Stereochemistry and Chirality:

Chiral object (molecule): Has a non-superimposable mirror image

Achiral object (not chiral)

1848 Louis Pasteur separated the "right-handed" and "left-handed" forms of tartaric acid (from wine)

Resolution - Separation of right and left-handed forms (enantiomers)

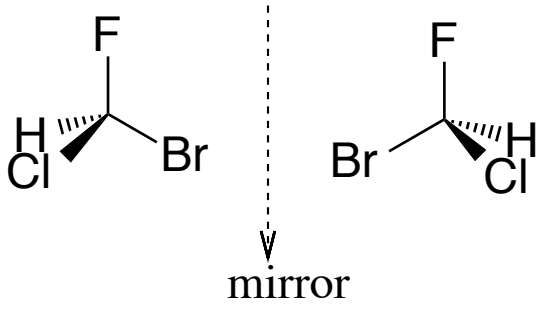
1874 J. van't Hoff and Le Bel proposed that differences are due to tetrahedral geometry of carbon
1877 Kolbe didn't receive van't Hoff's idea very well
1901 J. van't Hoff was the first recipient of the Nobel Prize in Chemistry

Enantiomers: Molecules that are stereoisomers and are non-superimposable mirror images of each other

Diastereomers: Stereoisomers that are not enantiomers.

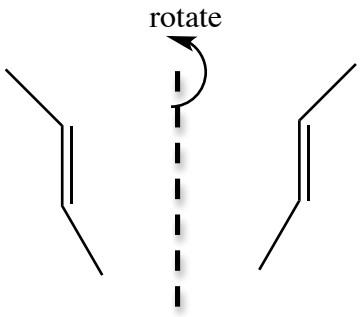
Enantiomers
Stereoisomer - Non-superimposable mirror images → Enantiomers

Example: Chiral molecule, non-superimposable mirror image



NON-SUPERIMPOSABLE → Enantiomers

Example: Achiral (not chiral) molecule; the mirror image is superimposable



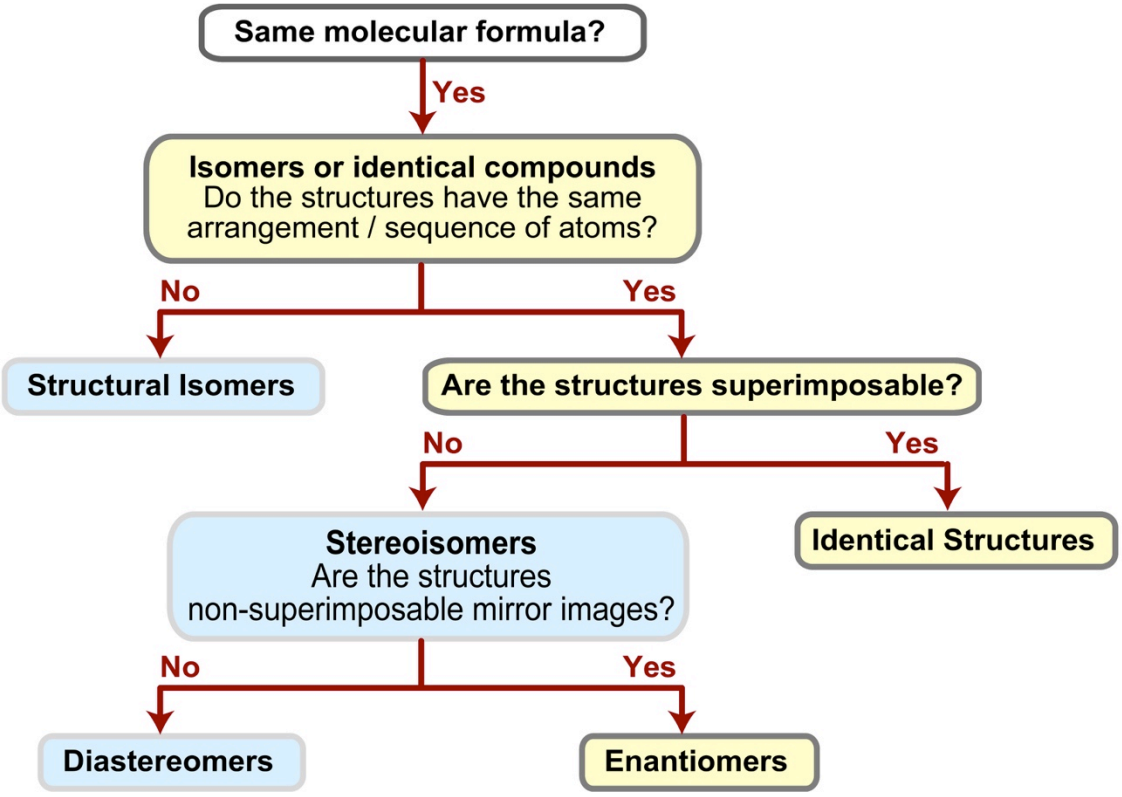
these two are identical

trans-2-butene is achiral

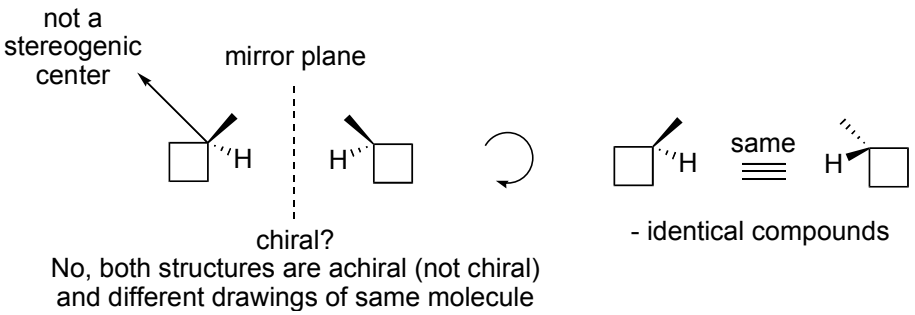
All stereoisomers that are not enantiomers are diastereoisomers

Note: If you have a mirror plane of symmetry within a molecule → achiral

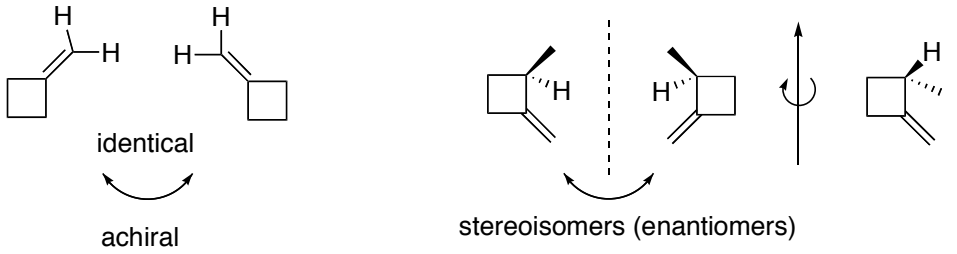
Structure Comparison:



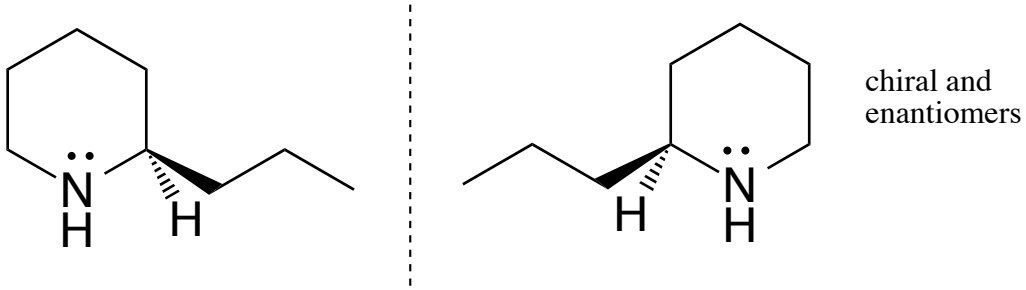
More Examples:



If there is plane of symmetry within a molecule, then the molecule is **achiral** (not chiral)

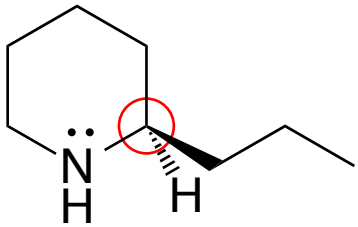


Coniine: Poison hemlock



Stereogenic center (chiral centers or asymmetric centers)

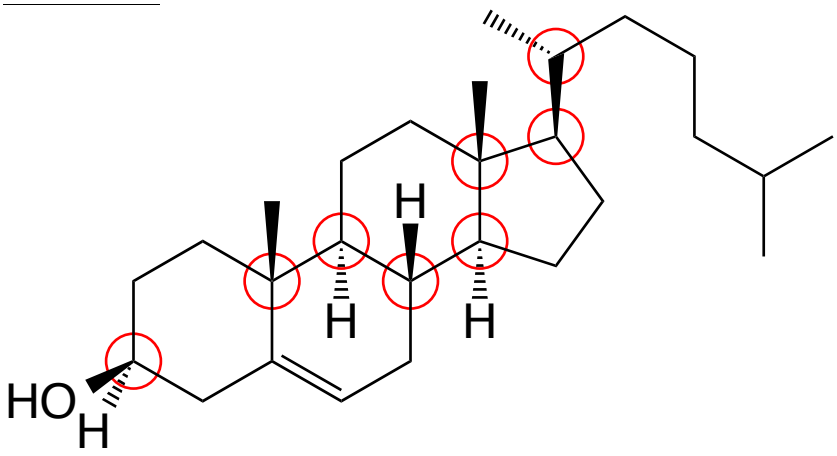
- Usually carbons with four different groups attached



At room temperature the lone pair on nitrogen sits above or below and inverts freely like an umbrella → not chiral

The carbon circled in red is a stereocenter

Cholesterol:



8 stereogenic centers
2^8 stereoisomers possible = 256

- 1 stereoisomer is cholesterol and is biologically active
- 1 is an enantiomer (to draw enantiomers, invert every stereogenic center)
- 254 diastereomers

R/S Nomenclature:

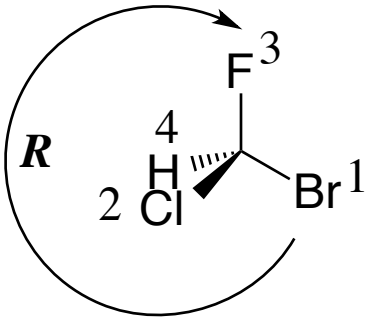
R and S designation of stereoisomers

- R = Rectus (count clockwise)
- S = Sinister (count counterclockwise)

Labeling a stereogenic centre as R or S:

- Identify all stereogenic centers (i.e. 4 different substituents)
- Assign priority based on atomic number (similar to *E* and *Z*). If you cannot decide, go to the next set of atoms.
- With the lowest priority group pointing back, count 1, 2, 3:
  - Clockwise → R configuration
  - Counterclockwise → S configuration

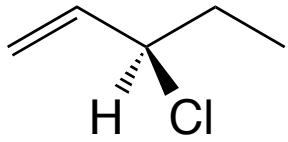
Each stereogenic center in a molecule is analyzed separately



Place lowest priority to the back

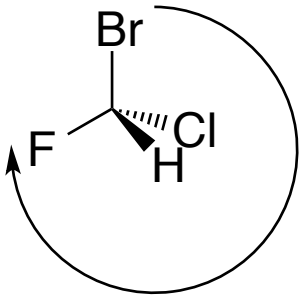
1,2,3 --> clockwise = "R"
1,2,3 --> counterclockwise = "S"

Example: 3-chloro-propene



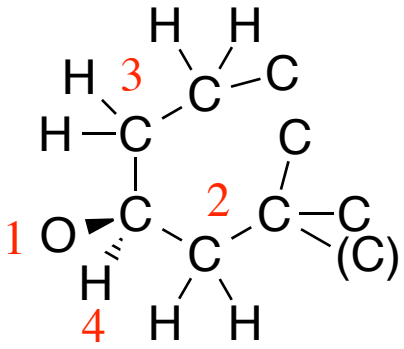
R-3-chloropropene

What if the lowest priority group is pointing forward?



- Counting 1, 2, 3 gives clockwise, BUT the smallest group is pointing forward, so the configuration is opposite of what you get if the smallest group is back
- In this case, the configuration of the stereogenic centre is "***S***"

Example: The carbinol carbon in cholesterol



Count 1,2,3 → counterclockwise is "S"