Lecture 8B

Carbs 1: Monosaccharides

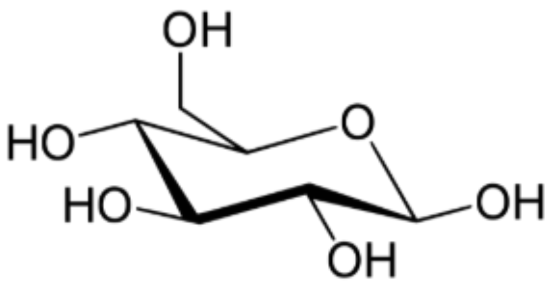
Chapter 10

Dr. Neil Voss

March 27, 2025

They are ALL Glucose!!!

A



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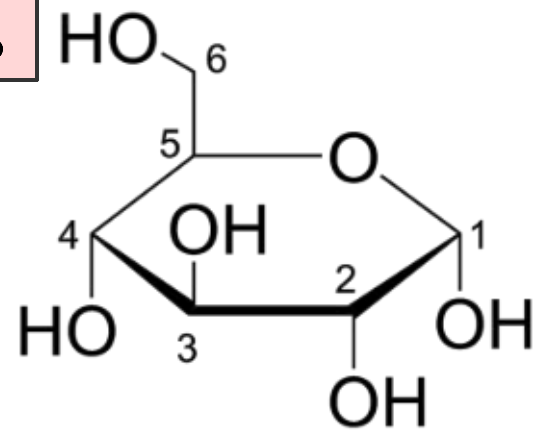

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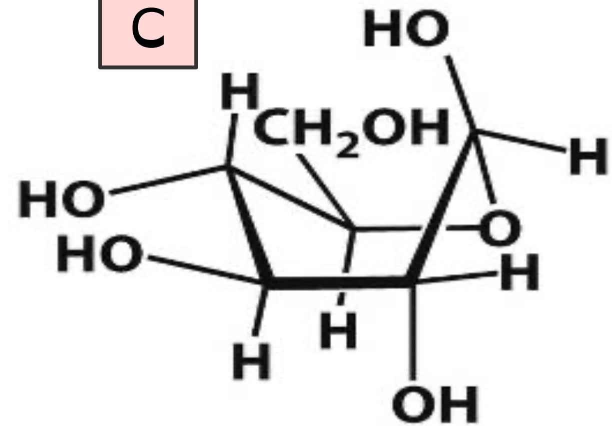

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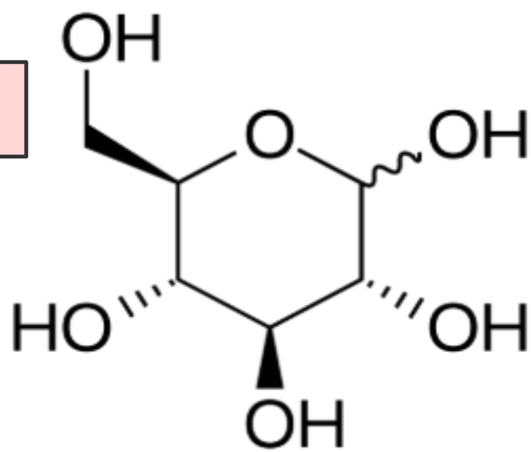

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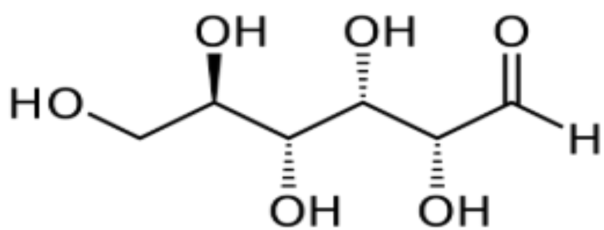

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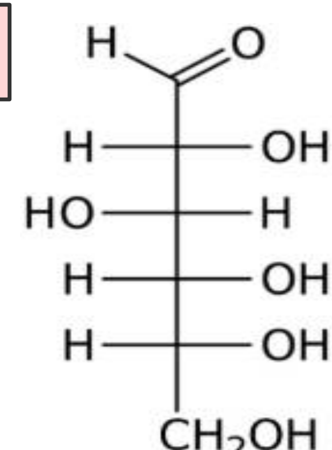
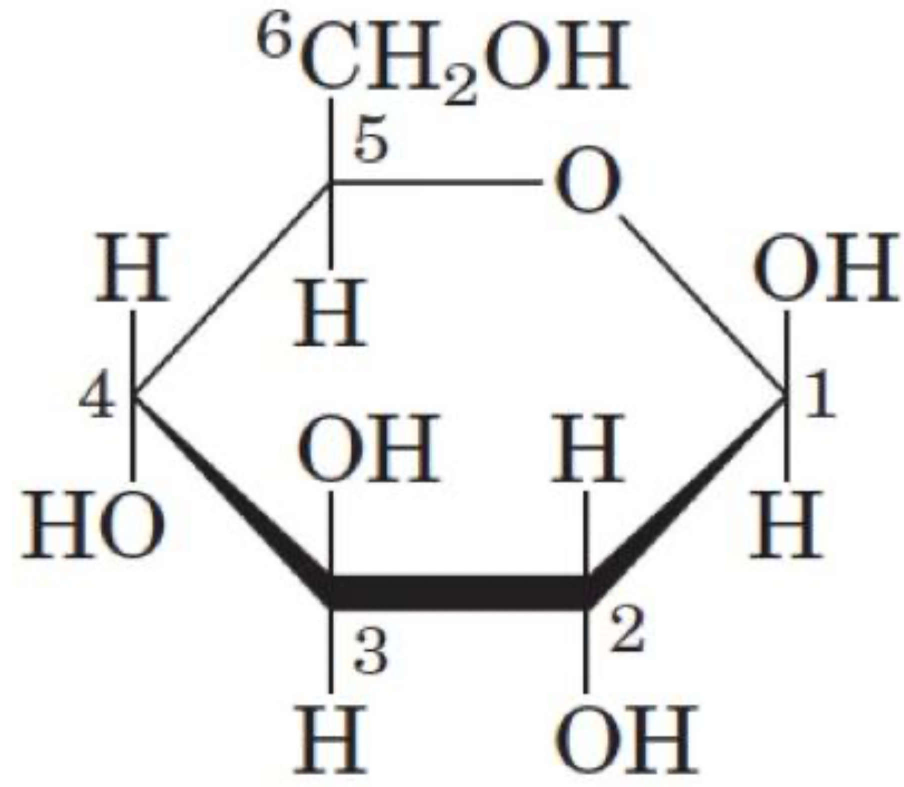


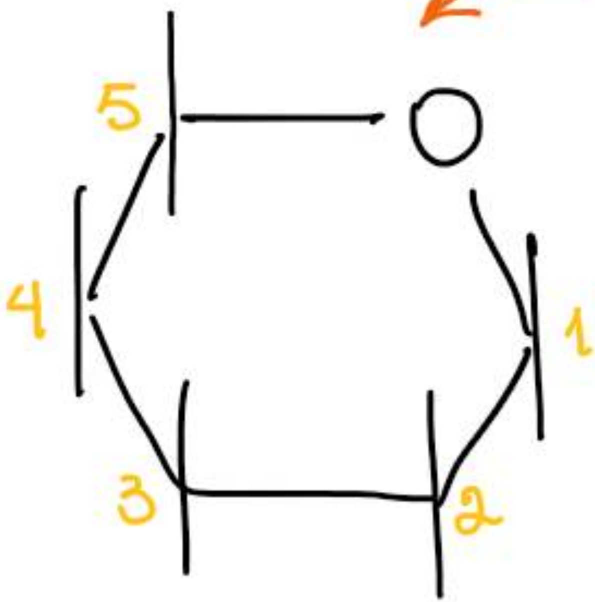
Haworth Projections

- A Haworth projection has the following characteristics:
  - A thicker line indicates atoms that are closer to the observer.
  - The groups below the plane of the ring correspond to those on the right-hand side of a Fischer projection.



β-D-Glucose

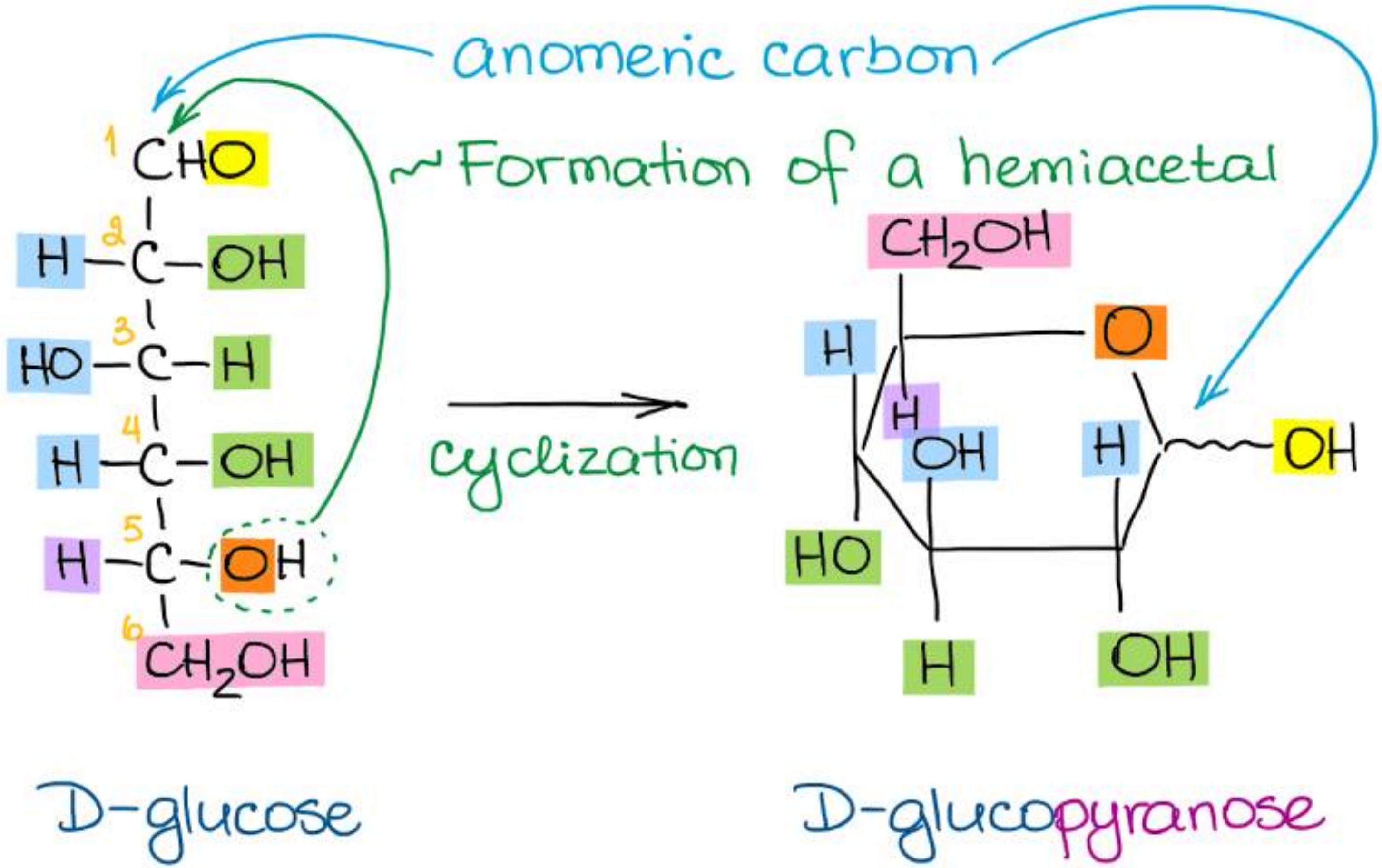
Haworth Projection (pyranose)



Haworth pyranose

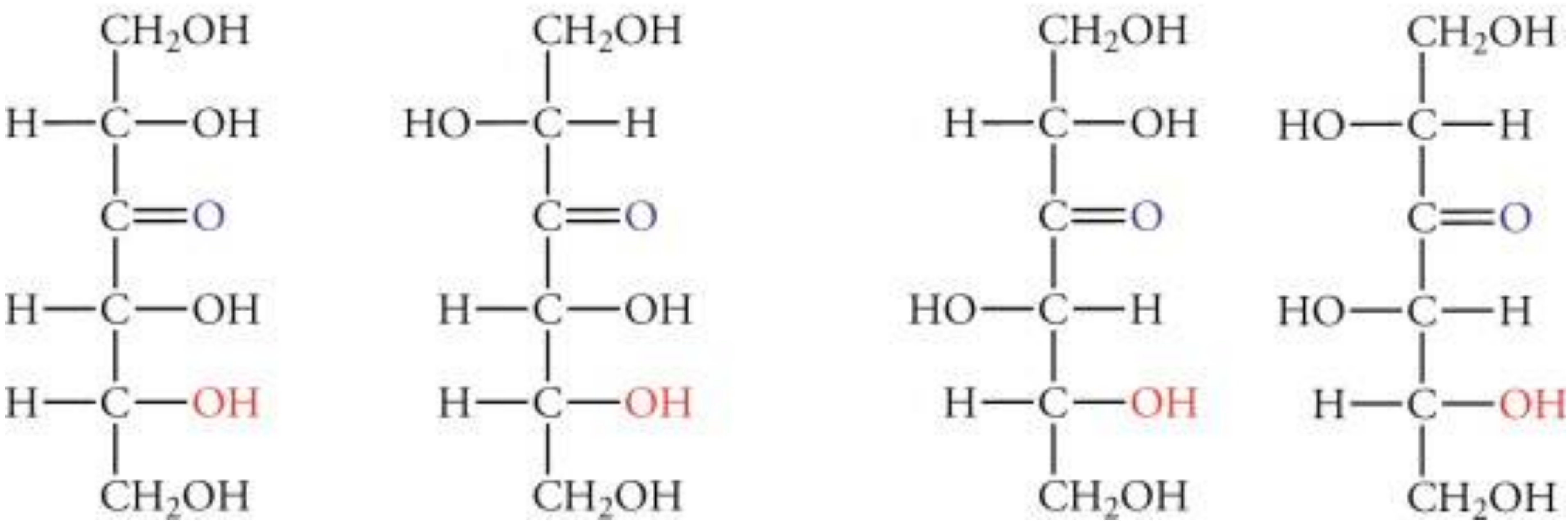
anomeric carbon

Fischer and Haworth

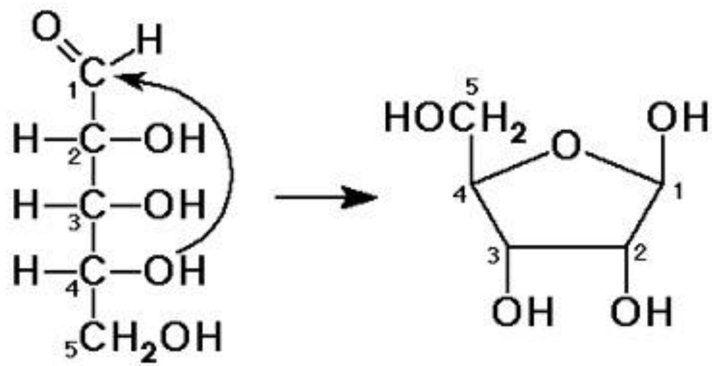


Not Found in Nature

3-Ketohexoses



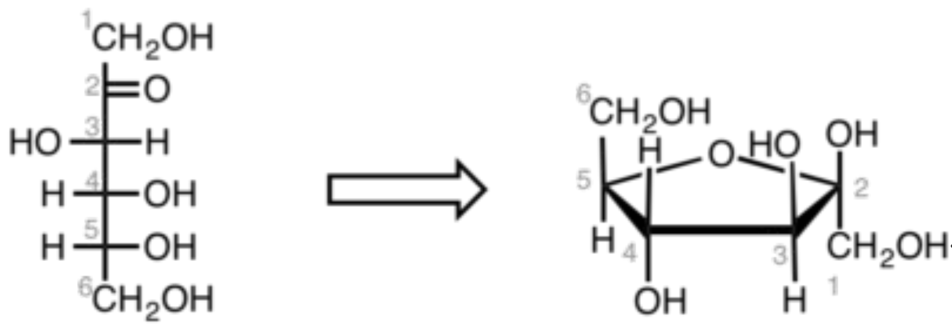
Haworth: Aldose vs. Ketose



D-ribose β-D-ribofuranose

aldose

only
-OH on
anomeric
carbon



D-fructose

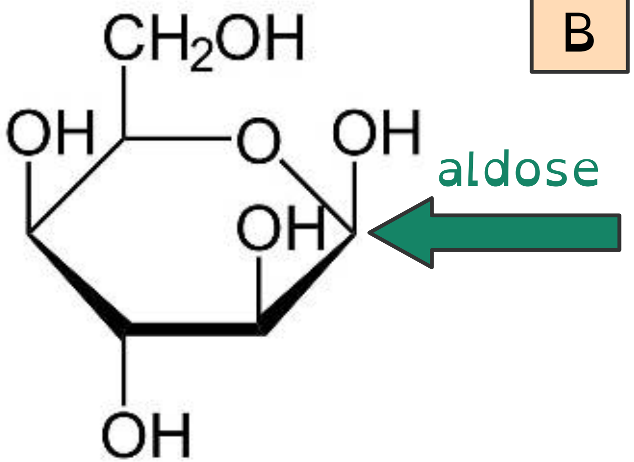
Haworth projection for the β- furanose

ketose

extra
CH_2OH off
anomeric
carbon

Haworth: Aldose vs. Ketose

A



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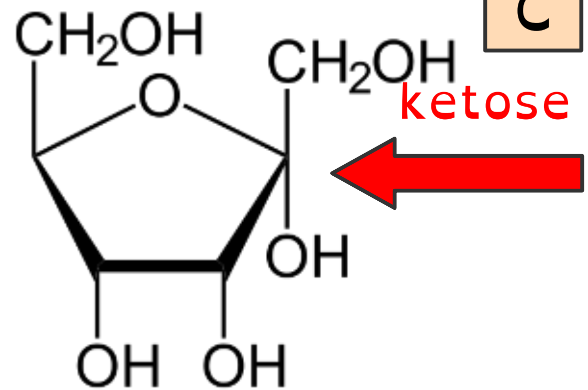

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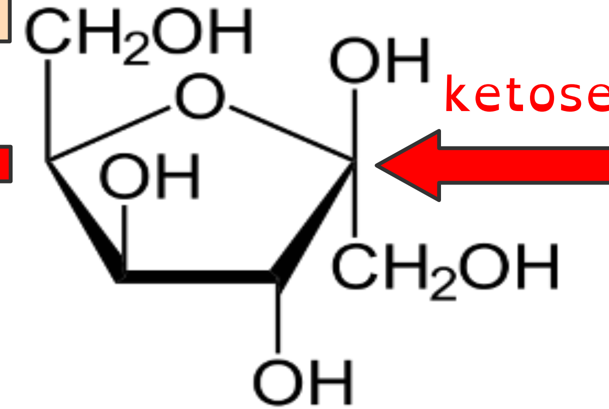

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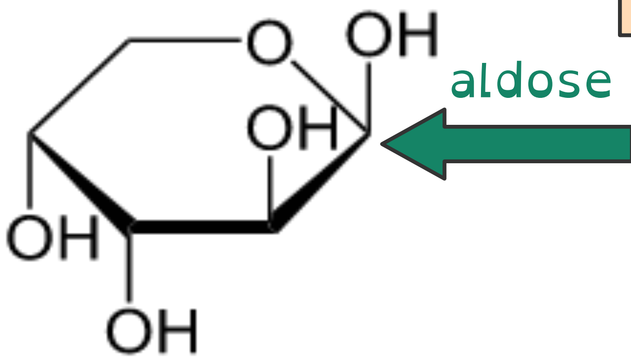

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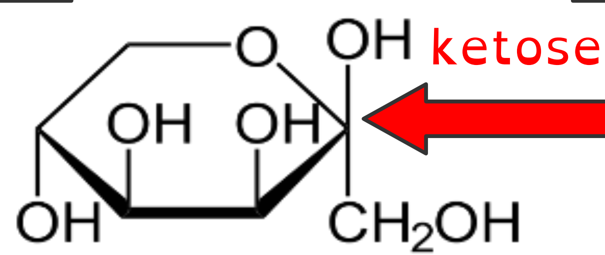

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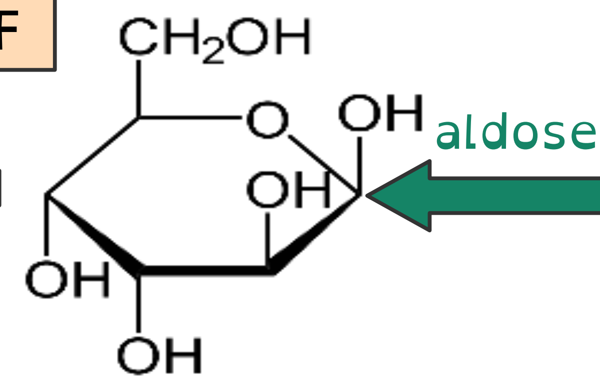
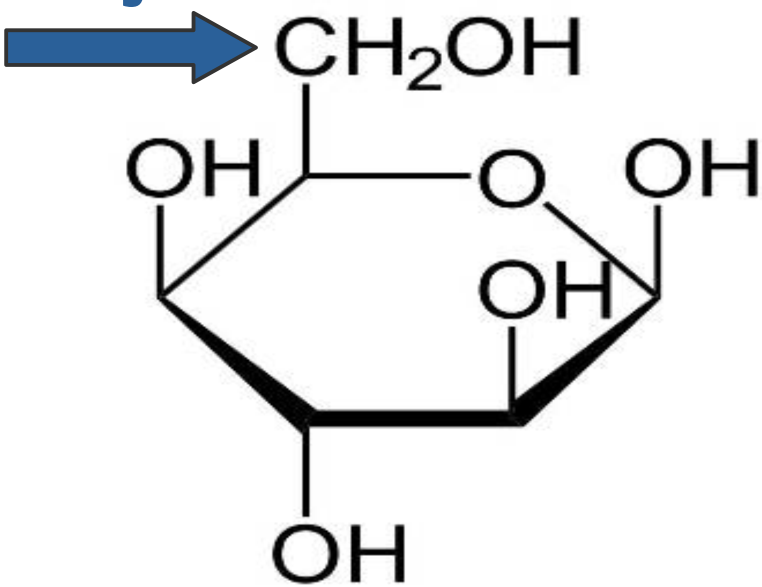


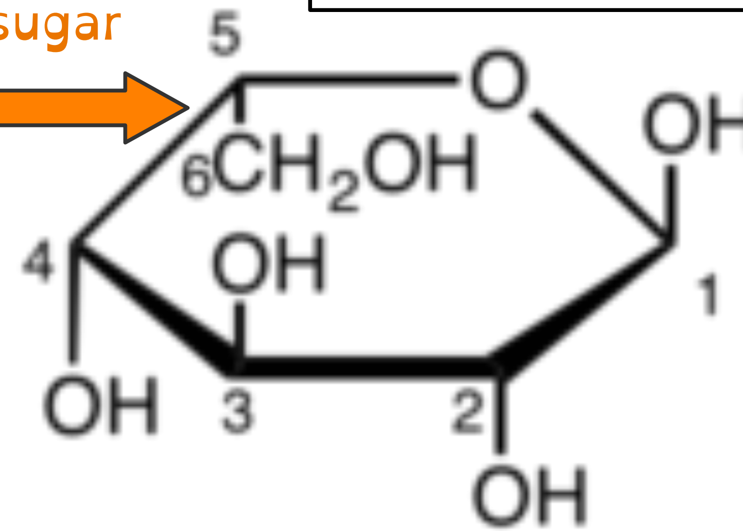
Haworth: D- vs. L-

D-sugar



L-sugar has the 6-carbon below the ring

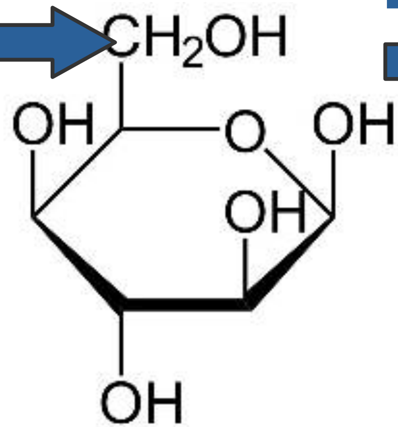
L-sugar



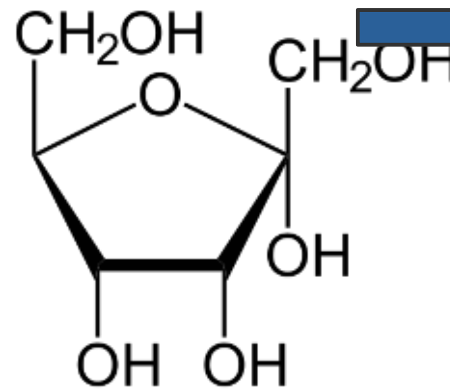
D-sugar has the 6-carbon above the ring

Haworth: D- vs. L-

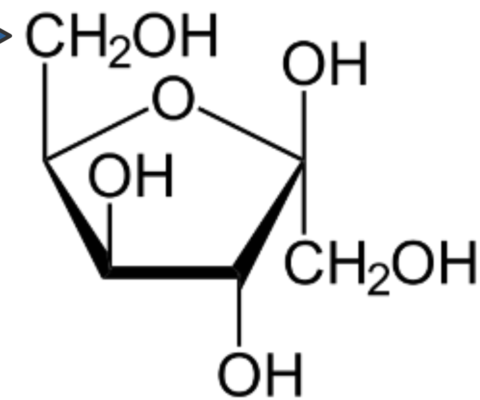
D-sugar



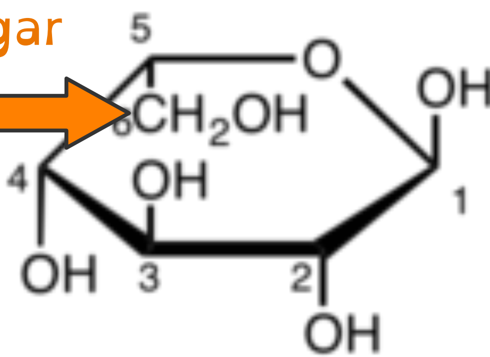
D-sugar



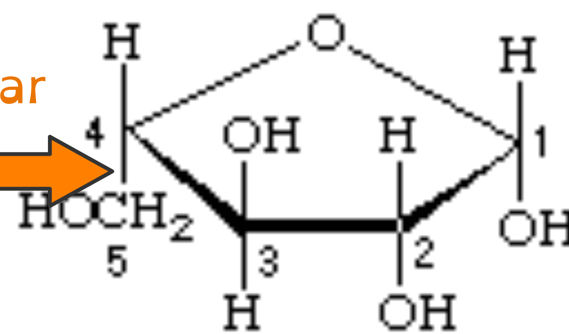
D-sugar



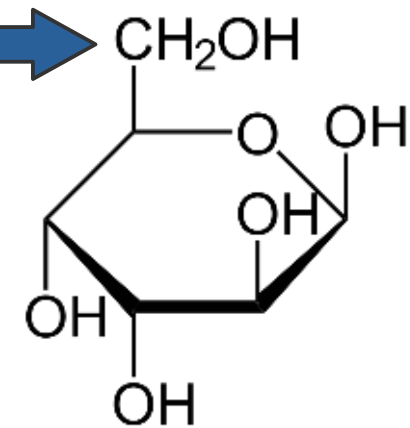
L-sugar



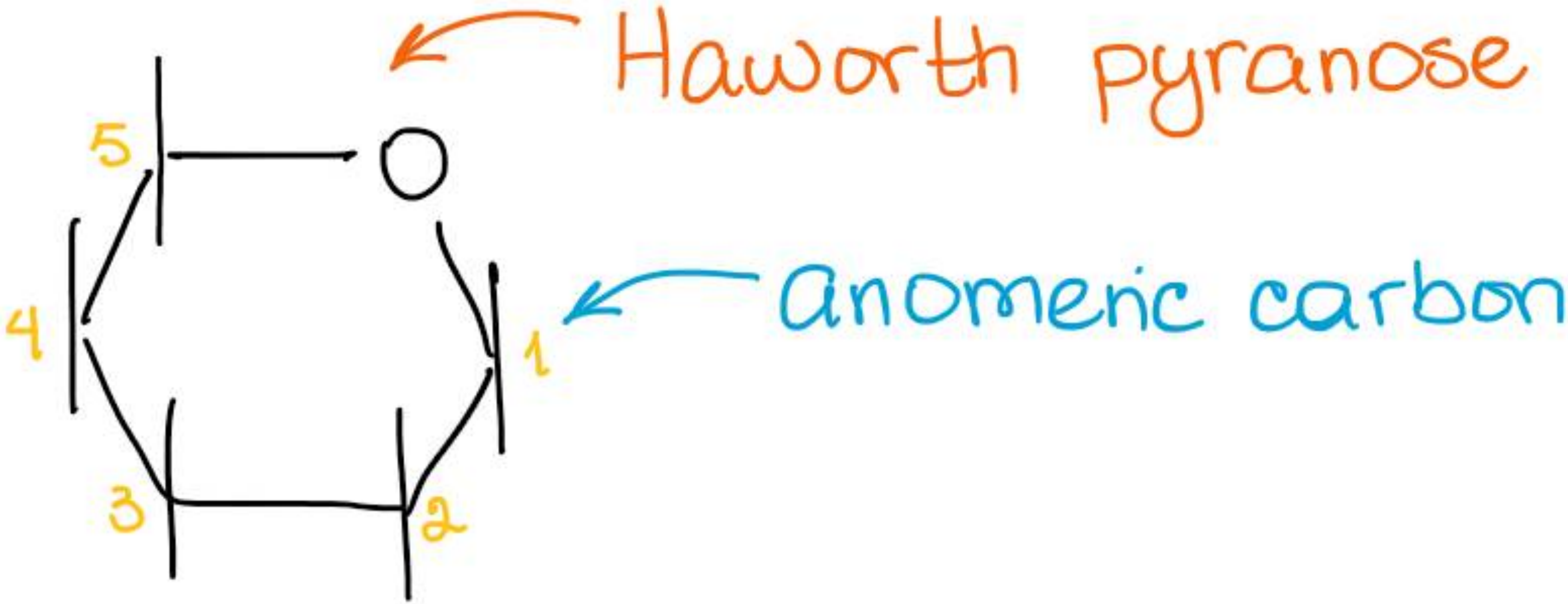
L-sugar

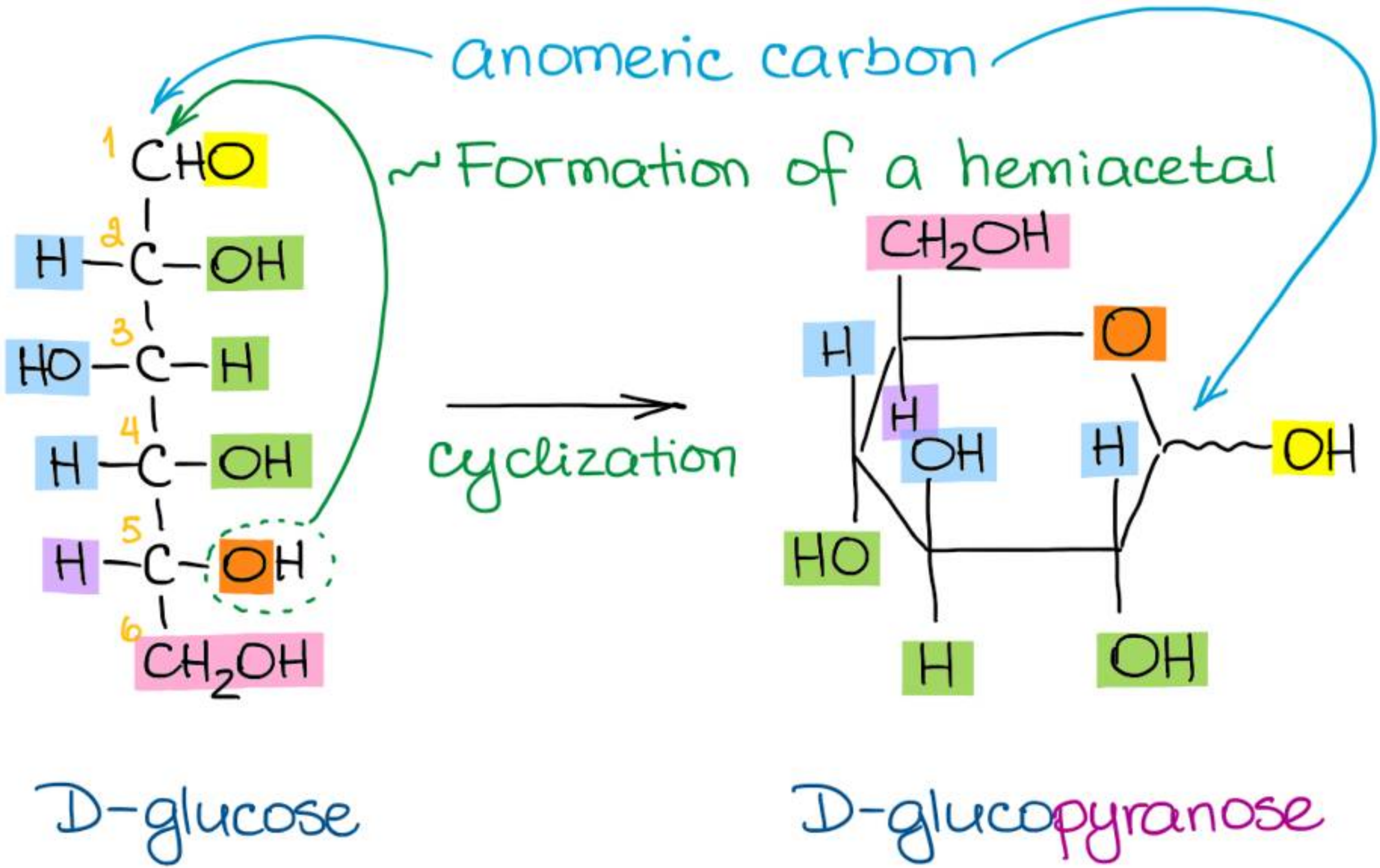


D-sugar

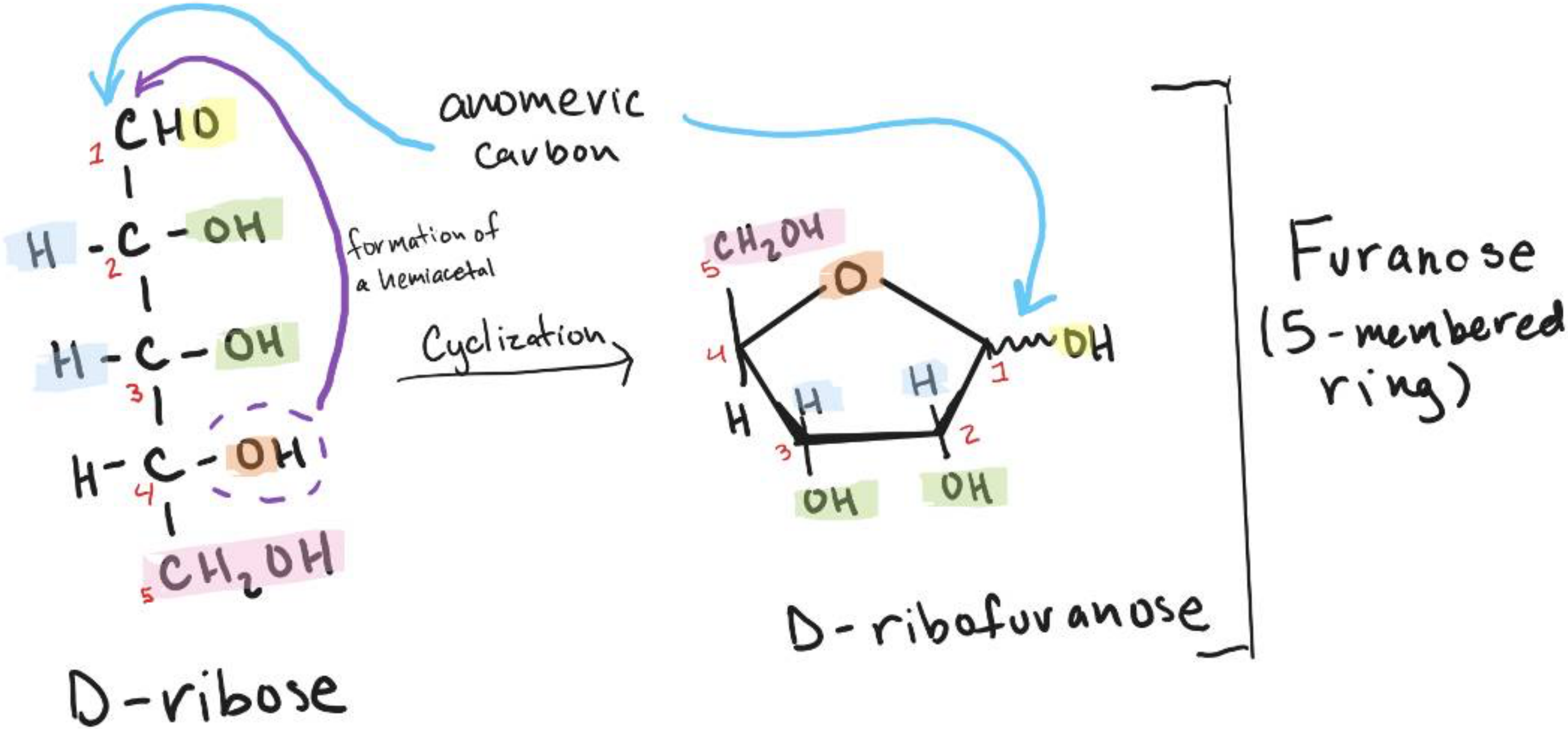


Haworth Projection (pyranose)

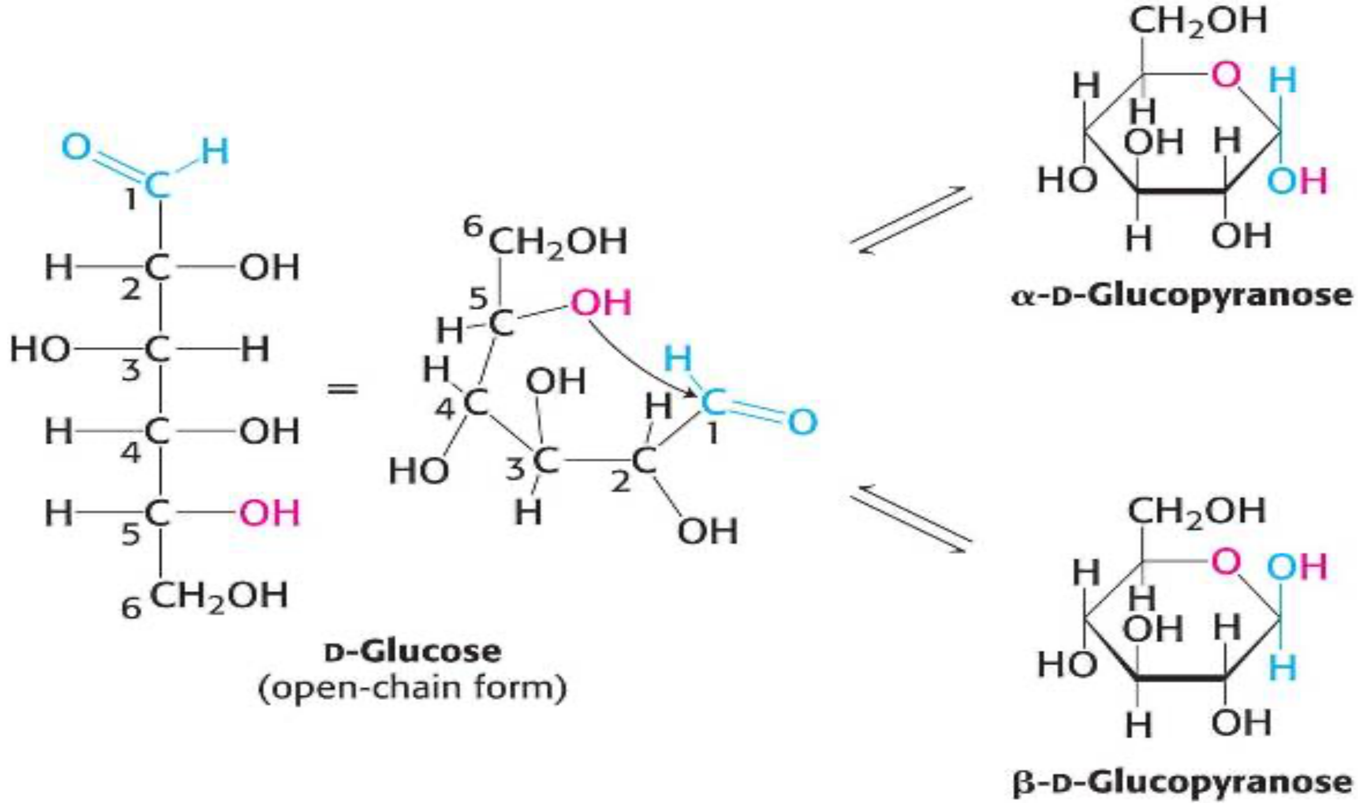




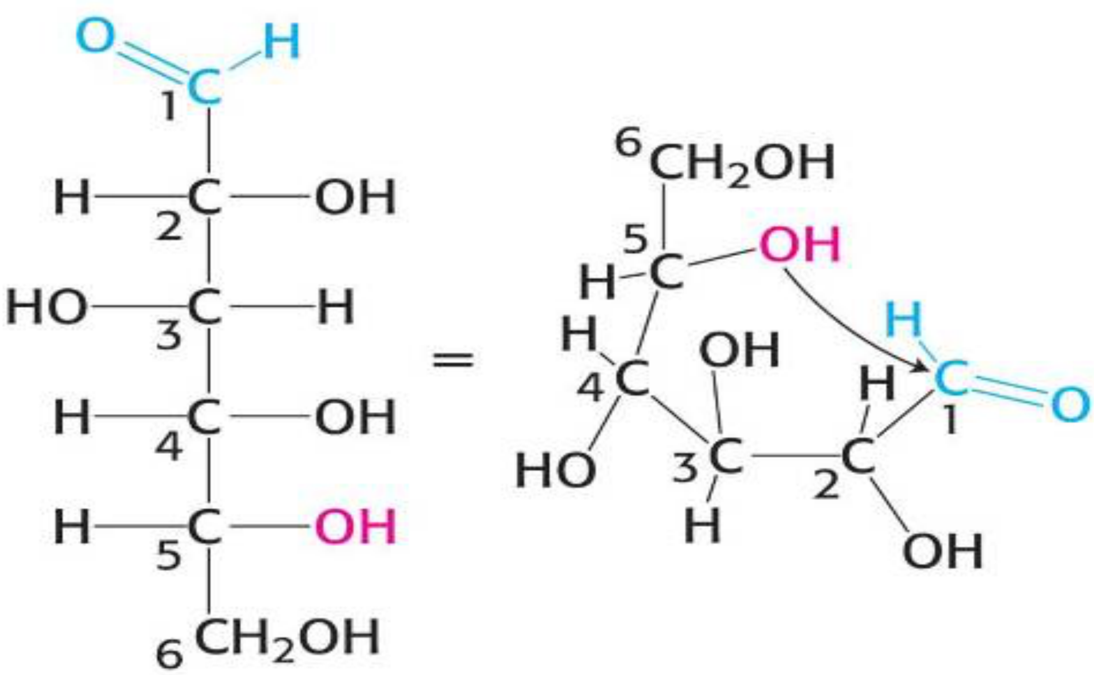
anomeric carbon
Formation of a hemiacetal
1 CHO
2 H—C—OH
3 HO—C—H
4 H—C—OH
5 H—C—OH
6 CH2OH
cyclization
CH2OH
H
O
H
OH
H
OH
HO
H
OH
D-glucose
D-glucopyranose


anomeric carbon
formation of a hemiacetal
Cyclization
D-ribose
D-ribofuranose
Furanose (5-membered ring)

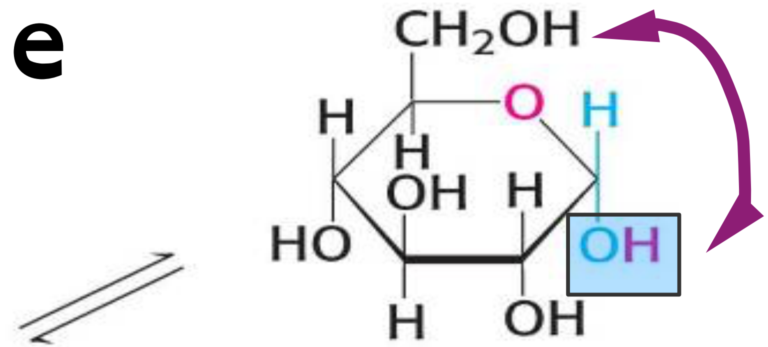
- Formation of a cyclic hemiacetal creates another diastereoisomeric form called an anomer.
- For D-configuration sugars:
  - The α form means the the hydroxyl at C-1 is below the plane of the ring.
  - The β form means that the hydroxyl at C-1 is above the plane of the ring.



Anomers of Glucose

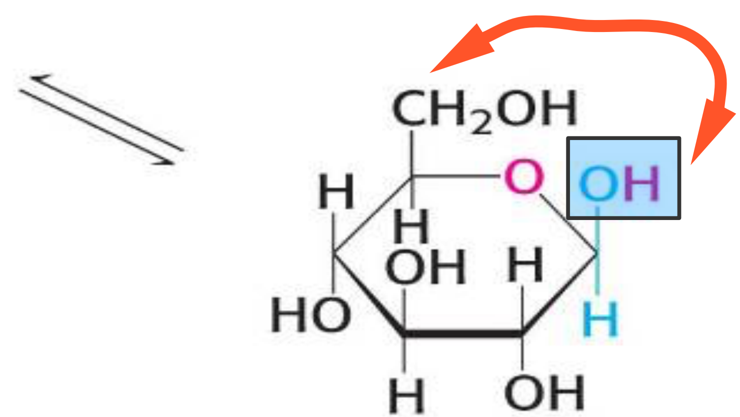


D-Glucose
(open-chain form)



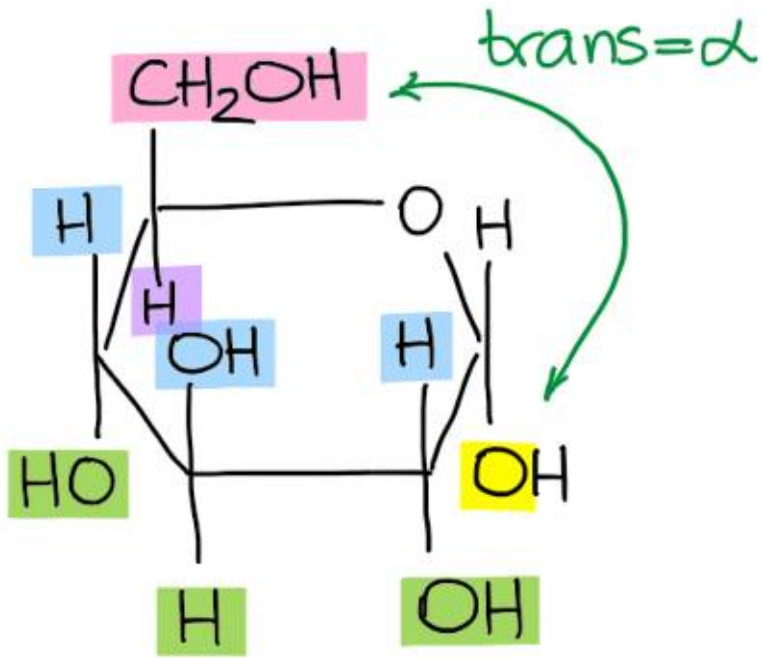
α-D-Glucopyranose

-OH is trans with CH_2OH

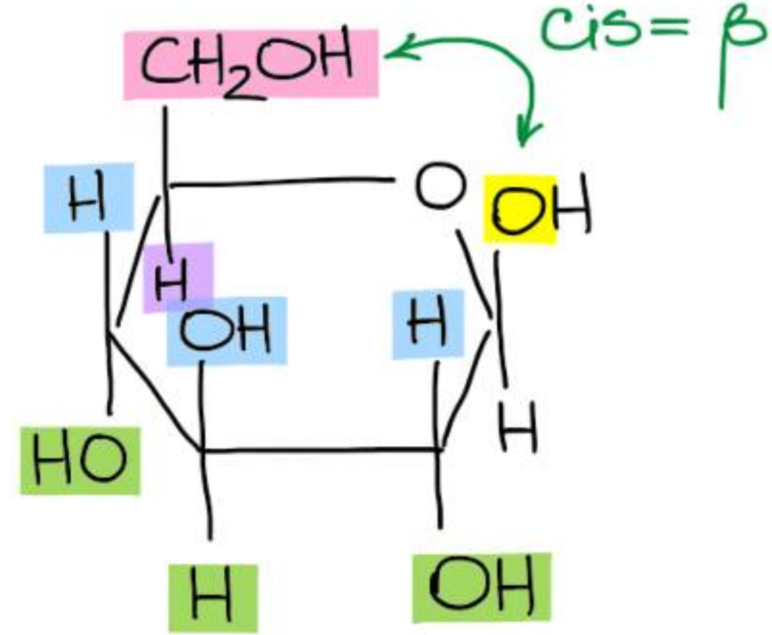


β-D-Glucopyranose

-OH is cis with CH_2OH



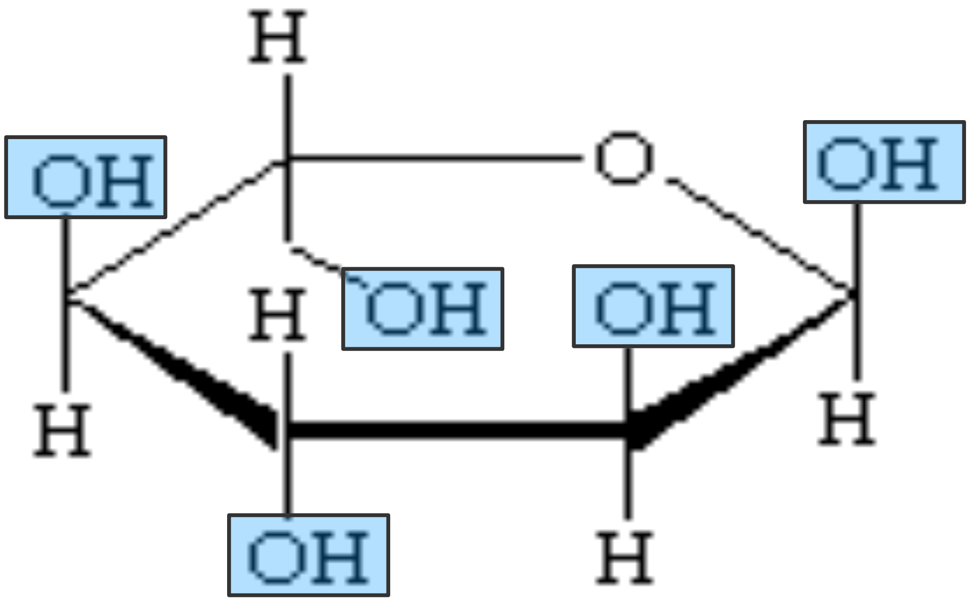
α-D-glucopyranose



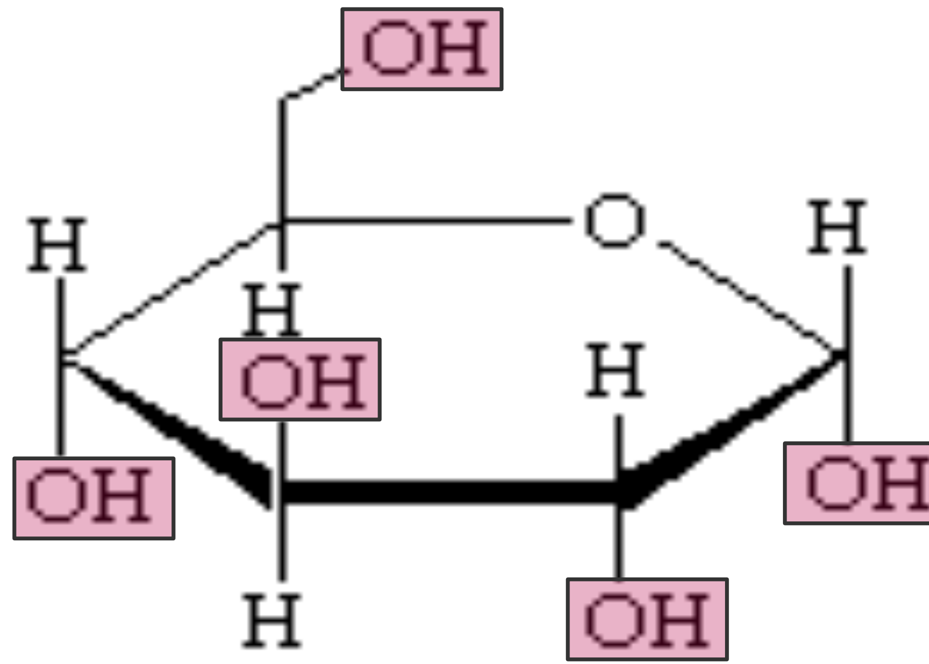
β-D-glucopyranose

Enantiomers of Glucose

α-L-glucose (mirror)

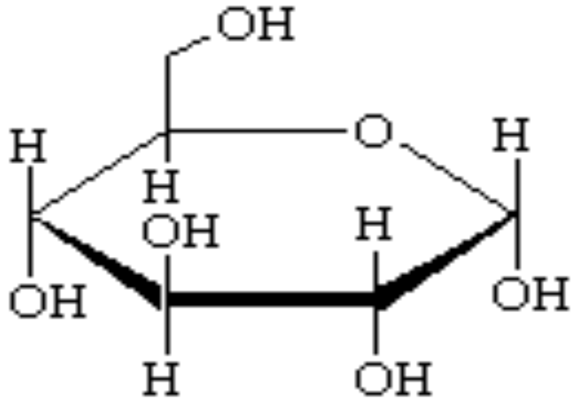


α-D-glucose

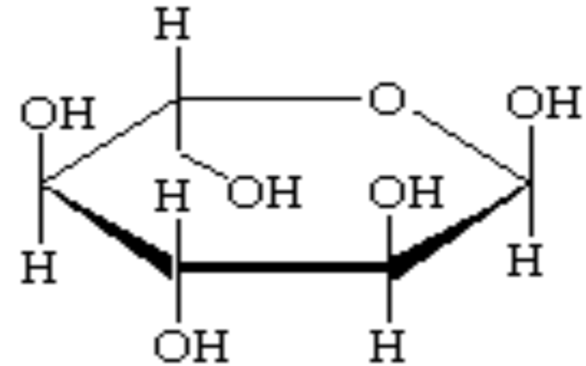


The D and L refer to the absolute configuration of the asymmetric carbon farthest from the aldehyde or keto group

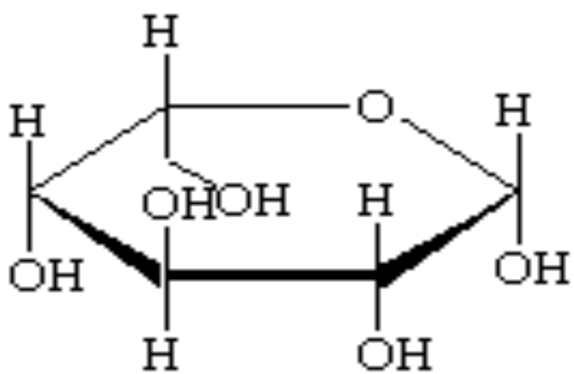
Enantiomers of Glucose



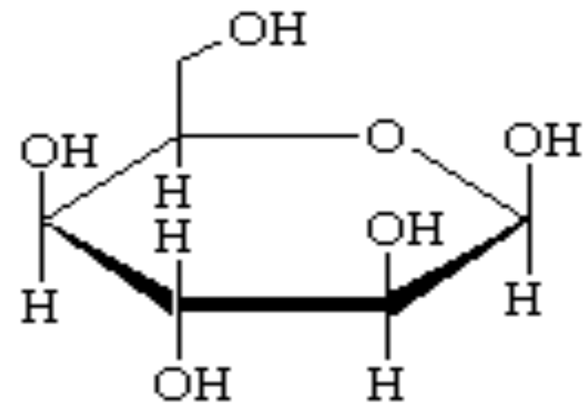
D-glucose



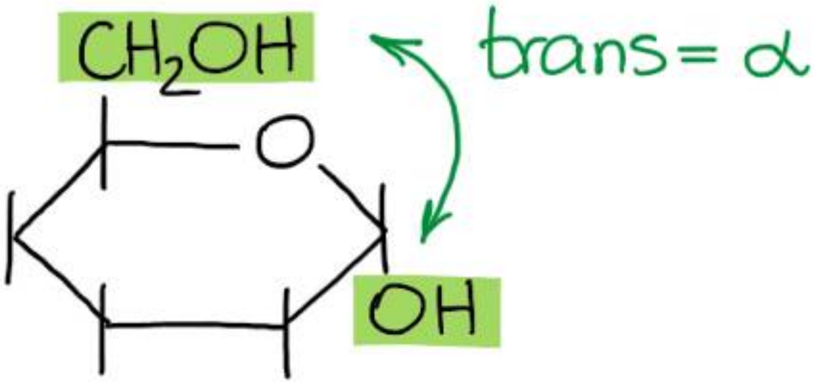
L-glucose



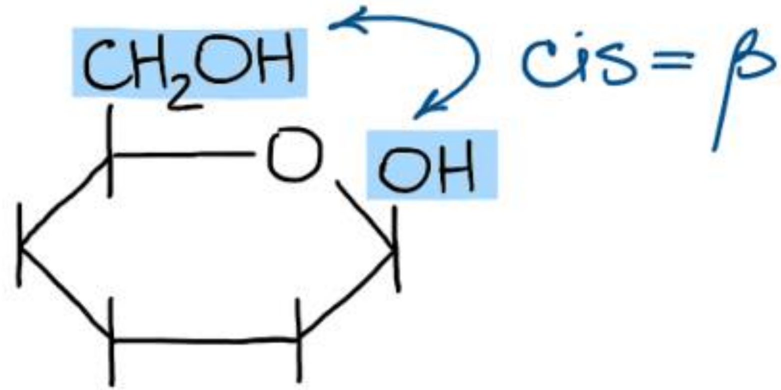
L-idose



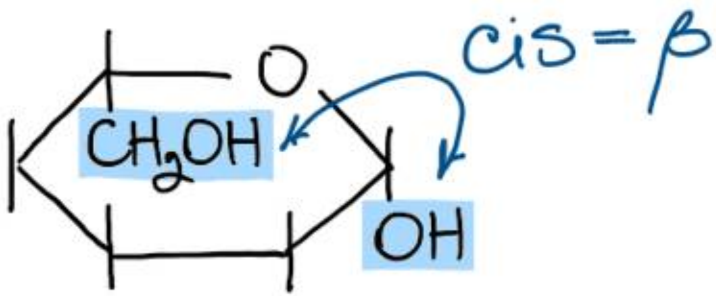
D-idose



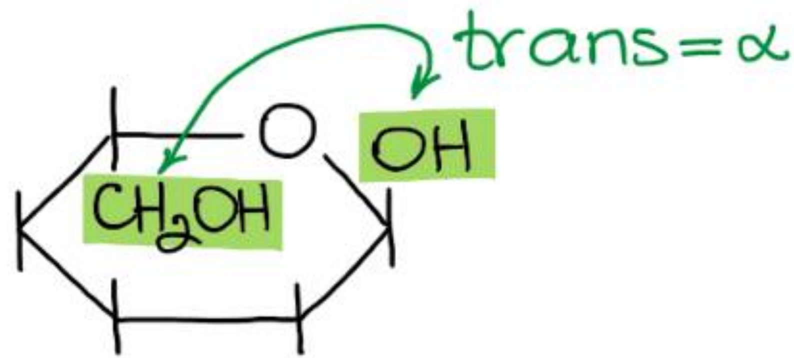
D-α-pyranose



D-β-pyranose

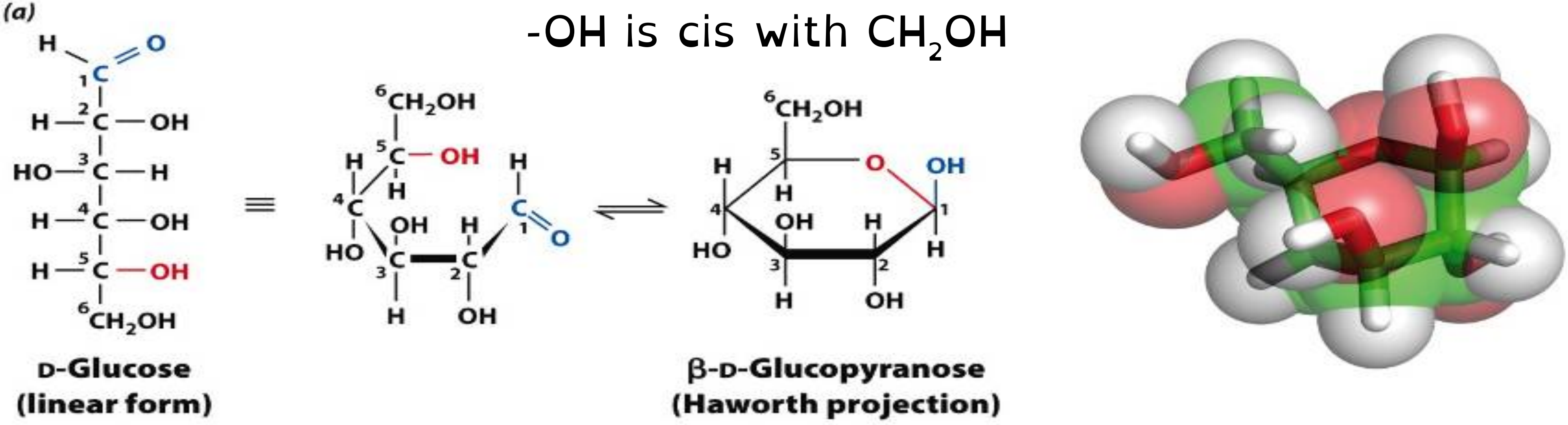


L-β-pyranose



L-α-pyranose

-OH is cis with CH_2OH



-OH is cis with CH_2OH

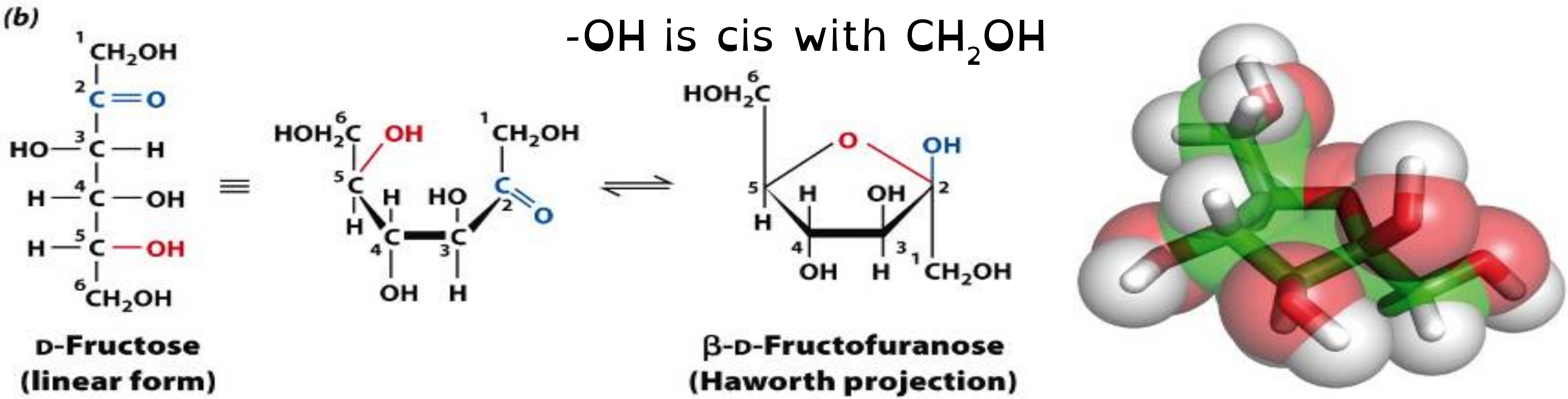
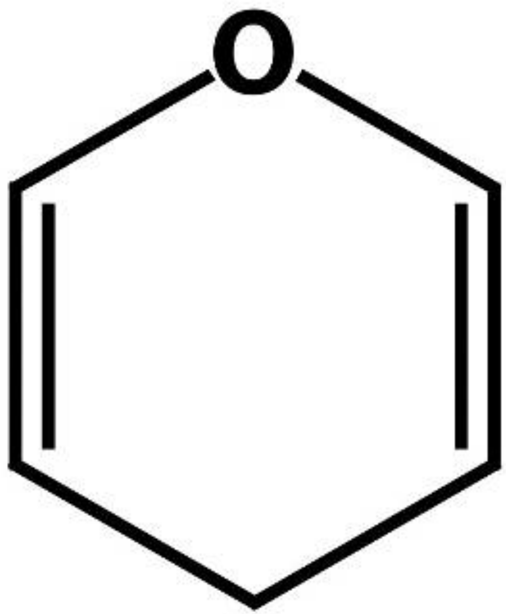


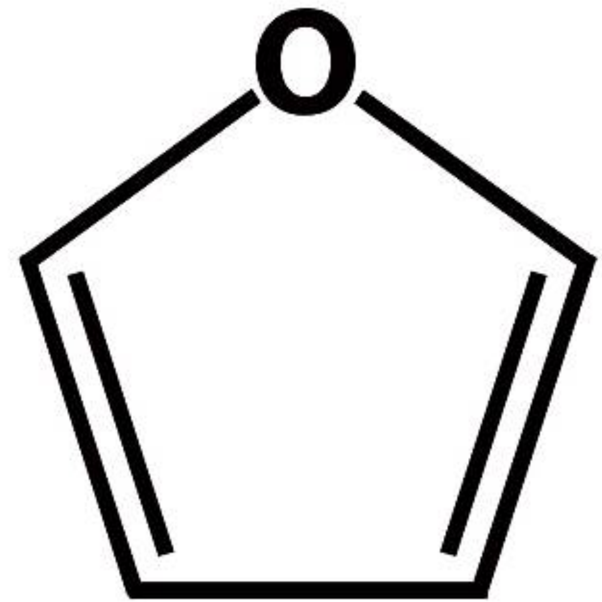
Figure 11-4

Two Common Types of Monosaccharide Rings



Pyran

Unnumbered 9 p125b
Biochemistry: A Short Course, First Edition

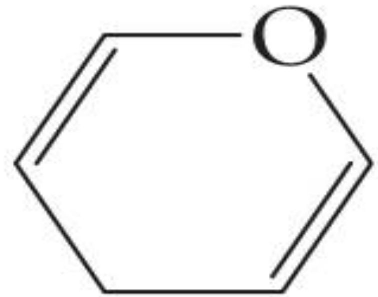


Furan

Unnumbered 9 p126b
Biochemistry: A Short Course, First Edition

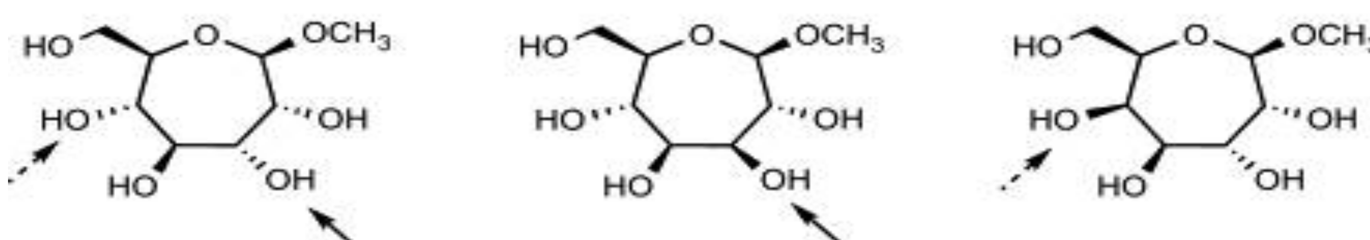
Ring Naming

Furan



Pyran

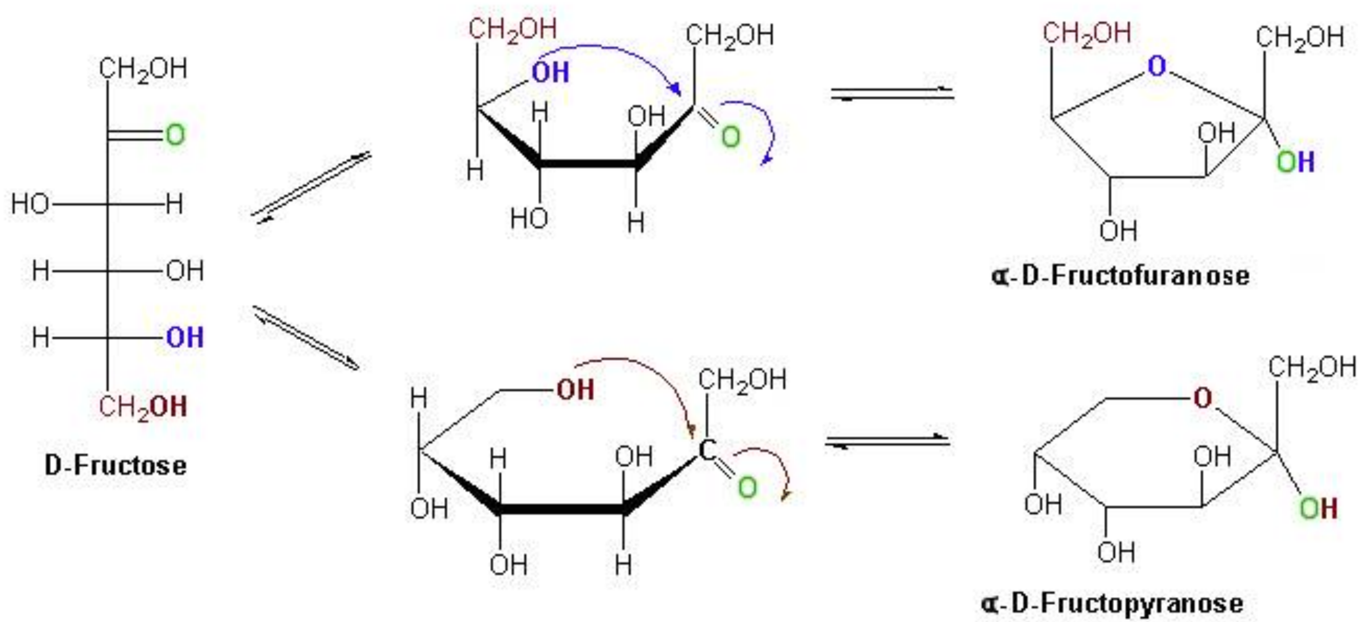
- "furan" for a 5-atom ring
- "pyran" for 6-atom ring
- "septan" for 7-atom ring ← not natural



200 208 209

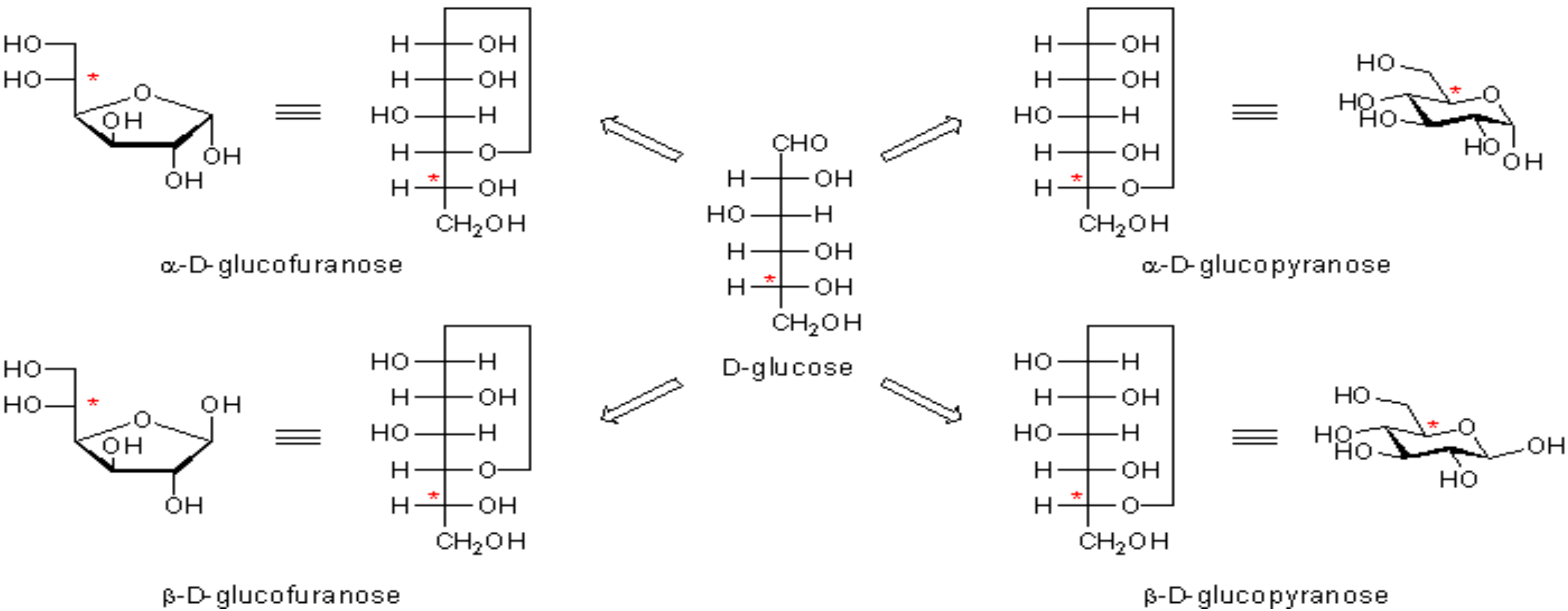
C) both pyranose and furanose ring forms.

Isomeric Forms of Fructose



In theory, any -OH group can react with carbonyl group >=O

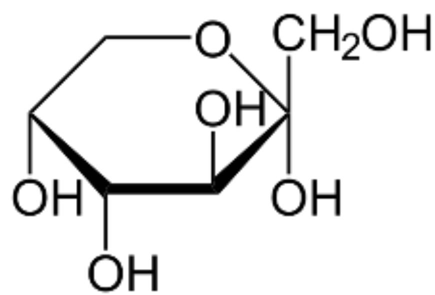
Both pyranose and furanose ring forms



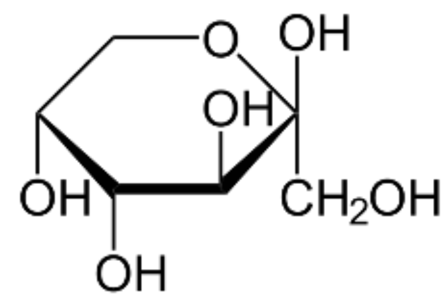
In theory, any -OH group can react with carbonyl group >=O

Haworth Projections of Fructose (ketohexose)

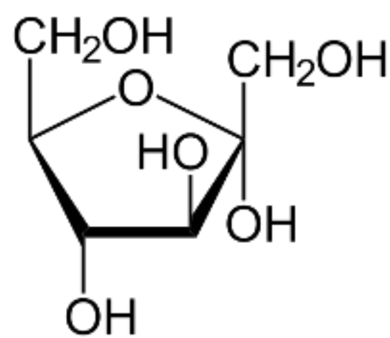
6



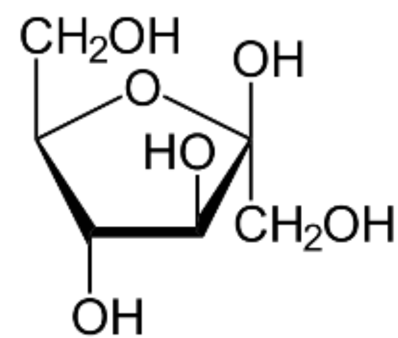
α-D-Fructopyranose



β-D-Fructopyranose



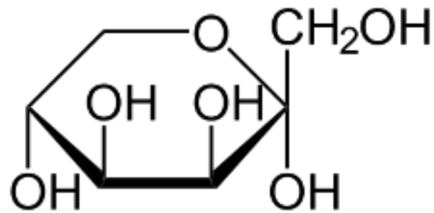
α-D-Fructofuranose



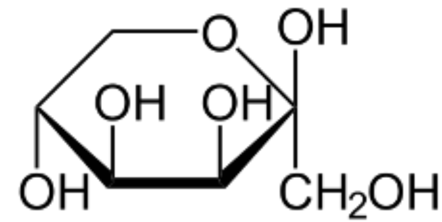
β-D-Fructofuranose

Haworth Projections of Tagatose? (ketohexose)

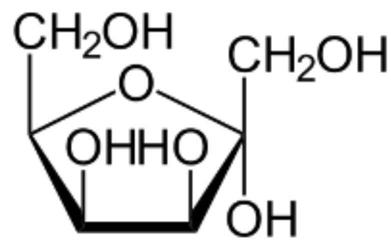
6



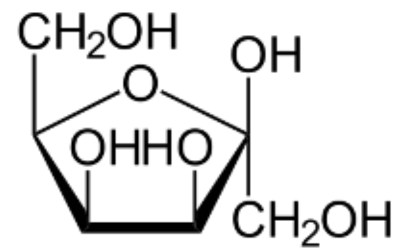
α-D-Tagatopyranose



β-D-Tagatopyranose



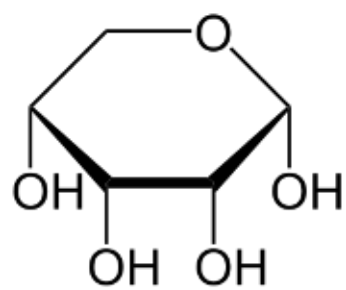
α-D-Tagatofuranose



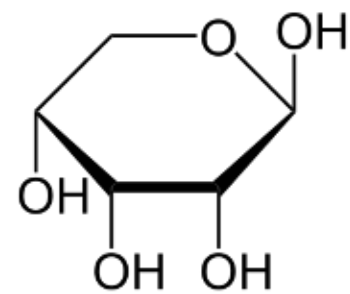
β-D-Tagatofuranose

Haworth Projections of Ribose (aldopentose)

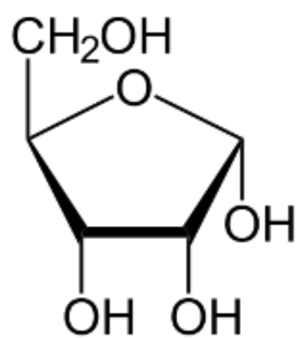
5



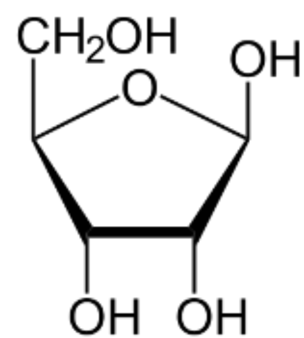
α-D-Ribopyranose



β-D-Ribopyranose



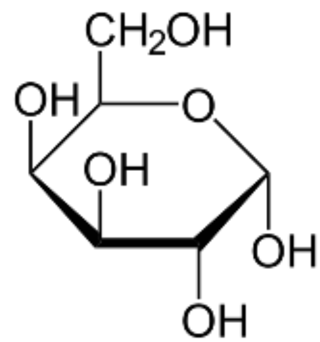
α-D-Ribofuranose



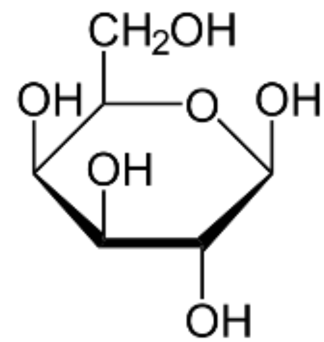
β-D-Ribofuranose

Haworth Projections of Galactose (aldohexose)

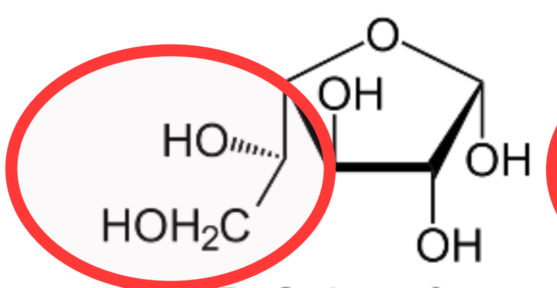
6



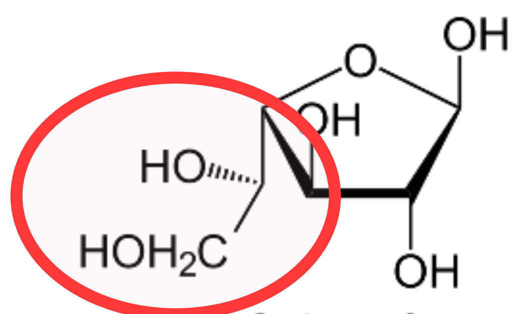
α-D-Galactopyranose



β-D-Galactopyranose

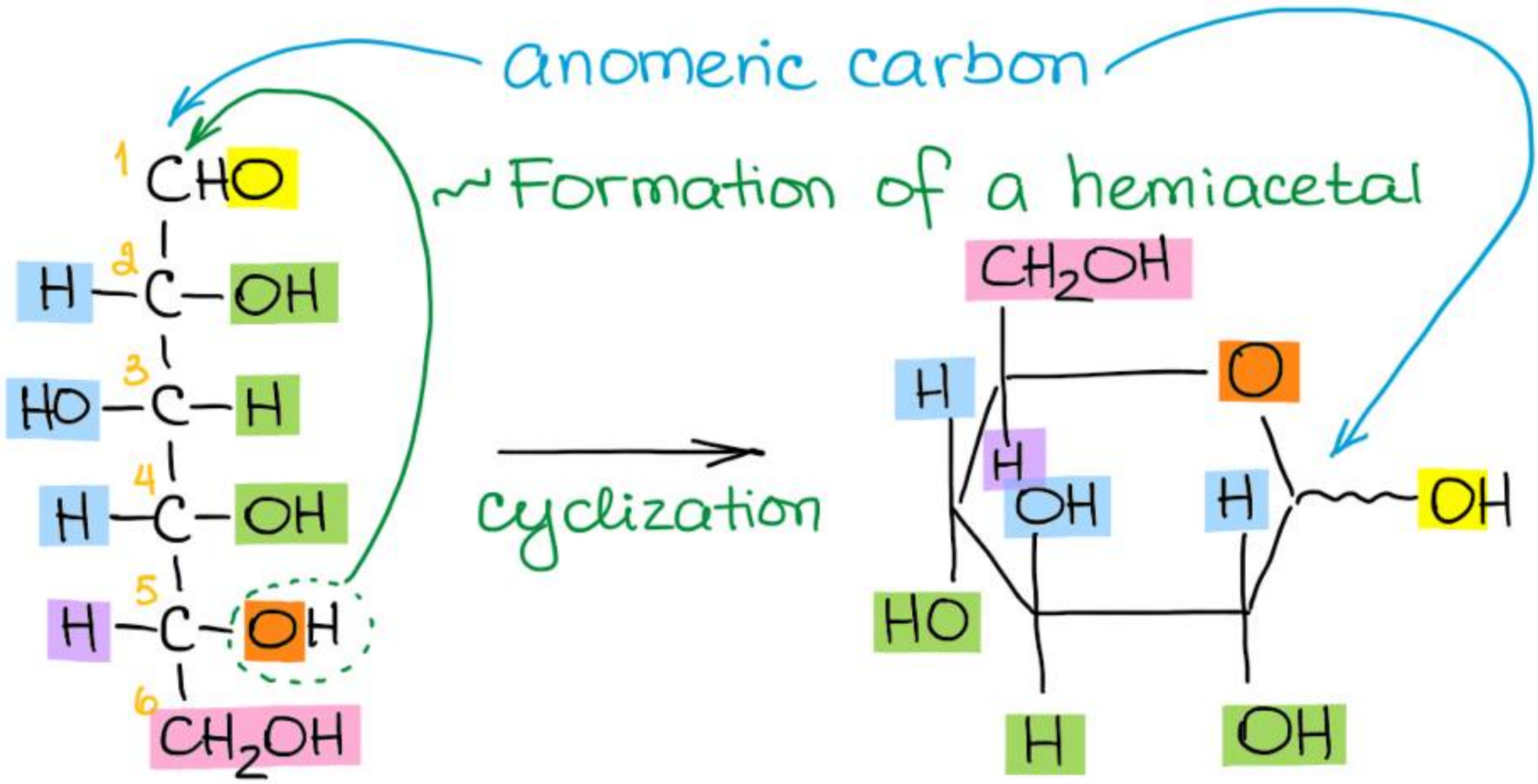


α-D-Galactofuranose



β-D-Galactofuranose

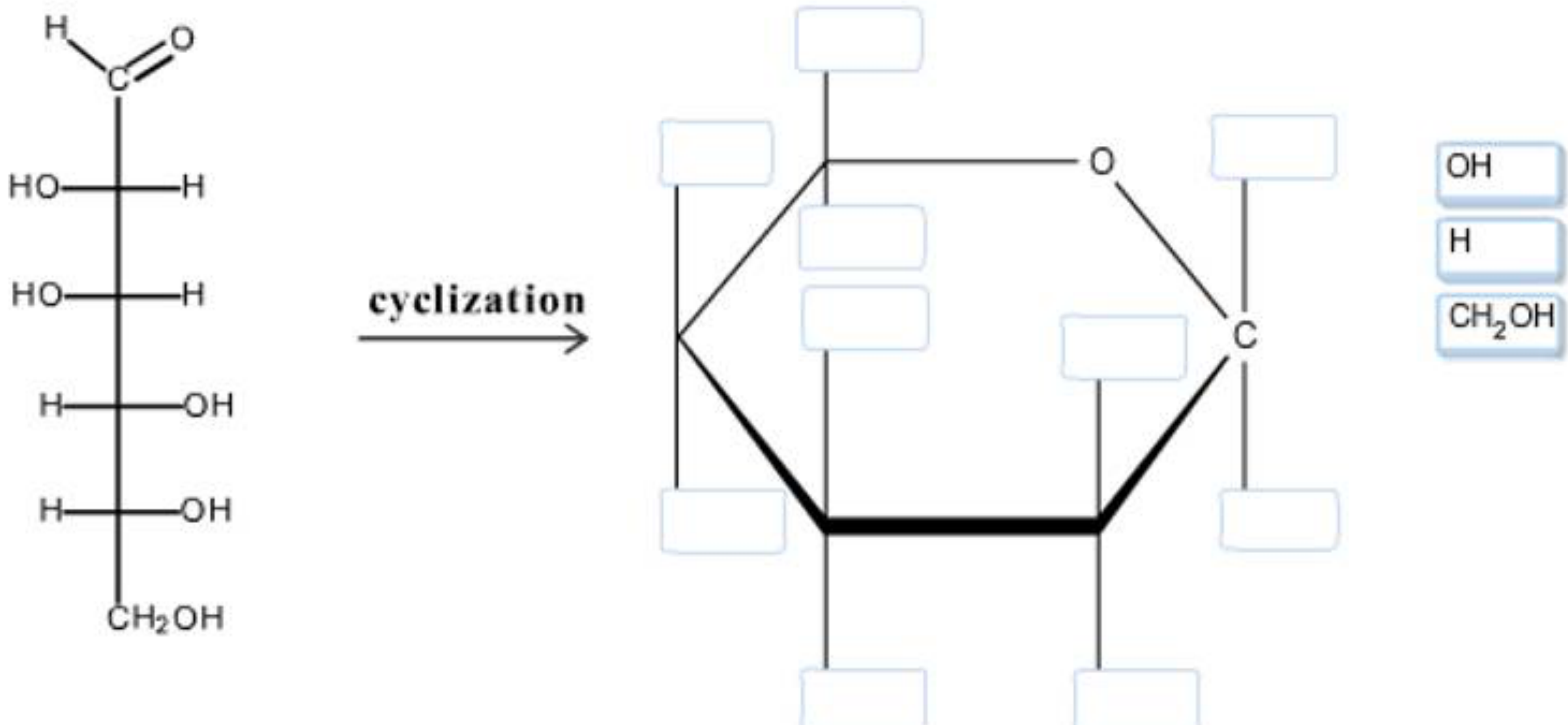
Convert Fischer to Haworth Problems



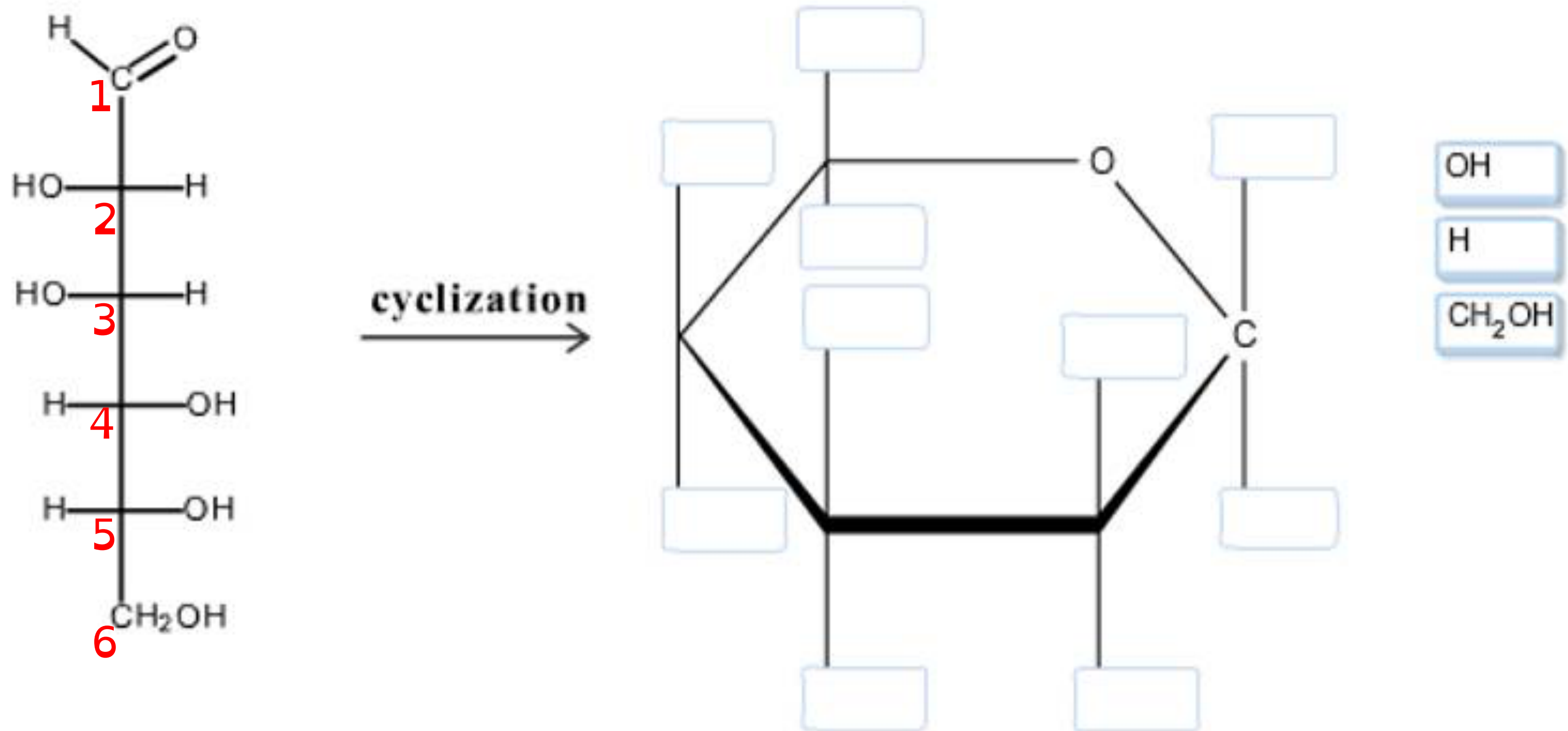
D-glucose D-glucopyranose

Convert Fischer to Pyranose Haworth

Draw the Haworth projection of the β-pyranose form of the Fischer projection provided by labeling the furanose ring. The anomeric carbon is shown.

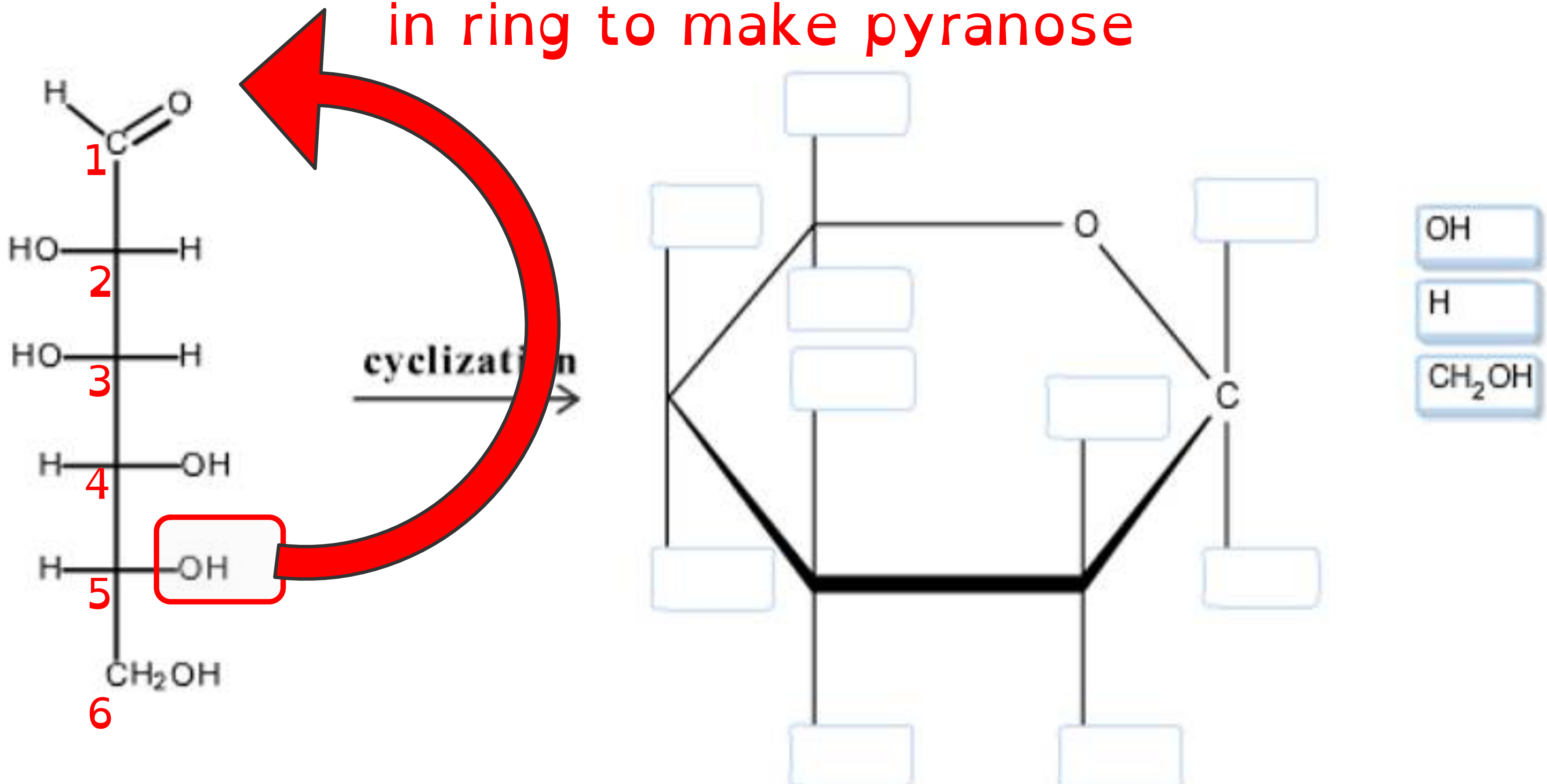


Draw the Haworth projection of the β-pyranose form of the Fischer projection provided by labeling the furanose ring. The anomeric carbon is shown.

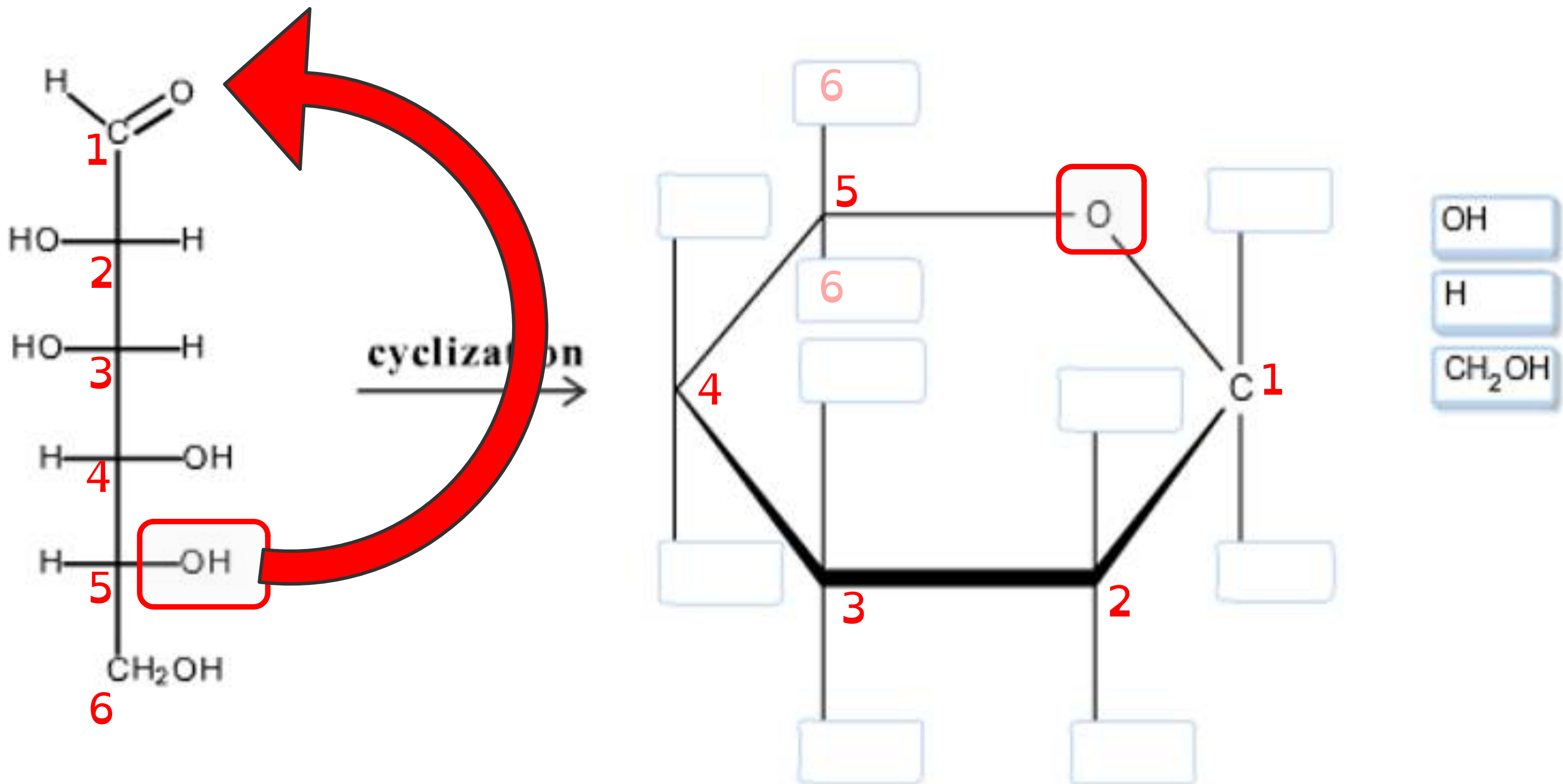


Draw the Haworth projection of the β-pyranose form of the Fischer projection provided by labeling the furanose ring. The anomeric carbon is shown.

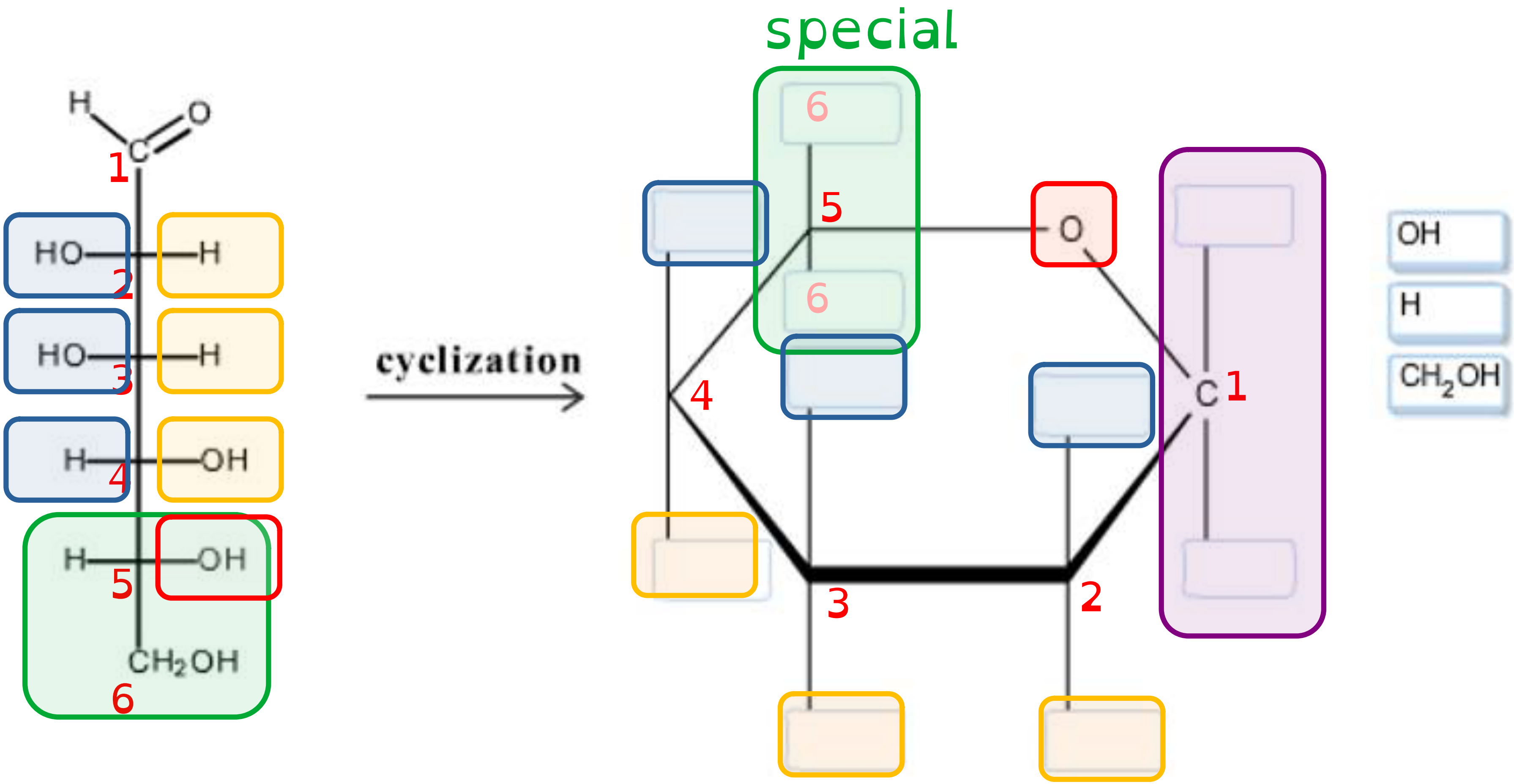
need 5 carbons (1,2,3,4,5)
in ring to make pyranose



Draw the Haworth projection of the β-pyranose form of the Fischer projection provided by labeling the furanose ring. The anomeric carbon is shown.

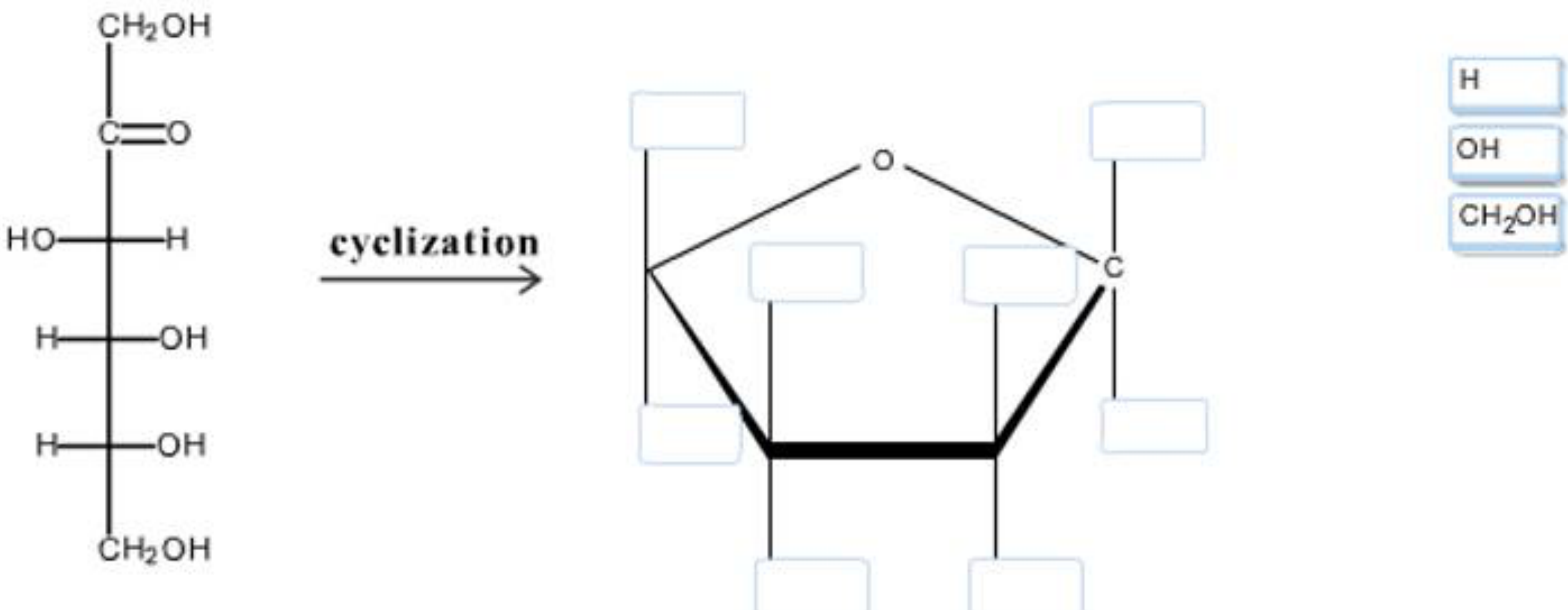


Draw the Haworth projection of the β-pyranose form of the Fischer projection provided by labeling the furanose ring. The anomeric carbon is shown.

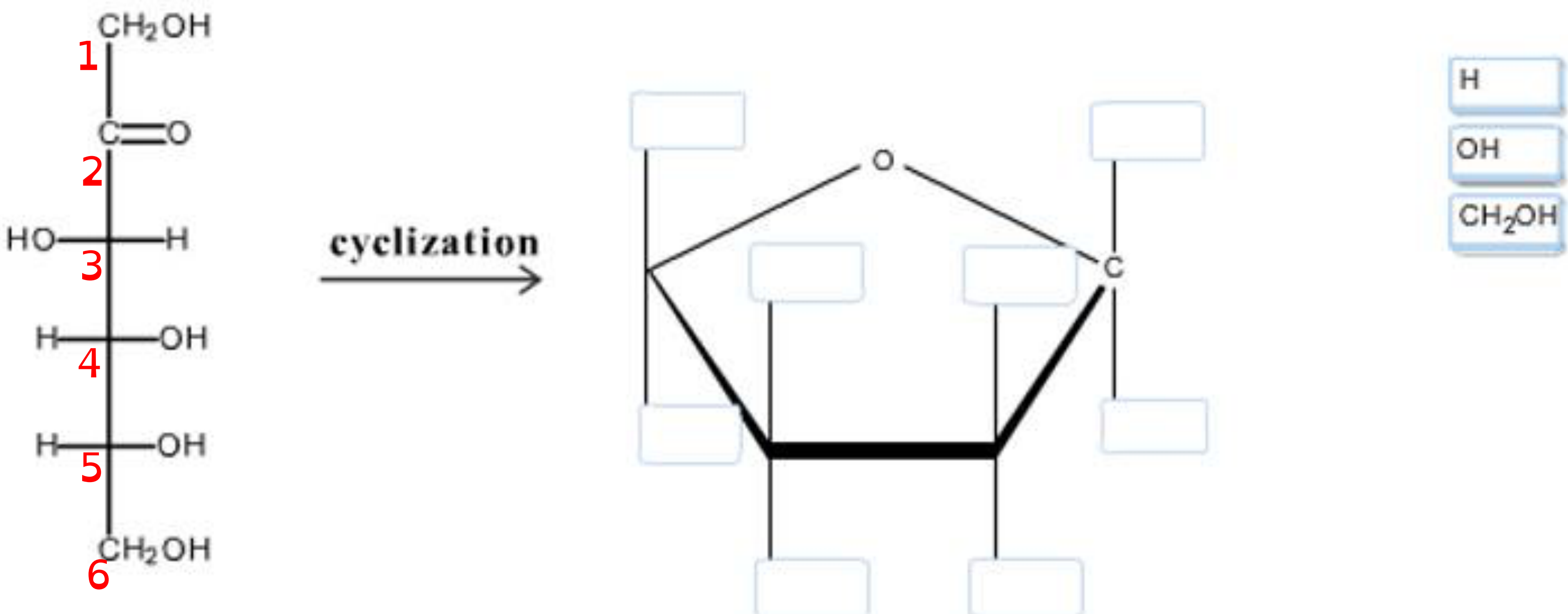


Convert Fischer to Furanose Haworth

Draw the Haworth projection of the α-furanose form of the Fischer projection provided by labeling the furanose ring. The anomeric carbon is shown.

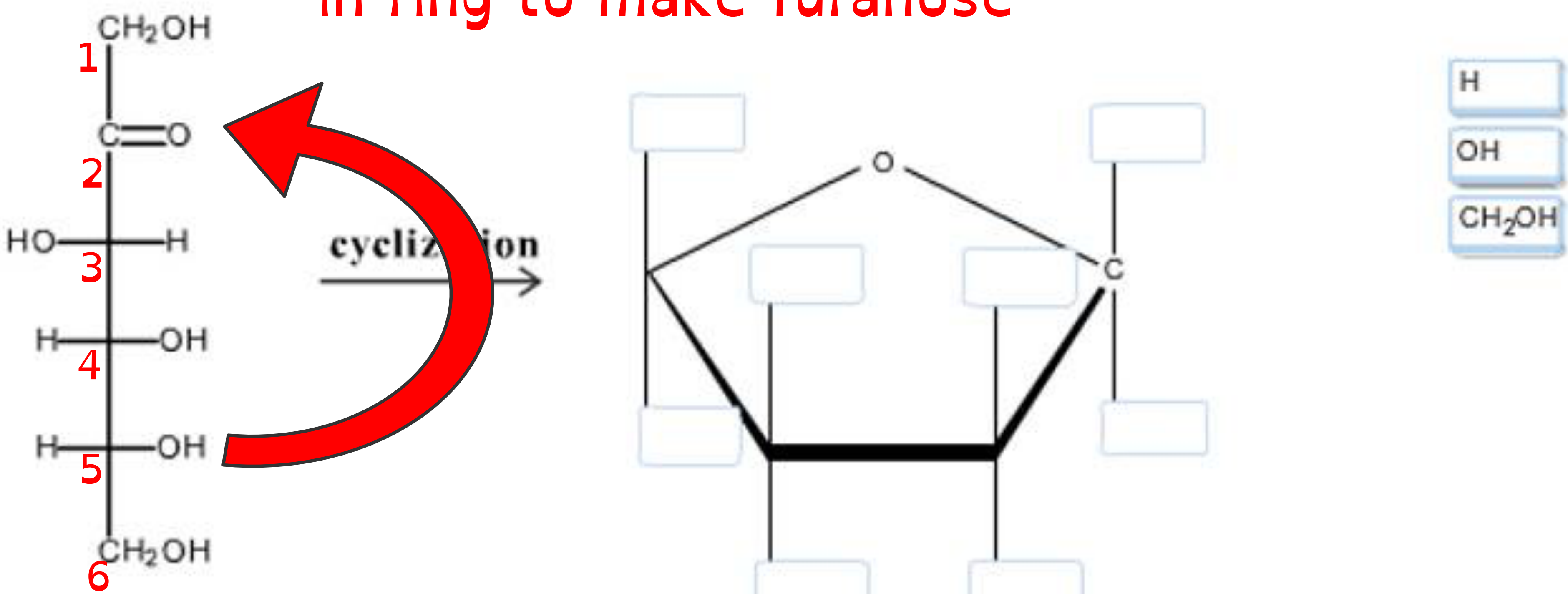


Draw the Haworth projection of the α-furanose form of the Fischer projection provided by labeling the furanose ring. The anomeric carbon is shown.

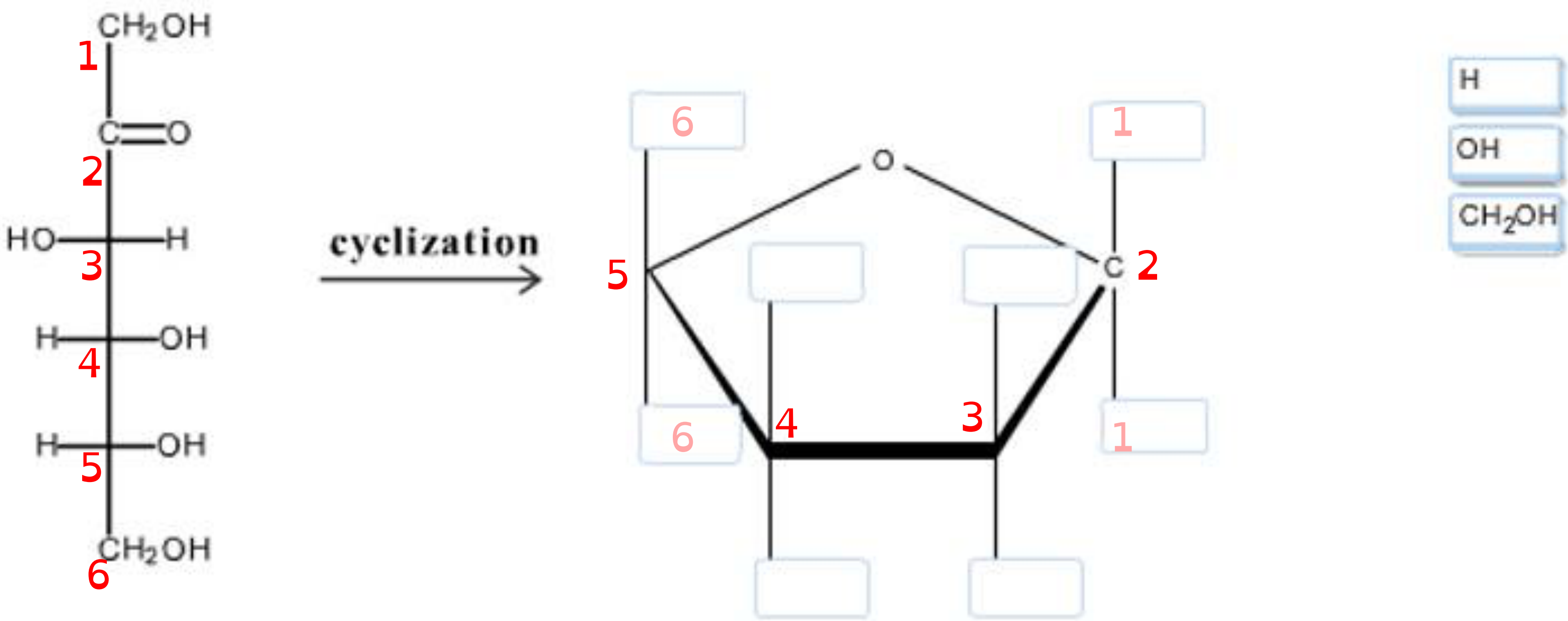


Draw the Haworth projection of the α-furanose form of the Fischer projection provided by labeling the furanose ring. The anomeric carbon is shown.

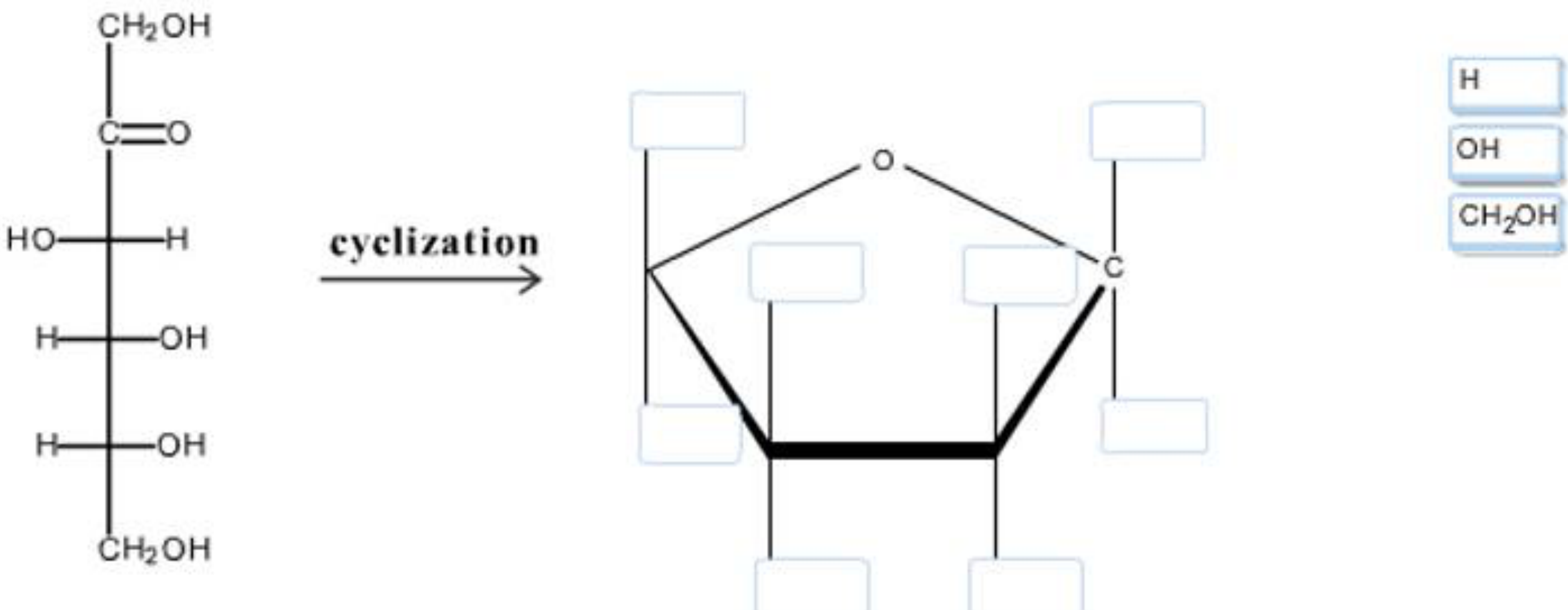
need 4 carbons (2,3,4,5) in ring to make furanose



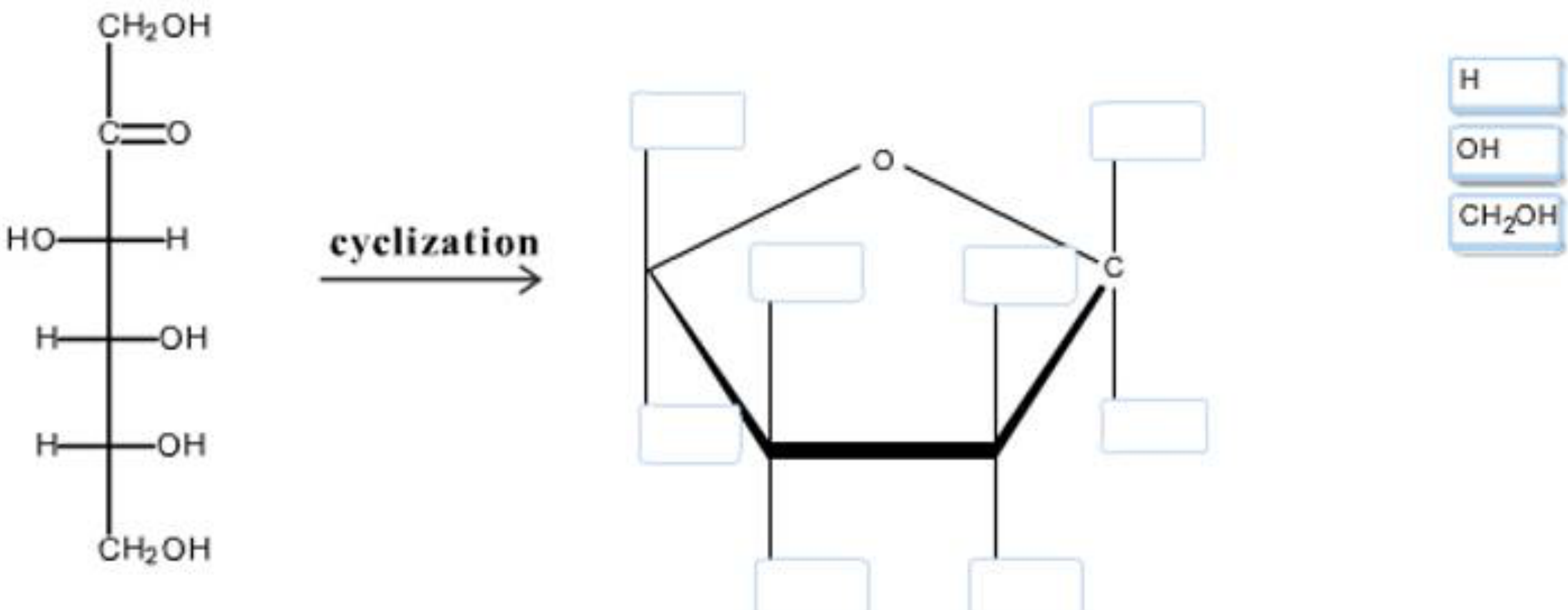
Draw the Haworth projection of the α-furanose form of the Fischer projection provided by labeling the furanose ring. The anomeric carbon is shown.



Draw the Haworth projection of the α-furanose form of the Fischer projection provided by labeling the furanose ring. The anomeric carbon is shown.



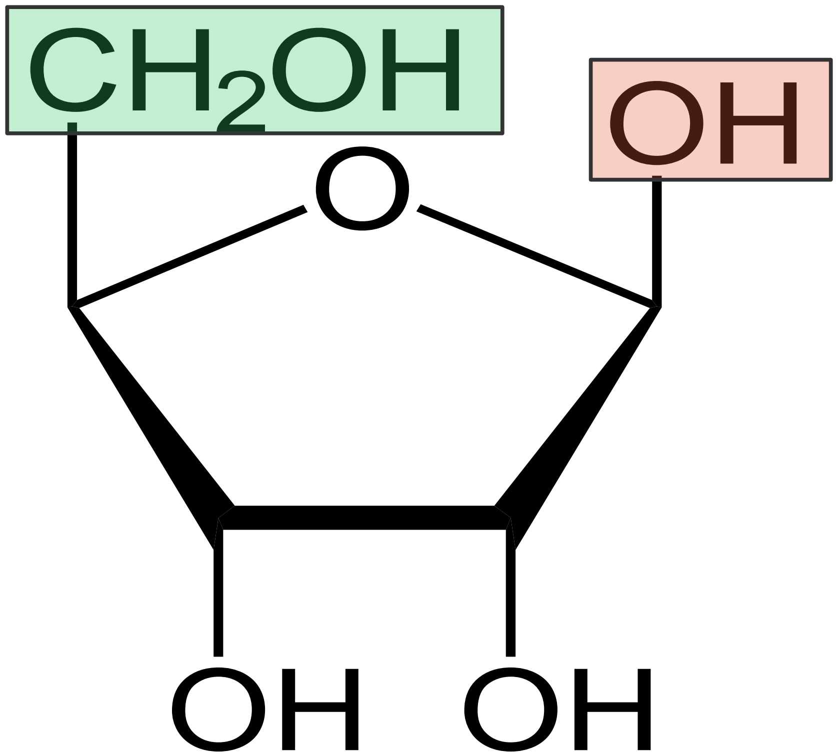
Draw the Haworth projection of the α-furanose form of the Fischer projection provided by labeling the furanose ring. The anomeric carbon is shown.



Classification Exercises

Classify This

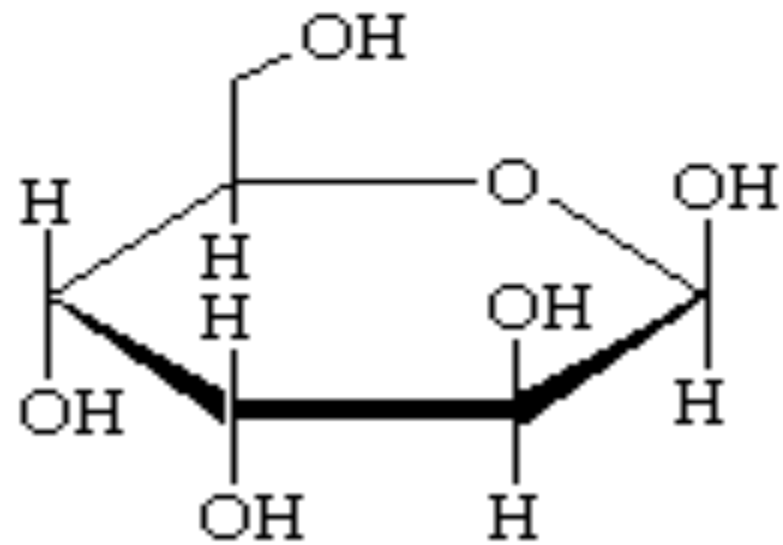
- **Double bond location:** Aldose vs. Ketose
- **# of Carbon Atoms:** Triose, Pentose, Hexose
- **Stereoisomers:** D- vs. L-sugars
- Ring form
  - **# of ring members:** pyranose vs. furanose
  - **Reducing anomers:** -OH trans (α, alpha) or -OH cis (β, beta)



β-D-Ribose

Classify This

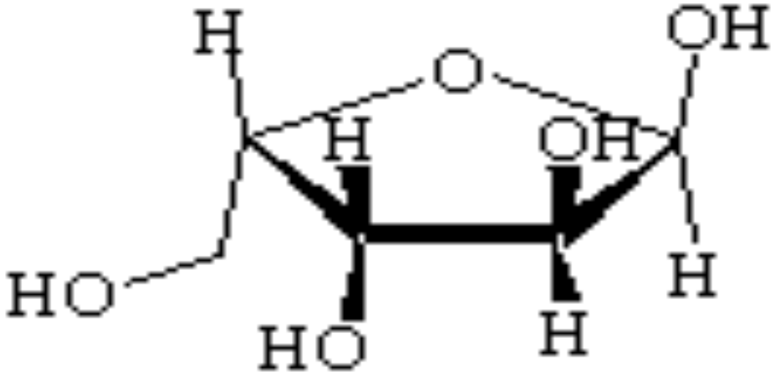
- **Double bond location:** **Aldose** vs. Ketose
- **# of Carbon Atoms:** Triose, Pentose, **Hexose**
- **Stereoisomers:** **D-** vs. L-sugars
- Ring form
  - **# of ring members:** **pyranose** vs. furanose
  - **Reducing anomers:** -OH trans (α, alpha) or **-OH cis (β, beta)**



β-D-altropyranose

Classify This

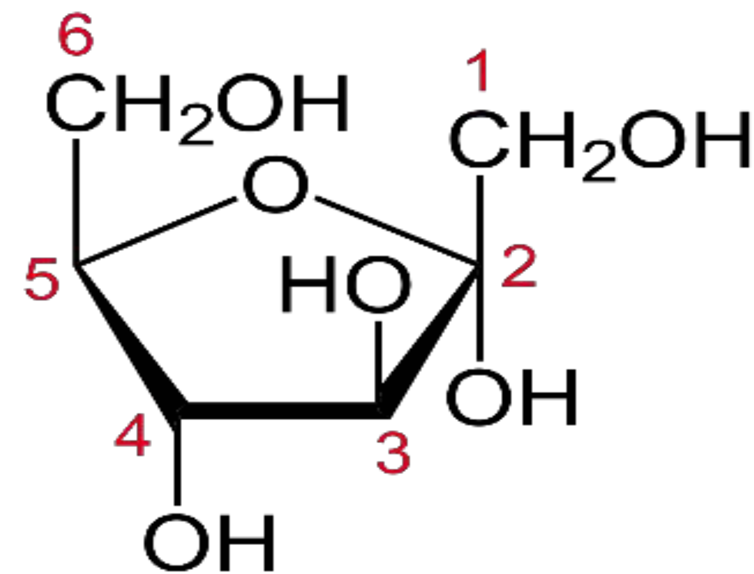
- **Double bond location:** [Aldose](#) vs. Ketose
- **# of Carbon Atoms:** Triose, **Pentose**, Hexose
- **Stereoisomers:** D- vs. **L-** sugars
- **Ring form**
  - **# of ring members:** pyranose vs. **furanose**
  - **Reducing anomers:** **-OH trans (α, alpha)** or -OH cis (β, beta)

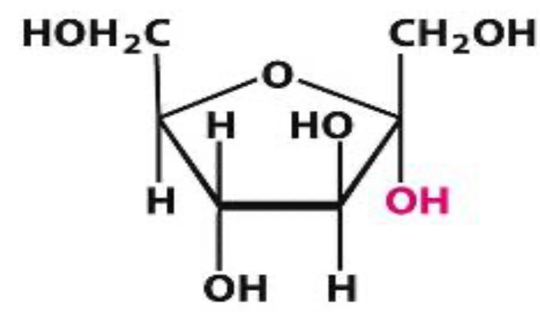


α-L-xylofuranose

Classify This

- **Double bond location:** Aldose vs. Ketose
- **# of Carbon Atoms:** Triose, Pentose, Hexose
- **Stereoisomers:** D- vs. L-sugars
- **Ring form**
  - **# of ring members:** pyranose vs. furanose
  - **Reducing anomers:** -OH trans (α, alpha) or -OH cis (β, beta)

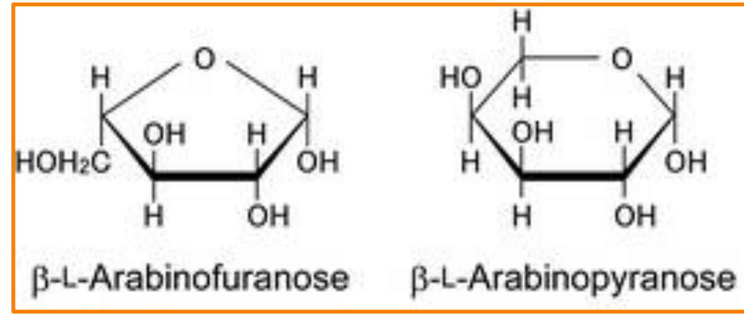


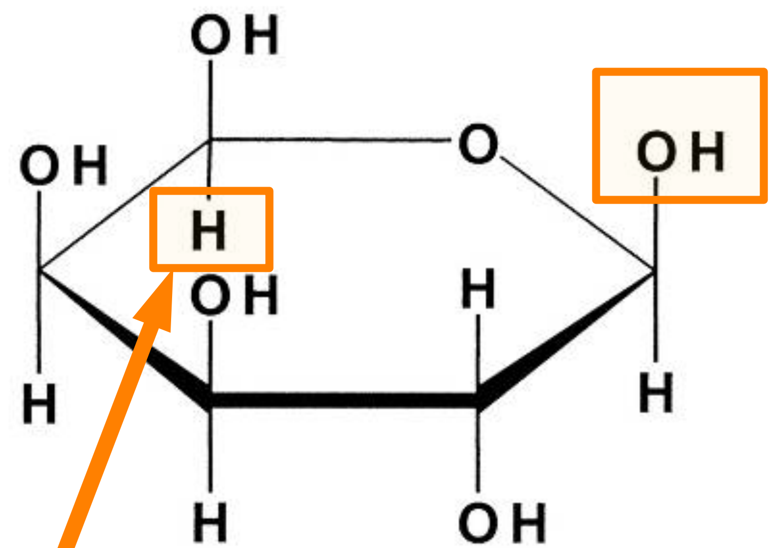


α-D-Fructofuranose

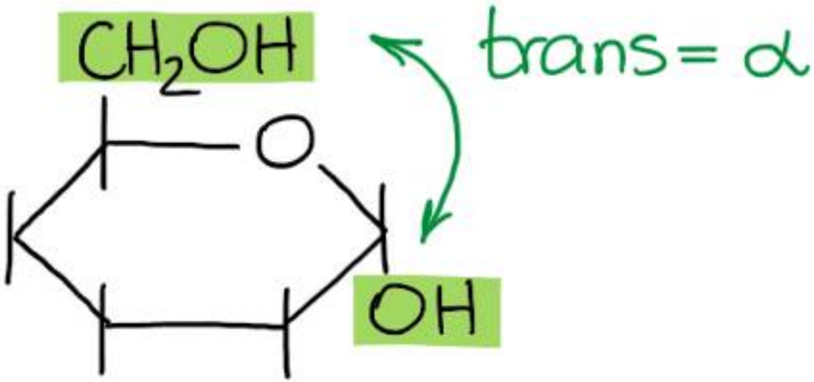
Classify This

- **Double bond location:** Aldose vs. Ketose
- **# of Carbon Atoms:** Triose, Pentose, Hexose
- **Stereoisomers:** D- vs. L-sugars
- **Ring form**
  - **# of ring members:** pyranose vs. furanose
  - **Reducing anomers:** -OH trans (α, alpha) or -OH cis (β, beta)

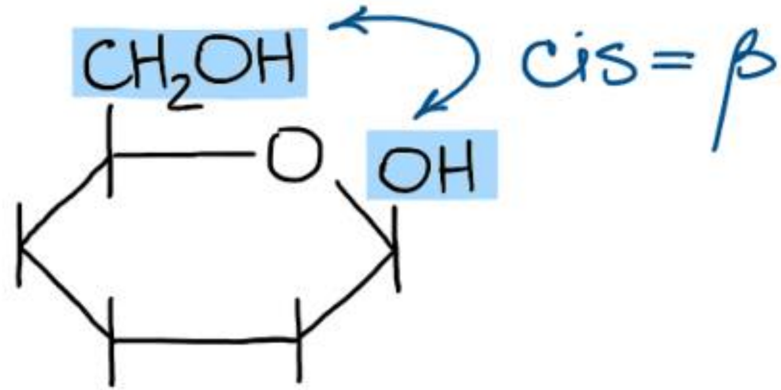




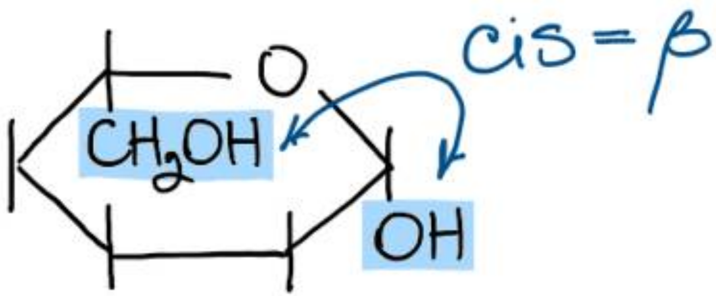
this is where the next carbon would go



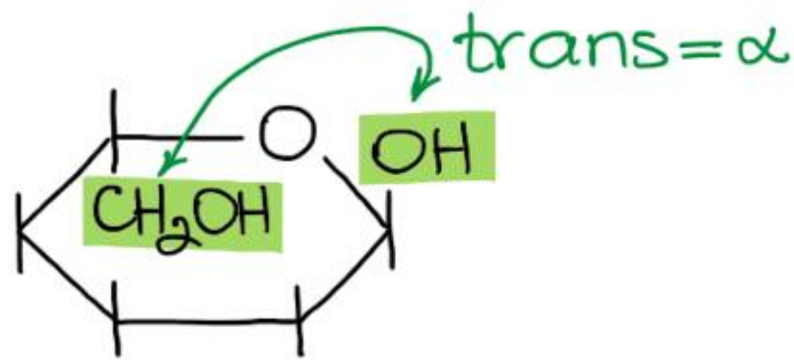
D-α-pyranose



D-β-pyranose



L-β-pyranose



L-α-pyranose

More Resources

- Organic Chemistry Tutor.com
  - https://www.organicchemistrytutor.com/converting-between-fischer-haworth-and-chair-forms-of-carbohydrates/
- Ketopentose
  - https://www.sciencedirect.com/topics/chemistry/ketopentose
- Wikipedia: Monosaccharide nomenclature
  - https://en.wikipedia.org/wiki/Monosaccharide_nomenclature
- Reducing Sugars:
  - https://www.masterorganicchemistry.com/2017/09/12/reducing-sugars/
- Archive of Monosaccharide Images
  - https://commons.wikimedia.org/wiki/User:NEUROtiker/gallery/archive1
- .

THE

END