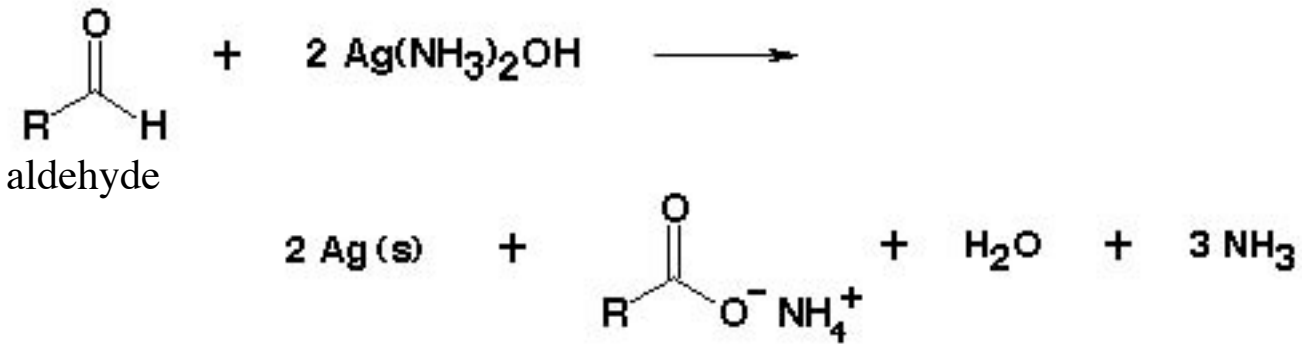
Silvering a Mirror or a Flask by the Tollens' Reagent

(Demonstration by Lee Marek, PowerPoint Slides by Bob Widing)

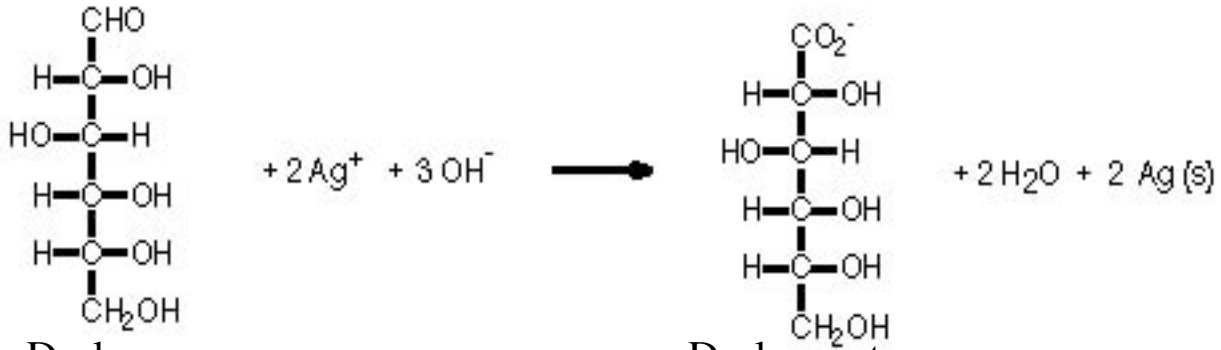
Some bottles silvered by Lee Marek

The Tollens' reaction oxidizes an aldehyde to a carboxylic acid salt. That oxidation drives a reduction of soluble silver ion to silver metal.



aldehyde

acid salt

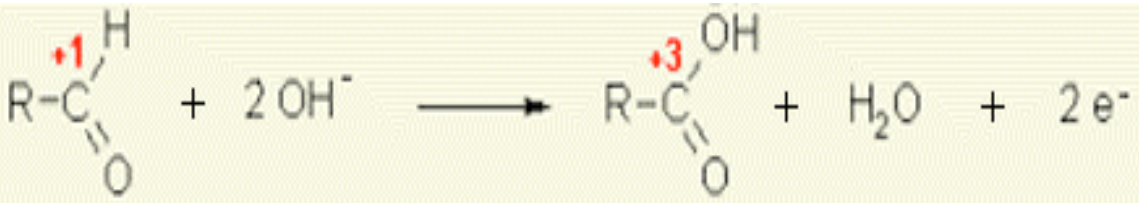


D-glucose

D-gluconate,
salt of gluconic acid

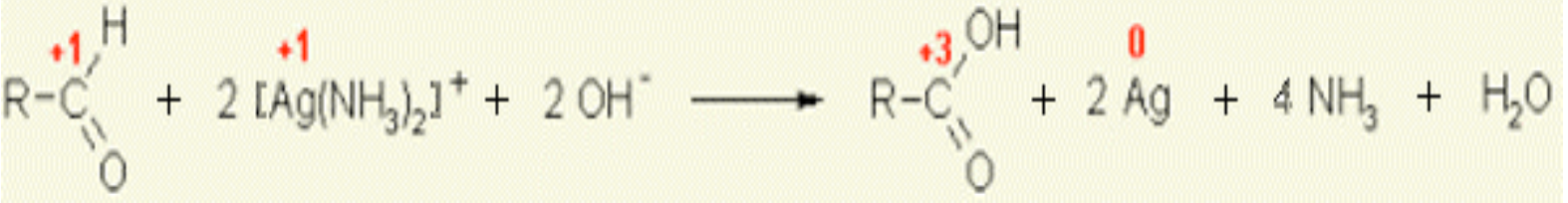
Tollens' reaction with oxidation numbers

oxidation half-reaction

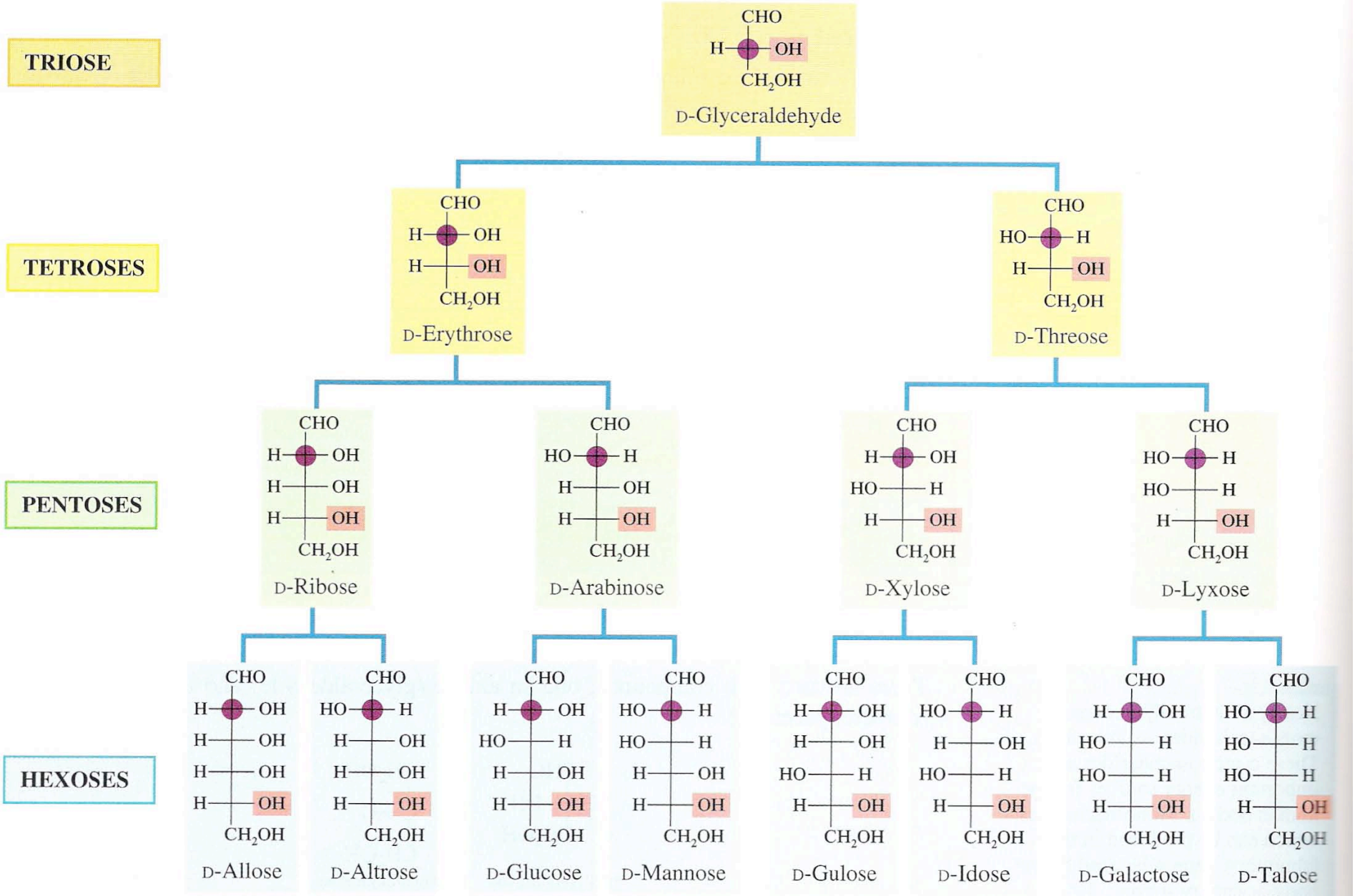


reduction half-reaction

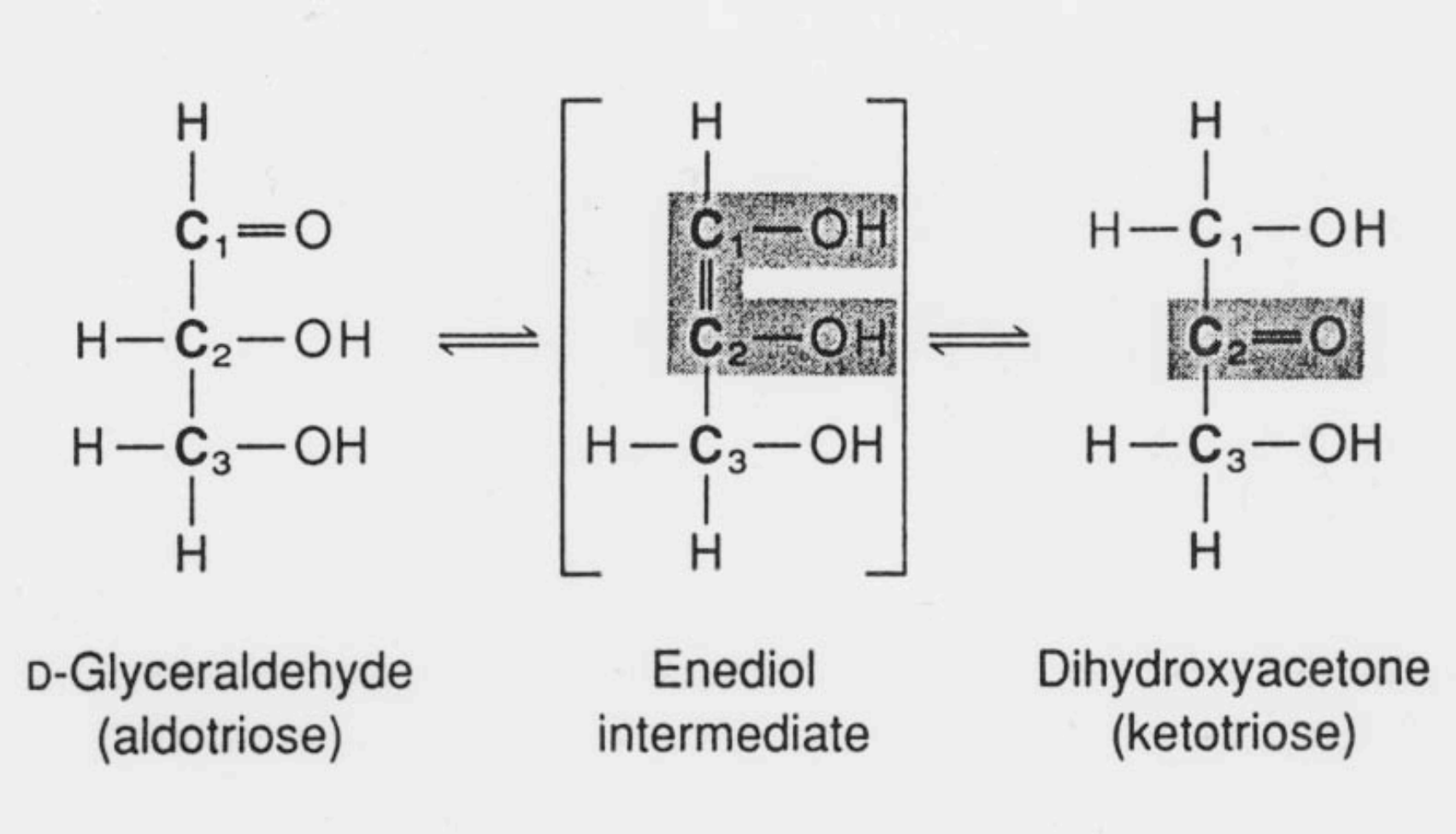
net reaction



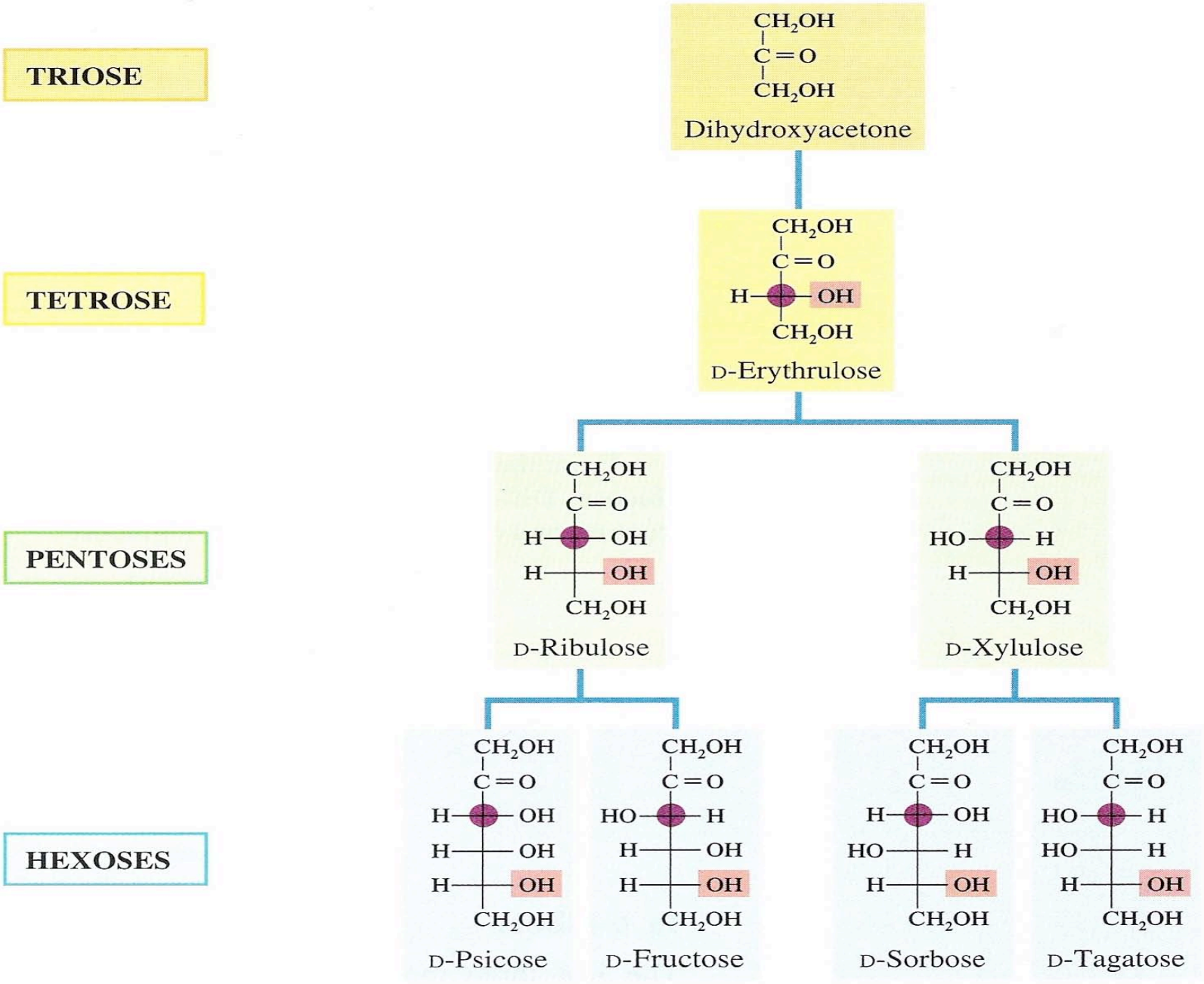
Monosaccharide aldoses



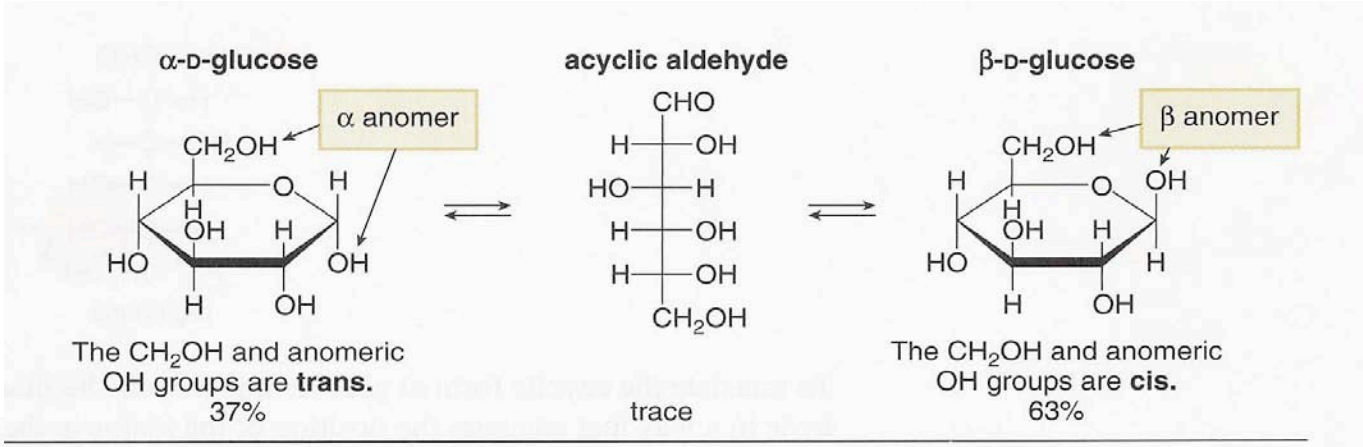
Isomerization of ketose-to-aldose via an enediol intermediate (Why C2 ketoses are also reducing sugars)

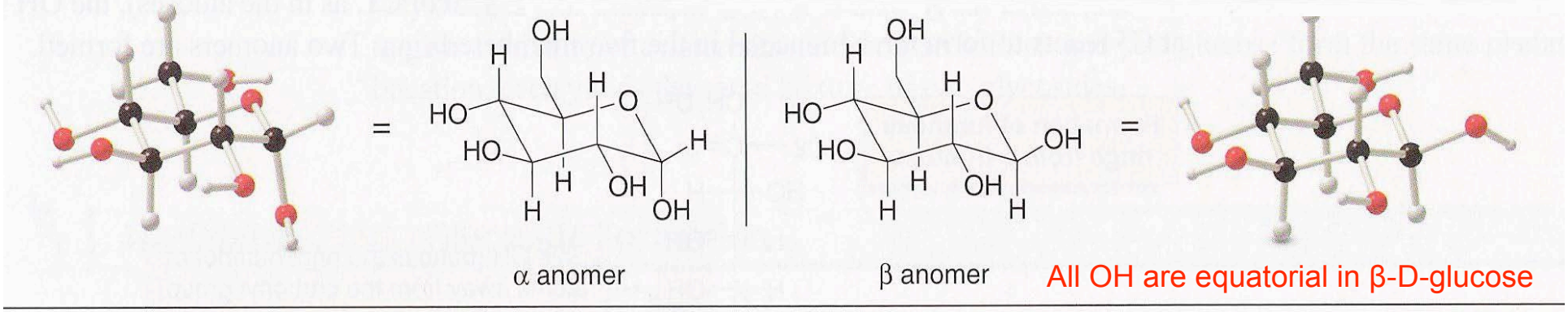


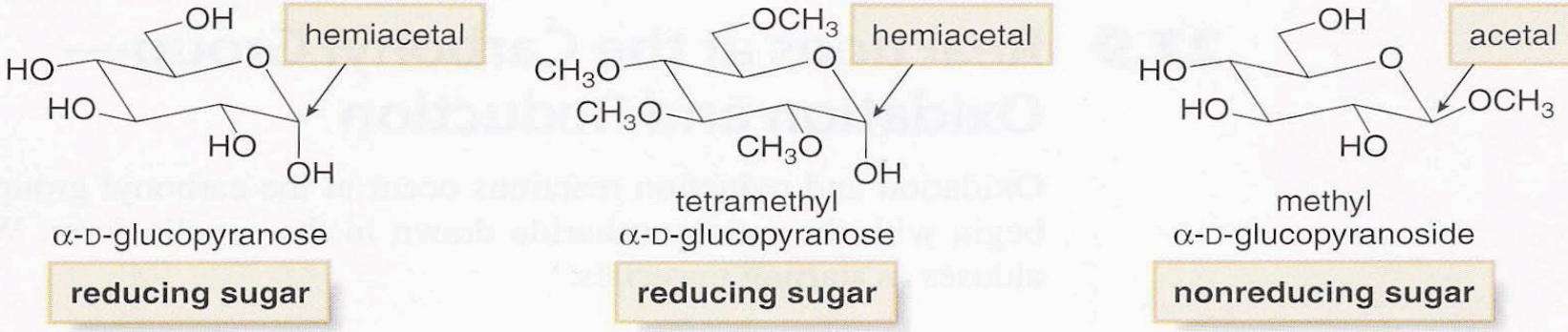
Monosaccharide ketoses



Ring and Chain forms of glucose







- Carbohydrates containing a hemiacetal are in equilibrium with an acyclic aldehyde, making them reducing sugars.
- Glycosides are acetals, so they are *not* in equilibrium with any acyclic aldehyde, making them nonreducing sugars.

Bernhard Tollens (1841-1918)

Tollens attended school at the Gelehrtenschule des Johanneums in Hamburg where he was influenced by his science teacher, Karl Möbius. After graduating in 1857, Tollens started an apprenticeship in pharmacy. He finished in 1862 and began studying chemistry in Göttingen in Wöhler's laboratory, then supervised by Friedrich Konrad Beilstein and Rudolph Fittig. In 1864, Tollens submitted his thesis and received his PhD without a defense. The latter was possible through the intercession of Wöhler so that Tollens could accept and begin an attractive job at a bronze factory. However, Tollens left the job after only six months and joined the group of Emil Erlenmeyer at the University of Heidelberg for six months. He later worked with Charles-Adolphe Wurtz in Paris and, for 11 months, was chief of the chemical laboratory at the University in the Portuguese capital Coimbra.[1]

Unable to resist the call of Wöhler, his former professor, Tollens returned to Göttingen in 1872 and there he remained in various positions until his death in 1918. It was during this final time in Göttingen that he started his work on carbohydrates, which yielded structures of several sugars, the Tollens reagent, and most of his publications.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