Monosaccharides

A Level

Part A Hexose formula

What is the chemical formula for a hexose monosaccharide?

Part B Pentose vs hexose

Which of the following are pentose monosaccharides?

- [ ] glucose
- [ ] fructose
- [ ] ribose
- [ ] deoxyribose
- [ ] galactose
- [ ] maltose

Which of the following are hexose monosaccharides?

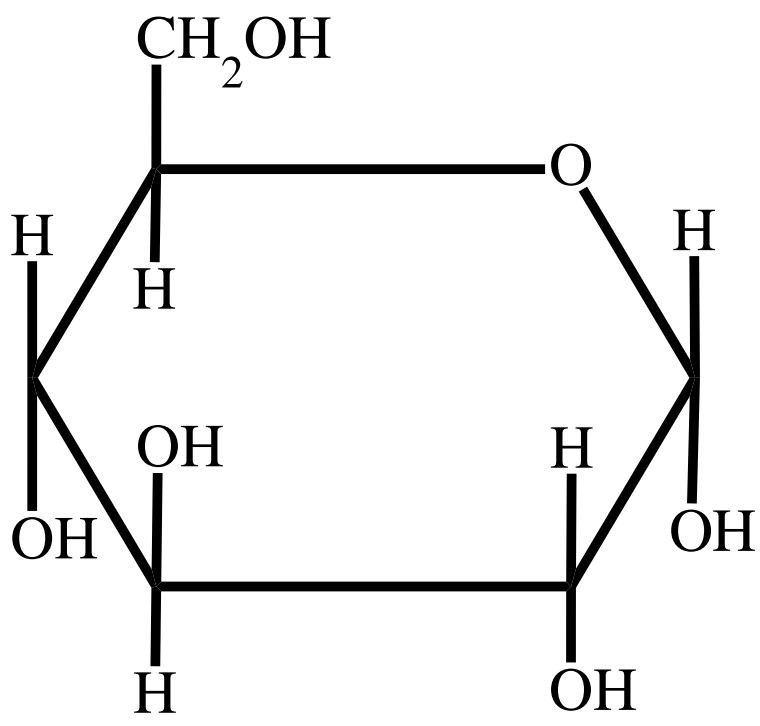
- [ ] glucose
- [ ] fructose
- [ ] ribose
- [ ] deoxyribose
- [ ] galactose
- [ ] maltose

Part C Identify the monosaccharides

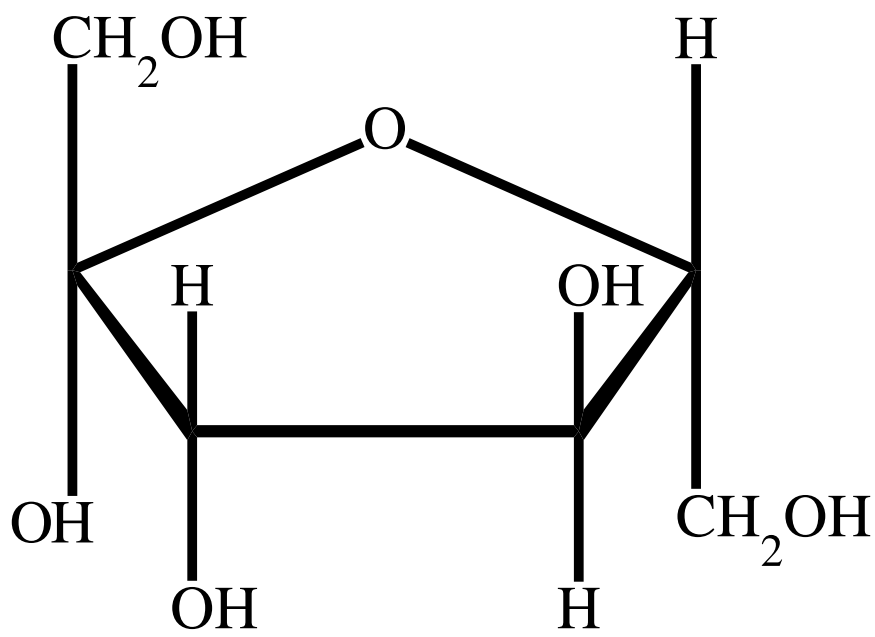
All hexose monosaccharides have the same molecular formula but different arrangements of the atoms in space i.e. they are isomers.

Six monosaccharides are shown below. Some are hexose monosaccharides and others are pentose monosaccharides.

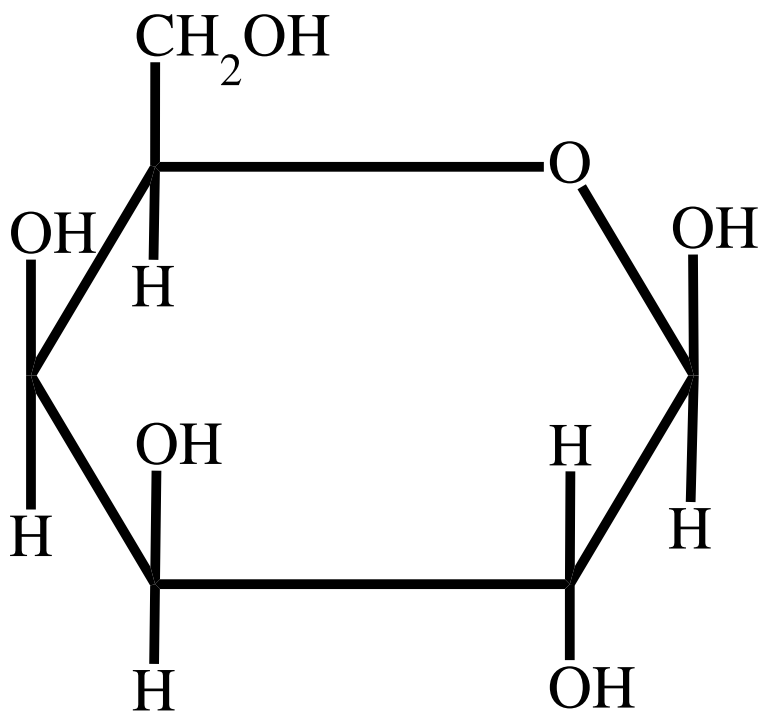
Image A is α-glucose.



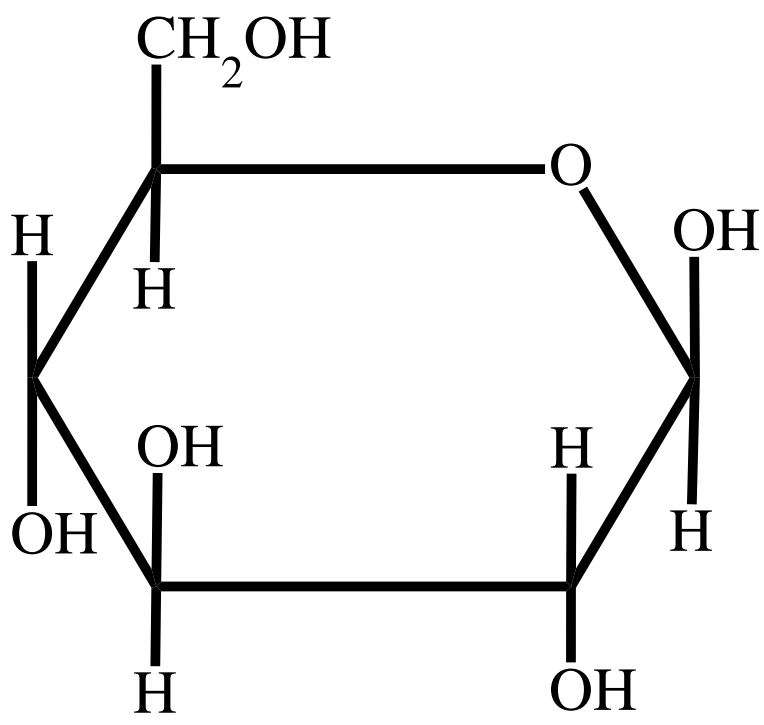
A: alpha-glucose



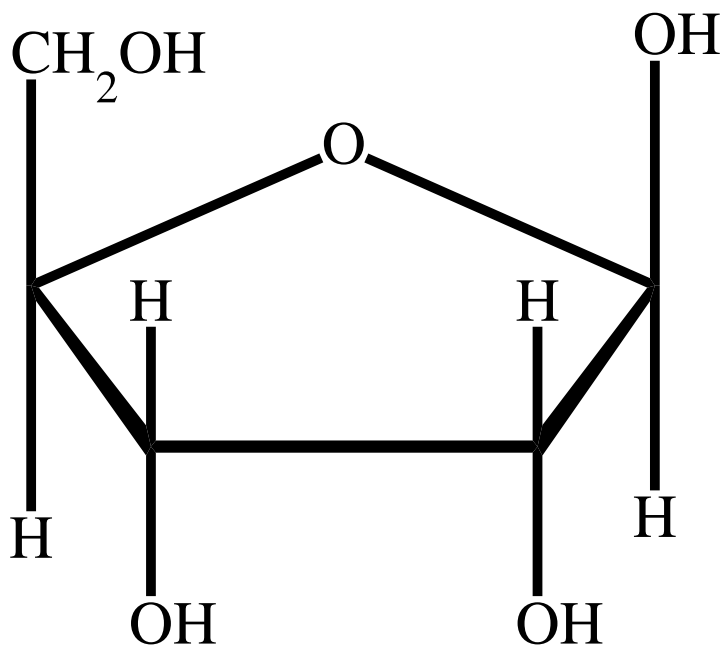
B


CH2OH
O
OH
H
OH
H
OH
H
H
H
OH

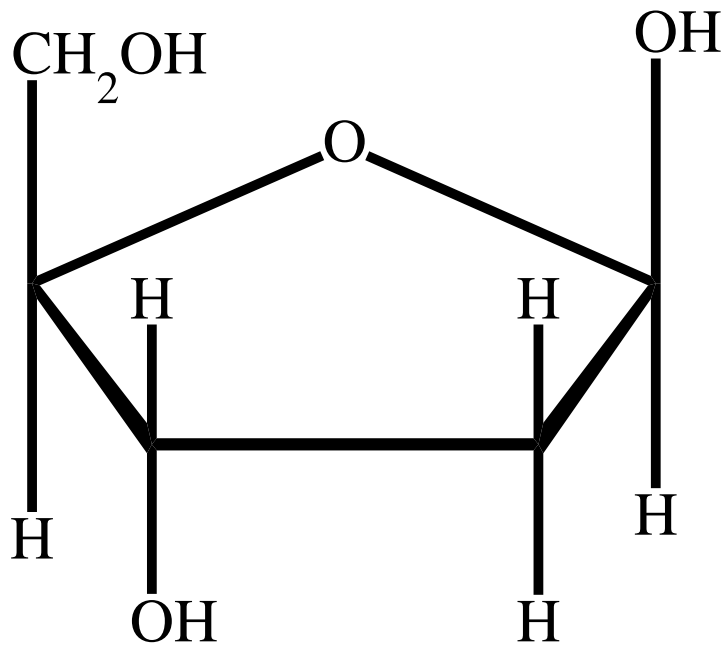
C


CH2OH
O
H
H
OH
OH
H
H
OH
OH

D


CH2OH
OH
O
H
H
H
H
OH
OH

E



F

Identify the other monosaccharides in the table below using the following information:

- β-glucose has the same structure as α-glucose except that the OH group and H atom bonded to the $\mathrm{C1}$ have switched positions
- β-galactose has the same structure as β-glucose except that the OH group and H atom bonded to $\mathrm{C4}$ have switched positions
- fructose has a five-membered ring whereas glucose has a six-membered ring
- ribose has an OH group bonded to the $\mathrm{C2}$

Monosaccharide	Image
α-glucose	A
β-glucose	
β-galactose	
β-fructose	
ribose	
deoxyribose	

Items:

B C D E F

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Disaccharides

A Level

Part A Name the disaccharide

Which disaccharide is formed by the condensation of two glucose molecules?

Which disaccharide is formed by the condensation of one glucose molecule and one fructose molecule?

Which disaccharide is formed by the condensation of one glucose molecule and one galactose molecule?

Part B α and β glycosidic bonds

[ ] is formed from two glucose molecules bonded by [ ], which means that the $\mathrm{C}1$ of one $\alpha-$glucose connects (via oxygen) to the $\mathrm{C}4$ of the next glucose (which may be $\alpha-$ or $\beta-$ glucose).

[ ] is formed from one galactose and one glucose molecule bonded by [ ], which means that the $\mathrm{C}1$ of the $\beta-$galactose connects (via oxygen) to the $\mathrm{C}4$ of the glucose (which may be $\alpha-$ or $\beta-$ glucose).

[ ] is formed from one glucose and one fructose molecule bonded by [ ], which means that the $\mathrm{C}1$ of the $\alpha-$glucose connects (via oxygen) to the $\mathrm{C}2$ of the $\beta-$fructose.

Items:

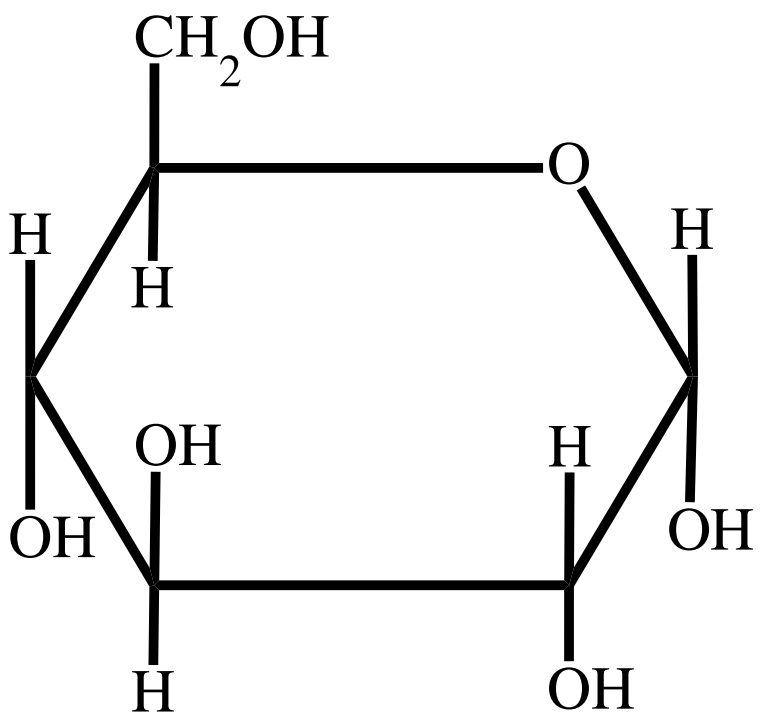
an $\alpha-1,4$ bond | **an $\alpha-1,\beta-2$ bond** | **Sucrose** | **Maltose** | **a $\beta-1,4$ bond** | **Lactose**

Part C Disaccharide formula

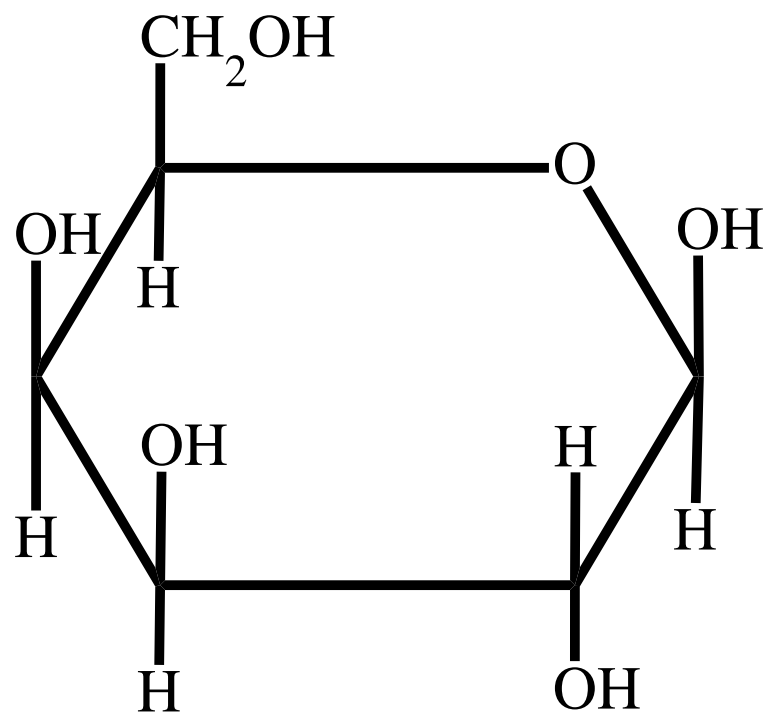
A disaccharide is produced by a condensation reaction between two hexose monosaccharides. What is the chemical formula for a disaccharide?

Part D Identify the disaccharides

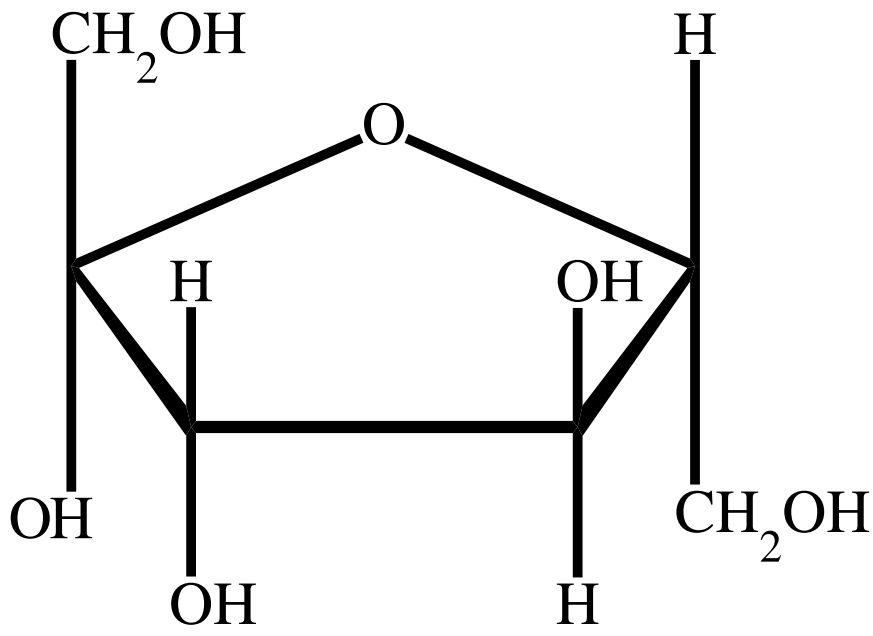
Three hexose monosaccharides are shown below.



alpha-glucose

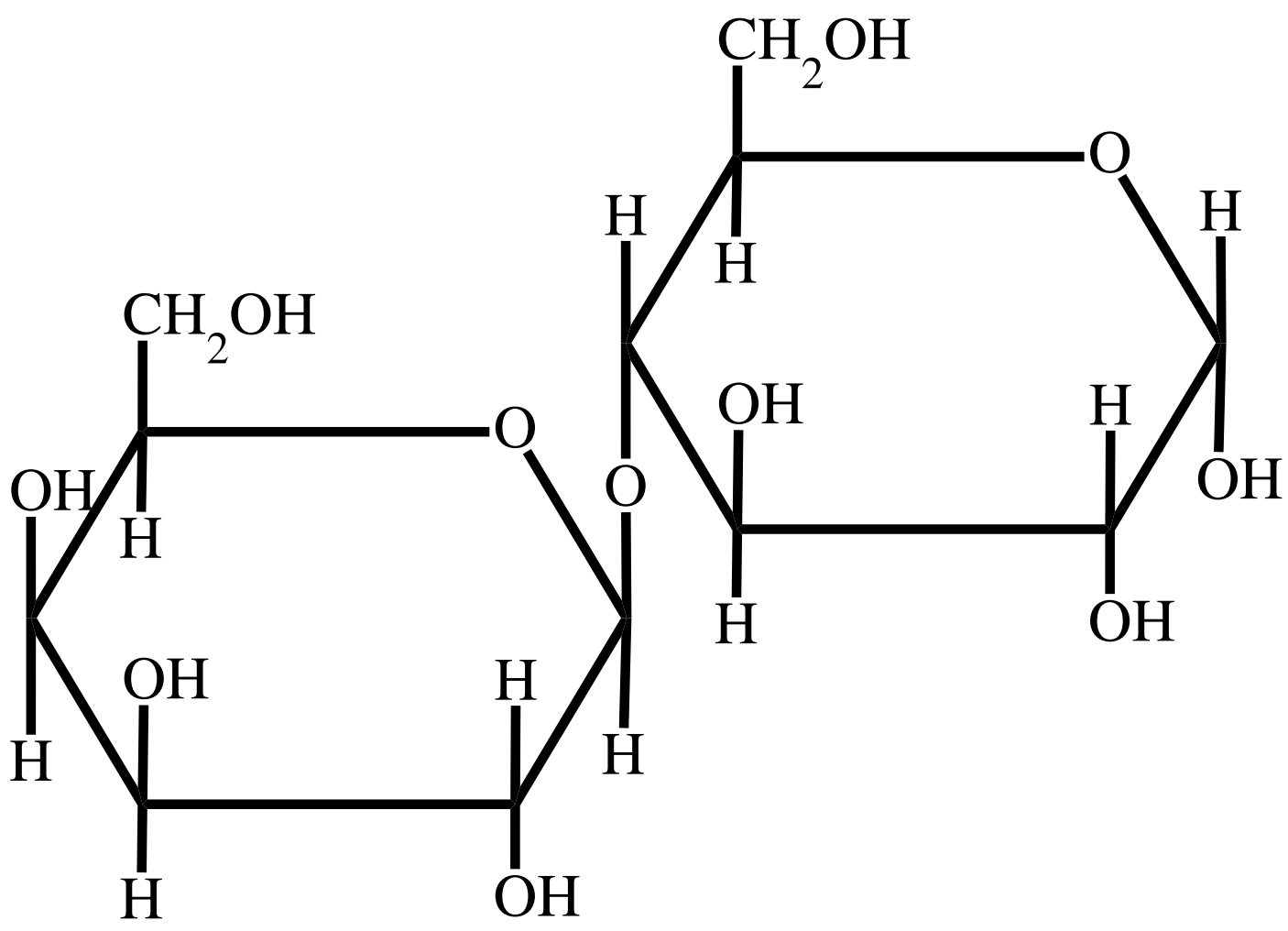


beta-galactose

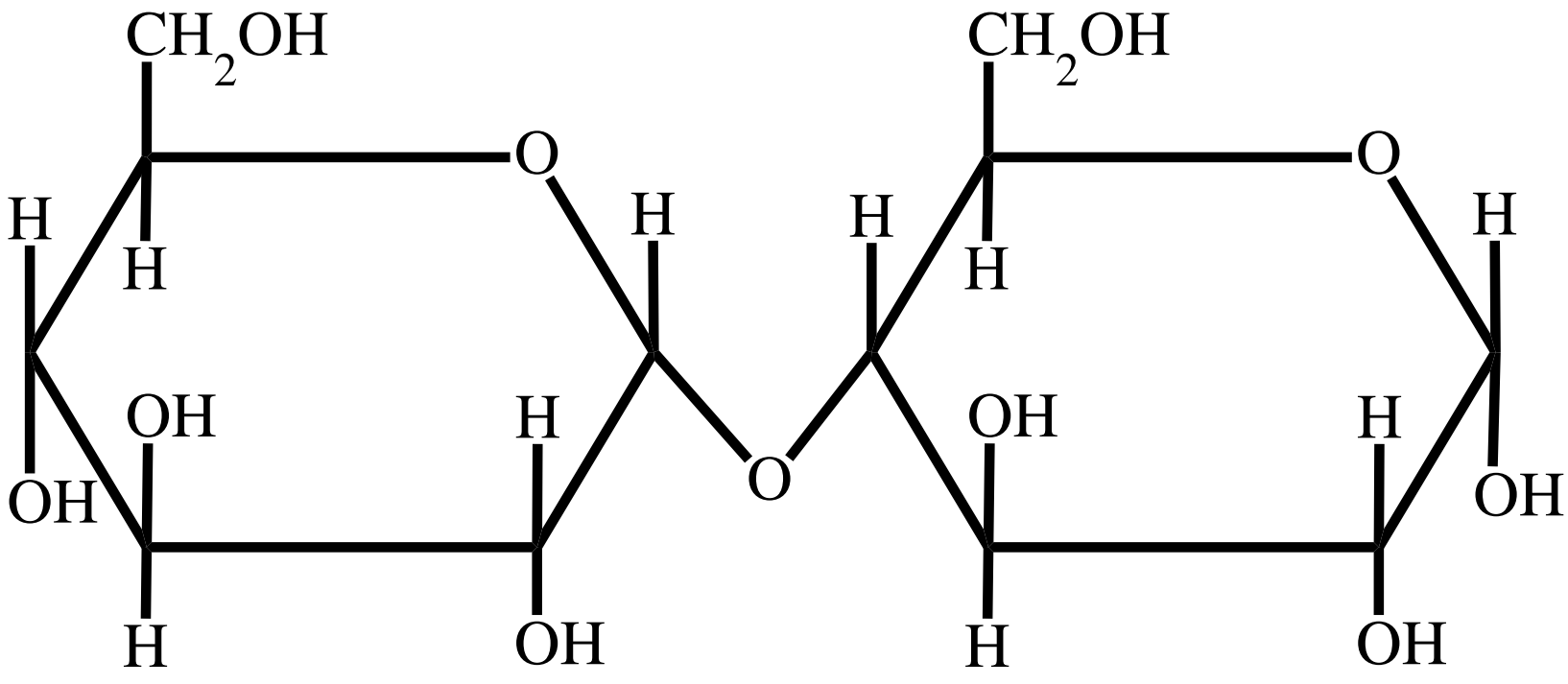


beta-fructose

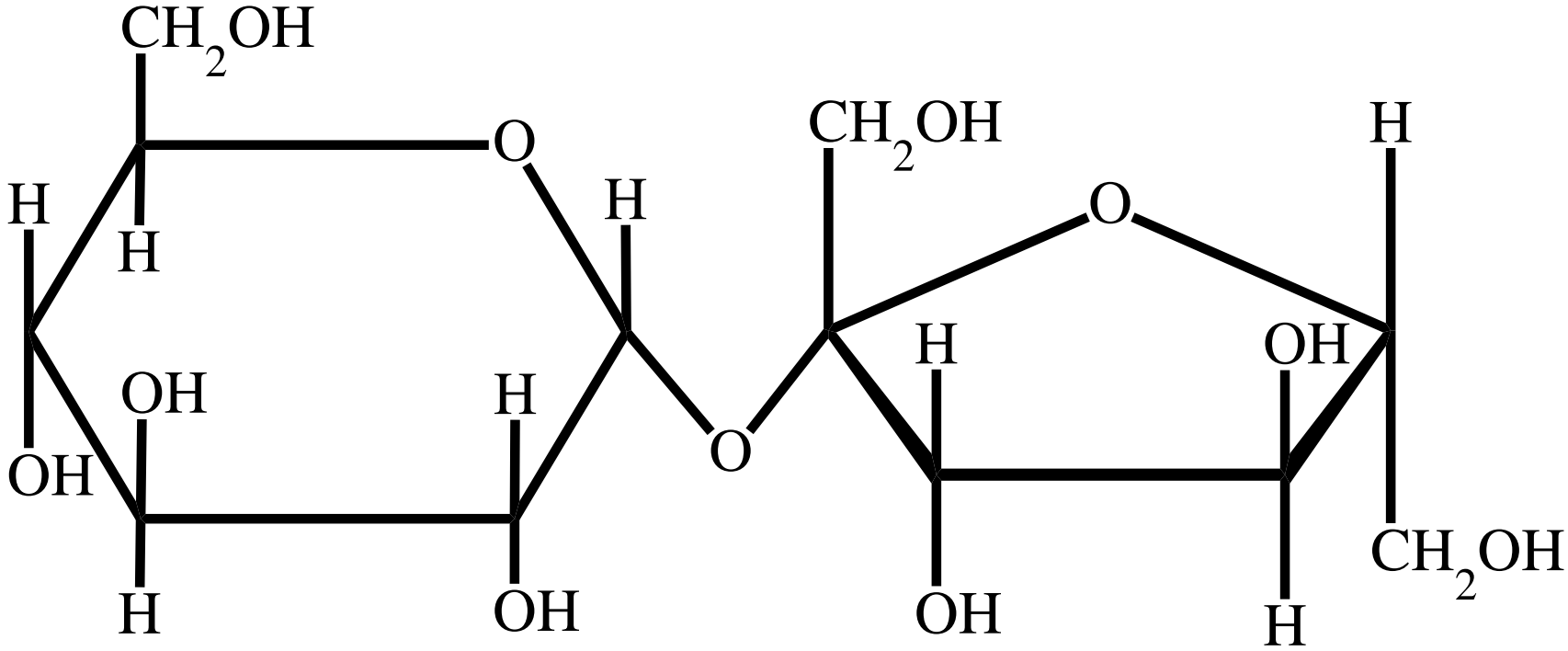
Identify the disaccharides below.



A



B



C

Image	Disaccharide
A	
B	
C	

Items:

maltose **lactose** **sucrose**

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Gameboard:

STEM SMART Biology Week 5 - Carbohydrates

Physics. You work it out.

Polysaccharides

A Level

Part A Starch

Starch is the main energy storage carbohydrate of plants. It is a mixture of two types of polysaccharides: amylose and amylopectin.

[ ] is an unbranched, coiled chain of hundreds to thousands of glucose molecules bonded by [ ] bonds.

[ ] is a branched molecule. Shorter chains of glucose molecules bonded by [ ] bonds connect at branching points via [ ] bonds.

Items:

$\alpha - 1,6$ $\beta - 1,4$ **Amylopectin** $\alpha - 1,4$ $\beta - 1,6$ **Amylose**

Part B Glycogen

Glycogen is the main energy storage carbohydrate of animals. In humans it is mostly found in the liver and in skeletal muscles. It is similar in structure to [ ], but is more highly branched (i.e. branching points occur more frequently). It consists of short chains of glucose molecules (bonded by [ ] bonds) connected to each other at branching points via [ ] bonds.

Items:

$\alpha - 1,4$ $\alpha - 1,6$ $\beta - 1,6$ $\beta - 1,4$ **amylopectin** **amylose**

Part C Cellulose

Cellulose is the main structural carbohydrate of plants, and forms the basis of their [ ]. It is an unbranched, straight chain of hundreds to thousands of glucose molecules bonded by [ ] bonds. The glucose molecules alternate in direction (top-bottom), which allows long, straight chains to form. These long chains are bonded by hydrogen bonds to form [ ], which associate to form [ ], which associate to form cellulose fibres.

Items:

cell membranes $\beta-1,4$ **macrofibrils** **cell walls** $\alpha-1,6$ $\alpha-1,4$ $\beta-1,6$ **microfibrils**

Part D Identify the polysaccharide

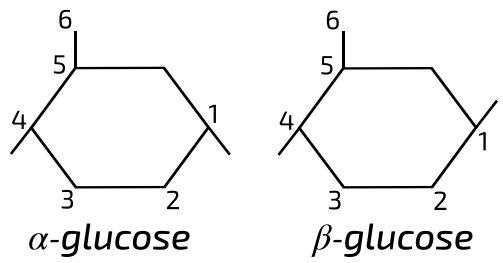
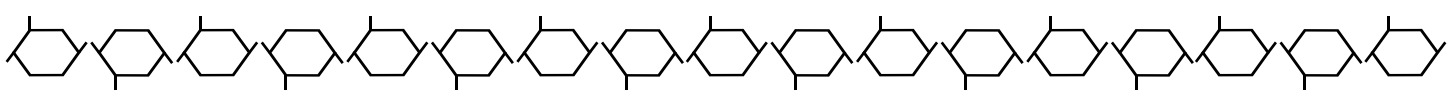
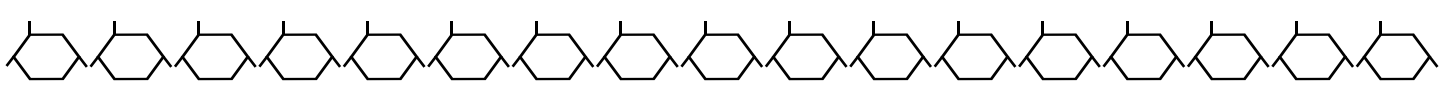


Figure 1: Simplified structures of $\alpha-$ and $\beta-$ glucose. The numbers of the 6 carbons in each glucose molecule are shown. Projections from carbons 1 and 4 represent hydroxyl groups. The hydroxyl groups attached to carbons 2 and 3 are not shown.

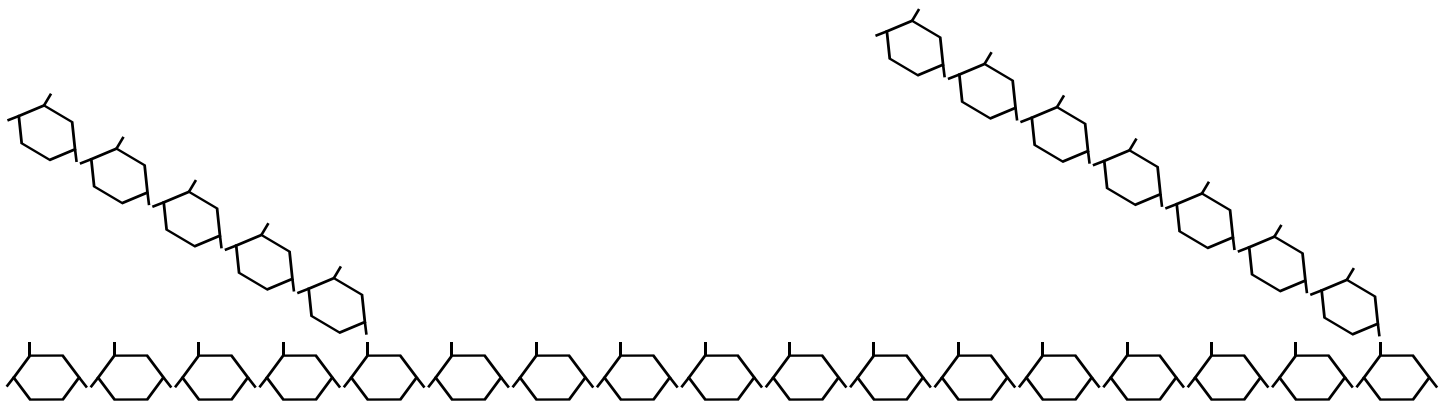
Each image below represents a part of a different polysaccharide, using the simplified structures of $\alpha-$ and $\beta-$ glucose shown in Figure 1.



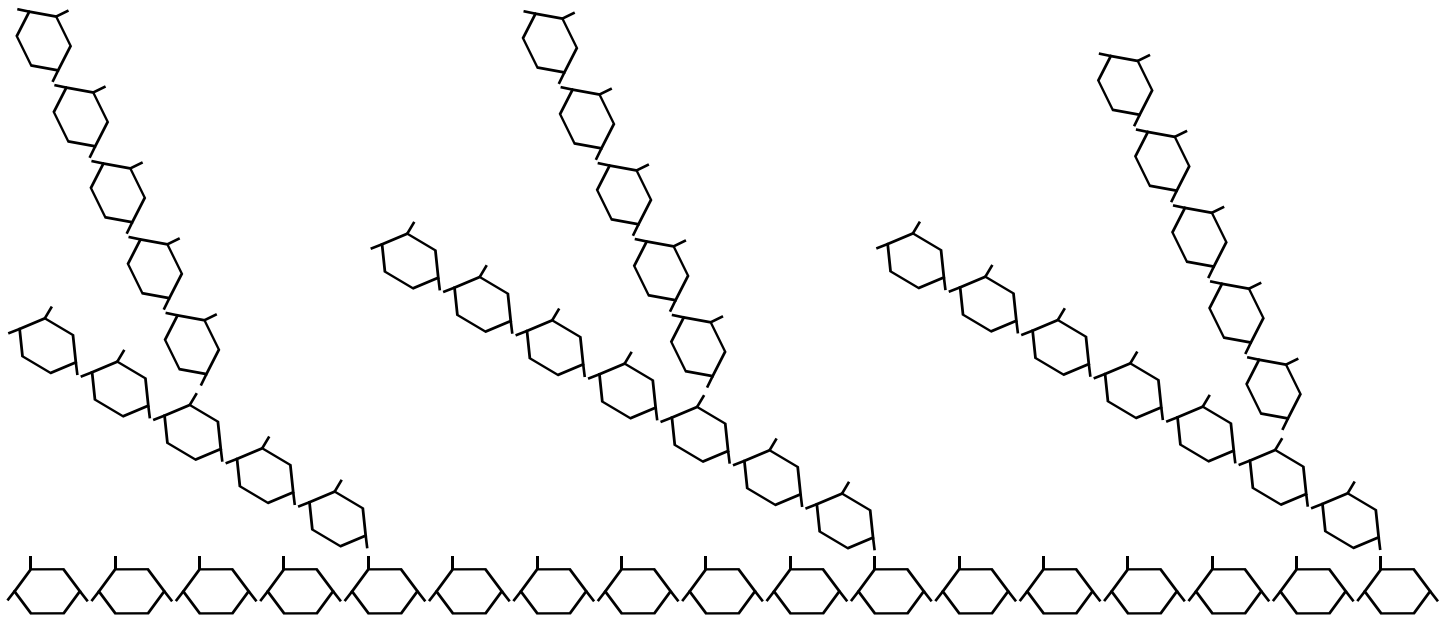
A



B



C



D

Match the polysaccharide to the image above.

Image	Polysaccharide
A	
B	
C	
D	

Items:

amylopectin **glycogen** **maltose** **galactose** **cellulose** **amylose**

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Gameboard:

STEM SMART Biology Week 5 - Carbohydrates

Carbohydrate Condensation

A Level

Part A Carbohydrate bonding

What kind of bond is formed between saccharides during condensation reactions?

Part B How much water?

How many molecules of water would be released in a condensation reaction of $1\,000$ α–glucose molecules to form one amylose molecule?

Part C Bond types

Carbohydrate	Monomers	Bonds
Glycogen		
Amylose		
Amylopectin		
Cellulose		

Items:

α–**glucose** β–**glucose** $\alpha-1,4$ **only** $\beta-1,4$ **only** $\alpha-1,4$ **and** $\alpha-1,6$

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Gameboard:

STEM SMART Biology Week 5 - Carbohydrates

Physics. You work it out.

Carbohydrate Hydrolysis

A Level

Part A Enzymes & products

Carbohydrate	Hydrolysis catalysed by	Product(s) of hydrolysis
Maltose		
Lactose		
Starch		
Cellulose		

Items:

cellulase **starchase** **amylase** **lactase** **maltose and/or glucose** **glucose and galactose** **maltase** **glucose only**

Part B Hydrolysis in humans

Which enzyme(s) do humans **not** have a gene for?

- [ ] amylase
- [ ] maltase
- [ ] cellulase
- [ ] lactase

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Gameboard:

STEM SMART Biology Week 5 - Carbohydrates

Carbohydrate Practicals

A Level

Part A Testing for reducing sugars

What is the name of the test used to determine if reducing sugars are present in a solution?

Fill in the blanks to explain how this test works.

The carbohydrate solution is added to [ ]: an alkaline solution containing copper(II) sulfate solution. The mixture is then heated. If reducing sugars are present, the solution will change colour from [ ] to [ ] (low concentration of reducing sugars), [ ] (medium concentration of reducing sugars), or [ ] (high concentration of reducing sugars). The colour change is due to copper(II) ions being reduced to copper(I) oxide.

Items:

red **Benedict's reagent** **green** **the Biuret reagent** **yellow/orange** **blue** **iodine solution**

Part B Reducing sugar or not?

Which of the following are reducing sugars? Select all that apply.

- [ ] galactose
- [ ] sucrose
- [ ] lactose
- [ ] starch
- [ ] glucose
- [ ] cellulose
- [ ] maltose

Part C Testing for starch

To test for the presence of starch, a solution of [ ] and potassium iodide is added to the sample. If starch is present, the solution will change colour from [ ] to [ ]. This colour change is due to a reaction between iodide ions and the [ ] molecules in starch.

Items:

amylose **iodine** **blue/black** **Benedict's reagent** **yellow/brown** **amylopectin**

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