

# Problem Set #6

## BMB 401 Spring 2004

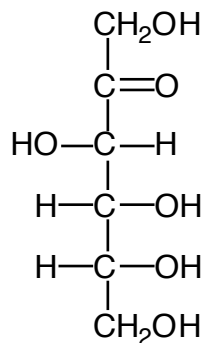
Problems from Lehninger: Chapter 9: 2, 3, 4, 5, 7, 9, 10, 11, 15, 16

Chapter 11: 1, 2, 4, 5, 7, 9, 10, 13

Chapter 12: 3, 4, 5, 12, 14, 15, 17

Problem 1 – The open chain structure for D-Fructose is shown below as its Fischer projection.

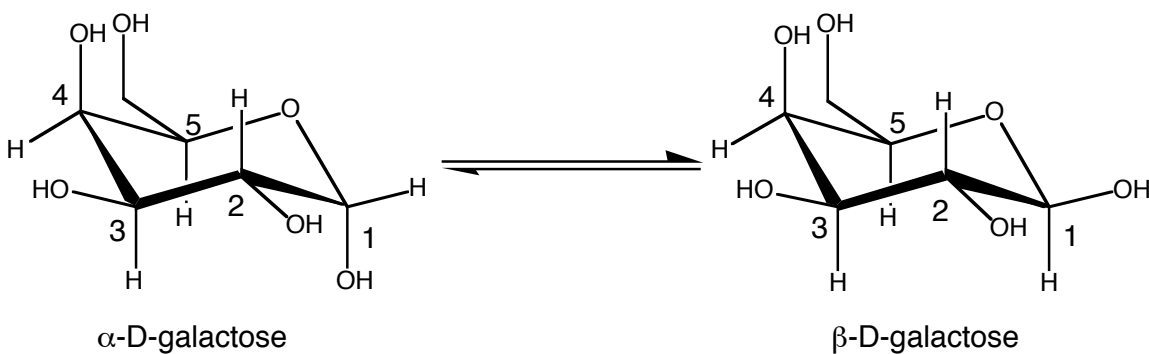
- How many chiral carbons does the molecule possess?
- What is the stereochemical configuration at each of the chiral carbons (R or S)?
- How many different stereoisomers of D-fructose are possible?
- Draw both the  $\beta$ -D-pyranose and  $\beta$ -D-furanose ring forms of D-fructose. Make sure that the stereochemistry at each of the carbons is correct. Circle the anomeric carbons.



D-Fructose

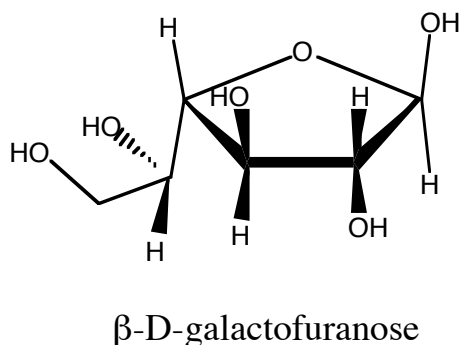
Problem 2 – How many different disaccharides containing D-galactopyranose plus D-glucopyranose are possible? How many of the above disaccharides are nonreducing disaccharides?

Problem 3 – Galactose mutarotase catalyzes the equilibration of  $\alpha$ - and  $\beta$ -anomers of certain sugars (D-galactose, D-glucose, D-xylose, D-arabinose, and D-fucose). This reaction can take place non-enzymatically, but the rate ( $0.032 \text{ min}^{-1}$ ) is too slow to satisfy the needs of the cell for galactose utilization.



Chemical modification experiments revealed that two histidine residues are in the active site, and are important in catalysis. Please sketch out a plausible mechanism for conversion of  $\alpha$ -D-galactose to  $\beta$ -D-galactose by galactose mutarotase.

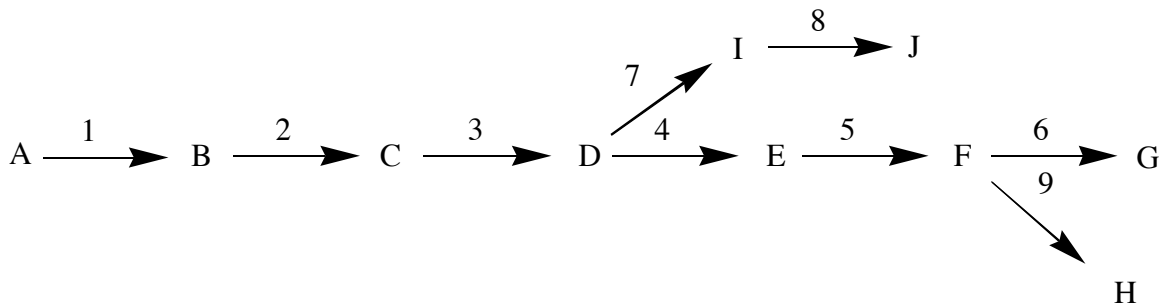
When  $\alpha$ -D-galactose is dissolved in water and allowed to come to equilibrium either in the presence or absence of galactose mutarotase,  $\beta$ -D-galactofuranose is observed as a minor product. Specifically show how your mechanism can account for this piece of data.



Problem 4 – Frequently, the first enzyme in a metabolic pathway is regulated allosterically by the final product of the pathway. What is meant by “the first enzyme in the pathway,” and why is this the enzyme that is often regulated.

Problem 5 – Show by writing the reactions how the combination of a protein kinase and its corresponding protein phosphatase, if unregulated, would form a futile cycle.

Problem 6 – Assume that the flow diagram shown represents an amino acid biosynthetic pathway where G, J, and H are amino acids and A is a common precursor. Products G, H, and J are required by the cell. Enzymes catalyzing the steps are numbered. Suggest a plausible scheme for the regulation of specific enzymes by their products.



Problem 7 – ATP is both a substrate and an inhibitor of the enzyme phosphofructokinase (PFK). Although the substrate fructose-6-phosphate binds cooperatively to the active site, ATP does not bind cooperatively. Explain how ATP may be both a substrate and an inhibitor of PFK.

Problem 8 – What is the significance of the chirality of the penultimate carbon of a monosaccharide?

Problem 9 – The polysaccharide inulin is an energy-storage substance found in the tubers of a number of plants. The major part of inulin is composed of fructoses linked  $\beta(1,2)$ . Draw the structure of inulin.

Problem 10 – Which would you expect to have the fastest nonezymatic flip-flop motion: phosphatidylethanolamine or phosphatidylserine?

Problem 11 – Draw the structure of 6,9,12-Octadecatrienoic acid.

Problem 12 – Draw the trans configuration of 9-Hexadecenoic acid.

Problem 13 – 1-stearoyl-2-oleoyl-phosphatidylcholine has a much lower phase transition temperature than distearoyl phosphatidylcholine. Explain why.

Problem 14 – Explain the rationale for the use of the term fluid mosaic to describe membranes.

Problem 15 – Discuss the difference between the structures of the cell walls of Gram positive and Gram negative bacteria.

Problem 16 – Inverted micelles are made by dispersing amphipathic molecules in a nonpolar solvent, such as benzene, together with a small amount of water. Draw the structure of an inverted micelle, and describe the forces that stabilize it.