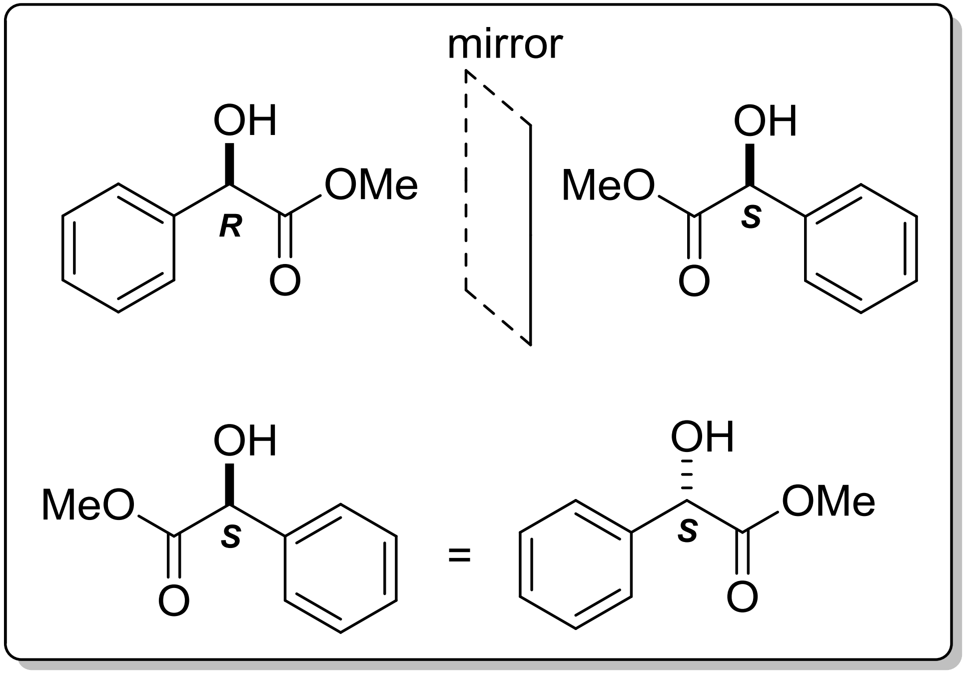
Enantiomers

Enantiomers are stereoisomers that are non-superimposable mirror images. A molecule with 1 chiral carbon atom exists as 2 stereoisomers termed **enantiomers** (see the example below).

Enantiomers differ in their configuration (*R* or *S*) at the stereogenic center. Configuration is assigned by the **Cahn-Ingold-Prelog** (CIP) rules – see CHEM 343 notes or textbook.



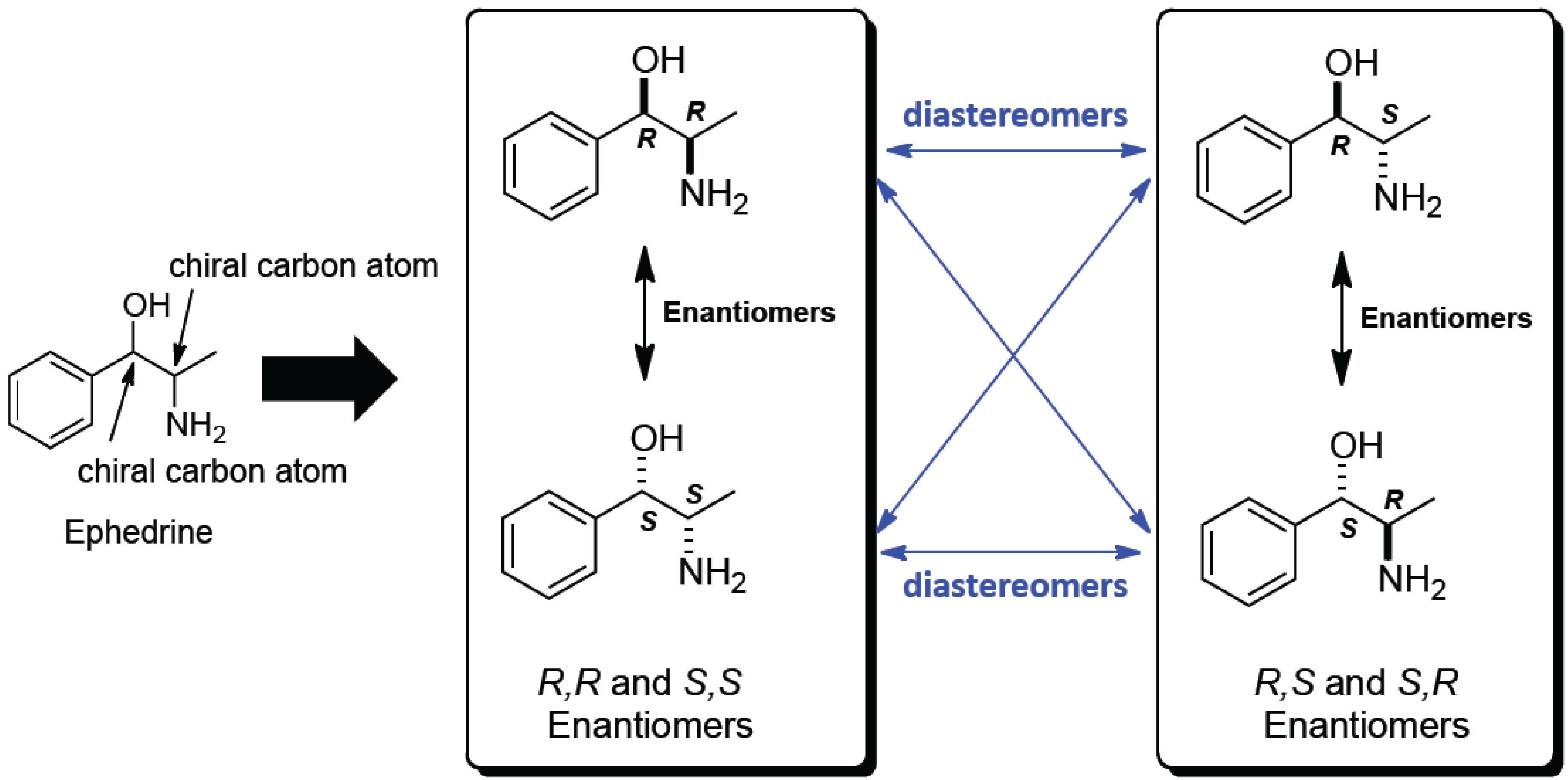
Enantiomers have identical chemical and physical properties in an achiral environment. Enantiomers rotate the direction of plane polarized light to equal, but opposite angles and interact with other chiral molecules differently.

Enantiomers and Diastereomers

A molecule with 2 chiral carbon atoms can exist as 3 or 4 stereoisomers.

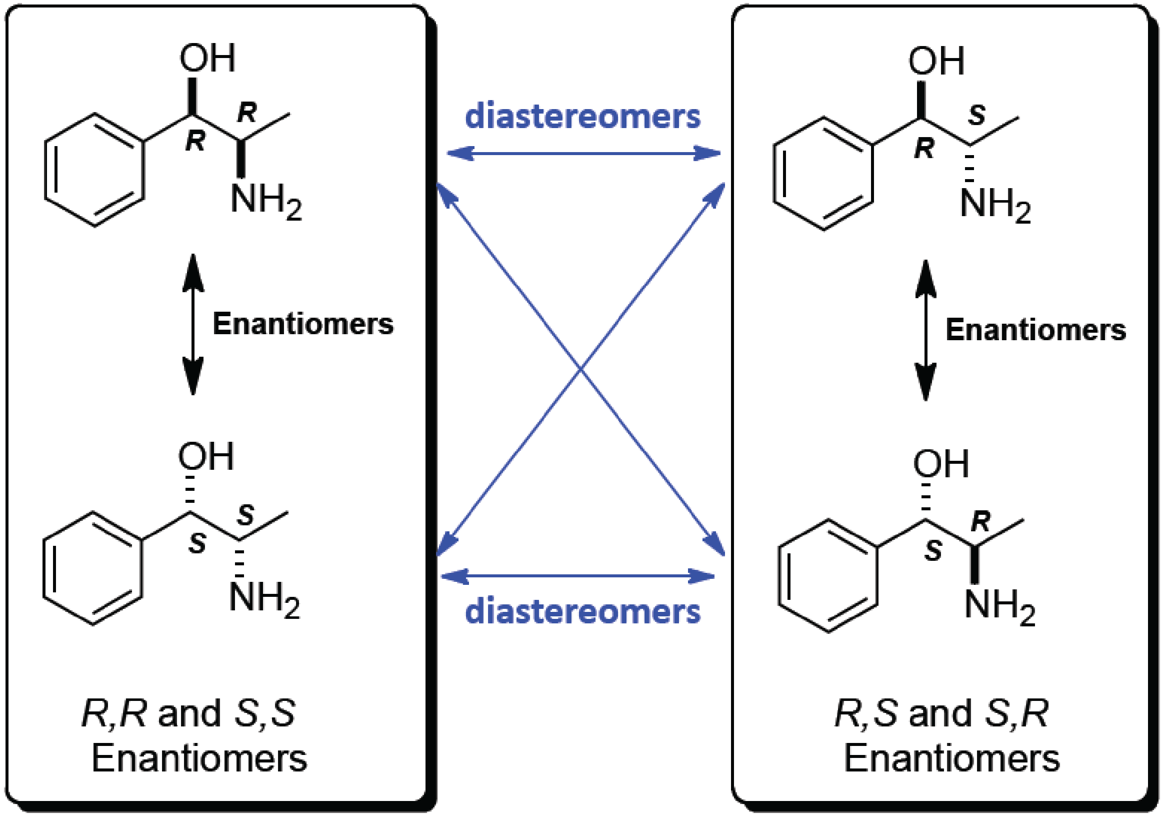
Diastereomers are stereoisomers that are not enantiomers.

Each stereoisomer of ephidrine has 1 **enantiomer** and 2 **diastereomers**



not a resonance arrow!

Enantiomers and Diastereomers



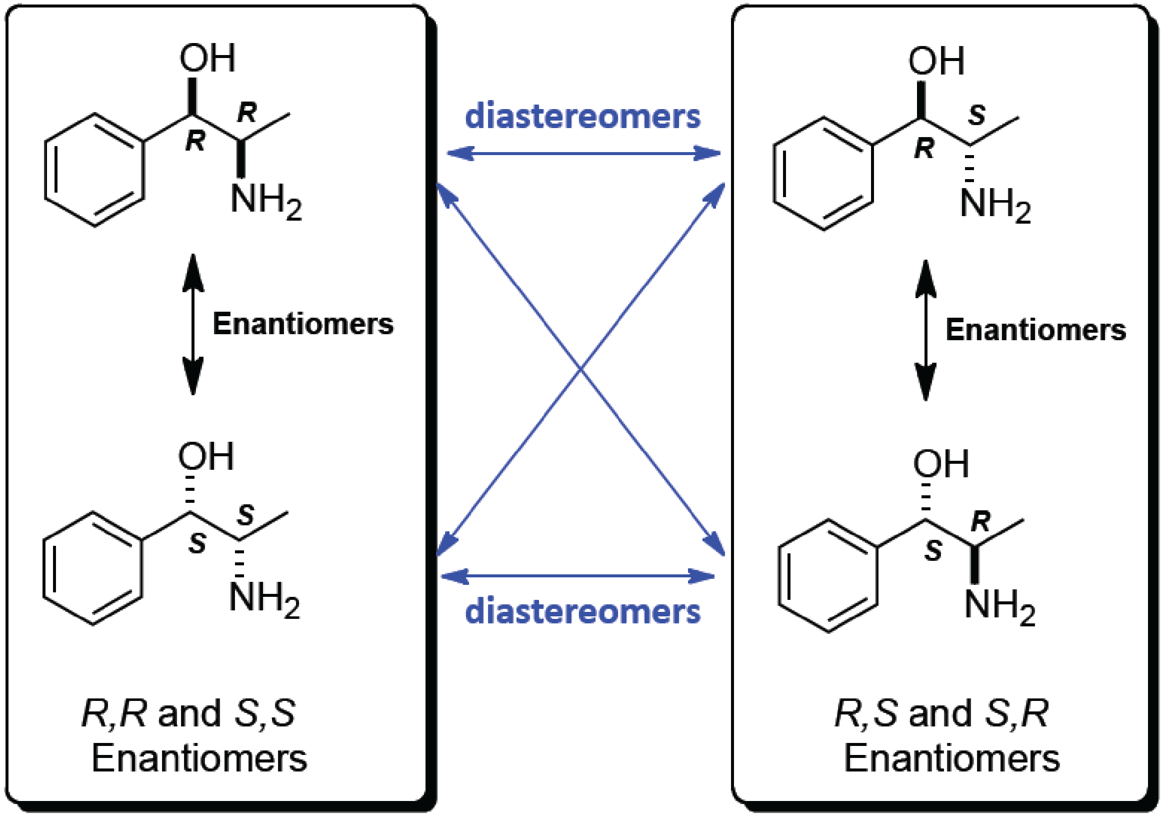
Properties of the 4 stereoisomers of ephedrine

	R, R	*S, S*	*R, S*	*S, R*
Melting range (°C)	117 - 118	117 - 118	40 - 41	40 - 41
Optical rotation (°)	-52.1	+52.1	-6.3	+6.3

Enantiomers have **identical** chemical and physical properties in an achiral environment.

Diastereomers have **different** chemical and physical properties (melting range, solubility, etc.)

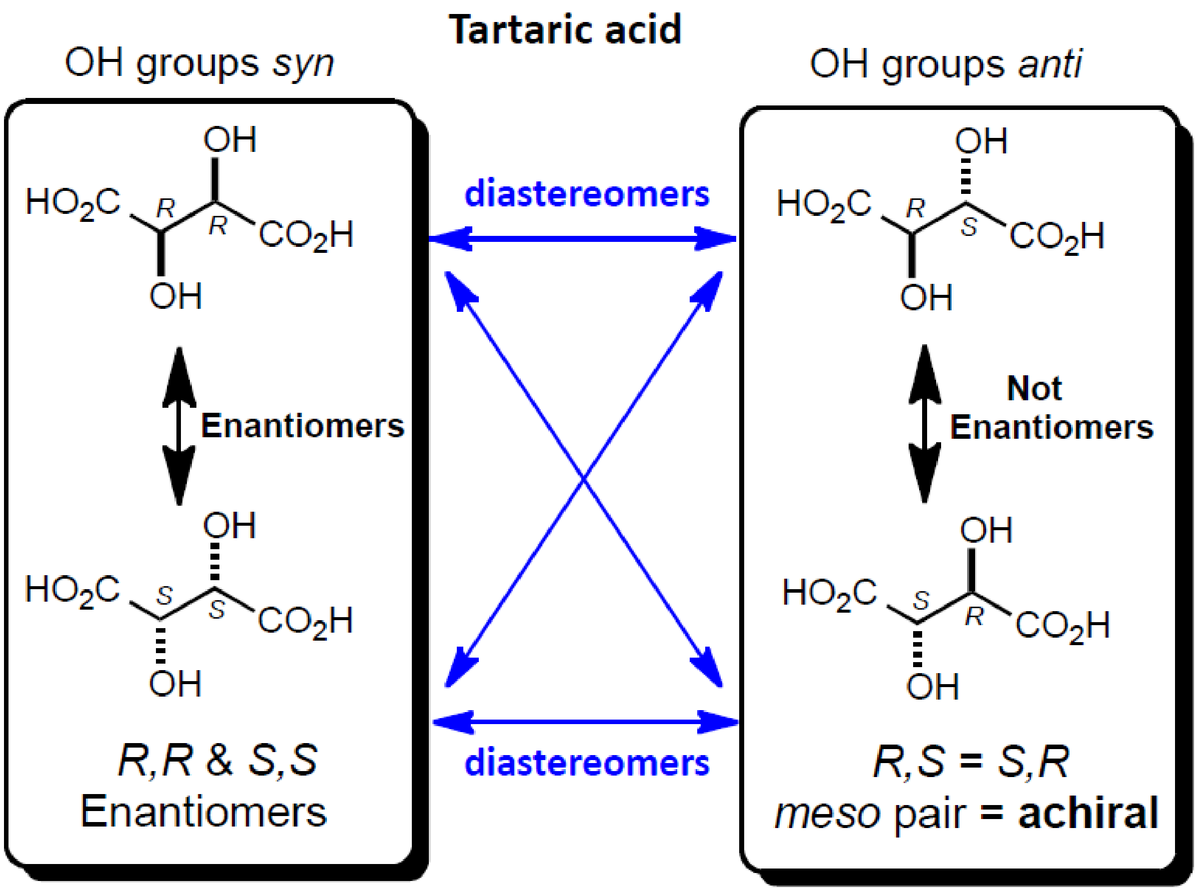
Enantiomers and Diastereomers



To convert between **enantiomers**, <u>both</u> chiral carbon atoms must change configuration. All stereocenters must be different for molecules to be enantiomers.

To convert between **diastereomers**, <u>only one</u> chiral carbon atom must change configuration. At least one stereocenter must be different, and at least one stereocenter must be the same for molecules to be diastereomers.

Enantiomers, Diastereomers and *Meso* Compounds



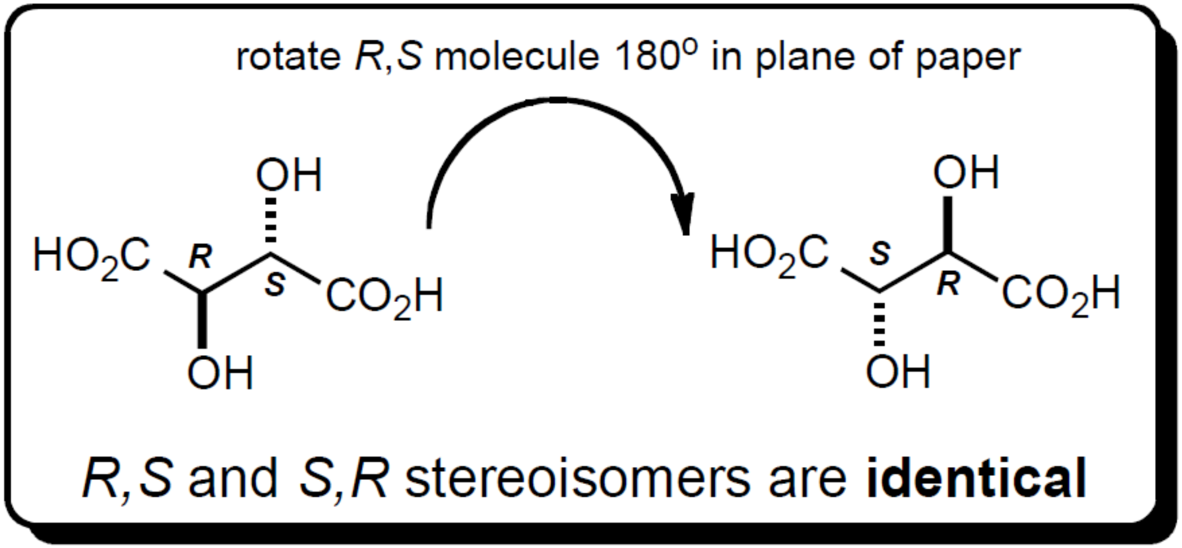
The *R,S* and *S,R* stereoisomers are NOT enantiomers

Tartatric acid is a **symmetrical molecule** containing 2 chiral carbon atoms

Why are the *R,S* and *S,R* stereoisomers **NOT** enantiomers?
Why are the *R,S* and *S,R* stereoisomers **ACHIRAL**?

Enantiomers, Diastereomers and *Meso* Compounds

Why are the *R*,*S* and *S*,*R* stereoisomers of tartaric acid **NOT** enantiomers?

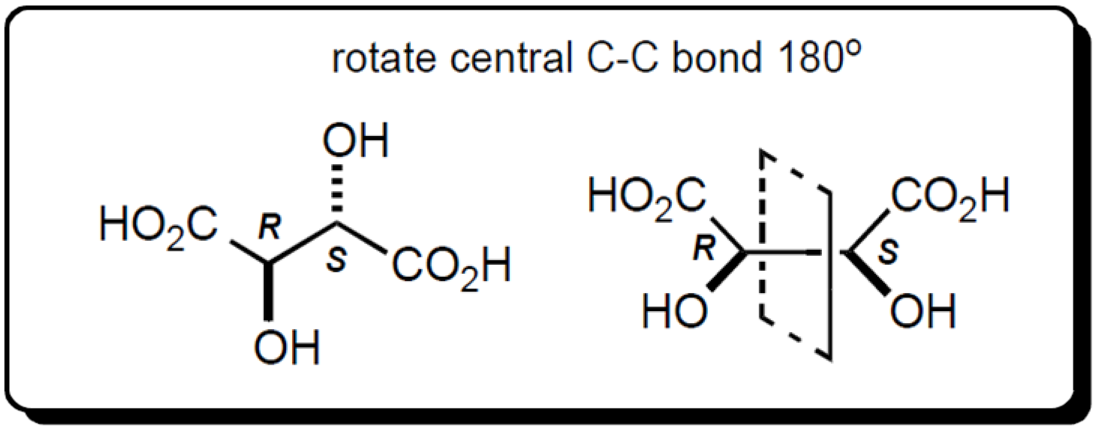


The *R*,*S* and *S*,*R* stereoisomers are superimposable on their mirror images and identical. They are the same molecule and it is not correct to describe them as separate species or separate stereoisomers.

They are a ***meso* compound**; a molecule with asymmetric carbon atoms whose mirror image is superimposable.

Enantiomers, Diastereomers and *Meso* Compounds

Why are the *R,S* and *S,R* stereoisomers of tartaric acid **achiral**?



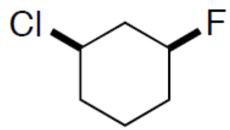
The *R,S* diastereomer of tartaric acid is a ***meso* compound.**

Meso compounds have a) an even number asymmetric atoms of opposite configuration.
b) an internal mirror plane bisecting the molecule.

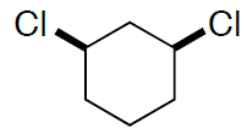
Each half of the *meso* compound is the mirror image of the other half and "cancels" the optical activity of the other, thus the molecule is **achiral.**

Enantiomers, Diastereomers and *Meso* Compounds

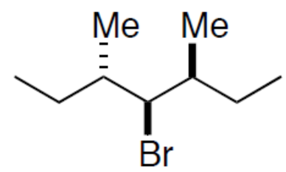
Which of the following molecules are *meso*?



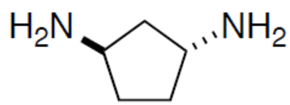
A



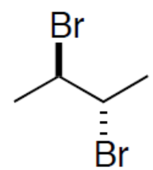
B



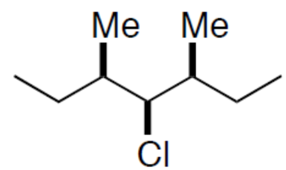
C



D



E



F

A: No B: Yes C: No D: No E: Yes F: Yes

Enantiomers, Diastereomers and *Meso* Compounds