

CARBOHYDRATES - SELF STUDY QUESTIONS

- Match the name to its correct description: (1) diastereoisomers, (2) enantiomers, (3) anomers:
 - Stereoisomers that are mirror images of each.
 - Stereoisomers that differ in configuration at the anomeric carbon.
 - Stereoisomers that are not mirror images of each other.
- Which of these compounds is unable to undergo mutarotation?
 - Glucose
 - Maltose
 - Lactose
 - Sucrose
- Glycogen and cellulose are both homopolymers of glucose. What is the difference between them?
- Removing lignin from wood pulp and forming the resulting cellulose fibers into sheets makes paper. Most of us have observed that untreated paper loses most of its strength when wet with water but maintains its strength when wet with oil. Why should this be the case?
- What functional group distinguishes a reducing sugar from a nonreducing sugar?
- Two conformations of a molecule can be interconverted without breaking any covalent bonds, but two configurations can only be interconverted by breaking a covalent bond. Which term applies to the chair and boat forms of glucose? Which term applies to the α and β anomers of glucose.
- What are the structural differences between the reducing and nonreducing ends of cellulose?
- How are the carbohydrate chains attached to O-linked glycoproteins? To N-linked glycoproteins?
- One can determine the anomeric purity of a sugar solution (% α and % β) by measuring the specific rotation, which is the amount a solution of the sugar rotates a beam of plane-polarized light. Pure α -D-galactose has a specific rotation of 150.7° , while pure β -D-galactose has a specific rotation of 52.8° . When either pure α -D-galactose or pure β -D-galactose are dissolved in water, the initial optical rotation changes over time until both solutions have a specific rotation of 80.2° . What is going on?
- Glucose oxidase catalyzes the oxidation of glucose. The enzyme is absolutely specific for β -D-glucose and will not react with α -D-glucose. Yet this enzyme is routinely used in clinical laboratories to determine blood glucose concentrations in samples that are mixtures of β -D-glucose and α -D-glucose. How is this possible?
- Antifreeze glycoproteins are O-linked glycoproteins found in the blood of Antarctic and Arctic fish. These glycoproteins have the structure $[\text{Ala-Ala-Thr}]_n\text{-Ala-Ala}$, where n can be as large as 50. Each Thr has a disaccharide attached. How might these proteins serve as antifreeze?
- If a polysaccharide is treated with methyl iodide, then subjected to acid hydrolysis, all the OHs in the sugar will be methylated except for the anomeric OH and those OHs involved in glycosidic linkages. If this procedure were carried with a sample of glycogen, what products would you expect to find?

ANSWERS

1. 1-c; 2-a; 3-b
2. Sucrose can't undergo mutarotation because it does not have a free anomeric carbon all the others do.
3. Glycogen has α (1 \rightarrow 4) and α (1 \rightarrow 6) linkages, while cellulose has β (1 \rightarrow 4) linkages.
4. Water disrupts the intrafiber hydrogen bonds that hold the cellulose fibers together; oil has no effect on hydrogen bonds.
5. Saccharides in which the anomeric carbon has not been derivatized are reducing sugars a mild oxidizing agent such as Ag^+ or Cu^{+2} can oxidize the aldehyde.
6. The chair and boat forms are conformational isomers; the α and β anomers are configurational isomers.
7. The nonreducing end has a free OH at position 4, while the reducing end has a free β - OH at position 1, which is a potential aldehyde and therefore reducing.
8. O-linked are via linkage to Thr or Ser, N-linked are via Asn.
9. The anomers are undergoing mutarotation until an equilibrium mixture of 28% α -D-galactose and 72% β -D-galactose is achieved.
10. As the β -D-glucose anomer is oxidized, mutarotation converts the α -D-glucose to β -D-glucose until all the glucose has been oxidized.
11. The highly hydrated proteins probably inhibit ice nucleation.
12. 2,3,4,6-tetra-O-methyl glucose (from the reducing end of the polymer); 2,3,6-tri-O-methyl glucose (from the α -(1 \rightarrow 4)-linked residues) and 2,3-di-O-methyl glucose (from the branch points).