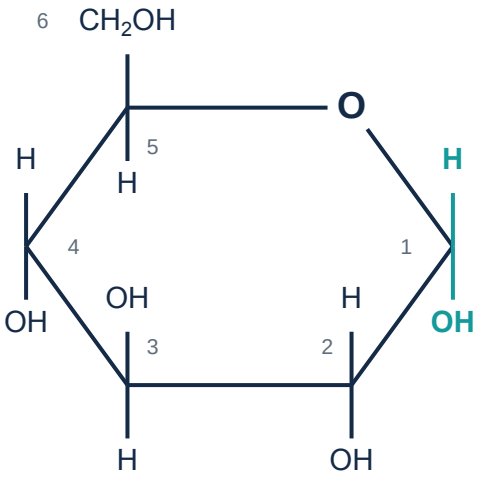
One OH group, two ring forms

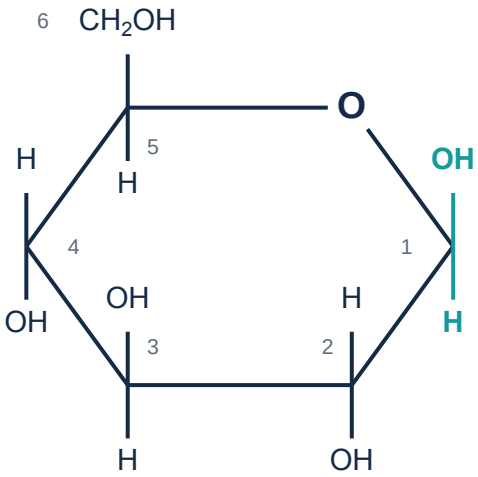
Glucose is a six-carbon monosaccharide. In the usual ring drawings of D-glucose, alpha and beta differ only in the arrangement of H and OH at carbon 1.

α-D-glucose



C1 OH down

β-D-glucose



C1 OH up

Haworth projections: the ring is shown schematically, not as a flat molecule. Small grey numbers identify carbon atoms; O is oxygen, not carbon 6.

1. SAME FORMULA AND CONNECTIVITY

Both forms have molecular formula $C_6H_{12}O_6$ and the same sequence of bonds. They are stereoisomers called anomers, not different molecular formulae. The defining difference is the three-dimensional arrangement at carbon 1.

2. COUNT FIVE RING CARBONS, NOT SIX

The six-membered ring contains five carbon atoms and one oxygen atom. Carbon 6 is the carbon of the CH_2OH group attached to carbon 5. A hexose has six carbons in total; not all six must be inside its ring.

The reference CH_2OH group points up in both drawings. Alpha: C1 OH is on the opposite side of the ring from CH_2OH. Beta: C1 OH is on the same side.

Scope: Cambridge Biology 9700 syllabus, section 2.2, outcome 1, p. 17.

Draw the ring systematically

Keep the same orientation for both forms: ring oxygen at the upper right and carbon 1 immediately clockwise from it. Then compare like with like.

1. START WITH THE RING

Draw a six-membered ring outline. Write O at the upper-right position. The other five vertices represent carbon atoms; carbon symbols may be omitted in this convention.

2. NUMBER THE CARBONS

Start with C1 at the right-hand vertex next to oxygen. Continue clockwise through C2, C3, C4 and C5. Put the C6-containing CH_2OH group above C5.

3. KEEP THE GLUCOSE PATTERN

At C2 the OH points down; at C3 it points up; at C4 it points down. Each of these carbons also has an H on the opposite side. C5 has H down and CH_2OH up.

4. CHOOSE ALPHA OR BETA

For alpha-D-glucose, put OH down and H up at C1. For beta-D-glucose, put OH up and H down at C1. Do not change the groups at the other carbons.

POSITION CHECK: THIS DRAWING ORIENTATION ONLY

GROUP	ALPHA	BETA
C1 OH	down	up
C2 / C3 / C4 OH	down / up / down	down / up / down
C5 CH_2OH	up	up

Scope: Cambridge Biology 9700 syllabus, section 2.2, outcome 1, p. 17.

Read structure, not page direction

A molecule can be drawn in different orientations. Identify carbon 1 and compare its OH with the reference CH_2OH group before naming the form.

1. ROTATING A DRAWING DOES NOT CHANGE THE MOLECULE

The shortcut "alpha down, beta up" applies to the standard D-glucose orientation used here. If a drawing is rotated on the page, compare the relative sides of C1 OH and CH_2OH. Rotating the whole drawing does not convert alpha into beta.

2. THE FORMS CAN INTERCONVERT IN WATER

Supporting explanation: free glucose rings can open and then close again. Re-closing can produce either anomer. This interconversion is not simply rotating a bond in an unchanged closed ring. Both free forms contribute to the same reducing-sugar behaviour.

3. WHY THE DIFFERENCE MATTERS LATER

ALPHA LINKAGES

Starch and glycogen are built from alpha-glucose units.

BETA LINKAGES

Cellulose contains beta-glucose units joined in beta-1,4 linkages.

The resulting bond geometry helps determine the shape and function of the polymer. Later lessons explain these linkages in detail.

FINAL DRAWING CHECK

Check the ring oxygen, the external C6 group, and the OH directions at C2-C4. At C1, H and OH must swap together between alpha and beta. Keep bonds attached to the correct vertices and labels clear of the bond lines.

Key distinction: anomers have the same connectivity but differ at the anomeric carbon (C1 in glucose). They are not structural isomers in the strict chemical sense.

Supporting reading: OpenStax Biology 2e, 3.2 Carbohydrates.