Chapter 5:
Stereochemistry

Today – Chapter 5 (5.1-5.3)

Stereochemistry

WEDNESDAY EXAM 1!

Friday! Chapter 5 (5.3, 5.5, 5.6, 5.8)

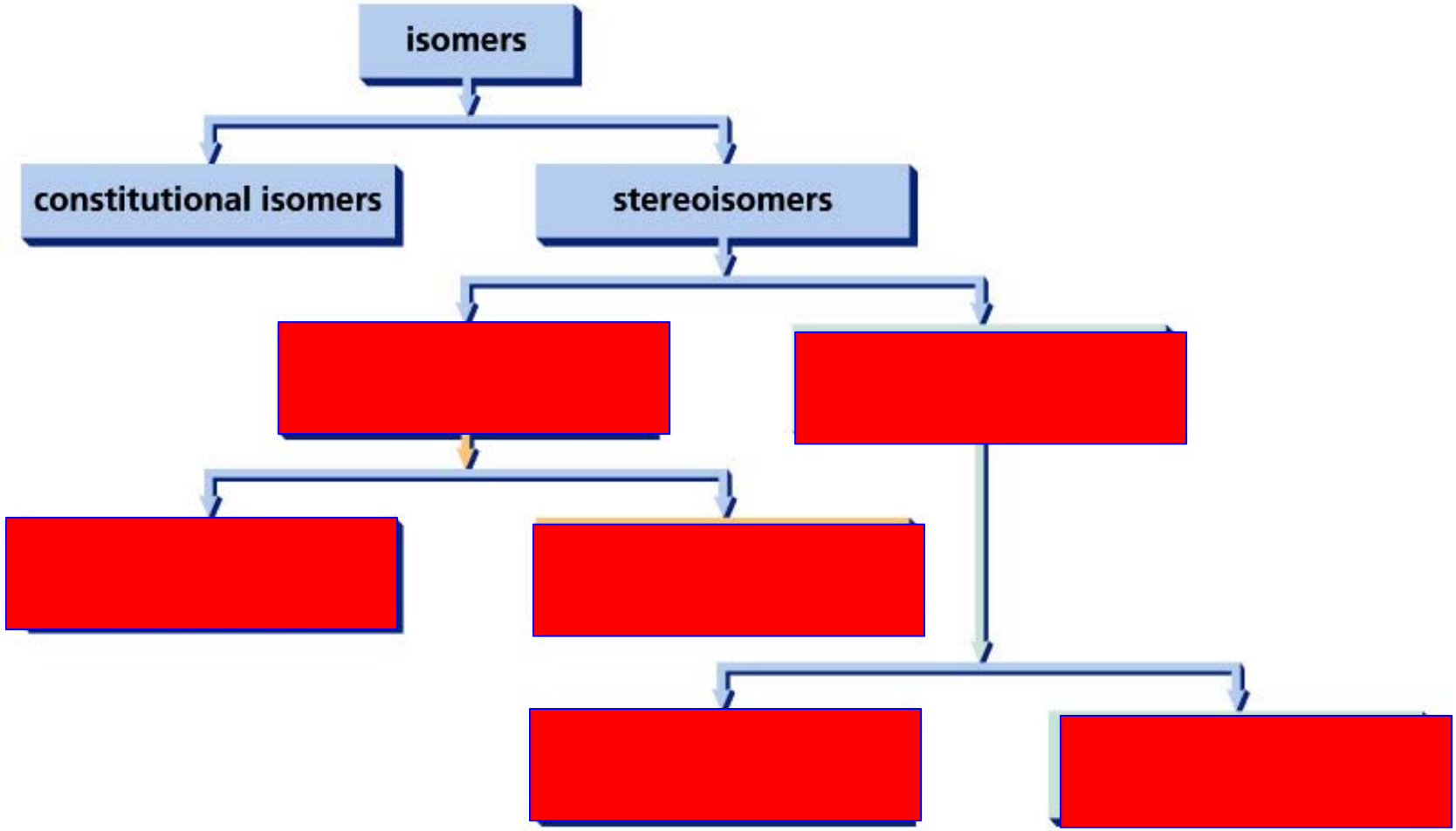
Diastereomers

Next Monday Chapter 5 (5.4, 5.9)

Resolving Enantiomers

Isomers

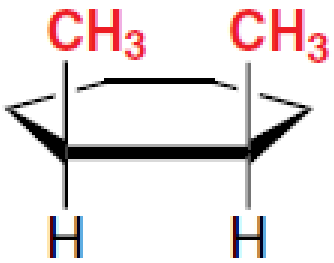
Nonidentical compounds having the same molecular formula

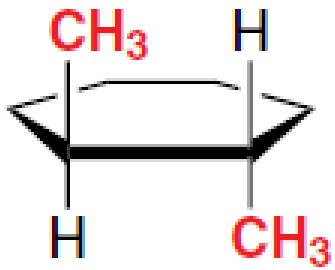


<u>Stereoisomers</u>: Isomers that contain the same atoms and same connectivity but differ in how the atoms are arranged in space.

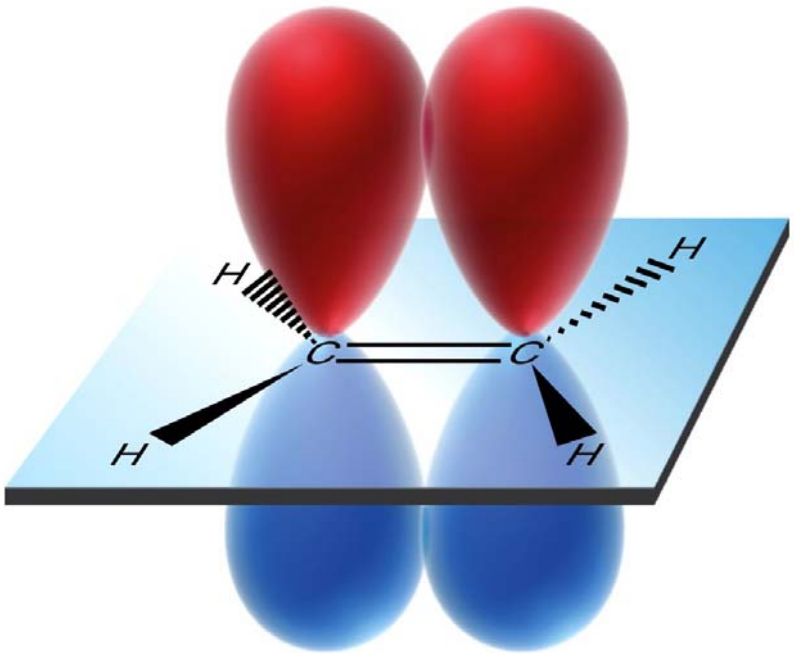
Isomers

- C–C bonds that are constrained in a cyclic structure cannot freely rotate.
- Although the two molecules below have the same connectivity, they are NOT identical.



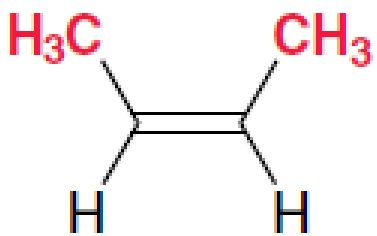


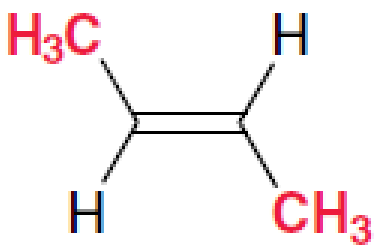
Isomers



π Bond

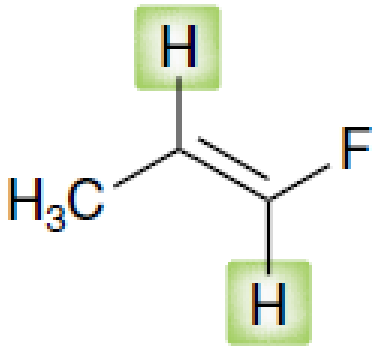
- Although the two molecules below have the same connectivity, they are NOT identical



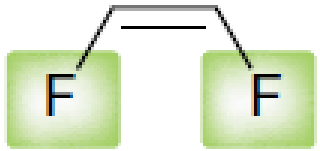


Isomers

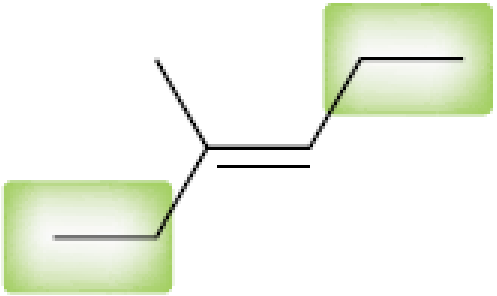
- Cis—identical groups are positioned on the SAME side of a C=C double bond.
- Trans—identical groups are positioned on OPPOSITE sides of a C=C double bond



trans because of the H's:

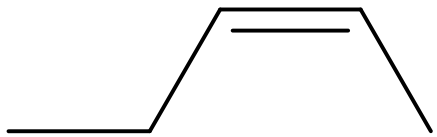


Two fluorine atoms are *cis*

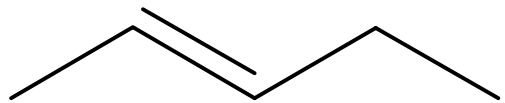


Two ethyl groups are *trans*

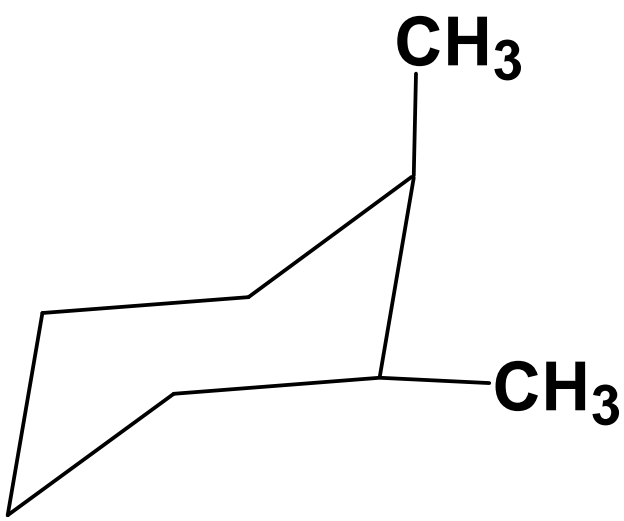
Cis-Trans Isomers



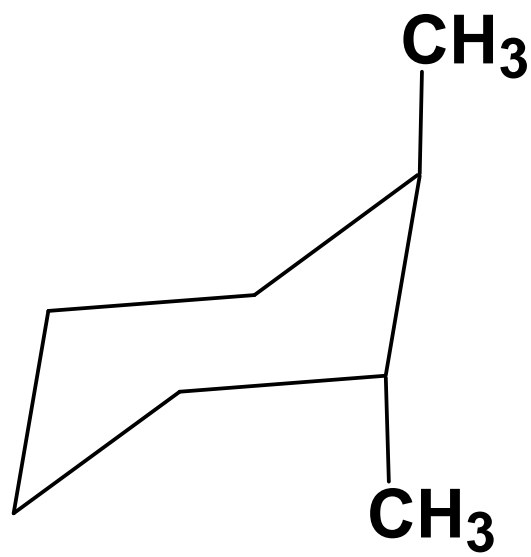
cis-2-pentene



trans-2-pentene



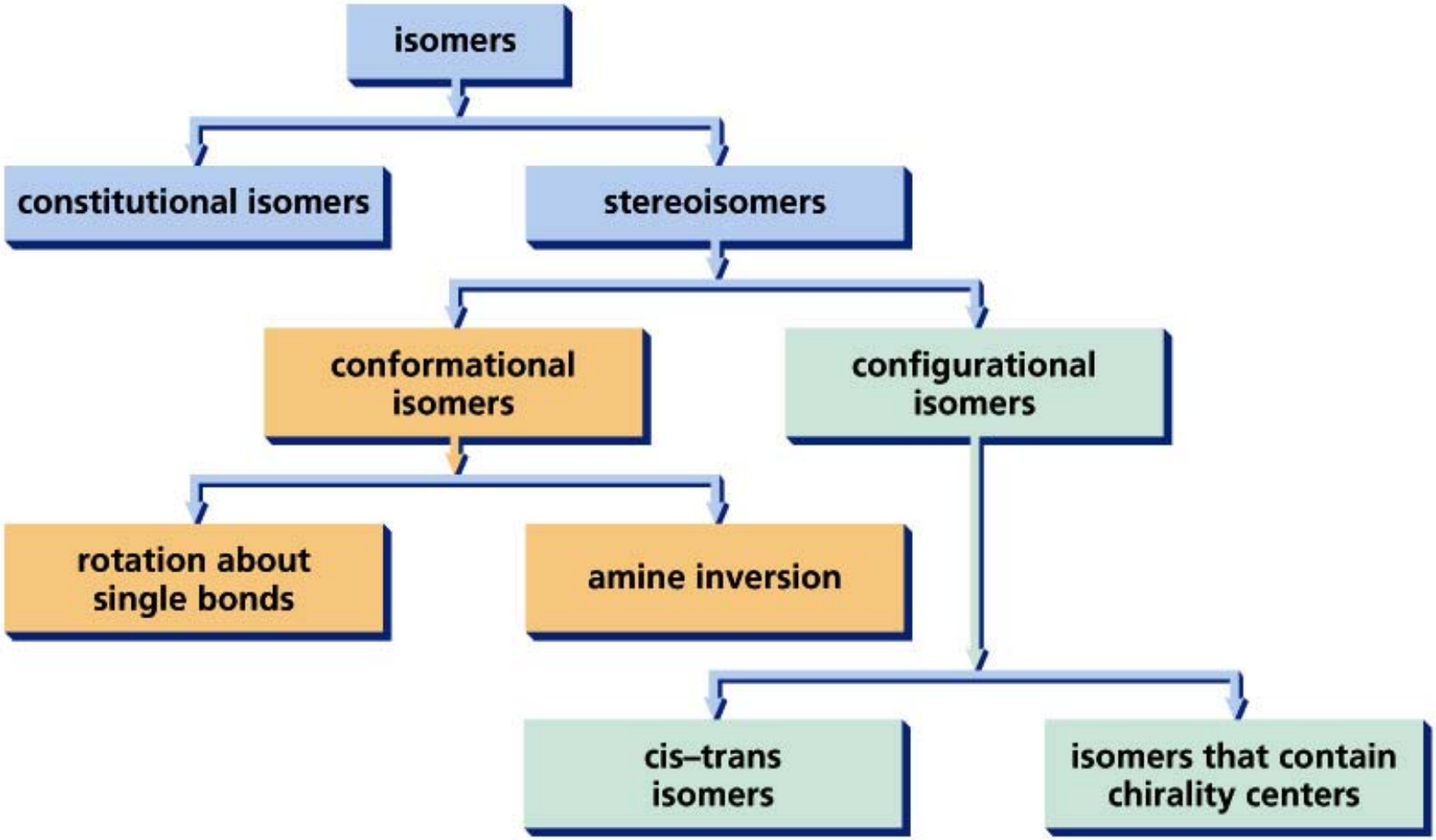
cis - 1,2-Dimethyl-cyclohexane



trans - 1,2-Dimethyl-cyclohexane

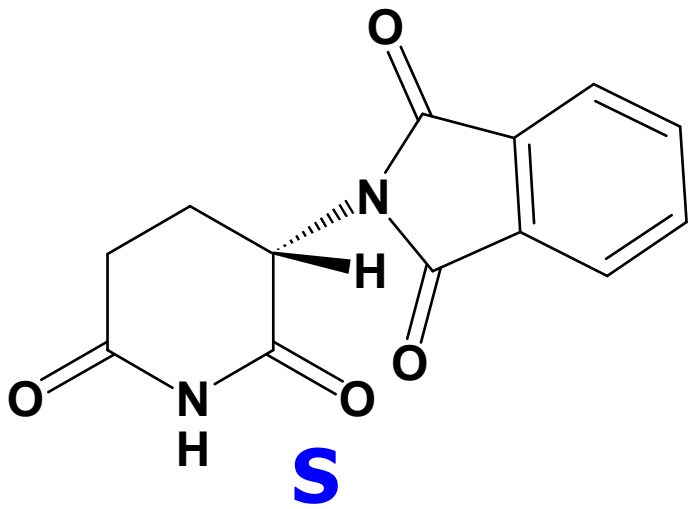
Isomers

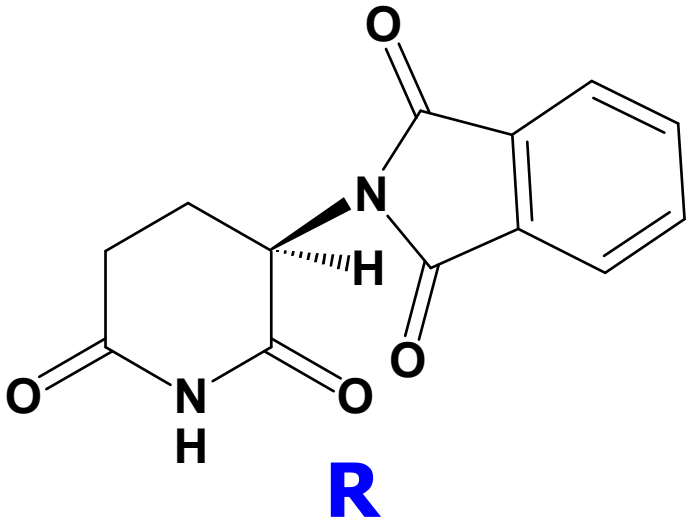
Nonidentical compounds having the same molecular formula



<u>Stereoisomers</u>: Isomers that contain the same atoms and same connectivity but differ in how the atoms are arranged in space.

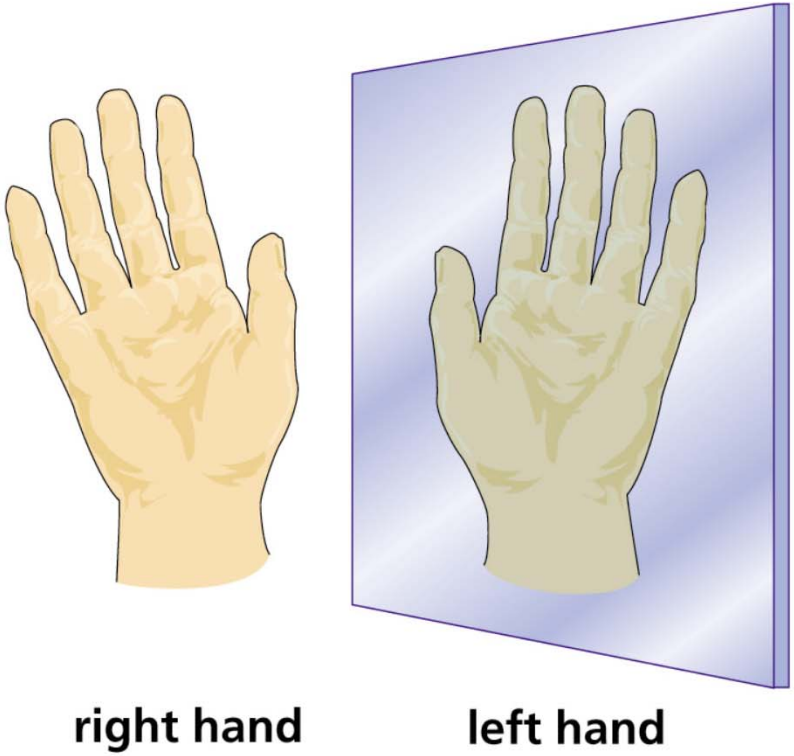
Thalidomide: why chirality matters

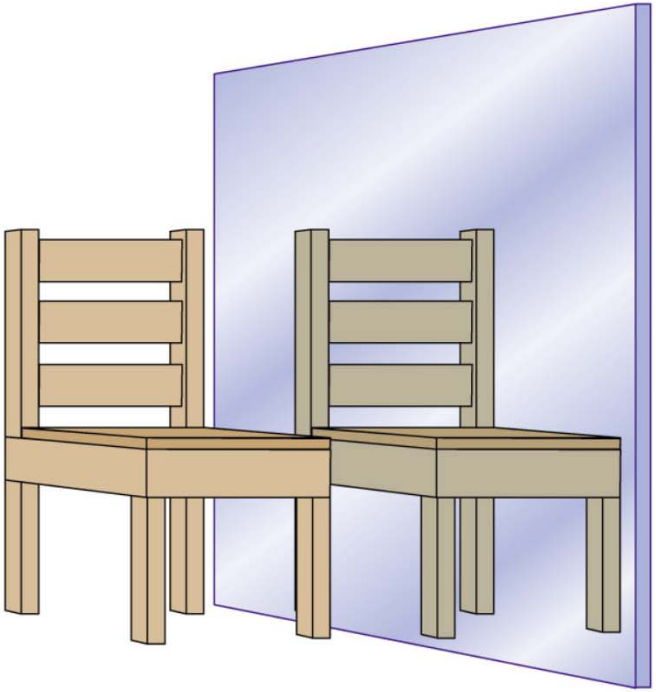




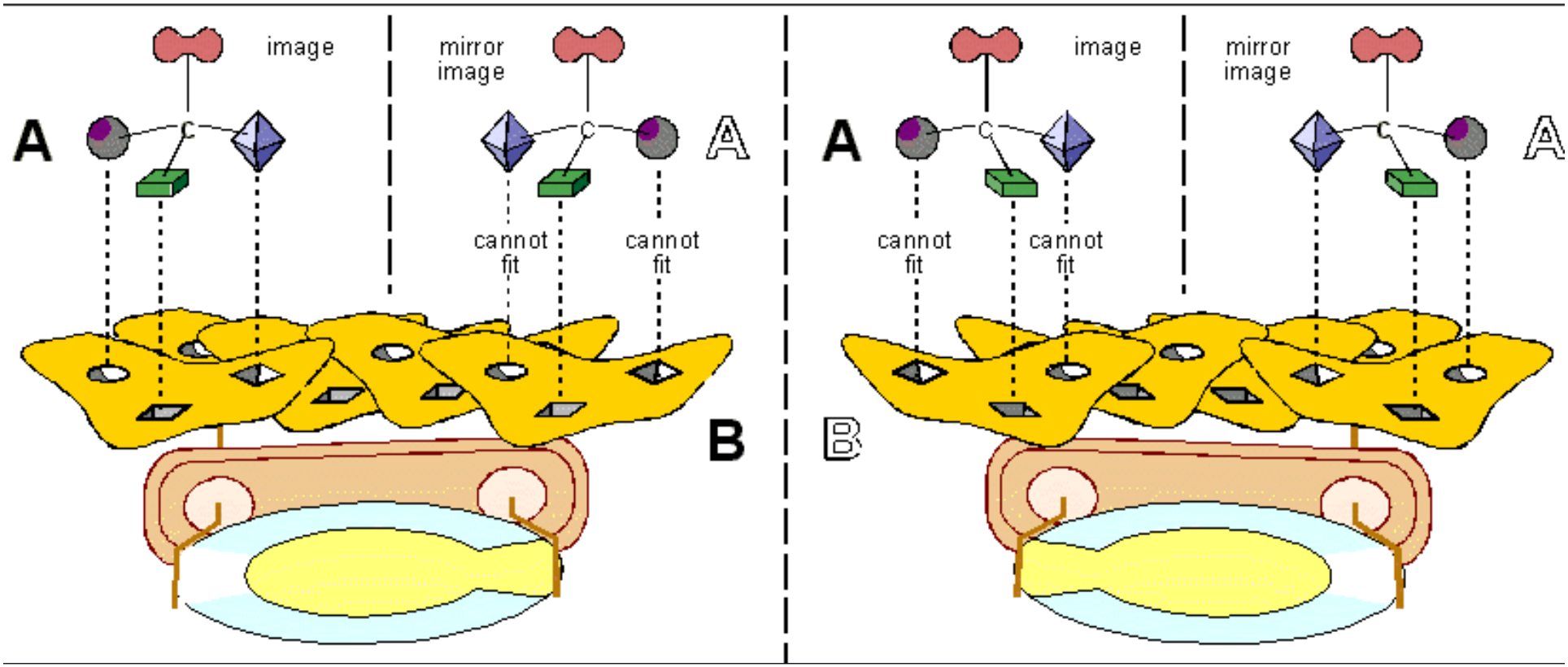
- Thalidomide - sedative resulted in severe birth defects only because the S and R isomers or enantiomers given as a mixture. Pure R form would probably have not created a problem.
- Thalidomide S enantiomer is now being used to treat MS.
- Must be avoided by women of child-bearing age!
- ***R and S are a way to designate the specific nature of a special kind of isomerism involving the "handedness" of molecules, called stereoisomerism.***

"Handedness"



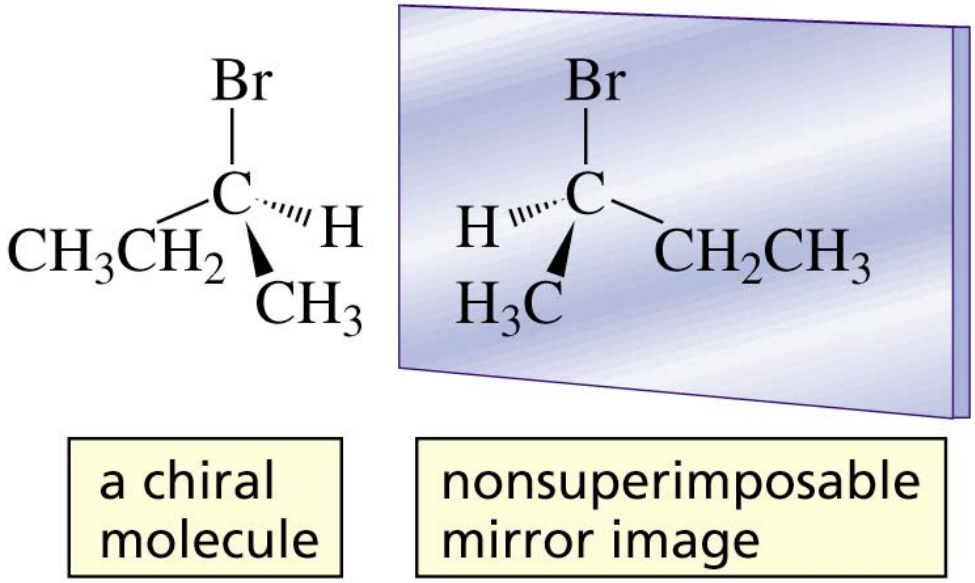


- Chirality: Whether something has "handedness"
- All sorts of common objects are chiral.
- The interactions between a chiral object and two enantiomers are different.



- We are concerned with chirality because natural products are often chiral.
- This holds for complex enzymatic systems and the simpler building blocks of life: Proteins, amino acids, sugars, etc.
- This means one enantiomer of a drug can have very different activity. (figure p. 204)

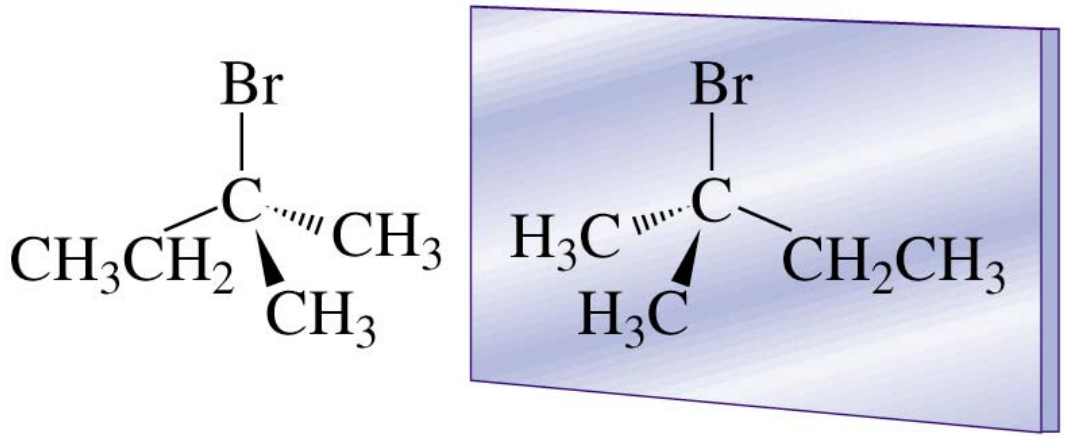
Chirality



2-bromobutane

- Chiral compound: A compound that is not superimposable on its mirror image.
- If an object is not superimposable on its mirror image it is chiral. If it is, it is achiral.
- The two different mirror image forms are enantiomers.

Example of an Achiral Molecule

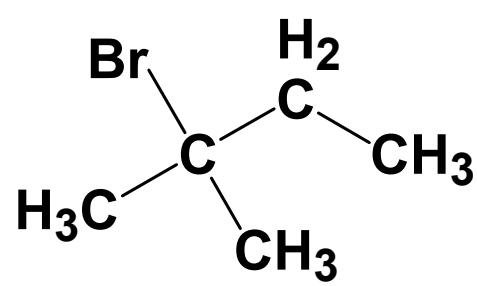


an achiral molecule

superimposable mirror image

identical molecules

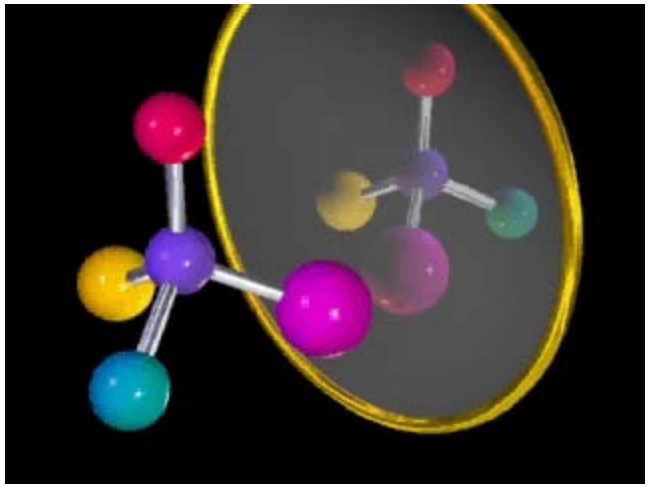
2-bromo-2-methylbutane

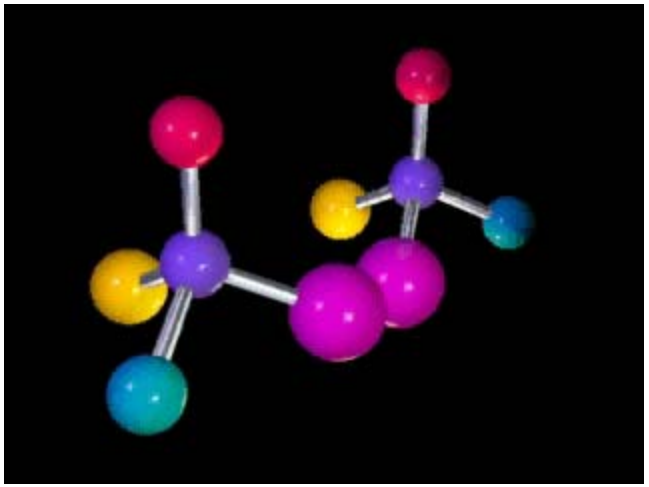


Achiral compounds have superimposable mirror images

Enantiomers

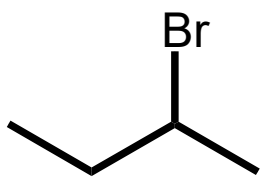
nonsuperimposable mirror-image molecules



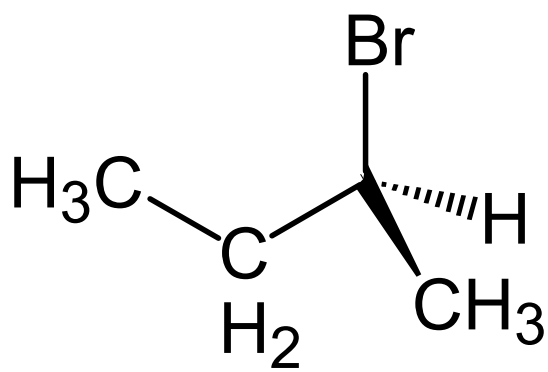


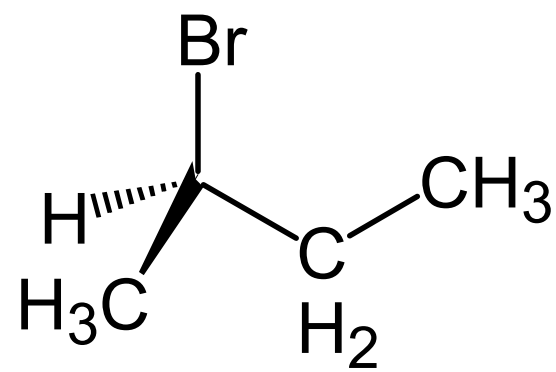
- Two enantiomers are stereoisomers: molecules that differ only in the way the different groups in the molecule are arranged in space.
- Enantiomers are also configurational isomers: bonds must be broken and remade to interconvert them.
- This interconversion requires energy.

Some Insights into Chirality



2-bromobutane





- 2-Bromobutane is chiral because it contains 4 unique groups around the one carbon atom or <u>stereocenter</u>.
- One such <u>stereocenter</u> guarantees chirality.
- We will see later that if 2 <u>stereogenic</u> centers are present chirality is not guaranteed, and does not occur if there is an internal mirror plane (<u>meso</u>).

Some Simplifying Tricks for Chirality

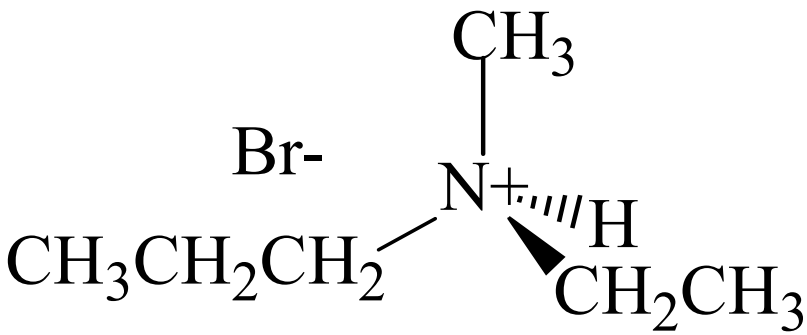
Trick 1: Look for just one (one is integral part of this rule) asymmetric carbon atom/stereogenic center to identify a chiral molecule.

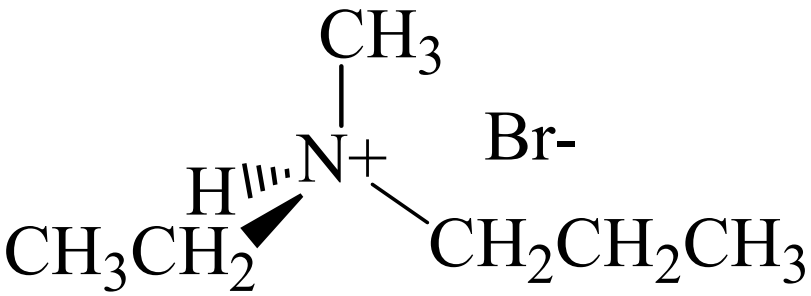
→ This guarantees chirality, but it is not the only way to achieve it.

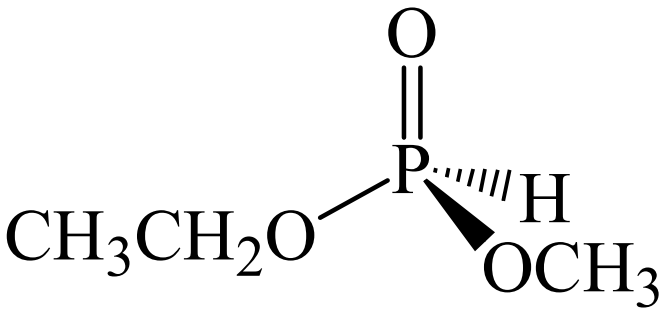
Trick 2: The presence of an internal mirror plane guarantees Achirality, but not all achiral molecules have mirror planes (this is rare).

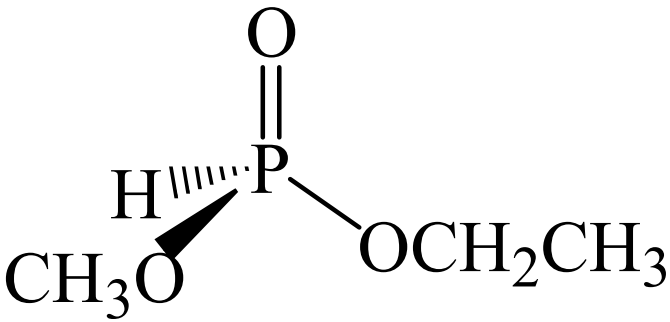
When in doubt, refer to mirror/plane non-superimposability test.

Atoms other than carbon can be asymmetric









For Next Time....

Today – Chapter 5 (5.1-5.3)

Stereochemistry

Wednesday – EXAM #1

Friday - Chapter 5 (5.3, 5.5, 5.6, 5.8)

Diastereomers (We will not cover 5.7.)

Monday Chapter 5 (5.4, 5.9 – 5.11)

Resolving Enantiomers

Suggested Homework Problems Chapter 5

#4, 9, 19,23,31, 36,38 (a-c), 39 (a-e),45, 55