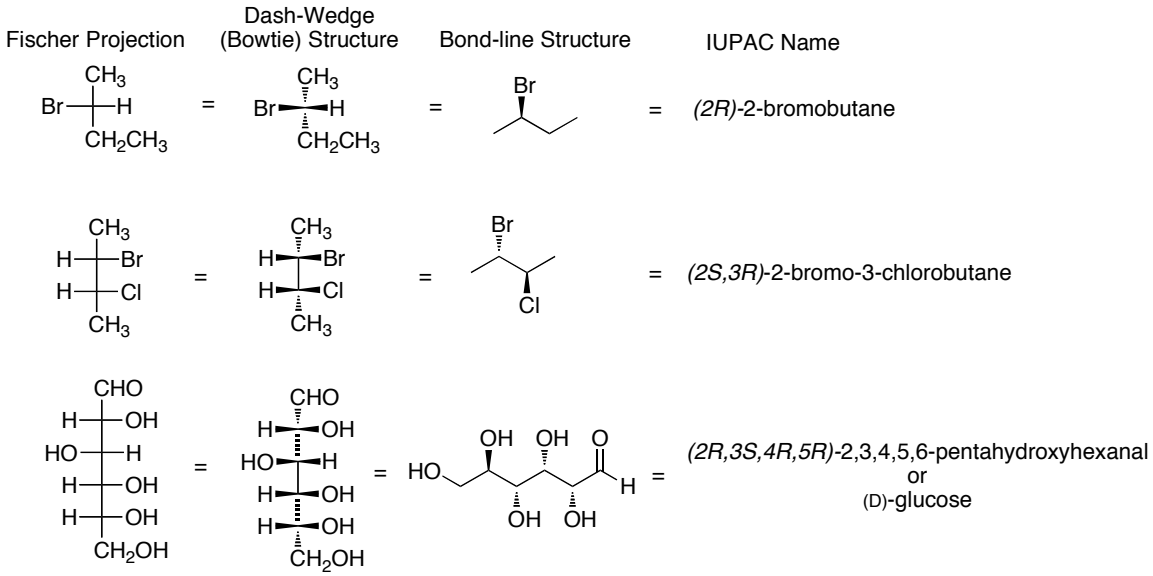
Assigning Stereochemistry IV

Fischer Projections

Fischer Projections were invented by Dr. Emil Fischer as a way of visualizing the stereochemistry of a three-dimensional molecule on a flat surface such as a piece of paper. While Fischer projections are not the only way to look at chiral molecules they are often useful for comparison of molecules with multiple contiguous stereocenters and are still used regularly when looking at biological molecules such as sugars and amino-acids.



Reading Fischer Projections:

- The bonds that are written horizontally are pointed towards the viewer (wedge)
- The bonds that are written vertically are pointed away from the viewer (dash).
- Typically the carbon chain is written vertically with C1 of the chain at the top.
- Molecules with multiple chiral centers are written in an all eclipsed conformation.
- When looking at carbohydrates (sugars) OH points to the right when the center is R and OH points to the left when the center is S.

Writing Fischer Projections - Single Stereocenter:

1) Find the stereocenter in the molecule. If there are multiple stereocenters see below.

2) Write in the fourth bond to H if necessary. The chiral center should have two in-plane, one dash, and one wedge groups. Whichever one is missing will be the bond to the H. If more than one group is not written you have at least two H attached and it's not a stereocenter.

3) Pick two groups to be the horizontal groups (wedges) on your Fischer projection. Usually it's easiest to visualize using the group that's already a wedge and one of the in-plane (line) groups.

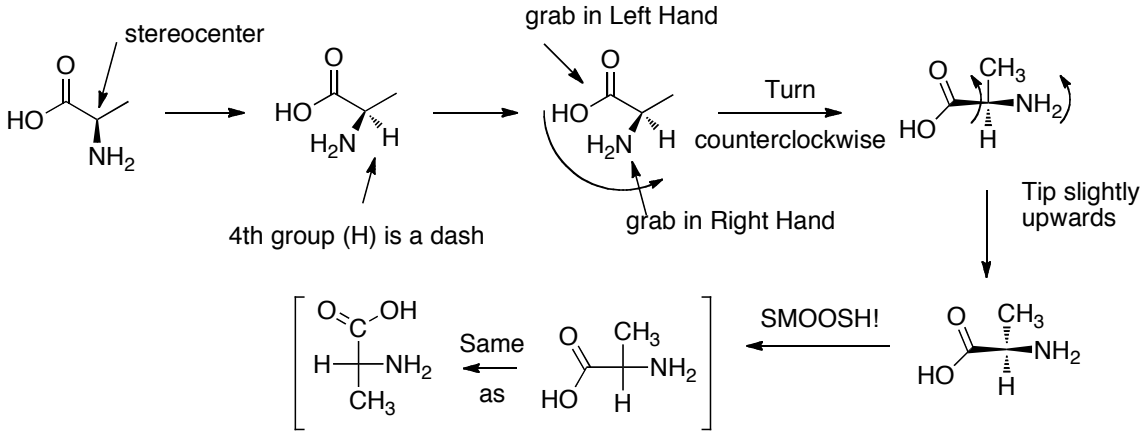
4) Imagine grabbing one group with your left hand and the other with your right hand.

5) Imagine pulling on the molecule and rotating it so the group in your left hand is pointing left and a bit towards you and the group in your right hand is pointing right and a bit towards you. Imagine you're reaching forward with both hands like a zombie to grab the molecule.

6) The molecule should now be oriented with wedges left/right and dashes up/down. If you have a group still in the plane and one back tip the two groups you're 'holding' to turn the in-plane group backwards a bit.

7) SMOOSH it flat and you're done!

Example: (D)-Alanine



Note: Picking different groups to be wedges will result in different though still correct Fischer projections.

Writing Fischer Projections - Multiple Stereocenters:

NOTE: To write a Fischer projection with multiple stereocenters a molecule needs to be in a fully eclipsed conformation, which is different from how molecules are usually drawn in bond-line structures.

1) Find the stereocenters in the molecule.

2) Write in the fourth bond to H if necessary. Each chiral center should have two in-plane, one dash, and one wedge groups. Whichever one is missing will be the bond to the H. If more than one group is not written you have at least two H attached and it's not a stereocenter.

Method A:

3) Rotate the molecule so the bond between the two stereocenters is vertical.

4) Rotate the top stereocenter so the dash is pointing up and back and the other two groups are pointing left and forward or right and forward. This should be about a 30° clockwise or counterclockwise turn.

5) Rotate the lower stereocenter so the dash is pointing down and back and the other two groups are pointing left and forward or right and forward. This should be about a 30° turn in the opposite direction of the top center.

6) SMOOSH it flat and you're done!

Method B:

3) Rotate the bond between the stereocenters so the molecule is eclipsed. This should be about a 60° turn leaving one side unmoved.

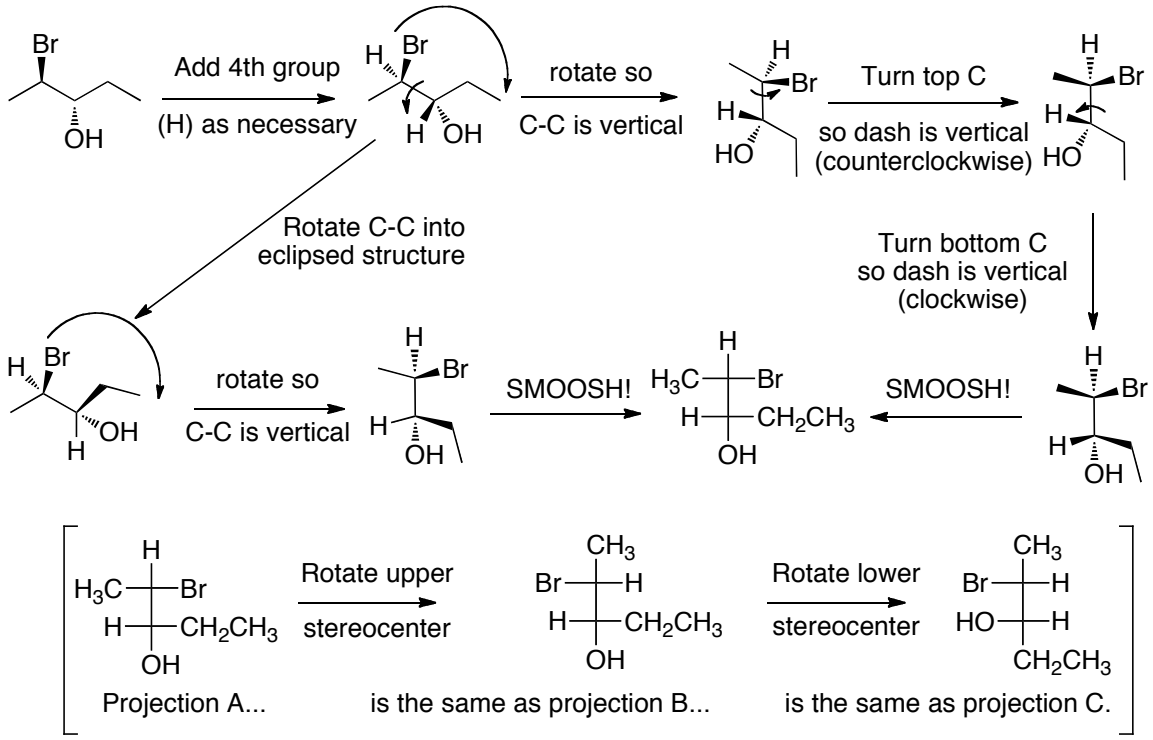
4) Rotate the molecule so the bond between the two stereocenters is vertical. (One side will be in plane, the top and bottom groups will be back and the other side will be wedges.

5) If desired, tip the molecule slightly counterclockwise so that both centers are oriented with wedges left/right and dashes up/down.

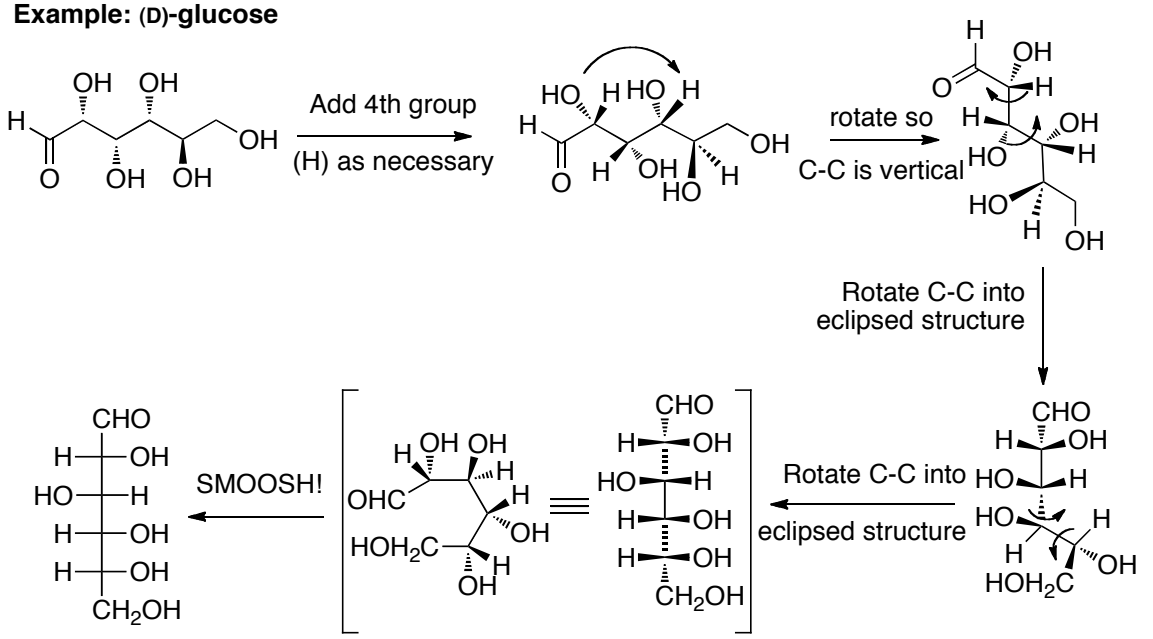
6) SMOOSH it flat and you're done!

NOTE: For more than two stereocenters rotate the all centers eclipsed before flattening.

Example: *(2R,3S)*-2-bromo-3-pentanol

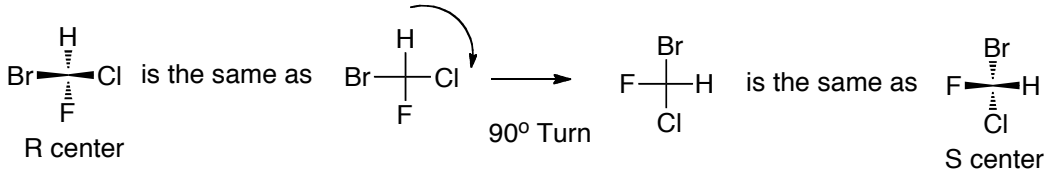


Example: (D)-glucose

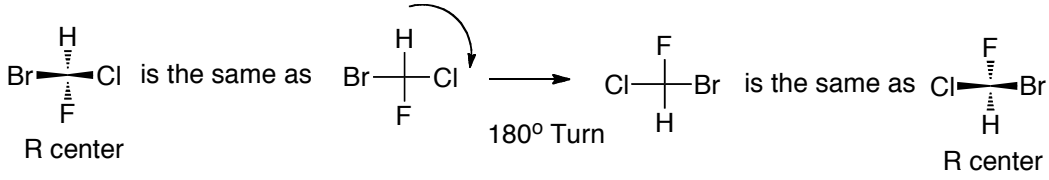


Rotating Fischer Projections:

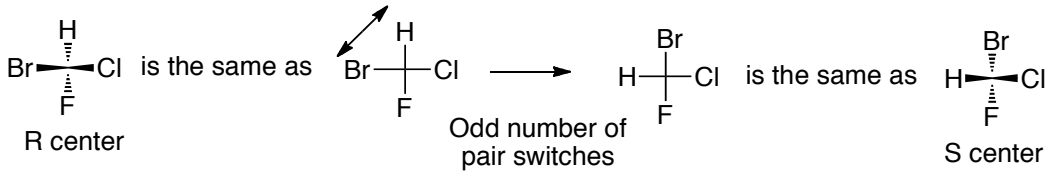
Rotating a Fischer projection 90° will give the enantiomer.



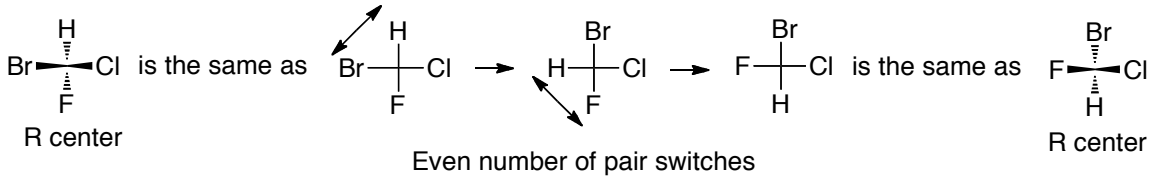
Rotating a Fischer projection 180° will give the original molecule.



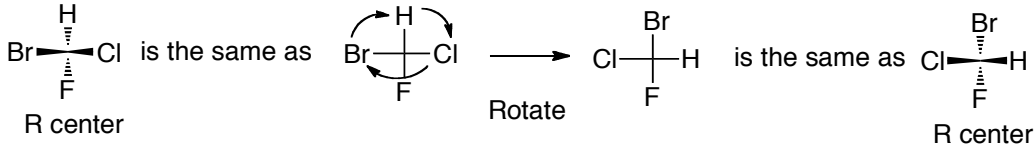
Switching two groups in a Fischer projection will give the enantiomer.



A second switch in the Fischer projection will go back to the original molecule.

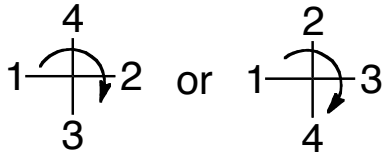


Rotation around a bond will also give the original molecule.

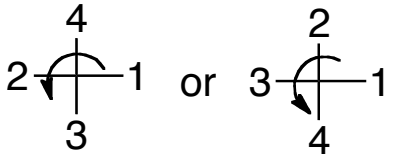


Assigning Stereochemistry using Fischer Projections:

Fischer projections can be used to assign stereochemistry. If the 4th (lowest) priority group is vertical the other three groups will show clockwise (R) or counterclockwise (S) rotation.



1,2,3 - Clockwise
R



1,2,3 - Counterclockwise
S