

Carbohydrates

BIOS 10016

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Objectives

- Know all definitions presented about Carbohydrates.
- Classify sugars and describe relationships between sugars based on chemical and structural differences.
- Use the nomenclature associated with sugar chirality and structure to name sugars in linear and hemiacetal/hemiketal forms.
- Number the positions in a sugar.
- Describe the differences between aldoses and ketoses.
- Describe the properties of the functional groups in sugars, and how it enables them to interact with other molecules, like water.
- Describe the formation, properties and prevalence of hemiacetal/hemiketal structures of sugars in solution.
- Interconvert between the Fischer, Projection and Haworth representations.
- Describe the reactions that sugars undergo:
 - Difference between reducing and non-reducing sugars
 - Isomerization, esterification, and glycoside formation
 - Identify and describe deoxy and amino sugars
- Describe the formation and naming of glycosidic linkages.
- Identify and name the glycosidic linkages that can exist between sugars.
- Describe the components, linkages and properties of disaccharides: lactose, maltose, and sucrose.
- Describe the properties of branched and linear polysaccharides and their dependence on the types of glycosidic linkages.
 - Differences between starch, amylose, amylopectin and cellulose

- Difference between amylose and heparin

Carbohydrates

Monosaccharides

- Monosaccharides are the simplest carbohydrates and are aldehydes or ketones containing two or more hydroxyl groups
- Aldehyde: aldoses; ketone: ketoses
- Smallest monosaccharides are composed of 3 carbons
- End carbon closest to the most oxidized carbon is 1
- Often represented in **Fischer** or **Haworth**
- Often named relative to glyceraldehyde: D, L (depends on where the hydroxyl group is)
- D sugars are the most common in nature

Chirality

D and L sugars are defined by the chiral carbon furthest from the most oxidized carbon and where the hydroxyl group is relative to that carbon.

3 carbons - **triose**

4 carbons - **tetrose**

5 carbons - **pentose**

6 carbons - **hexose**

Different forms of monosaccharides

constitutional isomers same formula, different attachment

stereoisomers same formula, different 3D orientation

enantiomers stereoisomers that are nonsuperimposable mirror images of each other (only look at the chiral carbons)

diastereoisomers stereoisomers that are not mirror images

epimers diastereoisomers that differ at only one asymmetric carbon atom

anomers diastereoisomers that differ at a new asymmetric carbon atom formed on ring closure (anomeric carbon (the carbon where the molecule attached differs): α is trans (CH₂OH and OH on opposite sides), β is cis (CH₂OH and OH on the same side)

Hemiacetal or **hemiketal** sugars

Aldehyde + alcohol \rightarrow hemiacetal

Ketone + alcohol \rightarrow hemiketal

Happens through **nucleophilic attack**

α and β designations based upon chirality at anomeric carbon

α and β conformations are in equilibrium in water. The linear conformation is the least dominant species in solution

Naming of cyclic sugars

Glucose forms a six-member ring: **pyranose** since it resembles pyran

Fructose forms a five-member ring: **furanose** since it resembles furan

α and β anomers result from carbonyl containing functional groups having two faces.