Question No. 1 of 10

Instructions: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.

Question

Question 1. Which statement about carbohydrates is ***correct***?

(A) Carbohydrates are composed of carbon, hydrogen, and nitrogen.
(B) The empirical formula for carbohydrates is $(CH_2O)_n$ suggesting they are carbon hydrates.
(C) There will be an ester group in each carbohydrate.
(D) Carbohydrates can not be converted into other organic molecules like fats or amino acids.
(E) Carbohydrates are not used in cellular structural elements as they are too flimsy.

Feedback

A. Incorrect!
Carbohydrates are actually composed of carbon, hydrogen and oxygen. Go back and review the overview of carbohydrates given in the tutorial.

B. Correct!
Carbohydrates earned their name from their structure. With the empirical formula of $(CH_2O)_n$, it was believed they were hydrates of carbon.

C. Incorrect!
Each carbohydrate has either a ketone group or an aldehyde group in it. Go back and review the overview of carbohydrates given in the tutorial.

D. Incorrect!
Carbohydrates can be used as the starting materials for other organic molecules including fats and amino acids. Go back and review the overview of carbohydrates given in the tutorial.

E. Incorrect!
Carbohydrates are used as structural elements in both plant and animal cells. Go back and review the overview of carbohydrates in the tutorial.

Solution

(1) Recall the overview of carbohydrates in the tutorial.

Carbohydrates are composed of carbon, hydrogen and oxygen. The empirical formula for carbohydrates is $(CH_2O)_n$ which initially suggested they were carbon hydrates to early researchers in the field. Each carbohydrate contains either an aldehyde group or a ketone group. Carbohydrates have many uses in biological systems and can be converted into other organic molecules like fats or amino acids.

(2) Read each statement carefully. Determine which one is correct.

(A) states carbohydrates are composed of carbon, hydrogen, and nitrogen. We know they are composed of carbon, hydrogen, and oxygen—not nitrogen. (B) states that the empirical formula for carbohydrates is $(CH_2O)_n$ suggesting they are carbon hydrates. This is true but we should finish looking at the other choices before making (B) our final answer. (C) states that there will be an ester group in each carbohydrate and we know this isn't true. Carbohydrates contain either an aldehyde group or a ketone. (D) states carbohydrates can not be used to make other organic compounds like fats or amino acids but this is incorrect too.

Therefore, the correct answer is (B).

Instructions: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.

Question

Question 2. Which one of the following classes of carbohydrates consists of three to twelve saccharide units?

(A) monosaccharide
(B) disaccharide
(C) oligosaccharide
(D) polysaccharide
(E) cellulose

Feedback

A. Incorrect!
A monosaccharide consists of a single polyhydroxyl aldehyde or ketone unit. Go back and review the classification system for carbohydrates.

B. Incorrect!
A disaccharide consists of two monosaccharide units. Go back and review the classification system for carbohydrates.

C. Correct!
An oligosaccharide consists of 3-12 monosaccharide units.

D. Incorrect!
A polysaccharide (AKA glycans) consists of more than 12 monosaccharide units. Go back and review the classification system for carbohydrates.

E. Incorrect!
Cellulose is a specific polysaccharide of carbohydrates found in plants. Go back and review the classification system for carbohydrates.

Solution

(1) Recall the classes of carbohydrates.

There are four classes of carbohydrates that are determined by the number of sugar residues in each molecule.

Monosaccharides consist of a single (mono = 1) polyhydroxyl aldehyde or ketone unit.
Disaccharides consist of two monosaccharides (di = 2).
Oligosaccharides consist of 3-12 monosaccharides (oligo is from the Greek and means few/little.)
Polysaccharides consist of more than 12 monosaccharides (poly is a prefix meaning many).

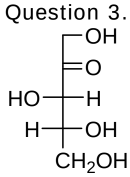
(2) Choose the correct name for a sugar consisting of 3-12 monosaccharides.

Therefore, the correct answer is (C).

Instructions: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.

Question

Question 3. Which of the following best describes the monosaccharide below?



(A) L-aldohexose
(B) L-ketopentose
(C) D-aldohexose
(D) D-ketopentose
(E) L-ketoheptose

Feedback

A. Incorrect!
This sugar is not an L-aldohexose. Go back and review the classification of monosaccharides.

B. Incorrect!
This sugar is not an L-ketopentose. Go back and review the classification of monosaccharides.

C. Incorrect!
This sugar is not a D-aldohexose. Go back and review the classification of monosaccharides.

D. Correct!
This sugar has five carbons so it is a pentose. Since it contains a ketone group, we can name it more specifically as a ketopentose. The configuration of the last chiral center has the hydroxyl group to the right so we know it is a D-ketopentose.

E. Incorrect!
The monosaccharide pictured has 5 carbons, not 7 so it is not a heptose. Also, by looking at the last chiral center, one can see the –OH is to the right, so it is a D sugar. Go back and review how monosaccharides are classified.

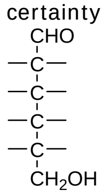
Solution

(1) Recall the generic naming of monosaccharides.

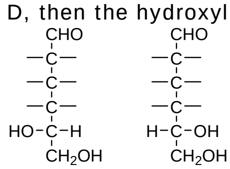
The generic name of a sugar can tell you a lot about the structure. Let's look at (A) as an example.

L-aldohexose

The first part we need to look at is hexose. The suffix –ose is used in naming sugars so we recognize this name as that of a carbohydrate. The prefix hex- means 6 carbons are present in this carbohydrate. Aldo indicates that the carbohydrate is an aldose or one that contains an aldehyde group. (Carbohydrates that contain a ketone group are called ketoses.) The carbohydrate is always drawn so that the aldehyde is at the top of the chain. Right now based on just this information, we can say with certainty the structure of the generic carbohydrate looks like this:



The L designation tells us about the configuration of the last chiral center in carbohydrate chain. If the carbohydrate is listed as L, then the hydroxyl group is on the left side of the Fischer projection. If it is D, then the hydroxyl is listed on the right side of the Fischer projection.



L - Sugar D - Sugar

(2) Look at the given carbohydrate structure.

There are 5 carbons present in the molecule so it is a pentose. It has a ketone group in it so it could be named as a ketopentose. The last chiral center on the chain has the hydroxyl group on the right so it is a D sugar. Thus, we would expect to describe this carbohydrate as a D-ketopentose.

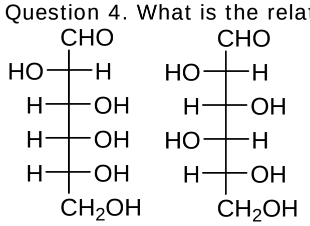
Therefore, the correct answer is (D).

Question No. 4 of 10

Instructions: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.

Question

Question 4. What is the relationship between these two sugars?



(A) They are aldose-ketose isomers.
(B) They are enantiomers.
(C) They are epimers.
(D) They are α and β anomers.
(E) They are meso compounds.

Feedback

A. Incorrect!
Both of these sugars are aldoses so they can not be aldose-ketose isomers. Go back and review the monosaccharides section of the tutorial for definitions of carbohydrate terminology.

B. Incorrect!
Enantiomers are nonsuperimposable mirror images. These molecules are not mirror images of each other. Go back and review the monosaccharides section of the tutorial for definitions of carbohydrate terminology.

C. Correct!
These sugars differ only at a single asymmetric carbon: C4. So they are C4 epimers.

D. Incorrect!
The terms α and β anomers refer to the orientation of the anomeric hydroxyl group in cyclic sugars. Since these sugars are drawn in their straight chain configurations they can not be anomers. Go back and review the monosaccharides section of the tutorial for definitions of carbohydrate terminology.

E. Incorrect!
These sugars do not contain a plane of symmetry so they can not be meso. Go back and review the definitions of carbohydrate terminology.

Solution

(1) Recall the terminology of monosaccharides.

Enantiomers are nonsuperimposable mirror images.
Aldose-ketose isomers are carbohydrate isomers where one is aldose and the other is a ketose.
Epimers are carbohydrates that differ at only one asymmetric carbon.
Anomers are carbohydrates in cyclic form and they differ only in the orientation of the hydroxyl group at the anomeric carbon. Alpha means the hydroxyl is down while beta means the hydroxyl is pointing upward.

(2) Study the given structures. Which of the above terms best describe them?

If you look closely, notice that the carbohydrates are almost identical. They differ only at one asymmetric carbon: C4. They are C4 epimers.

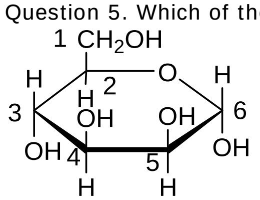
Therefore, the correct answer is (C).

Question No. 5 of 10

Instructions: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.

Question

Question 5. Which of the following statements about the sugar below is ***incorrect***?



(A) The anomeric carbon is labeled as 2.
(B) This sugar is an aldohexose.
(C) This sugar is an α anomer though through mutarotation it could become a β anomer.
(D) This sugar is a reducing sugar.
(E) The cyclic form of this sugar is a pyranose ring.

Feedback

A. Correct!
The anomeric carbon is the carbon labeled as 6. Go back and review the definition of anomeric carbon.

B. Incorrect!
This sugar is an aldohexose. It has 6 carbons in its skeleton and it is derived from an aldose. (If the ring were to open to the straight chain form of the sugar, one would find an aldehyde on carbon 6.)

C. Incorrect!
With α anomers, the hydroxyl group on the anomeric carbon is pointing down. With β anomers, the hydroxyl group is pointing up. Most sugars, including this one, can access both anomers via a process called mutarotation.

D. Incorrect!
This sugar is capable of reducing copper ions while being oxidized to a sugar acid. How do you tell? A sugar will be a reducing sugar if the cyclic form of the sugar is free to ring-open to the straight chain form. Any sugar that contains a hemiacetal will be a reducing sugar while any sugar that contains an acetal will not be.

E. Incorrect!
A six membered ring containing an oxygen atom is formed when the acyclic sugar's –CH_2OH group attacks the carbonyl carbon. This ring is called a pyranose ring.

Solution

(1) Recall monosaccharide terminology as you read each statement.

(A) states that the anomeric carbon is labeled as 2.

The anomeric carbon is an asymmetric carbon that is formed when a hydroxyl group attacks the carbonyl of the aldehyde or ketone in the straight chain configuration to form a cyclic saccharide. Generally, carbohydrates are drawn so that the anomeric carbon is on the right side of the ring and is directly attached to the oxygen that is part of the ring. In this case, the anomeric carbon is labeled as carbon 6.

(B) states that the sugar is an aldohexose.

There are 6 carbons present so it is a hexose. Check the anomeric carbon. If there is a hemiacetal present, then the carbohydrate is an aldose. If there is a acetal present, then the carbohydrate is a ketose. Here, a hemiacetal is present so it is an aldose. The statement is correct.

(C) states the sugar is an α anomer though through mutarotation it could become a β anomer.

Alpha anomer refers to the orientation of the hydroxyl group on the anomeric carbon. Is it pointing down? Yes, it is so the carbohydrate is an alpha anomer. Since the anomeric carbon is free (not involved in a bond to another residue), the cyclic form will be in equilibrium with the straight chain form. In a process called mutarotation, the alpha and beta anomers can interconvert. The statement is correct.

(D) states the carbohydrate is a reducing sugar.

In order to be a reducing sugar, the anomeric carbon must be free. As discussed earlier, this carbohydrate does have a free anomeric carbon so it is a reducing sugar. This statement is correct.

(E) states the cyclic form of this sugar is a pyranose ring.

A six membered ring containing an oxygen atom is formed when the acyclic sugar's –CH_2OH group attacks the carbonyl carbon. This ring is called a pyranose ring.

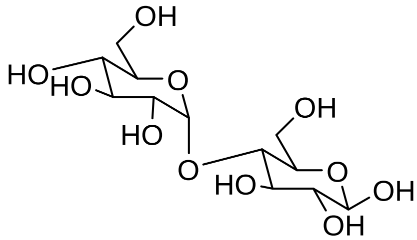
Therefore, the correct answer is (A).

Question No. 6 of 10

Instructions: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.

Question

Question 6. How is the monosaccharide units linked in the disaccharide below?



(A) β (1,6) glycosidic linkage
(B) α (1,6) glycosidic linkage
(C) β (1,4) glycosidic linkage
(D) α (1,4) glycosidic linkage
(E) β (1,5) glycosidic linkage

Feedback

A. Incorrect!
This is not an example of a beta linkage or of a 1,6 linkage. Go back and review the section on glycosidic linkages.

B. Incorrect!
This is not an example of a 1,6 linkage. Go back and review how the glycosidic bonds are numbered.

C. Incorrect!
Close! This is not an example of a beta linkage. Go back and review how the configuration of groups attached to the anomeric carbon is determined.

D. Correct!
The glycosidic linkage is between the anomeric carbon of one residue (carbon 1) and the fourth carbon of the second residue. The alpha term refers to the orientation of the oxygen group on the anomeric carbon that is part of the linkage.

E. Incorrect!
This is not an example of a β (1,5) glycosidic linkage. Go back and review how the glycosidic bonds are numbered.

Solution

(1) Recall the convention for describing linkages between carbohydrate residues.

All glycosidic linkages are listed as either α or β. The Greek letters refer to the orientation of the oxygen on the anomeric carbon that is involved in the bond. Alpha means it is pointing down from the anomeric carbon and beta means it is pointing up from the anomeric carbon.

Usually there are numbers listed with each glycosidic linkage. These numbers tell you the location numbers of the carbons involved in the linkage. A 1,4 linkage means there is a bond between the anomeric carbon of one residue (carbon 1) to the fourth carbon of the other residue. Likewise, a 1,6 linkage means there is a bond connecting the two monosaccharides between carbon 1 on the first residue and carbon 6 on the other.

(2) Look at the glycosidic linkage. Determine α/β and its location numbers.

The disaccharide above has a linkage between carbon 1 of the first residue and carbon 4 of the other. The oxygen on the carbon labeled 1 in the linkage is pointing down so it is an alpha linkage.

Put it together: α (1,4) glycosidic linkage.

Therefore, the correct answer is (D).

Question No. 7 of 10

Instructions: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.

Question

Question 7. What reaction is used to join two monosaccharides together to form a disaccharide?

(A) Condensation
(B) Mutarotation
(C) Reduction
(D) Glycogenolysis
(E) All of the above.

Feedback

A. Correct!
Condensation reactions, also called dehydration, splits a molecule of water out in the process of joining two sugar residues.

B. Incorrect!
Mutarotation is the process of isomerism about the anomeric carbon of a sugar. Go back and review the reactions of disaccharides.

C. Incorrect!
Reduction reactions reduce the oxidation state of atoms or molecules. The joining of two sugar residues does not result in the reduction of the oxidation state of either sugar. Go back and review the reactions of disaccharides.

D. Incorrect!
Glycogenolysis is the process of breaking down glycogen to provide a constant source of blood glucose. Go back and review the reactions of disaccharides.

E. Incorrect!
Only one of the above choices is the correct answer. Go back and review the reactions of disaccharides.

Solution

(1) Recall the reactions of carbohydrates covered in the tutorial.

There were really only two reactions mentioned. The reduction of copper (II) by a reducing sugar and the condensation reaction of di, oligo, and polysaccharides were the ones covered by the tutorial.

Condensation reactions are used to join together monosaccharides to build larger sugars. Water is split out in the process which is also known as dehydration.

(2) Read each choice carefully and find one that matches.

Therefore, the correct answer is (A).

Question No. 8 of 10

Instructions: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.

Question

Question 8. What are the two categories of polysaccharides?

(A) Homopolysaccharides, heteropolysaccharides
(B) Mucopolysaccharides, glycosaminoglycans
(C) Glycoproteins, glycosaminoglycans
(D) Glycoproteins, proteoglycans
(E) None of the above

Feedback

A. Correct!
The two categories of polysaccharides are homopolysaccharides and heteropolysaccharides.

B. Incorrect!
Mucopolysaccharides are actually just another name for glycosaminoglycans. Go back and review the terminology of polysaccharides.

C. Incorrect!
Glycoproteins and glycosaminoglycans are members of the same category of polysaccharides but they are not the names of the two main categories. Go back and review the terminology of polysaccharides.

D. Incorrect!
Glycoproteins and proteoglycans are members of the same category of polysaccharides but they are not the names of the two main categories. Go back and review the terminology of polysaccharides.

E. Incorrect!
The correct answer may be found in the choices above.

Solution

(1) Recall the two categories of polysaccharides.

Homopolysaccharides are polysaccharides that contain only one kind of monosaccharide.
Heteropolysaccharides are polysaccharides that are composed of different monosaccharides or their derivatives.

(2) Read each choice carefully and choose the correct answer.

Therefore, the correct answer is (A).

Question No. 9 of 10

Instructions: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.

Question

Question 9. Which of the following homopolysaccharides functions as the main storage polysaccharide in plants?

(A) chitin
(B) cellulose
(C) starch
(D) glycogen
(E) sucrose

Feedback

A. Incorrect!
Chitin is the structural component of invertebrate exoskeletons. Go back and review the common homopolysaccharides covered in the tutorial.

B. Incorrect!
Cellulose is the structural component of plants' cell walls. Go back and review the common homopolysaccharides covered in the tutorial.

C. Correct!
Starch is the main storage polysaccharide in plants.

D. Incorrect!
Glycogen is the main storage polysaccharide in animals. Go back and review the common homopolysaccharides covered in the tutorial.

E. Incorrect!
Sucrose is a non-reducing disaccharide and not a storage polysaccharide. Go back and review common polysaccharides.

Solution

(1) Recall the types of homopolysaccharides covered in the tutorial.

Remember, homopolysaccharides are polysaccharides that contain only one kind of monosaccharide. Four types of homopolysaccharides were discussed: chitin, cellulose, glycogen, and starch.

Chitin is the structural component of invertebrate exoskeletons. Cellulose is the structural component of plants' cell walls. Glycogen is the main storage polysaccharide in animals. Starch is the main storage polysaccharide in plants.

(2) Read the question carefully and choose the correct answer.

The main storage polysaccharide in plants is starch.

Therefore, the correct answer is (C).

Question No. 10 of 10

Instructions: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.

Question

Question 10. What is the end product of the process called glycolysis?

(A) glucose
(B) acetyl CoA
(C) carbon dioxide
(D) ATP
(E) pyruvate

Feedback

A. Incorrect!
Glucose is the starting material for glycolysis not the end product. Go back and review glucose metabolism.

B. Incorrect!
Acetyl CoA is the starting material for the Krebs cycle. Go back and review glucose metabolism.

C. Incorrect!
Carbon dioxide is a product of the Krebs cycle. Go back and review glucose metabolism.

D. Incorrect!
ATP is a product of the Krebs cycle. Go back and review glucose metabolism.

E. Correct!
Glucose is transformed into pyruvate via the process of glycolysis.

Solution

(1) Recall the processes involved in glucose metabolism.

Glucose enters glycolysis and is transformed into pyruvate. Pyruvate is then changed into acetyl CoA which enters the Krebs cycle. In the Krebs cycle, acetyl CoA is used to make water, carbon dioxide and ATP, the energy storage molecule for the body.

(2) Read each choice carefully and choose the correct answer.

Therefore, the correct answer is (E).

