



Universidad Autónoma del Estado de Hidalgo



Instituto de Ciencias de la Salud

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# Carbohidratos

# Carbohydrates



## Área del Conocimiento: 3 Medicina y Ciencias de la Salud

### Abstract

This presentation is part of the course “Biochemistry” imparted in the Medicine Academic Area, Health Sciences Institute – UAEH in July-December 2011.

What exactly is a carbohydrate?, the appreciable solubility of these molecules in water was commensurate with the presence of hydroxyl groups and there was often evidence for the carbonyl group of an aldehyde or ketone. These polyhydroxylated aldehydes and ketones were termed aldoses and ketoses respectively with the more common members referred to as aldopentoses and aldohexoses and ketopentoses and ketohexoses. The term sugar is used to describe monosaccharides and the somewhat higher molecular weight di and trisaccharides.

**Key words:** Carbohydrates, aldopentoses, aldohexoses, ketopentoses, ketohexoses



## Área del Conocimiento: 3 Medicina y Ciencias de la Salud

### Resumen

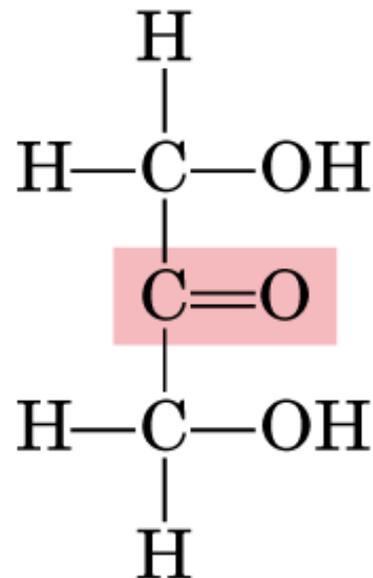
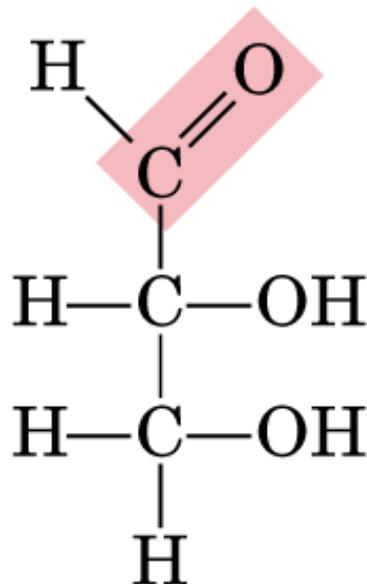
Esta presentación es parte del curso de “Bioquímica” impartida en el Área Académica de Medicina, Instituto de Ciencias de la Salud-UAEH en Julio-Diciembre 2011.

¿Qué es exactamente un carbohidrato?, La apreciable solubilidad de estas moléculas en el agua fue proporcional con la presencia de grupos hidroxilo y con frecuencia se evidenció el grupo carbonilo de una cetona o aldehído. Estos aldehídos y cetonas polihidroxilados fueron llamados aldosas y cetosas, respectivamente, con los miembros más comunes que se contemplan como aldopentosas y aldohexosas y cetopentosas y cetohehexosas. El término azúcar se utiliza para describir a los monosacáridos y di, trisacáridos de mayor peso molecular.

**Palabras Clave: Carbohidratos, aldopentosas, aldohexosas, cetopentosas y cetohehexosas.**



Los carbohidratos se definen como derivados **aldehídos o cetónicos de alcoholes polivalentes (polihidroxílicos)**.





# Ejemplos de presencia y funciones bioquímicas de los monosacáridos

Monosaccharides	Natural Occurrence	Physiological Role <sup>a</sup>
<b>Trioses</b>		
Glyceraldehyde	Widespread (as phosphate)	The 3-phosphate is an intermediate in glycolysis
Dihydroxyacetone	Widespread (as phosphate)	The 1-phosphate is an intermediate in glycolysis
<b>Tetroses</b>		
D-Erythrose	Widespread	The 4-phosphate is an intermediate in carbohydrate metabolism
<b>Pentoses</b>		
D-Arabinose	Some plants, tuberculosis bacilli	Plant glycosides, cell walls
L-Arabinose	Widely distributed in plants, bacterial cell walls	Constituent of cell walls, plant glycoproteins
D-Ribose	Widespread, in all organisms	Constituent of ribonucleic acid
2-D-Deoxyribose	Widespread, in all organisms	Constituent of deoxyribonucleic acid
D-Xylose	Woody materials	Constituent of plant polysaccharides
<b>Hexoses</b>		
D-Galactose	Widespread	Milk (as part of lactose); structural polysaccharides
L-Galactose	Agar, other polysaccharides	Polysaccharide structures
D-Glucose	Widespread	A major energy source for animal metabolism; structural role in cellulose
D-Mannose	Plant polysaccharides, animal glycoproteins	Polysaccharide structures
D-Fructose	A major plant sugar; part of sucrose	Intermediate in glycolysis (phosphate esters)
<b>Heptoses</b>		
D-Sedoheptulose	Many plants	Intermediate in Calvin cycle in photosynthesis and pentose phosphate pathway

<sup>a</sup>Some of these monosaccharides have additional roles that are not listed.



## Clasificación

1. Osas, Monosacáridos, azúcares simples (aldosas y cetosas)
2. Ósidos
  - a) **Holósidos**
    - \*Combinación de varias osas (oligósidos u oligosacáridos 2-10 unidades)
    - \*Poliósidos formados por más de 10 unidades monoméricas osas
  - a) **Heterósidos**

Combinación de varias osas con una fracción no-glucosídica



## Clasificación de los carbohidratos según su grupo funcional y número de carbonos

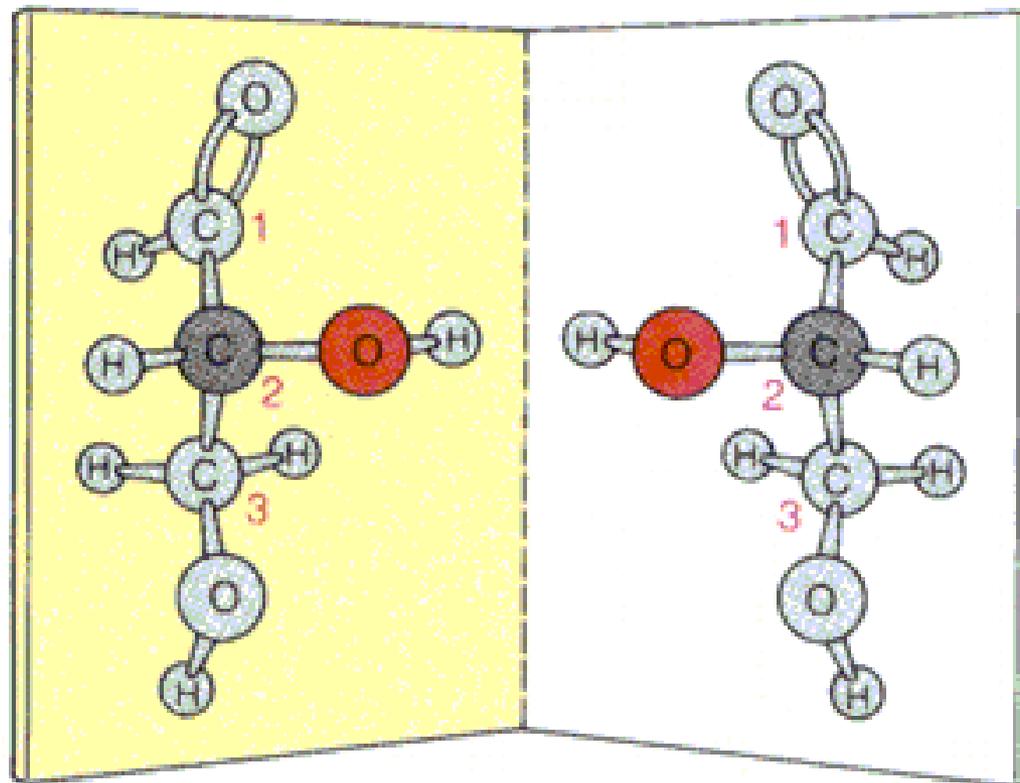
Aldosas	Cetosa
Aldotriosa	Cetotriosa
Aldotreosa	Cetotreosa
Aldopentosa	Cetopentosa
Aldohexosa	Cetohehexosa



# Ejemplos de Carbohidratos

Número de carbonos	Aldosas	Cetosos
Triosas	Gliceraldehído	Dihidroxiacetona
Tetrosas	Eritrosa	Eritrulosa
Pentosas	Ribosa	Ribulosa
Hexosas	Glucosa	Fructosa

# Enantiómeros

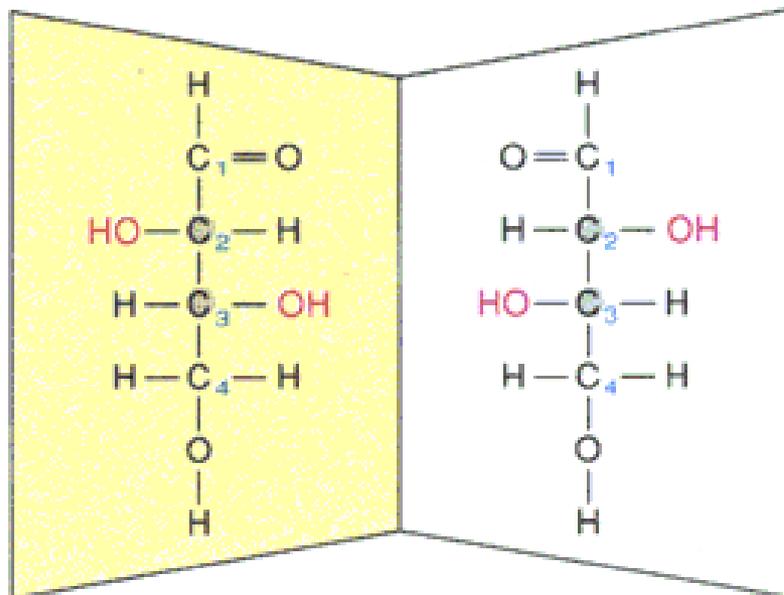


D-Glyceraldehyde

L-Glyceraldehyde

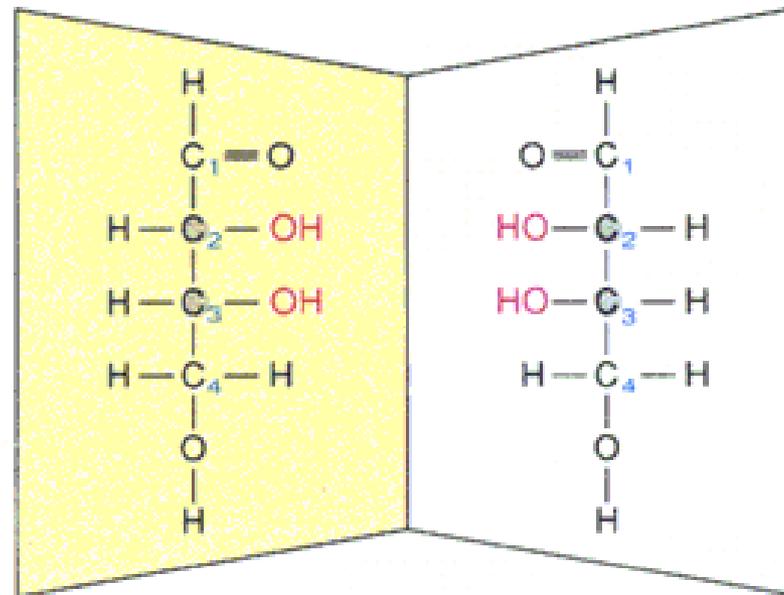


# Estereoquímica de las aldotetrasas



D-Threose

L-Threose

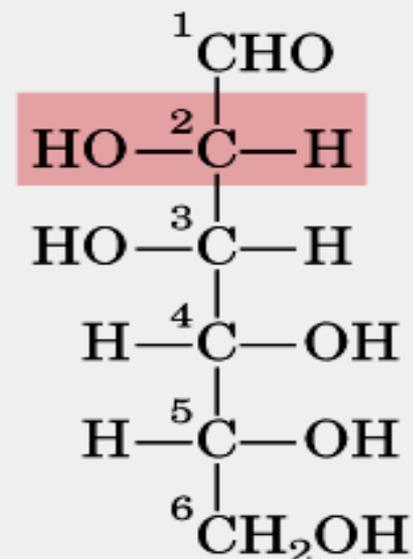


D-Erythrose

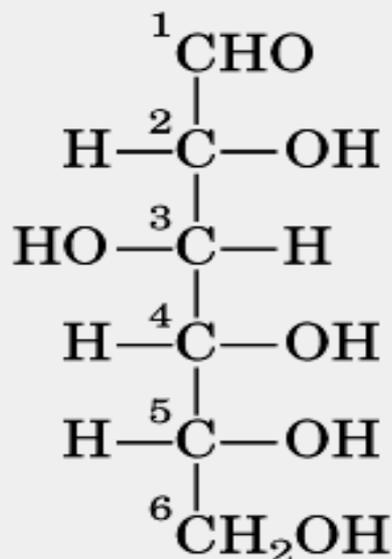
L-Erythrose



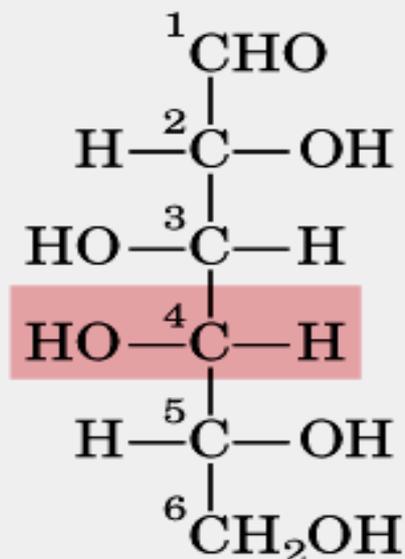
## EPÍMEROS: Difieren en la posición de un solo grupo hidroxilo



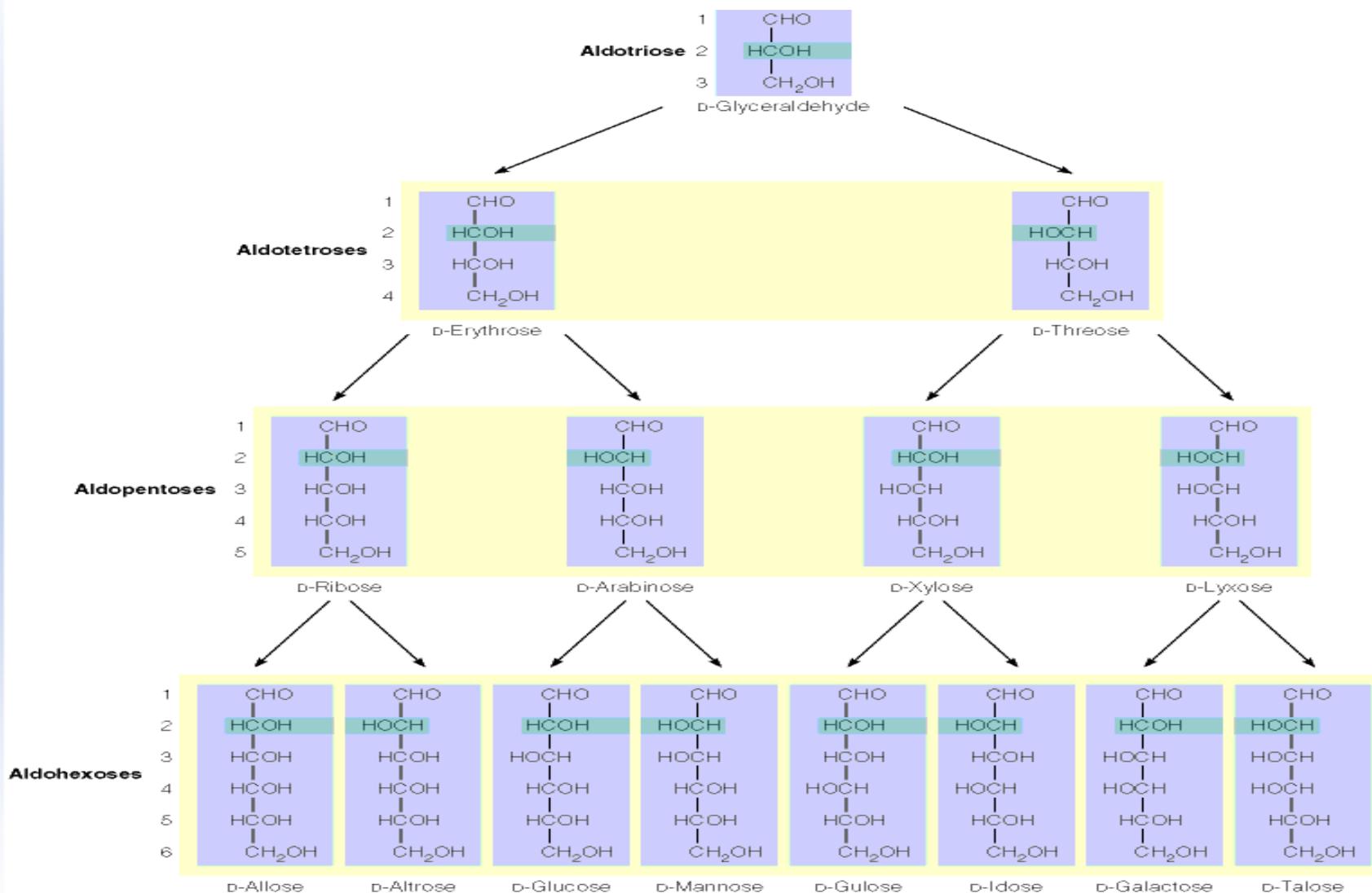
D-Mannose  
(epimer at C-2)



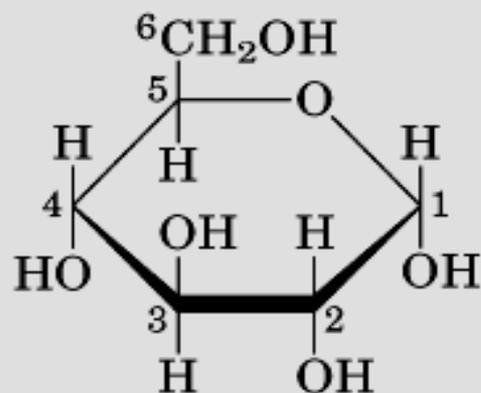
D-Glucose



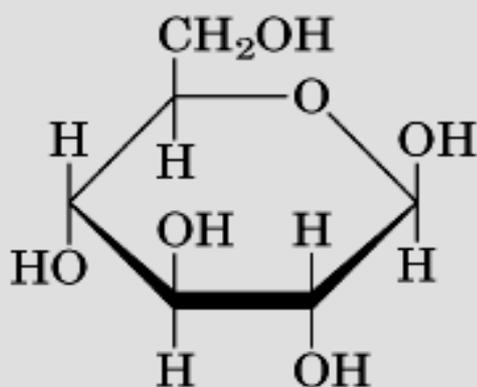
D-Galactose  
(epimer at C-4)



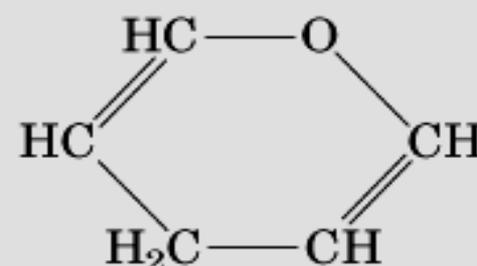
(a) D-Aldoses



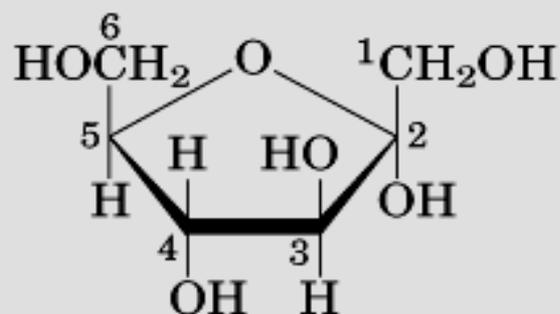
$\alpha$ -D-Glucopyranose



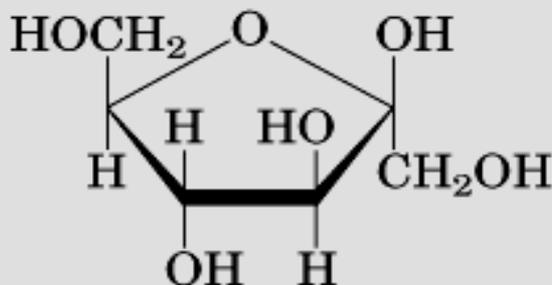
$\beta$ -D-Glucopyranose



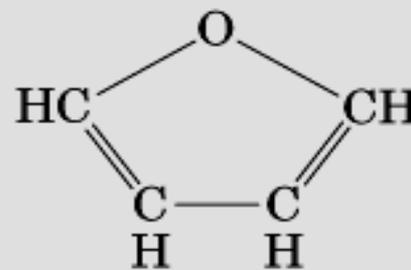
Pyran



$\alpha$ -D-Fructofuranose



$\beta$ -D-Fructofuranose



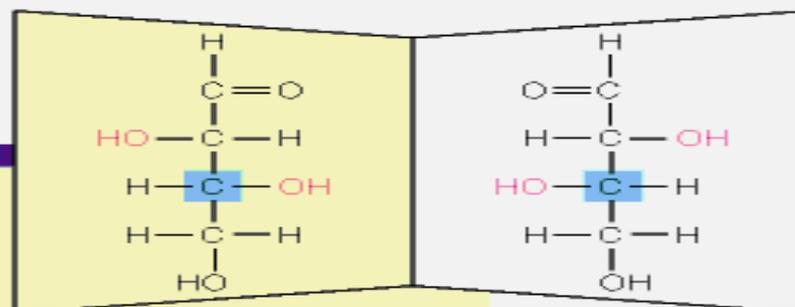
Furan



### Enantiomers

Stereoisomers that are mirror images of one another

The boxed asymmetric carbon (farthest from aldehyde) determines d/L designation

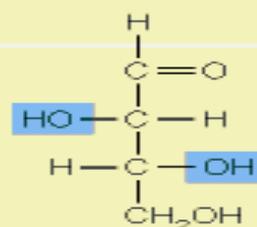


D-Threose

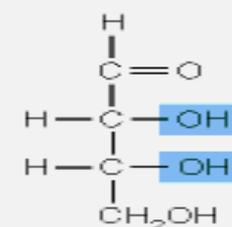
L-Threose

### Diastereomers

Stereoisomers that are not mirror images of one another



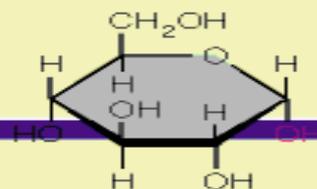
D-Threose



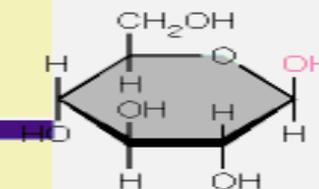
D-Erythrose

### Anomers

Stereoisomers that differ in configuration at the anomeric carbon



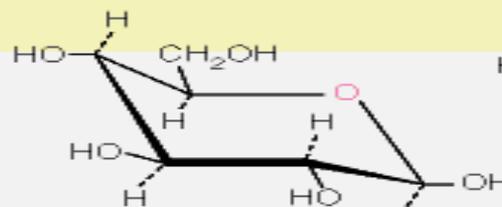
$\alpha$ -D-Glucopyranose



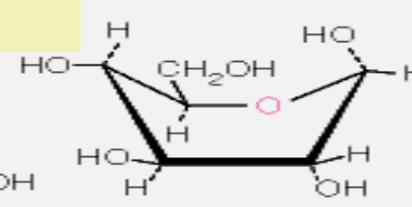
$\beta$ -D-Glucopyranose

### Conformational isomers

Molecules with the same stereochemical configuration, but differing in three-dimensional conformation



$\beta$ -D-Glucopyranose chair form



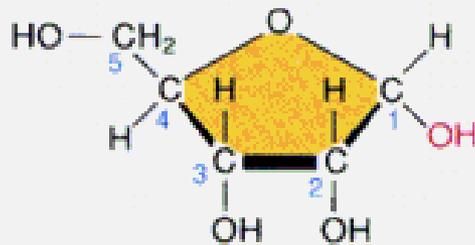
$\beta$ -D-Glucopyranose boat form



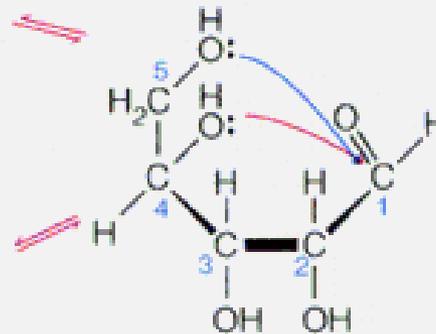
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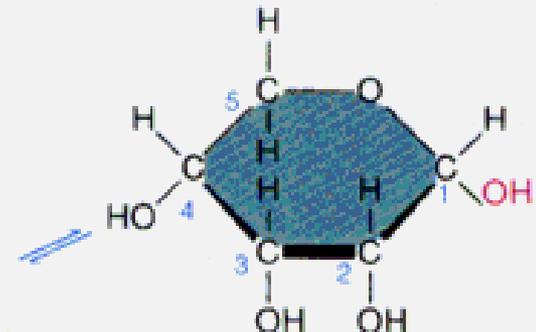
Pyran



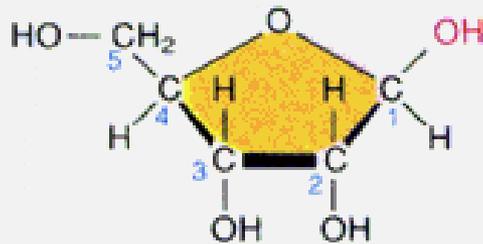
$\alpha$ -D-Ribofuranose



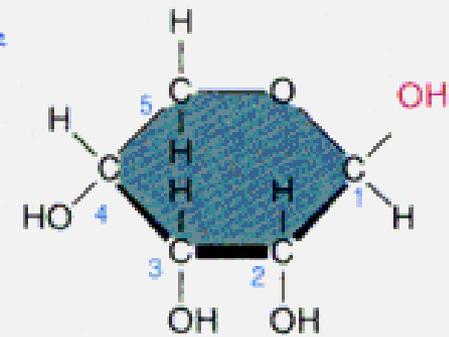
D-Ribose



$\alpha$ -D-Ribopyranose



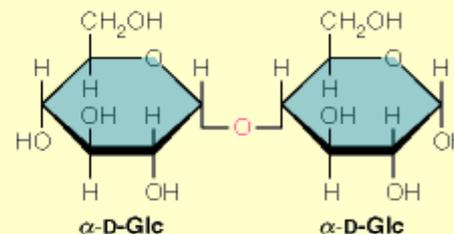
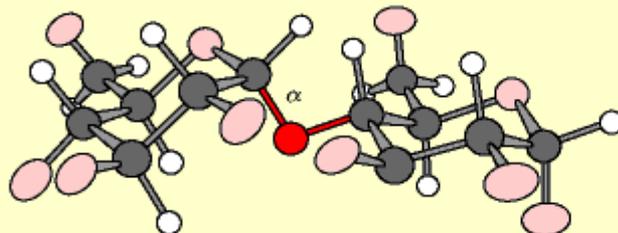
$\beta$ -D-Ribofuranose



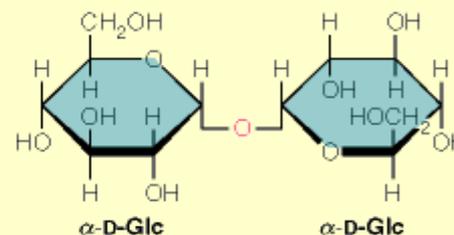
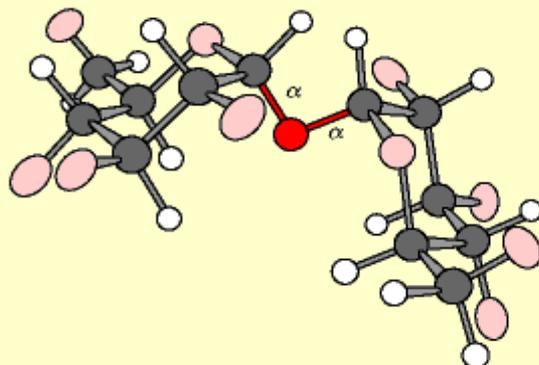
$\beta$ -D-Ribopyranose

(a) DISACCHARIDES with  $\alpha$  connections

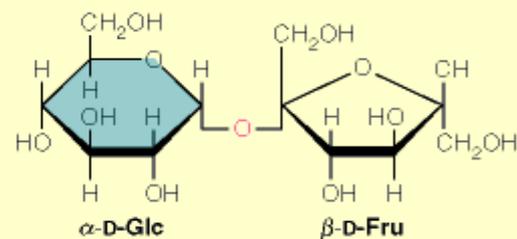
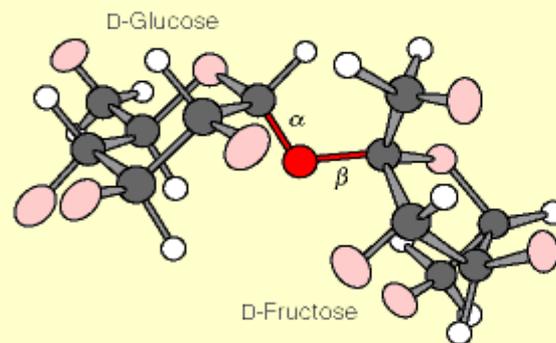
Maltose:  
 $\alpha$ -D-glucopyranosyl  
(1 $\rightarrow$ 4)  $\alpha$ -D-glucopyranose



$\alpha$ , $\alpha$ -Trehalose:  
 $\alpha$ -D-glucopyranosyl  
(1 $\rightarrow$ 1)  $\alpha$ -D-glucopyranose

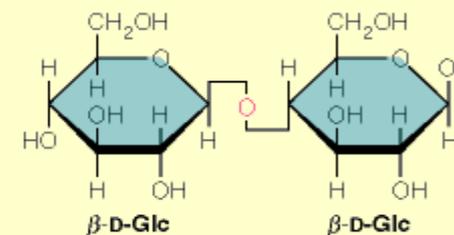
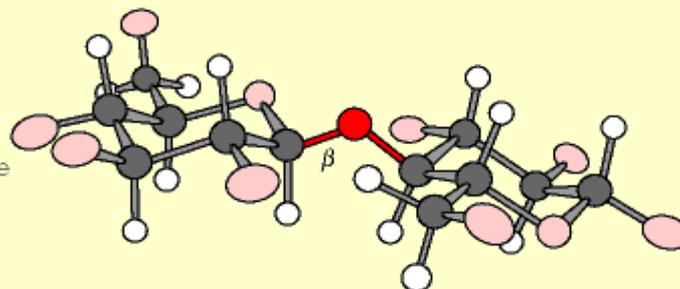


Sucrose:  
 $\alpha$ -D-glucopyranosyl  
(1 $\rightarrow$ 2)  $\beta$ -D-fructofuranoside

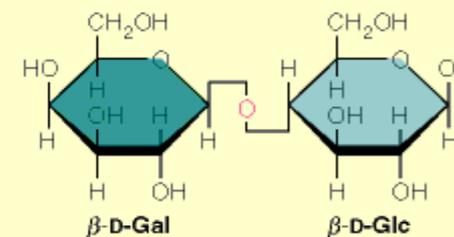
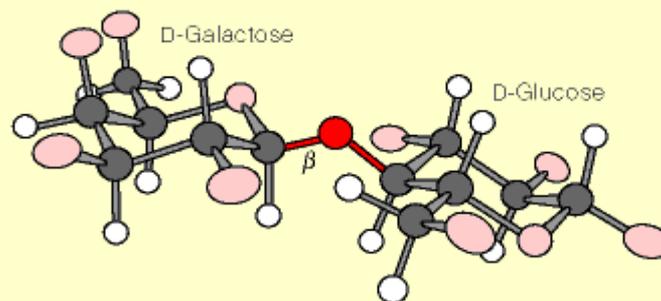


(b) DISACCHARIDES with  $\beta$  connections

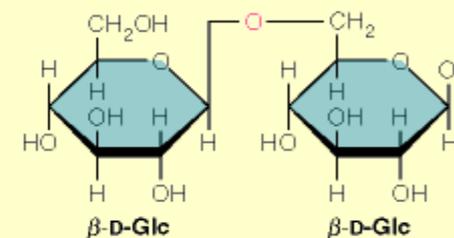
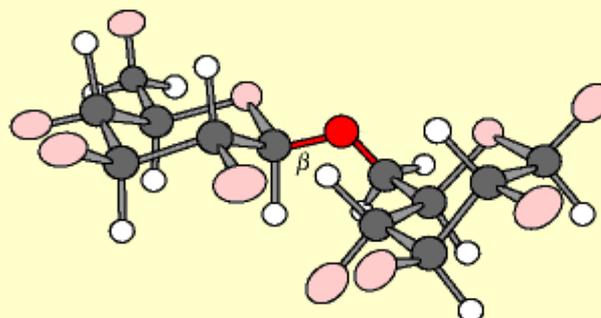
Cellobiose:  
 $\beta$ -D-glucopyranosyl  
(1 $\rightarrow$ 4)  $\beta$ -D-glucopyranose



Lactose:  
 $\beta$ -D-galactopyranosyl  
(1 $\rightarrow$ 4)  $\beta$ -D-glucopyranose



Gentiobiose:  
 $\beta$ -D-glucopyranosyl  
(1 $\rightarrow$ 6)  $\beta$ -D-glucopyranose





## Presencia y funciones bioquímicas de algunos disacáridos representativos

Disaccharide	Structure	Natural Occurrence	Physiological Role
Sucrose	$\text{Glc}\alpha(1\rightarrow2)\text{Fru}\beta$	Many fruits, seeds, roots, honey	A final product of photosynthesis; used as primary energy source in many organisms
Lactose	$\text{Gal}\beta(1\rightarrow4)\text{Glc}$	Milk, some plant sources	A major animal energy source
$\alpha,\alpha$ -Trehalose	$\text{Glc}\alpha(1\rightarrow1)\text{Glc}\alpha$	Yeast, other fungi, insect blood	A major circulatory sugar in insects; used for energy
Maltose	$\text{Glc}\alpha(1\rightarrow4)\text{Glc}$	Plants (starch) and animals (glycogen)	The dimer derived from the starch and glycogen polymers
Cellobiose	$\text{Glc}\beta(1\rightarrow4)\text{Glc}$	Plants (cellulose)	The dimer of the cellulose polymer
Gentiobiose	$\text{Glc}\beta(1\rightarrow6)\text{Glc}$	Some plants (e.g., gentians)	Constituent of plant glycosides and some polysaccharides



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