

Question Bank on Stereochemistry

here are some questions and answers on the topic of epimers in the context of carbohydrates:

1. Question: What are epimers?

Answer: Epimers are diastereomers that contain more than one chiral center but differ from each other in the absolute configuration at only one chiral center⁶.

2. Question: How do epimers differ in the position of the atoms?

Answer: Epimers differ in the position of the atoms attached at one chiral carbon⁵.

3. Question: What is the relationship between D-sorbose and D-fructose?

Answer: They are diastereomers that are also epimers¹.

4. Question: What is the enantiomer of D-sorbose?

Answer: It is an L-sugar that has an opposite configuration around three carbons¹.

5. Question: What reagent will oxidize D-sorbose?

Answer: Alkaline cupric ion¹.

6. Question: What is similar when comparing D-talose to D-fructose?

Answer: D-gulose has the same number of carbon atoms as D-fructose¹.

Questions and Answers on Epimers of Glucose

1. Question: What is an epimer?

Answer: An epimer is a type of stereoisomer where two compounds differ in configuration at only one specific stereogenic center out of several. In the context of carbohydrates like glucose, epimers differ at one of the carbon atoms in the sugar molecule.

2. Question: What are the most common epimers of glucose?

Answer: The most common epimers of glucose are mannose and galactose. Mannose is an epimer of glucose at the C-2 position, while galactose is an epimer of glucose at the C-4 position.

3. Question: Describe the structural difference between D-glucose and D-mannose.

Answer: D-Glucose and D-Mannose differ in the configuration around the C-2 carbon. In D-glucose, the hydroxyl group on C-2 is on the right side in the Fischer projection, whereas in D-mannose, the hydroxyl group on C-2 is on the left side.

4. Question: Describe the structural difference between D-glucose and D-galactose.

Answer: D-Glucose and D-Galactose differ in the configuration around the C-4 carbon. In D-glucose, the hydroxyl group on C-4 is on the right side in the Fischer projection, whereas in D-galactose, the hydroxyl group on C-4 is on the left side.

5. Question: How are epimers of glucose important in biological systems?

Answer: Epimers of glucose play crucial roles in biological systems. For instance, D-mannose is important in glycoprotein biosynthesis and cell recognition processes, while D-galactose is essential in the synthesis of glycolipids and

glycoproteins. The interconversion of these sugars is also significant in metabolic pathways like the Leloir pathway, where galactose is converted to glucose-1-phosphate.

6. Question: What enzyme is responsible for the epimerization of glucose to mannose in metabolic pathways?

Answer: The enzyme responsible for the epimerization of glucose to mannose in metabolic pathways is phosphomannose isomerase. This enzyme catalyzes the reversible conversion of mannose-6-phosphate to fructose-6-phosphate, which can then enter glycolysis or gluconeogenesis pathways.

7. Question: Can epimers interconvert spontaneously in aqueous solutions?

Answer: No, epimers cannot interconvert spontaneously in aqueous solutions because the interconversion requires breaking and reforming covalent bonds at the chiral center. This process typically requires the action of specific enzymes, such as epimerases or isomerases, to catalyze the interconversion.

8. Question: Explain the significance of the enzyme UDP-galactose 4-epimerase in carbohydrate metabolism.

Answer: UDP-galactose 4-epimerase is crucial in carbohydrate metabolism as it catalyzes the reversible conversion of UDP-galactose to UDP-glucose. This reaction is part of the Leloir pathway, which is essential for the utilization of galactose derived from the diet. Deficiency in this enzyme can lead to galactosemia, a metabolic disorder that can cause serious health issues if untreated.

9. Question: How can the epimerization of glucose be experimentally determined?

Answer: The epimerization of glucose can be experimentally determined using techniques such as nuclear magnetic resonance (NMR) spectroscopy, which allows for the observation of changes in the chemical environment of specific carbons. High-performance liquid chromatography (HPLC) can also be used to separate and identify different epimers based on their retention times.

10. Question: Provide an example of how epimerization can affect the properties of a sugar.

Answer: Epimerization can significantly affect the properties of a sugar, such as its reactivity, recognition by enzymes, and biological function. For example, while glucose is readily metabolized by glycolytic enzymes, mannose is not as efficiently processed in glycolysis and is instead more involved in glycoprotein synthesis. Similarly, galactose must be converted to glucose-1-phosphate via the Leloir pathway before it can enter central metabolic pathways.

These questions and answers cover various aspects of epimers of glucose, providing a comprehensive understanding suitable for advanced study.