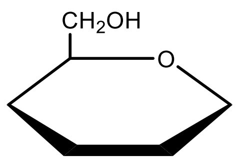
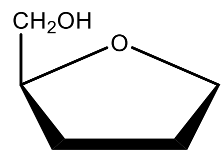
Haworth Projection

To convert a Fischer Projection (line) to a Haworth Projection, you must first identify the type of monosaccharide involved. If the carbohydrate represents an aldohexose, the pyranose ring will be used. If the carbohydrate represents a ketohexose, the furanose ring will be used.

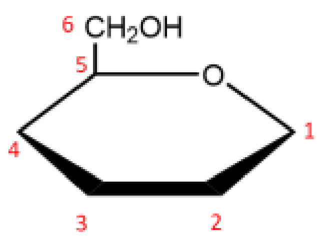


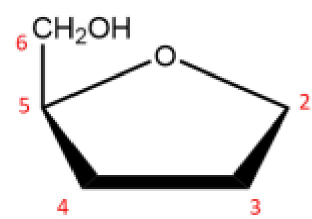
pyranose



furanose

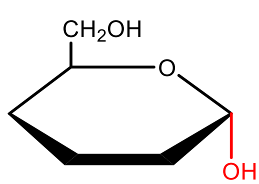
Please note that carbon 6 is always sticking up out of the ring (top face). Next, depending on whether the α or β anomer is the target, that will dictate how the OH (and carbon 1 if a furanose) is arranged around the anomeric carbon. Recall, the anomeric carbon is the carbon that was originally the carbonyl (C=O) carbon in the Fischer Projection. So, carbon 1 of the pyranose is the anomeric carbon and carbon 2 of the furanose.

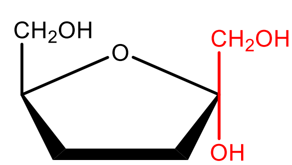




The α and β anomers are determined with respect to carbon 6. In the α anomer, the OH on the anomeric carbon is trans to carbon 6. Recall, trans means opposite side. Therefore, in the alpha anomer, since carbon 6 is pointing up (top face), the OH on the anomeric carbon points down (bottom face). If the ring is a furanose, carbon 1 would point up (opposite direction of the OH group).

alpha anomers

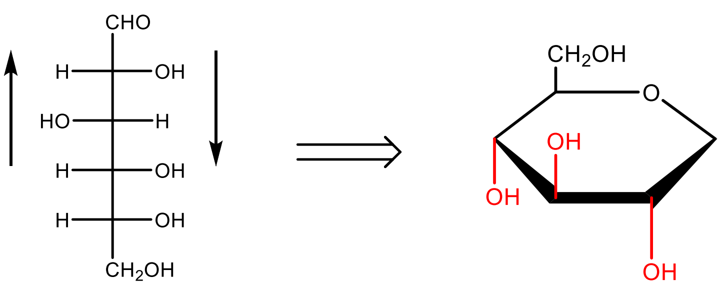




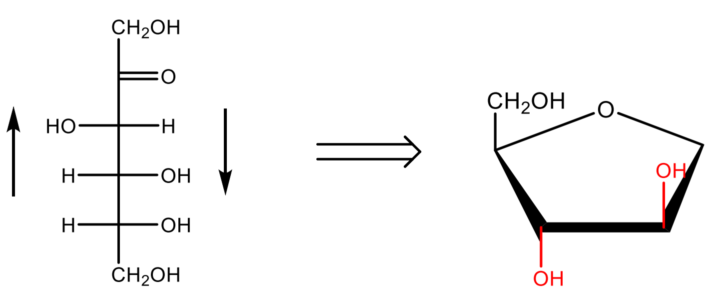
In the β anomer, the OH on the anomeric carbon is cis to carbon 6. Recall, cis means same side. Therefore, in the beta anomer, since carbon 6 is pointing up (top face), the OH on the anomeric carbon points up (top face). If the ring is a furanose, carbon 1 would point down (opposite direction of the OH group).

beta anomers

To fill in the other carbon atoms, it will depend on the directions of the H and OH in the Fischer Projection structures. The mnemonic, "Left Up to You" may be useful. This mnemonic simply means that for those missing carbon atoms (carbons 2, 3 and 4 of the pyranose or carbons 3 and 4 of the furanose), any group to the left of the Fischer projections would point up (top face). If those are top face, then the groups to the right would point down (bottom face).

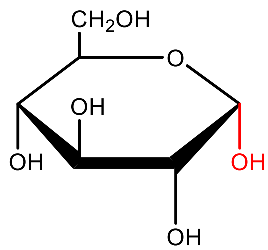


Fischer Projection (left) and Haworth (right) of D-glucose. The Haworth is incomplete.

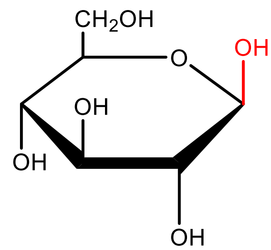


Fischer Projection (left) and Haworth (right) of D-fructose. The Haworth is incomplete.

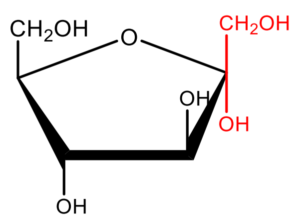
Since the Fischer Projection of any given carbohydrate is always the same, the Haworth Projection is essentially always the same. The only differences between the Haworth Projection of the alpha or beta form of a single carbohydrate, is how the OH (and carbon 1 if a furanose ring) is arranged around the anomeric carbon to determine whether the molecule is alpha or beta.



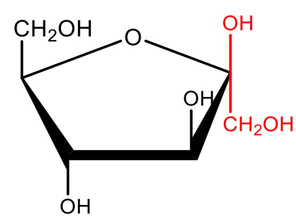
α-D-glucose



β-D-glucose



α-D-fructose



β-D-fructose

So, to sum it up, to determine alpha or beta, simply look at the direction of the OH on the anomeric carbon. If the OH is pointing in the opposite direction of carbon 6, it is alpha (trans). If the OH is pointing in the same direction of carbon 6, it is beta (cis).