (engaged in bonds), no one has a free hand to give an electron (reduce Fehling's).

## Question 7-5 (Exam Review)

### The Question:

"The conversion of sugar B (an aldose) to sugar C (a ketose):"

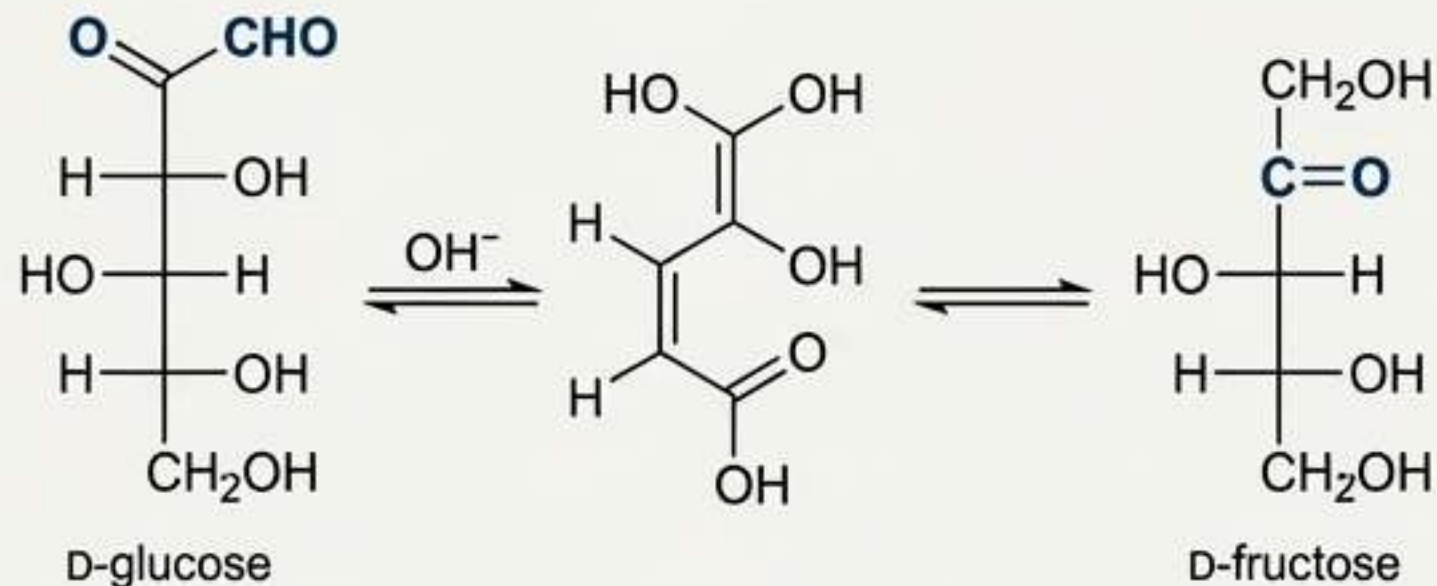
- A. Is an interconversion.
- B. Occurs in an alkaline medium.
- C. Allows the transformation of an aldehyde function into a ketone function and vice versa.
- D. Sugars B and C are functional isomers.
- E. All of the answers are correct.

Correct Answer: E

### Professional Explanation (Teacher Mode)

This describes the **Lobry de Bruyn-Alberda van Ekenstein transformation**, a base-catalyzed isomerization of sugars. In a weakly **alkaline solution**, an aldose can rearrange into a ketose, and vice versa, via an **enediol intermediate**. Therefore:

- (A & C) It is an **interconversion** between aldehyde and ketone.
- (B) It requires a basic (**alkaline**) medium.
- (D) Aldoses and ketoses with the same formula are **functional isomers**.



**Memory Trick:** Remember "**BASE**ball lets you **SWITCH** hitters." A **base** (alkaline solution) allows sugars to **switch** between aldose and ketose forms.

## Question 8 (Exam Review)

### The Question:

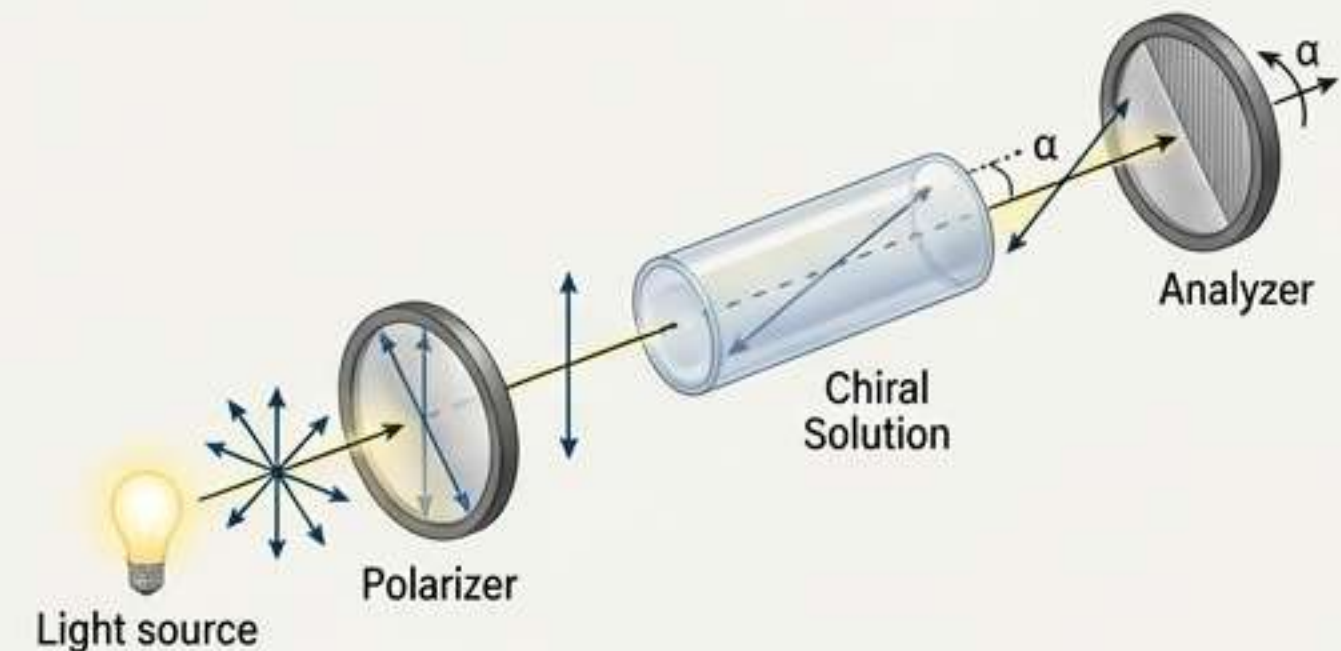
"Regarding the asymmetric carbon (C\*), choose the **incorrect** statement:"

- A. It carries four different substituents.
- B. It creates a center of chirality in the molecule.
- C. A substance containing an asymmetric carbon is **inactive on polarized light**.
- D. The number of possible isomers is 2<sup>n</sup>.
- E. A chiral molecule is not superimposable on its mirror image.

Correct Answer: C

### Professional Explanation (Teacher Mode)

This is a repeated concept check, emphasizing its importance. The presence of a single **asymmetric (chiral) carbon** is sufficient to make a molecule chiral. A key physical property of chiral molecules is their ability to rotate the plane of polarized light, a phenomenon known as **optical activity**. Therefore, the statement that a substance with a C\* is **optically inactive** is fundamentally **incorrect**.



**Memory Trick:** "Asymmetric means **active**. Symmetric means **static**." An asymmetric molecule actively interacts with light.

## Question 9 (Exam Review)

**The Question:** Concerning the D and L series of sugars, choose the **incorrect** statement:

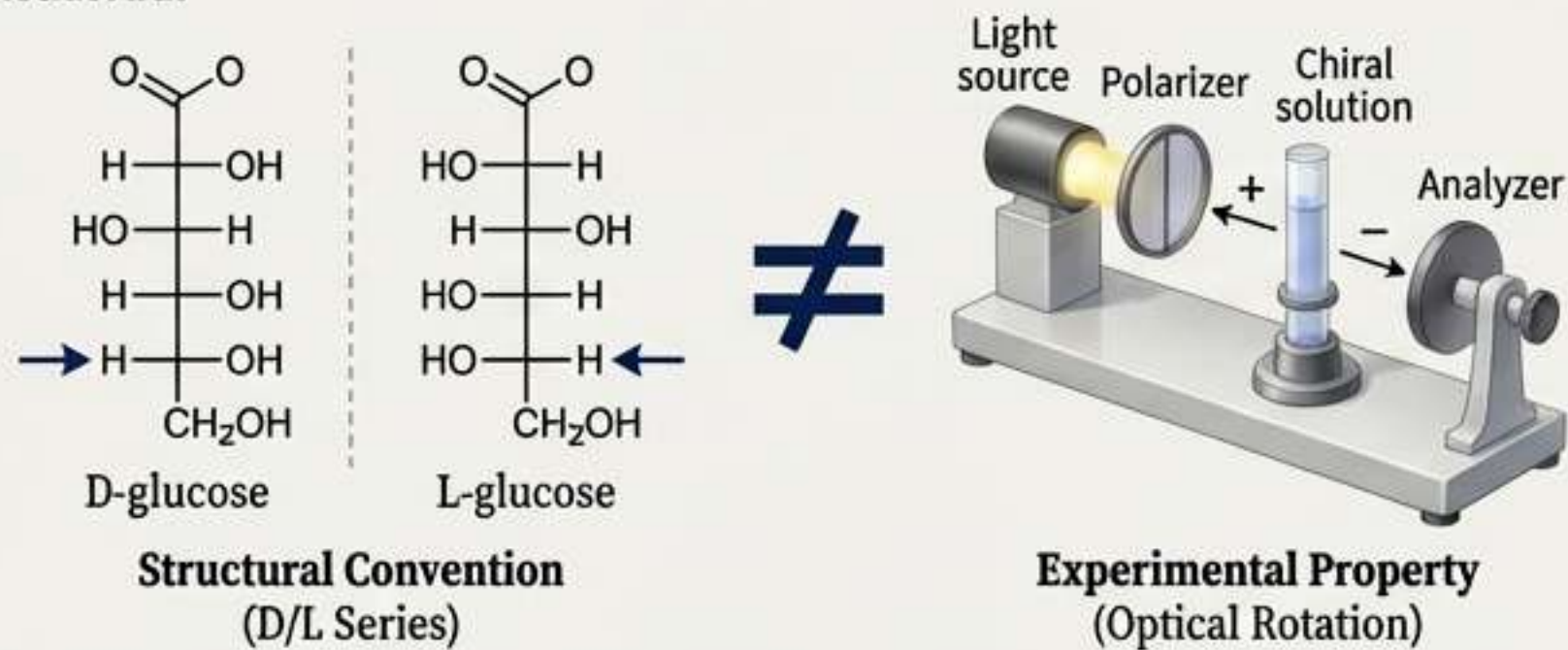
- A. The series is determined by the position of the -OH on the subterminal carbon.
- B. D-glucose and L-glucose are mirror images of each other (enantiomers).
- C. Membership in the D or L series determines the direction of light rotation (dextro/levo).
- D. Most natural sugars belong to the D series.
- E. The number of isomers for an aldose is  $2^{n-2}$  and for a ketose is  $2^{n-3}$ .

**Correct Answer: C**

### Professional Explanation (Teacher Mode):

The D/L designation is a **structural descriptor** based on the configuration of the chiral carbon furthest from the carbonyl group, relative to glyceraldehyde. It has **NO correlation** with the direction of optical rotation, which is an experimentally measured property denoted by (+) for dextrorotatory and (-) for levorotatory. For example, D-fructose is levorotatory (-). Statement C **incorrectly** links these two independent concepts.

### Visual Aid:



### Mnemonic & Style

**Memory Trick:** "Doesn't Link to Direction!" The D/L notation is about **Design**, not the Direction of light rotation.

## Question 10 (Exam Review)

**The Question:** Concerning the cyclic form of sugars, choose the **correct** statement:

- A. A new center of asymmetry is formed at position 1.
- B. The most common rings are furanoses and pyranoses.
- C. -OH groups on the right in Fischer appear below the plane of the ring.
- D. The hemiacetal hydroxyl determines the  $\alpha$  and  $\beta$  forms.
- E. All of the answers are correct.

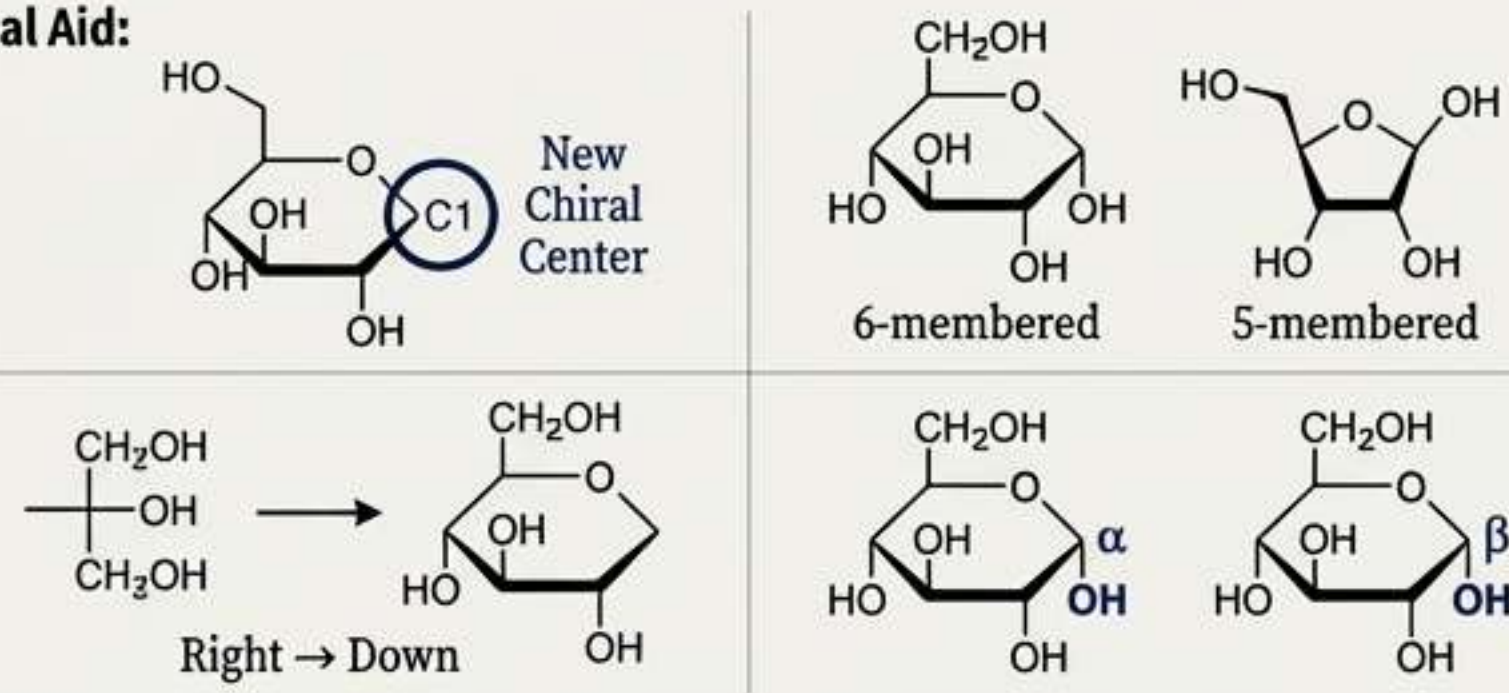
**Correct Answer: E**

### Professional Explanation (Teacher Mode):

As established previously, all individual statements about sugar cyclization are correct.

- **New Chiral Center:** The anomeric carbon is created.
- **Common Rings:** Pyranose (6-membered) and furanose (5-membered) rings are most stable.
- **Fischer to Haworth:** The 'down-right' rule is the standard convention.
- **Anomer Definition:** The  $\alpha/\beta$  designation depends on the stereochemistry of the new hemiacetal hydroxyl.

### Visual Aid:



### Mnemonic & Style

**Memory Trick:** Think **CARD**: Center (new chiral), Anomers ( $\alpha/\beta$ ), Rings (pyran/furan), Down-right rule. All parts of the CARD deck are correct.

## Question 11 (Exam Review)

What happens when sugars are placed in a hot, acidic medium?

- A. The sugars degrade.
- B. There is an exchange between sugars.
- C. Furfural derivatives are formed.
- D. Polyols are formed.
- E. Aldonic acids are formed.

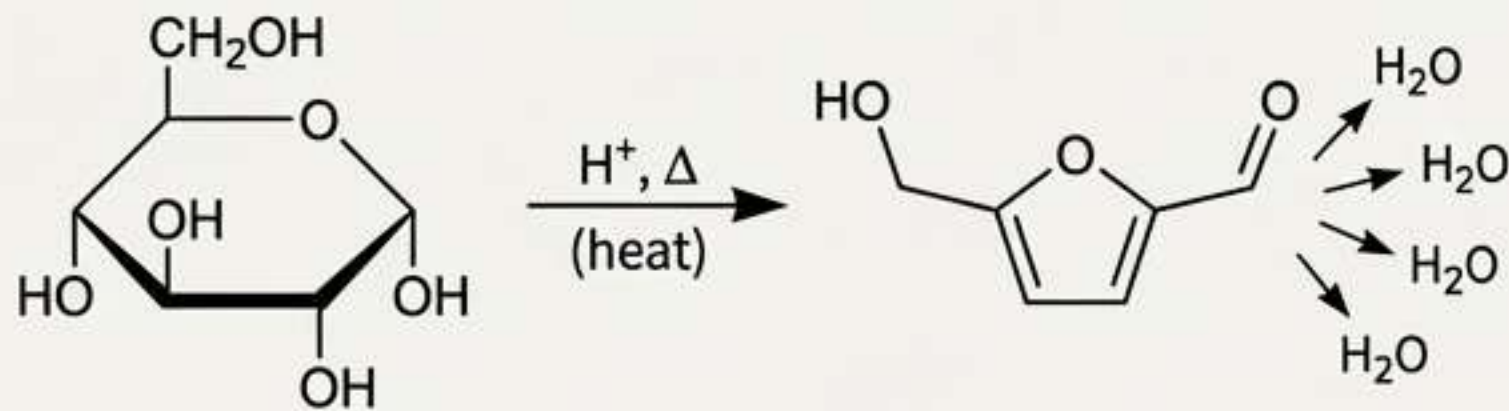
Correct Answer: **C**

### Professional Explanation (Teacher Mode)

In the presence of **strong non-oxidizing acid** and **heat**, carbohydrates undergo **dehydration**. This reaction removes several water molecules from the sugar structure, leading to the formation of cyclic compounds called **furfurals** (from pentoses) or 5-hydroxymethyl-furfural (from hexoses).

This reaction is the basis for qualitative tests like the Molisch test.

Polyols are from reduction, and aldonic acids are from mild oxidation.



### Mnemonic & Style:

Memory Trick: "Hot acid makes sugar **furious**." This intense condition forces the sugar to lose water and form **furfural**.

## Question 12 (Exam Review)

Regarding a reducing disaccharide, choose the **incorrect** statement:

- A. It contains a free hemiacetal function.
- B. It reduces Fehling's reagent.
- C. It is formed by the union of two sugars via an osyl-ose bond.
- D. It gives a red precipitate with  $Cu_2O$  upon heating.
- E. It is formed by the union of two sugars via an osyl-oside bond.

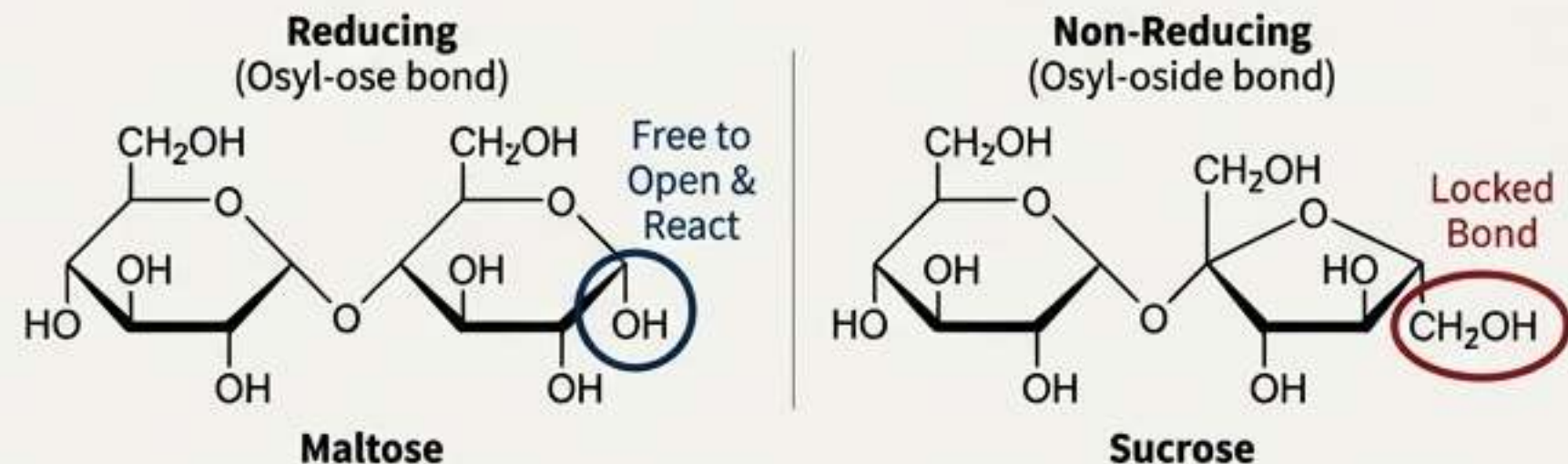
Correct Answer: **E**

### Professional Explanation (Teacher Mode)

This question hinges on glycosidic bond nomenclature.

- A **reducing sugar** must have a **free hemiacetal group** (A).
- An **osyl-ose** bond links an anomeric carbon to a non-anomeric alcohol, leaving one hemiacetal. This is characteristic of reducing disaccharides (C).
- An **osyl-oside** bond connects **two anomeric carbons**, locking both units and resulting in a **non-reducing** sugar.

Therefore, statement E is **incorrect** for a reducing disaccharide.



### Mnemonic & Style:

Memory Trick: "**O**side locks both **s**ides." An osyl-**oside** bond means the molecule is non-reducing. An osyl-**ose** bond leaves one end **loose** to reduce.

## Question 13 (Exam Review)

**The Question:** A triholoside is:

- A. A simple sugar.
- B. A heteroside.
- C. A holoside.
- D. A monosaccharide.
- E. A polysaccharide.

**Correct Answer: C**

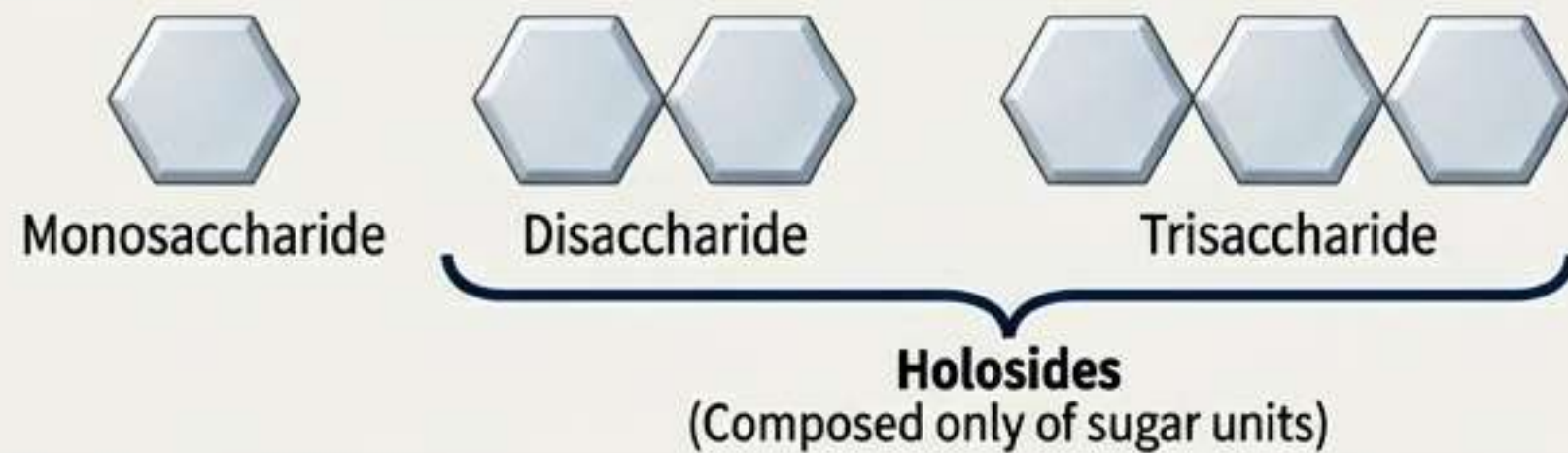
**Professional Explanation (Teacher Mode):**

This is a classification question. The term “triholoside” breaks down as:

- **Tri-**: means three.
- **-holo-**: means “whole,” indicating it is composed entirely of sugar units.
- **-side**: refers to a glycoside or sugar.

Therefore, a triholoside is a molecule made of three sugar units and nothing else. This fits the definition of a **holoside** (a carbohydrate made only of monosaccharides).

**Visual Aid:**



**Mnemonic & Style:**

Memory Trick: If it ends in “**-holoside**,” it’s a **holoside**. The prefix (di-, tri-, poly-) just tells you the number of units.

## Question 14 (Exam Review)

**The Question:** Acid hydrolysis of a compound yields 2 moles of D-glucose and 1 mole of D-galactose. What is the composition of the compound?

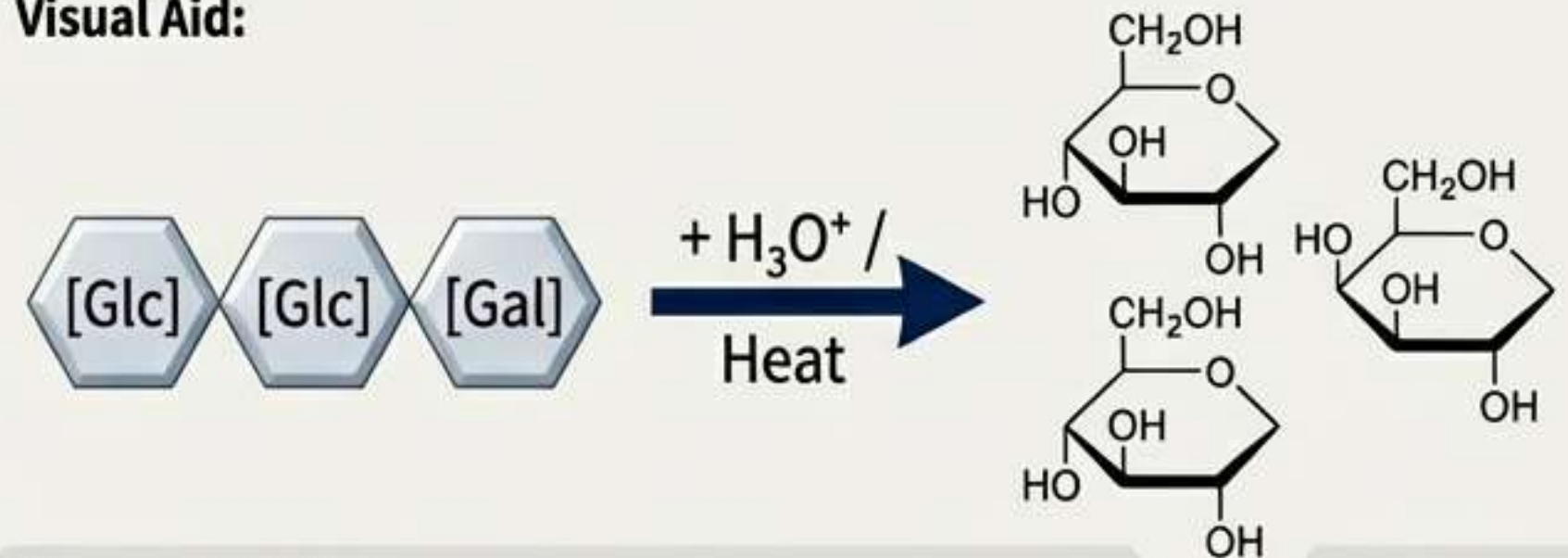
- A. [Various structural options]
- B. [Various structural options]
- C. The compound is composed of two D-glucose units and one D-galactose.
- D. [Various structural options]
- E. [Various structural options]

**Correct Answer: C**

**Professional Explanation (Teacher Mode):**

**Acid hydrolysis** is a non-selective method that breaks all glycosidic bonds in a carbohydrate, breaking it down into its constituent **monosaccharide** units. The question states that the hydrolysis products are D-glucose and D-galactose in a **2:1 molar ratio**. This directly tells us the composition of the original trisaccharide, without revealing the linkage or sequence.

**Visual Aid:**



**Mnemonic & Style:**

Memory Trick: “**Hydrolysis is homicide** for bonds.” It kills all the links and reveals the individual suspects (the monosaccharides).

## Question 15 (Exam Review)

### The Question:

The Fehling's reaction with the triholoside is positive. This means:

- ☐ A. The triholoside is non-reducing.
- ☐ B. It contains a free anomeric carbon.
- ☐ C. It does not color the Fehling's reagent.
- ☐ D. It reduces copper(II) to copper(I) oxide (red).
- ☐ E. b + d.

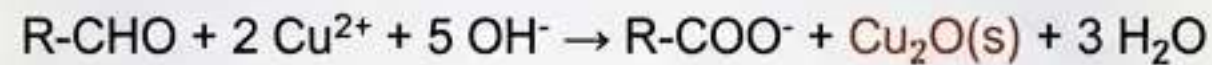
**Correct Answer: E**

### Professional Explanation (Teacher Mode):

A **positive Fehling's test** is the hallmark of a **reducing sugar**.

- (B) This is the structural requirement: a **free anomeric carbon** allows the ring to open, exposing an aldehyde group.
- (D) This describes the chemical reaction: the sugar is oxidized as it **reduces** blue cupric ions ( $\text{Cu}^{2+}$ ) to red cuprous oxide ( $\text{Cu}_2\text{O}$ ).

Since both the structural requirement (B) and the chemical outcome (D) are correct, the combined answer (E) is the most complete.



**Memory Trick:** For a positive test, the sugar must be **free (B)** to **do** the job (D).

## Question 16 (Exam Review)

### The Question:

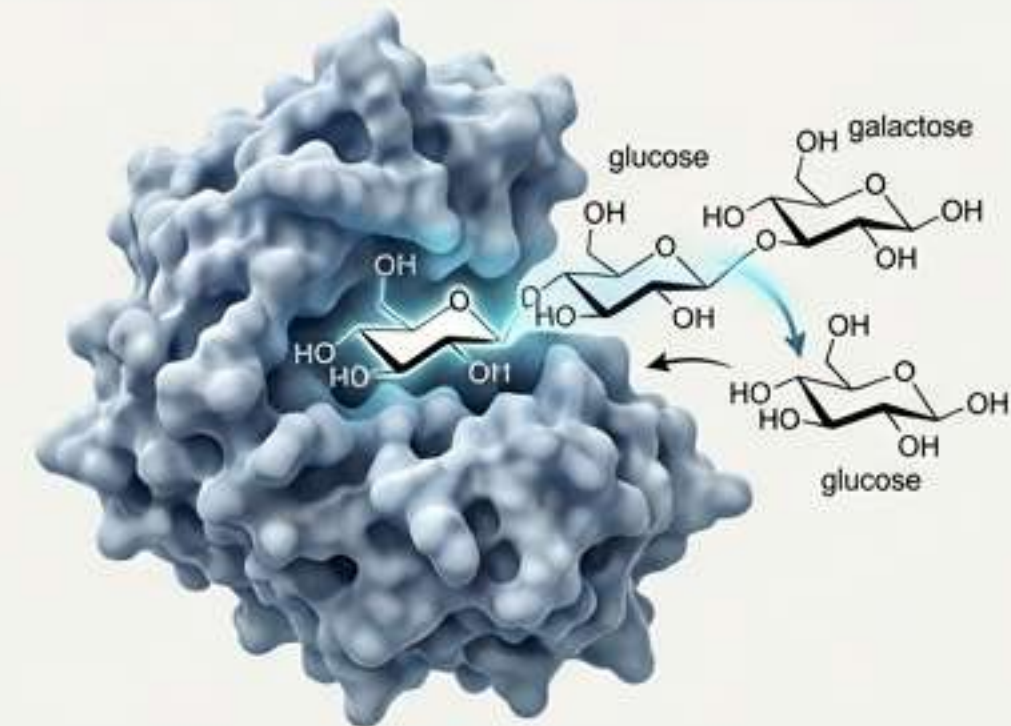
A glucosidase completely hydrolyzes this triholoside. What can be inferred about the structure?

- ☐ A. [Inference about linkages]
- ☐ B. [Inference about linkages]
- ☒ C. Both glycosidic bonds involve the anomeric carbon of a  $\beta$ -glucose.
- ☐ D. [Inference about linkages]
- ☐ E. [Inference about linkages]

**Correct Answer: C**

### Professional Explanation (Teacher Mode):

This question tests enzyme specificity. **Glycosidases** are highly specific enzymes. A **glucosidase** specifically cleaves bonds involving a glucose residue. The fact that the enzyme can *completely* hydrolyze the trisaccharide (2x Glc, 1x Gal) implies that both linkages involve glucose in the correct anomeric configuration for that specific enzyme (in this case, a  **$\beta$ -glucosidase**).



**Memory Trick:** "Enzymes are **picky eaters**." A **glucosidase** only eats **glucose** links, and a  **$\beta$ -glucosidase** will only eat them if they're served in the  **$\beta$ -style**.

## Question 17 (Exam Review)

**The Question:** "After methylation and hydrolysis of a triholoside, the products are 2,3,4-tri-O-methylglucose, 2,3,4,6-tetra-O-methylglucose, and 2,3,6-tri-O-methylgalactose. What is the structure?"

- A. [Various structural formulas]
- B.  $\beta$ -D-glucopyranosyl(1 $\rightarrow$ 6) $\beta$ -D-glucopyranosyl(1 $\rightarrow$ 4)D-galactopyranose
- C. [Various structural formulas]
- D. [Various structural formulas]

Correct Answer: **B**

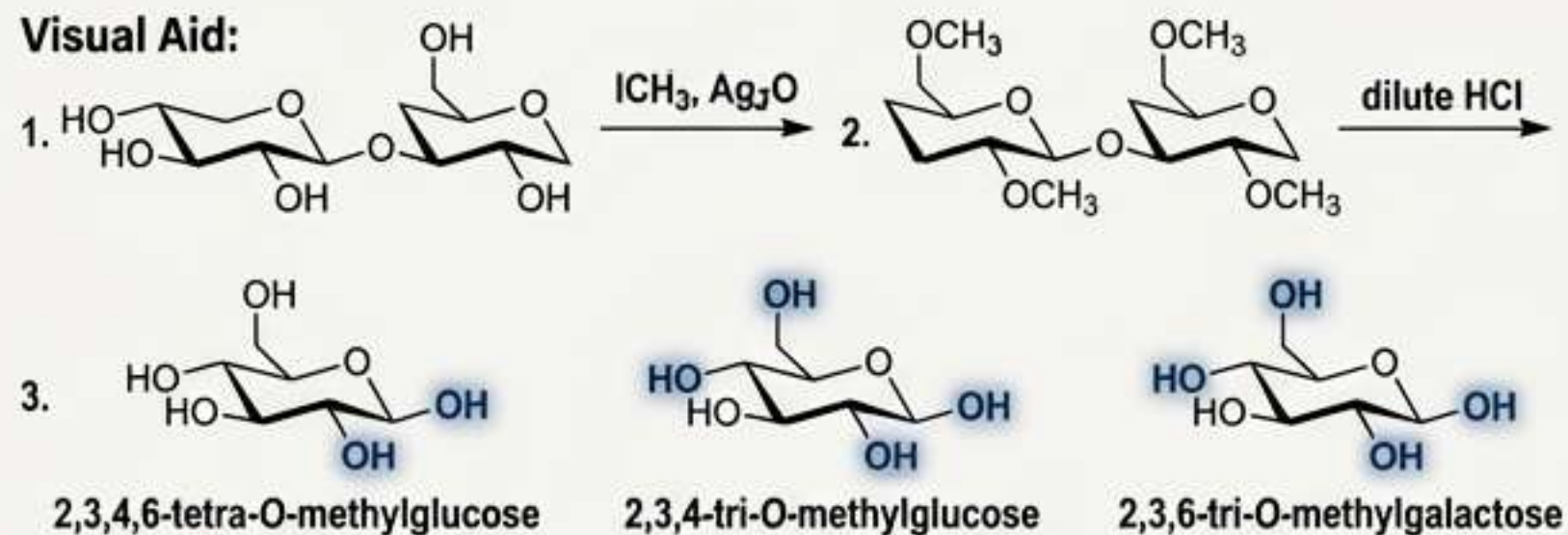
**Professional Explanation (Teacher Mode):**

This is a **methylation analysis** problem.

1. **Methylate:** All free -OH groups become -OCH<sub>3</sub>.
2. **Hydrolyze:** Glycosidic bonds break.
3. **Analyze:** Free -OH positions reveal linkage points.
  - **Tetra-methylglucose:** Non-reducing end (linked via C1).
  - **Tri-methylglucose (2,3,4):** Middle unit (linked via C1 & C6).
  - **Tri-methylgalactose (2,3,6):** Reducing end (linked via C4).

**Result:** Glc(1 $\rightarrow$ 6)Glc(1 $\rightarrow$ 4)Gal.

**Visual Aid:**



**Memory Trick:** "**Methylation** puts a **cap** on it." The positions that *don't* get a methyl cap are where the sugar was linked to another.

## Question 18 (Exam Review)

**The Question:** "D-glucose and D-fructose are:"

- A. Hexoses with the same chemical formula.
- B. Epimers.
- C. Mirror images of each other.
- D. Constitutional isomers.
- E. Aldopentoses.

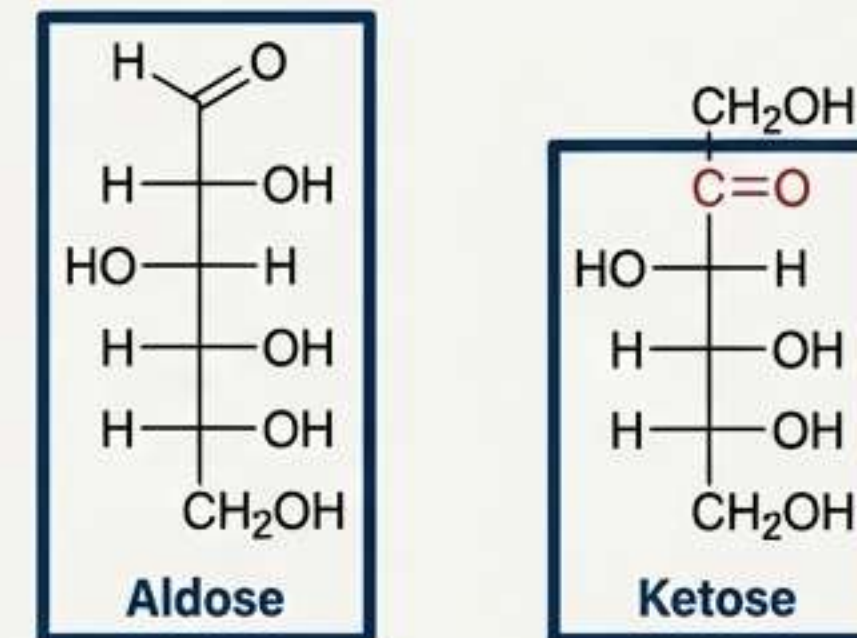
Correct Answer: **A and D**

**Professional Explanation (Teacher Mode):**

Let's evaluate the relationship:

- **A/D:** Both are **hexoses** (C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>). However, glucose is an **aldose** and fructose is a **ketose**. Molecules with the same formula but different functional groups are **constitutional (or structural) isomers**.
- **B: Epimers** are stereoisomers differing at only one chiral center; these have different functional groups entirely.
- **E:** They are **hexoses** (6 carbons), not pentoses (5 carbons).

**Visual Aid:**



**Memory Trick:** "Glucose and Fructose are **functional** friends, not **epic** twins." They are **functional isomers**, not epimers.

## Question 19 (Exam Review)

**The Question:** "Regarding a reducing sugar, choose the incorrect statement:"

- ☐ A. It is capable of oxidizing Fehling's reagent.
- ☐ B. It must possess a free hemiacetal group.
- ☐ C. It gives a positive Schiff reaction.
- ☐ D. It gives a red precipitate with copper oxide  $\text{CuO}_2$ .
- ☐ E. It contains a glycosidic bond of the osyl-oxide type.

**Correct Answer:** A, D, E are all incorrect.

**Professional Explanation (Teacher Mode):**

Let's analyze the flaws:

- \* (A) A reducing sugar **REDUCES** other substances; it itself gets **oxidized**.
- \* (D) The red precipitate is **cuprous oxide ( $\text{Cu}_2\text{O}$ )**, not  $\text{CuO}_2$ .
- \* (E) An **osyl-oxide** bond creates a **NON-reducing** sugar.

Statements A, D, and E are fundamentally **incorrect**.

Statements B and C are correct properties.

Properties of a Reducing Sugar	
CORRECT ✓	INCORRECT ✗
<input type="checkbox"/> Possesses a free hemiacetal group	<input type="checkbox"/> Oxidizes other reagents
<input type="checkbox"/> Reduces $\text{Cu}^{2+}$ to $\text{Cu}_2\text{O}$	<input type="checkbox"/> Forms $\text{CuO}_2$ precipitate
	<input type="checkbox"/> Has osyl-oxide bonds

Memory Trick: **LEO** the lion says **GER**: Loss of Electrons is Oxidation, Gain of Electrons is Reduction. The sugar **loses** electrons to **give** them to copper.

## Question 20 (Exam Review)

**The Question:** "Regarding glycogen, choose the correct statements:"

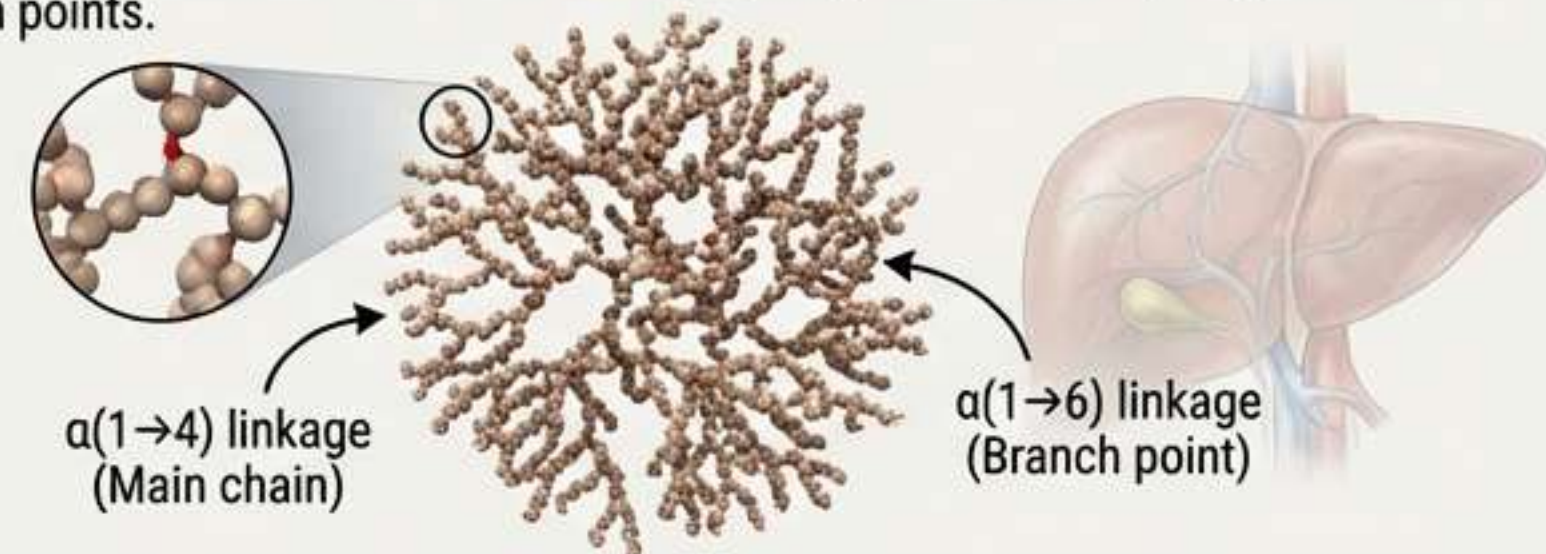
- ☐ A. It is a homogeneous and linear polysaccharide.
- ☐ B. It is the storage form of glucose in animals.
- ☐ C. It rapidly releases glucose between meals.
- ☐ D. It is found in all cells of the body.
- ☐ E. It is composed of glucose units linked by  $\alpha(1\rightarrow4)$  and  $\alpha(1\rightarrow6)$  bonds.

**Correct Answer:** B, C, E

**Professional Explanation (Teacher Mode):**

Let's evaluate the key features of glycogen:

- \* (A) **Incorrect**. Glycogen is a homopolysaccharide but is highly **branched**, not linear.
- \* (B) **Correct**. It is the primary short-term **energy storage** polysaccharide in **animals**.
- \* (C) **Correct**. Its highly branched structure provides many non-reducing ends for rapid enzymatic cleavage.
- \* (D) **Incorrect**. It is primarily stored in the **liver** and **muscle**.
- \* (E) **Correct**. The main chain is linked by  $\alpha(1\rightarrow4)$  bonds, with  $\alpha(1\rightarrow6)$  bonds at branch points.



Memory Trick: Think of Glycogen as a **Go-to Glucose Granary** for animals. It's **branched** to give quick energy from many 'twigs' at once.

## Question 21 (Exam Review)

Regarding cellulose, choose the **correct** statements:

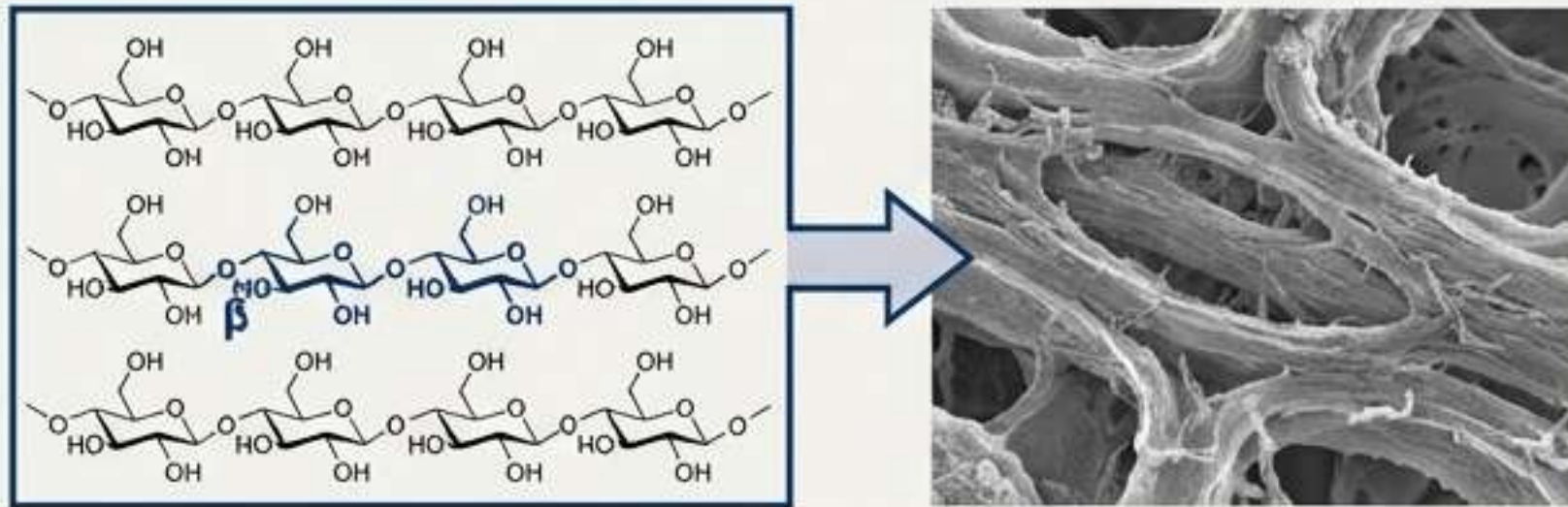
- A. It is a plant polyside.
- B. It is hydrolyzed by  $\alpha$ -glucosidases.
- C. It contains only  $\beta(1\rightarrow4)$  linkages.
- D. It is composed of long, unbranched chains of glucose.
- E. It is not digested into glucose in the human digestive tract.

**Correct Answer: A, C, D, E**

### Professional Explanation (Teacher Mode)

Cellulose is a major structural polysaccharide:

- A. Correct. It is the primary component of **plant cell walls**.
- B. **Incorrect**. Its  $\beta(1\rightarrow4)$  bonds require  **$\beta$ -glucosidases** (cellulase), which humans lack.
- C. Correct. Its structure is exclusively  $\beta(1\rightarrow4)$  linked glucose.
- D. Correct. Cellulose chains are **linear and unbranched**, forming strong fibers.
- E. Correct. Humans cannot digest cellulose; it serves as dietary fiber.



Memory Trick: **Cellulose** is for **cell** walls. It uses  **$\beta$ -bonds** to **build** strong, straight **bricks**. Humans can't break  **$\beta$ -bonds**.

## Question 22 (Exam Review)

Regarding D-glucose and D-mannose, choose the **correct** statements:

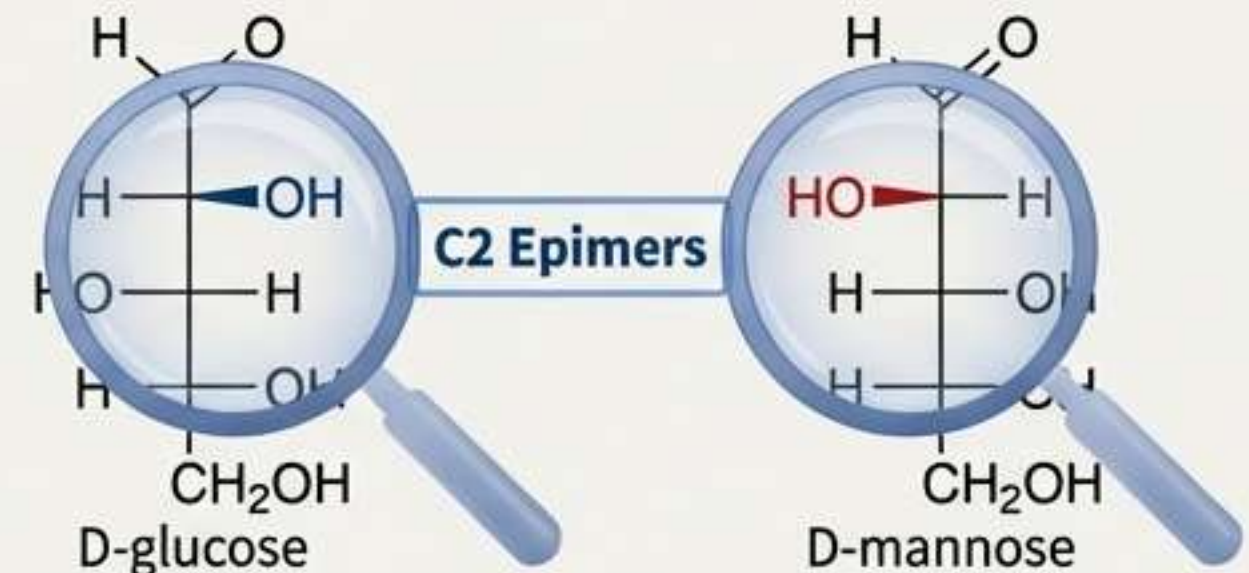
- A. They are epimers.
- B. They are mirror images of each other.
- C. They are stereoisomers (enantiomers).
- D. They are aldohexoses.
- E. They are ketohexoses.

**Correct Answer: A and D**

### Professional Explanation (Teacher Mode)

Let's analyze the relationship:

- D. Correct. Both are six-carbon aldoses, making them **aldohexoses**.
- A. Correct. D-glucose and D-mannose differ *only* in the configuration of the hydroxyl group at **carbon 2**. Diastereomers that differ at exactly one chiral center are **epimers**.
- B & C. **Incorrect**. They are diastereomers, not mirror images (enantiomers).
- E. **Incorrect**. They are aldoses, not ketoses.



Memory Trick: "A **man's C2** epimer is his **glue**."  
(**M**annose is the C2 epimer of **G**lucose).

## Question 23 (Exam Review)

### The Question:

"Regarding D-glucose and L-glucose, choose the **correct** statements:"

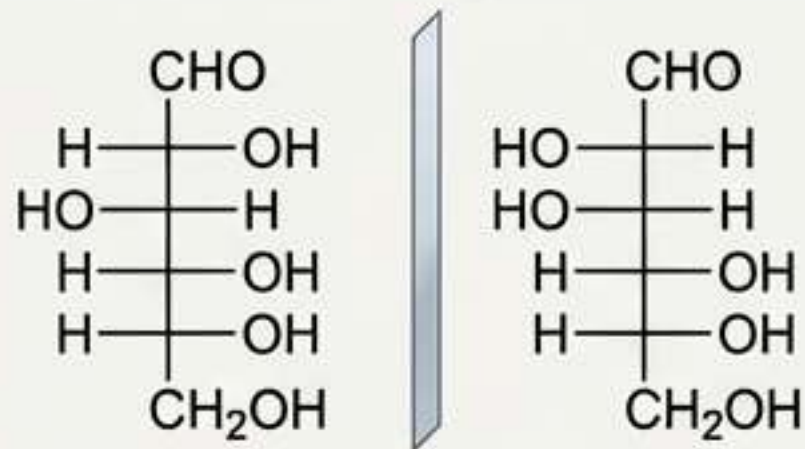
- A. They are aldohexoses.
- B. They are mirror images of each other (enantiomers).
- C. They are functional isomers.
- D. They have the same physical and chemical properties.
- E. They have the same specific rotation on polarized light.

**Correct Answer: A and B**

### Professional Explanation (Teacher Mode):

This question is about enantiomers.

- (A) Correct. Both are six-carbon aldoses, so they are **aldohexoses**.
- (B) Correct. L-glucose is the non-superimposable **mirror image** of D-glucose, the definition of **enantiomers**.
- (D & E) **Incorrect**. Enantiomers have identical physical properties *except\** for their interaction with polarized light. They rotate it by the **same magnitude** but in **opposite directions**.



**Memory Trick:** Think of L-glucose as the "**Left-hand**" version of D-glucose. Same glove (**aldohexose**), but a mirror image.

## Question 24 (Exam Review)

### The Question:

"Regarding the glycosidic bond, choose the **correct** statement:"

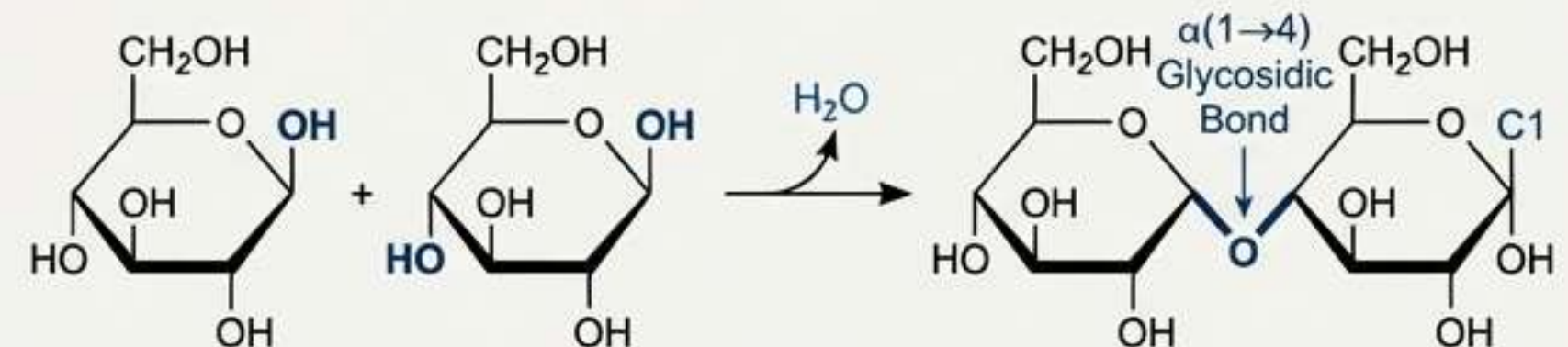
- A. It is an ether-type bond formed between two anomeric carbons.
- B. It forms between an anomeric -OH and an alcoholic -OH.
- C. It is a hemiacetal bond.
- D. It is hydrolyzed by dilute bases.
- E. It is formed between an NH<sub>2</sub> group and an -OH group.

**Correct Answer: B**

### Professional Explanation (Teacher Mode):

A glycosidic bond is formed via a dehydration reaction.

- (B) The most common type (osyl-ose) forms between the **hemiacetal hydroxyl** on the **anomeric carbon** of one sugar and an **alcoholic hydroxyl** on another sugar.
- (C) The final bond is an **acetal**, not a hemiacetal.
- (D) It is stable to bases but readily **hydrolyzed by acid**.
- (A) It is an acetal, and while it *can* form between two anomeric carbons, B is the more general case.



**Memory Trick:** "**Anomer** meets **alcohol** for a **dehydration date**." The result is a stable **acetal** relationship (the glycosidic bond).

## Question 25 (Exam Review)

### The Question:

Starch is composed of: (choose the correct statements)

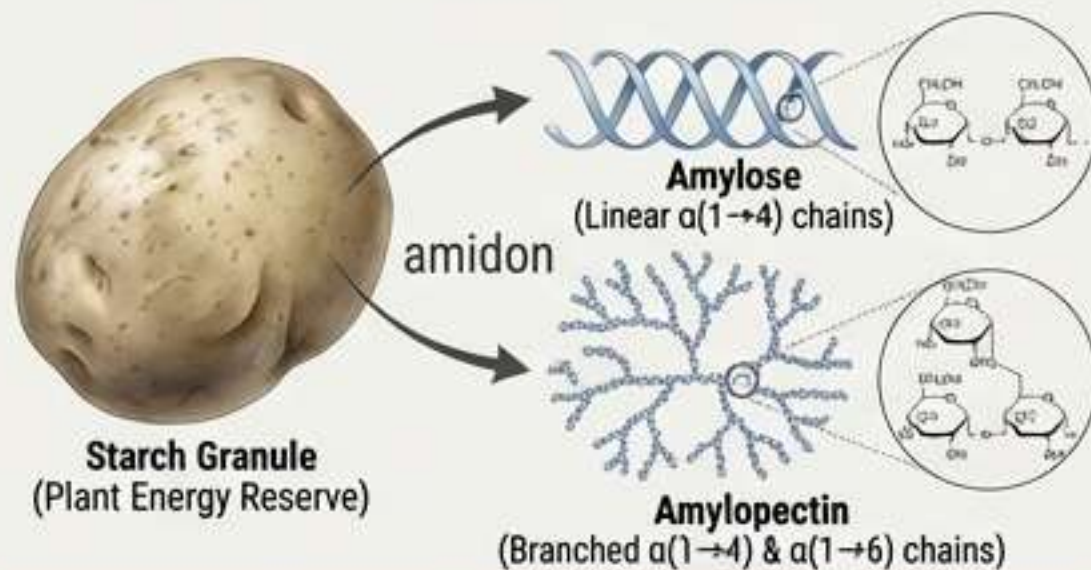
- A. Amylose and amylopectin.
- B. Linear and branched chains of glucose.
- C.  $\alpha(1\rightarrow4)$  and  $\alpha(1\rightarrow6)$  linkages.
- D. It is found in plants as an energy reserve.
- E. All of the answers are correct.

**Correct Answer: E**

### Professional Explanation (Teacher Mode):

This is a comprehensive question on **starch**.

- (D) It is the primary energy reserve in **plants**.
- (A) It is a mixture of two polymers: **amylose** and **amylopectin**.
- (B & C) These options describe the components. **Amylose** is a **linear** polymer of glucose linked by  **$\alpha(1\rightarrow4)$**  bonds. **Amylopectin** is a **branched** polymer with  $\alpha(1\rightarrow4)$  main chains and  **$\alpha(1\rightarrow6)$**  branch points.



**Memory Trick:** A plant's energy pantry has two **STArch** staples: **AmyLose** (**L**inear) and **AmyloPectin** (**P**ointed branches).

## Question 26 (Exam Review)

### The Question:

Which of the following polysaccharides is heterogeneous?

- A. Glycogen
- B. Starch
- C. Cellulose
- D. Dextran
- E. Inulin

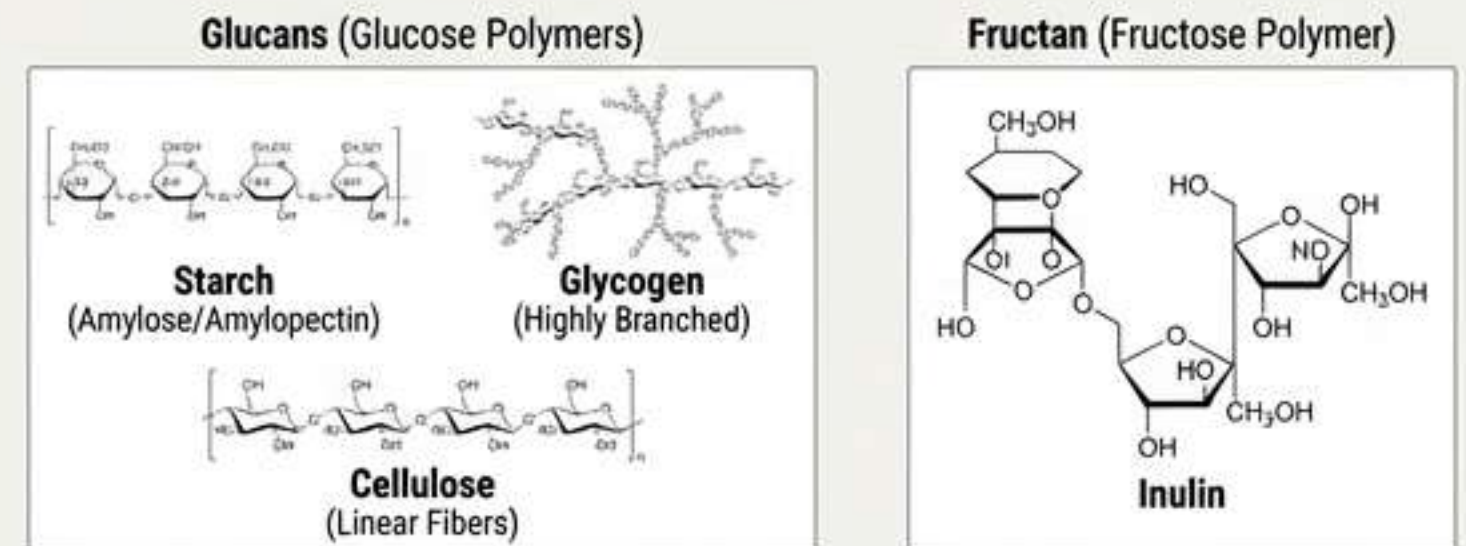
**Correct Answer: E**

### Professional Explanation (Teacher Mode):

A **homopolysaccharide** is made of a single type of monomer.

- Glycogen, Starch, Cellulose, and Dextran are all **glucans**—polymers made exclusively of **glucose**.
- **Inulin** is a **fructan**—a polymer made of **fructose** units.

In the context of this question, where all other options are glucose polymers, inulin is heterogeneous relative to the group, as it's made of a different building block (fructose).



**Memory Trick:** "All the others are on the **GLUCOSE** team. **INULIN** is **IN** a league of its own (the fructose league)."

## Question 27 (Exam Review)

### The Question:

Which sugar is not found in nature?

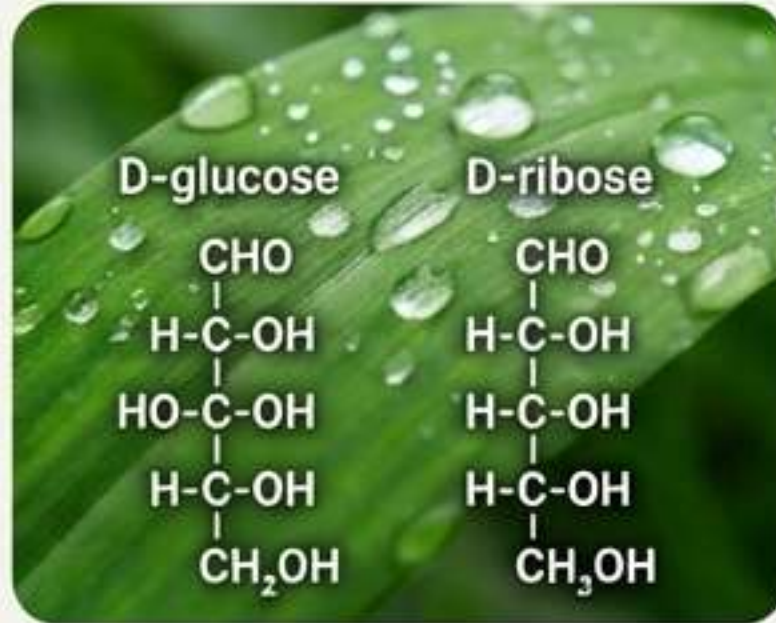
- A. D-glucose
- B. D-fructose
- C. D-galactose
- D. L-glucose
- E. D-ribose

**Correct Answer: "D"**

### Professional Explanation (Teacher Mode):

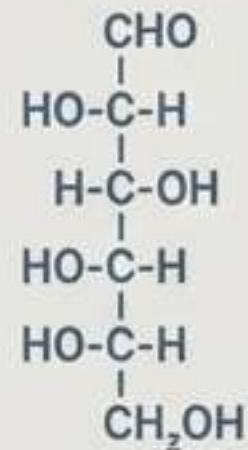
A fundamental principle of biochemistry is that living organisms exhibit a strong preference for **D-series sugars**. D-glucose, D-fructose, D-galactose, and D-ribose are all ubiquitous and essential. The enzymes for carbohydrate metabolism are stereospecific for D-isomers. While some rare L-sugars exist in nature, **L-glucose** is essentially absent from natural biological systems.

Abundant in Nature



Virtually Absent in Nature

L-glucose



**Memory Trick:** Life is 'D-lightful!' Biology overwhelmingly prefers the **D-series** of sugars. The **L-series** gets 'Left out.'

## Question 28 (Exam Review)

### The Question:

Regarding the Molisch reaction, choose the correct statement:

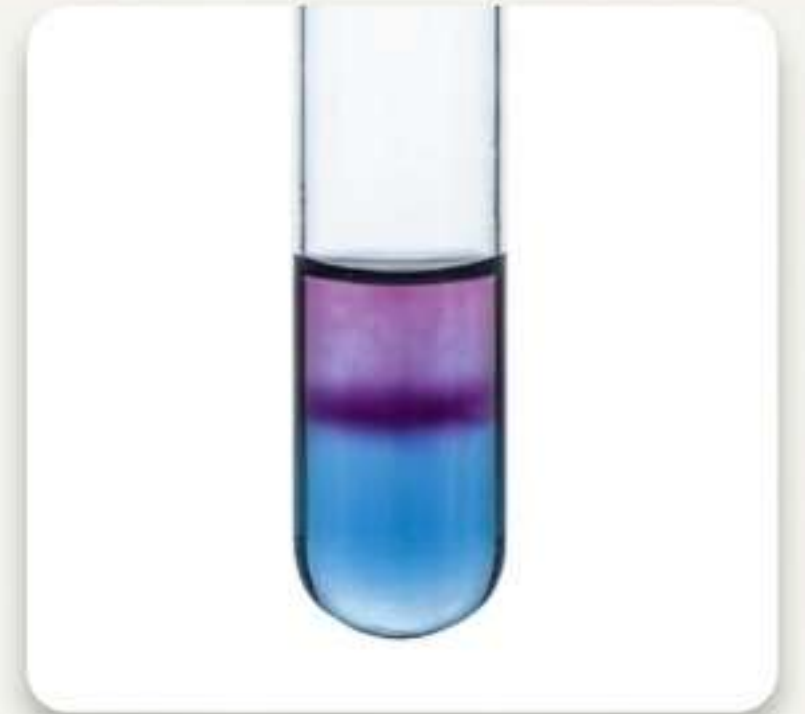
- A. It detects only pentoses.
- B. It gives a violet ring in the presence of any carbohydrate.
- C. It is based on the reaction of furfural with  $\beta$ -naphthol.
- D. It uses dilute sulfuric acid.
- E. Is specific for reducing sugars.

**Correct Answer: "B"**

### Professional Explanation (Teacher Mode):

The Molisch test is a **general, qualitative test for all carbohydrates**.

- The mechanism involves **concentrated sulfuric acid** which dehydrates any sugar into a **furfural** derivative.
- This furfural then reacts with  **$\alpha$ -naphthol** (not  $\beta$ -naphthol) to produce a **purple or violet**-
- Because it works on any molecule that can be dehydrated to a furfural, it detects virtually all carbohydrates, not just specific types.



**Memory Trick:** 'Mo-lisch is for Mo-st all carbs.' It gives a 'Very Violet' ring for a Very positive result.

## Question 29 (Exam Review)

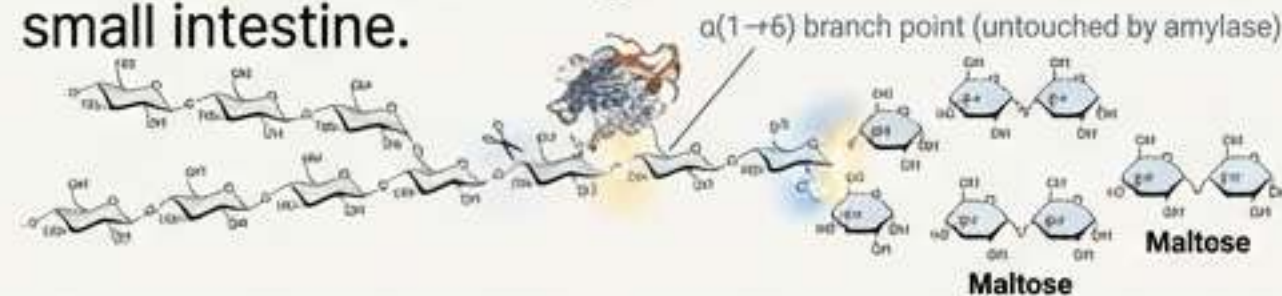
What is the main product of starch hydrolysis by salivary amylase?

- A. Glucose
- B. Fructose
- C. Maltose
- D. Sucrose
- E. Lactose

**Correct Answer: C**

### Professional Explanation (Teacher Mode):

**Salivary amylase** begins carbohydrate digestion by cleaving internal  **$\alpha(1\rightarrow4)$  glycosidic bonds** in starch. It cannot break the  $\alpha(1\rightarrow6)$  branch points or terminal bonds. This incomplete hydrolysis breaks the large starch polymer into smaller fragments. The primary product is **maltose**, the disaccharide of two  $\alpha(1\rightarrow4)$  linked glucose units. Further breakdown to glucose occurs later in the small intestine.



**Memory Trick:** "Saliva **malts** the starch." In your mouth, amylase turns starch into **maltose**.