how to determine the relationship between two molecules: general method

<table>
<tr><td>different numbers of atoms
different molecules that are not isomers</td><td colspan="3">same numbers of atoms
isomers or identical</td></tr>
<tr><td></td><td>different connectivity
structural/ constitutional isomers
(different physically and chemically)</td><td colspan="2">same connectivity
stereoisomers or identical</td></tr>
<tr><td></td><td></td><td colspan="2">nonsuperimposable (different arrangement in space)
stereoisomers</td><td rowspan="2">superimposable
identical</td></tr>
<tr><td></td><td></td><td>not mirror images
diastereomers
(different physically, similar chemically)</td><td>mirror images
enantiomers
(identical except for: light rotation, and reaction with other chiral molecules)</td></tr>
</table>

"Enantiomers" refers to the *relationship* between *two* molecules (similar to the word "twins").
"Stereoisomers" and "diastereomers" refer to *relationship* between *two or more* molecules (similar to the word "cousins").

how to determine the relationship between two molecules: stereocenters method

(1) Identify stereocenters. "Stereocenter" refers to a single atom that is attached to four *groups*, all of which are different. A stereocenter need not be attached to four different *atoms*. (2) Identify meso molecules. A meso molecule is a molecule with stereocenters and a plane of symmetry. (3) Identify pseudostereocenters. A pseudostereocenter is an atom that is in a meso molecule, on the plane of symmetry, and connected to four groups, *three* of which are different. When comparing meso molecules, treat pseudostereocenters like actual stereocenters.

<table>
<tr><td>different numbers of atoms
different molecules not isomers</td><td colspan="6">same numbers of atoms
isomers or identical</td></tr>
<tr><td></td><td>different connectivity
structural/ constitutional isomers</td><td colspan="5">same connectivity
stereoisomers or identical</td></tr>
<tr><td></td><td></td><td>cis and trans
diastereomers</td><td colspan="4">not cis and trans</td></tr>
<tr><td></td><td></td><td rowspan="2"></td><td colspan="3">stereocenters (SC's)</td><td rowspan="2">no stereocenters
identical</td></tr>
<tr><td></td><td></td><td>opposite config at some SC's, and same config at some SC's
diastereomers</td><td colspan="2">opposite at all SC's</td><td>same at all SC's
identical</td></tr>
<tr><td></td><td></td><td></td><td></td><td>not meso
enantiomers</td><td>meso
identical</td><td></td></tr>
</table>

The "stereocenters method" does not work for special cases such as allenes, spiro compounds, and diphenyls.

how to identify whether a molecule is chiral or achiral, meso or not meso: general method

superimposable mirror image / plane of symmetry **achiral** (do not rotate plane-polarized light)		nonsuperimposable mirror image / no plane of symmetry **chiral** (do rotate plane-polarized light)
no stereocenters **not meso**	stereocenters **meso**	

"Chiral", "achiral", and "meso" refer to the characteristics of a *single* molecule (similar to the word "tall").

how to identify whether a molecule is chiral or achiral, meso or not meso: stereocenters method

no stereocenters **achiral, not meso**	stereocenters	
	plane of symmetry **achiral, meso**	no plane of symmetry **chiral**

The "stereocenters method" does not work for special cases such as allenes, spiro compounds, and diphenyls.

swapping and rotating; R/S vs. +/-

give opposite configuration: single swap, 90° Fischer rotation	**give same configuration:** double swap, 180° Fischer rotation
A "swap" involves swapping *groups* only. All the *bonds* must still be oriented in the same directions for the "swap rules" to work.	
+/-: Indicates rotation of plane-polarized light—clockwise (+) or counterclockwise (-). Determined from experiment, not from R or S.	**R/S:** For stereocenter *nomenclature* ("absolute configuration") only. R and S do *not* indicate the direction in which light is rotated.

how to determine R or S ("absolute configuration")

if the priority 4 group is pointing **into** the page	Determine whether the groups with priorities 1→2→3 are arranged clockwise (R) or counterclockwise (S) on the page. This gives you the actual configuration.
if the priority 4 group is pointing **out of** or **in the plane of** the page	1. Swap the priority 4 group with a group that is pointing into the page. You can do this by just swapping priority numbers without actually redrawing any groups.
	2. Using the new arrangement of priority numbers from step one, determine whether priorities 1→2→3 are arranged clockwise (R) or counterclockwise (S) on the page.
	3. The actual configuration of the original molecule is the opposite of the configuration from step two.

"R" and "S" refer to the nomenclature for a single stereocenter.