Stereochemistry and Chirality:

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

Achiral object (not chiral)

- Louis Pasteur 1848

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

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

Structure comparison:



Mirror images are non-superimposable : Stereoisomers -> Enantiomers

eg. The mirror images below are superimposable



Trans-2-butene is achiral.

All stereoisomers that are not enantiomers are diastereoisomers.



- If you have a mirror plane of symmetry within a molecule \rightarrow Achiral

Eg.



Stereogenic centre (chiral centers or asymmetric centers)

often a tetrahedral atom (carbon) with four different groups attached to it

R and S designation of stereoisomers

- R = Rectus

-S = Sinister

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Each stereogenic center analyzed separately.



mirror plane

Labeling a stereogenic centre as R or S:

- 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 group pointing back, count 1, 2, 3:

clockwise \rightarrow R configuration, counterclockwise \rightarrow S configuration



R-bromochlorofluoromethane

eg.

H) Br

- #3 is stereogenic center

3-Bromo-1-Pentene



- clockwise So "R" - configuration.

eg.



- 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"

To draw an enantiomer invert every stereogenic centre



Enantiomer of coniine (non toxic)

Cholesterol



- stereogenic centres (8)
 - 256 stereoisomers possible or 2^8
 - 1 isomer is cholesterol
 - 1 is enantiomer of cholesterol
 - 254 are diastereomers.
- To draw enantiomer invert every stereogenic center:



eg.



quinine - anti-malarial drug from the bark of the tree *Cinchona officinalis*

malaria is cause by *Plasmodium* species transmitted by *Anopheles* mosquito

<u>Fischer projection</u> – a convention for drawing organic molecules in which horizontal groups are understood to point toward you, and vertical groups backward. eg. Tartaric acid



<u>Meso compounds</u>: have stereogenic centres but are achiral. The one above has an internal plane of symmetry.

All compounds with internal plane of symmetry are achiral (not chiral).