Wood Chemistry

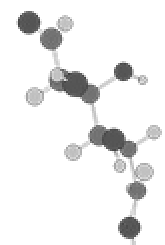
PSE 406 / Chem E 470

Lecture 2:

Monosaccharides

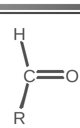
Why Study Monosaccharides?

As we discussed in lecture 1, wood carbohydrates (cellulose and hemicelluloses) are made of various sugars such as glucose, mannose, xylose, etc. In order to understand the properties and reactions of the carbohydrates, we need to understand monosaccharides.

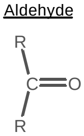

D-glucose

What is a Monosaccharide?

- Monosaccharides are polyhydroxy aldehydes or ketones (aldoses or ketoses) of 3-9 carbons.
  - » Polyhydroxy means that there is more than 1 hydroxyl group (OH) on the carbon backbone.
  - » Aldehydes and ketones both contain carbonyl groups.
- Typically monosaccharides contain either 5 or 6 carbons.



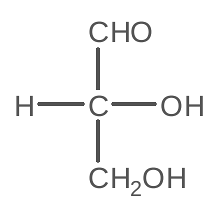
Aldehyde



Ketone

Glyceraldehyde

- This 3 carbon sugar is the simplest monosaccharide.
  - » It is an aldehyde.
  - » As is the case with all monosaccharides, it contains an asymmetric or chiral carbon. This means there are 4 different groups attached to this carbon
  - » Because of this, there are 2 different stereoisomers of this structure known as **enantiomers**.



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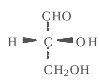
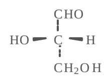
Glyceraldehyde Representations

1. Wedge and Dash



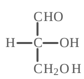
D-glyceraldehyde



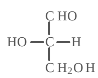
L-glyceraldehyde

In this representation, the dotted lines indicate bonds going into the paper the wedges indicate bonds coming out of the paper.

2. Fischer Formula



D-glyceraldehyde



L-glyceraldehyde

In the Fischer representation, vertical lines indicate bonds going into the paper while horizontal lines indicate bonds coming out of the paper.

Notes

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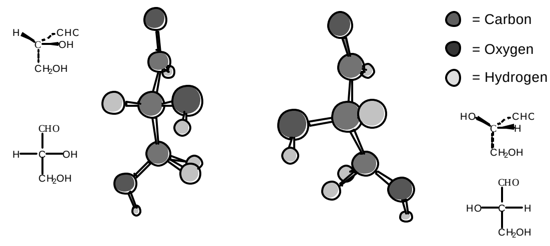
3 D Views of the Enantiomers of Glyceraldehyde



D Glyceraldehyde L Glyceraldehyde

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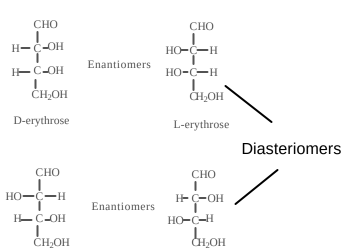
Four Carbon Sugars
(Not Found in Hemicelluloses or Cellulose)



D-erythrose L-erythrose D-threose L-threose

With 2 chiral centers in the molecule, there are 4 sterioisomers, two pairs of enatiomers and two pairs of diasteriomers.

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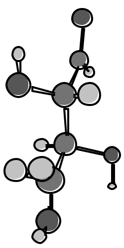
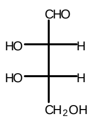
Stereochemistry

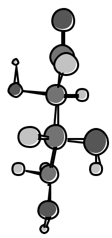
- Enantiomers are identical in physical properties except that they rotate polarized light in opposite directions. From a biochemical standpoint, they are different.
- Diastereoisomers possess different physical properties
- For n asymetric carbons there are:
  - » 2^n maximum possible number of sterioisomers
  - » 2^{n-1} maximum possible number of enantiometric pairs
  - » That means there are 2^{n-1} possible diastereoisomer pairs

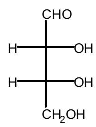
Enatiomers of Erythrose





L Erythrose

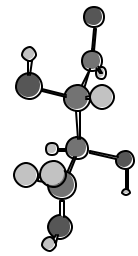


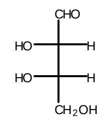


D Erythrose

Are you a 3D type of Student?

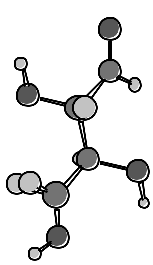
- How do chemical representations correlate with the actual spatial arrangement of the molecule?
- The representations are a simplified (but tricky way) of showing the molecule.





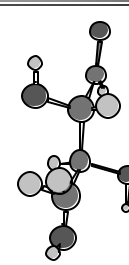
Simple Bob Method for 3D

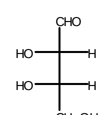
- Remember, in the Fischer formula, the vertical lines always go into the paper. You don't want your molecule to be a circle so in 3D the carbon backbone alternates in and out of the page.



Simple Bob Method for 3D (II)

Check out the second carbon down, in the 3d version the carbons attached to this atom both are going into the page. The OH group and the H group attached to this carbon are coming out of the page and pointing to the left and right respectively. Therefore, in the Fischer formula these are drawn to the left and right.





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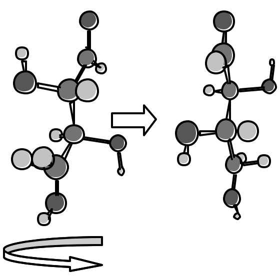
Simple Bob Method for 3D (III)

Now if you go to the 3rd carbon from the top, you will notice that the carbon above and below it are coming out of the page; this is unacceptable. To fix this, we rotate the molecule 180°.



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Simple Bob Method for 3D (IV)

If you look at the molecule now you will see that the OH and H groups on the 3rd carbon now stick out of the page and are on the left and right side respectively. Draw them into the Fischer formula and you get your final molecule.

It may seem a little tricky but it is a fun thing to do at parties.