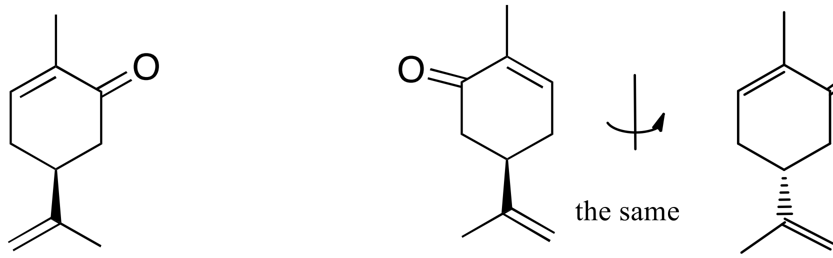
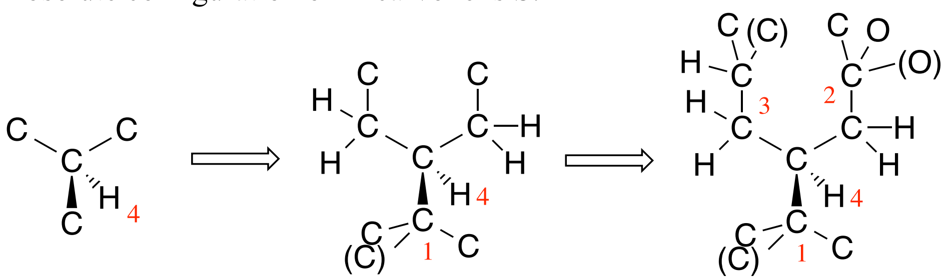
<u>Demo:</u> <u>Odor of Carvone (two enantiomers with different odor)</u>

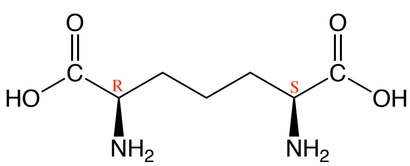


S-carvone (caraway-like) R-carvone (spearmint-like)

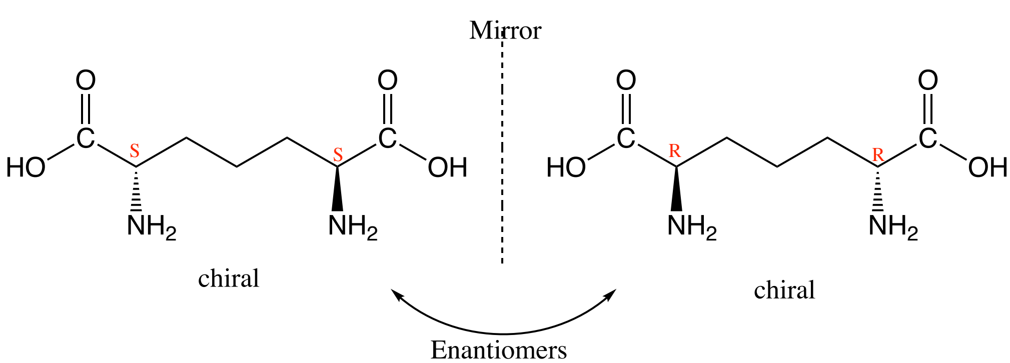
Absolute configuration of D-carvone is S:



<u>Another example:</u> Diaminopimelic acid

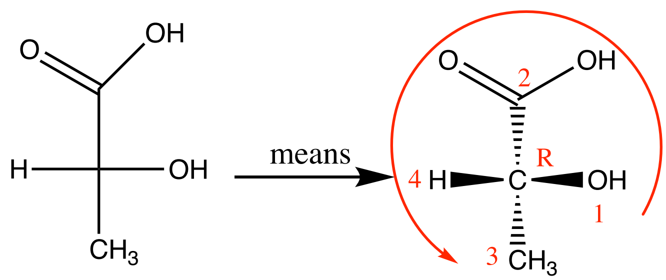


- Achiral molecule even though there is symmetry, it contains stereogenic center (s) and this kind of molecules are called **<u>Meso compounds</u>**
- Diaminopimelic acid - a component of bacterial cell wall
- this R,S diaminopimelic acid (above) is a diastereomer of the enantiomers (S,S or R,R diaminopimelic acid) below:

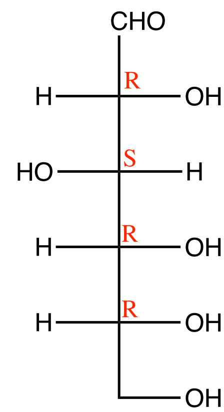


Fischer Projections

A method of drawing chemical structures, where the horizontal components are coming towards you and the vertical ones are going back



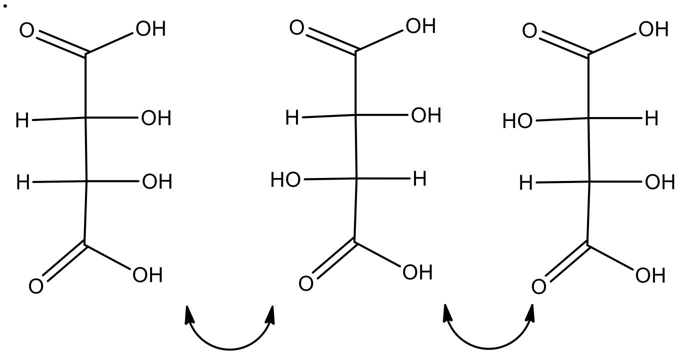
Lactic acid



D-Glucose ($C_6H_{12}O_6$)

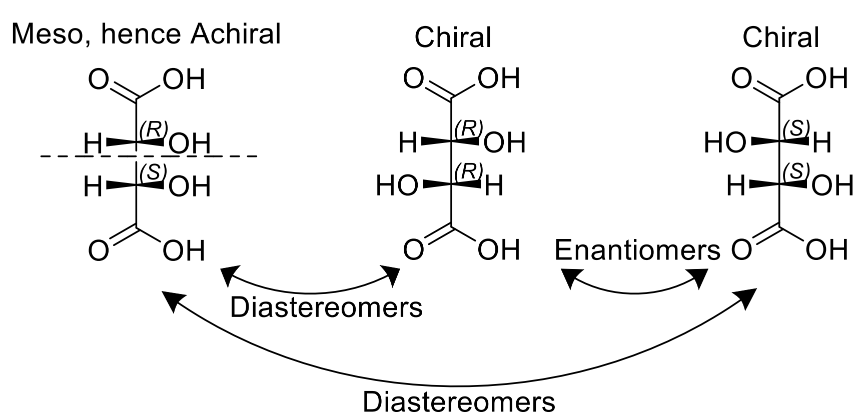
Another Example: tartaric acid

Fisher projections:



Achiral (Meso)　　Diastereomers　　Enantiomers

Relationship between stereoisomers of tartaric acid



Physical Properties of Enantiomers

- Same physical properties with achiral agents or procedures
  - Melting point, boiling point, solubility in achiral solvents
- Enantiomers behave differently with chiral agents
- Diastereomers have different physical properties (m.p, b.p, density, solubility)

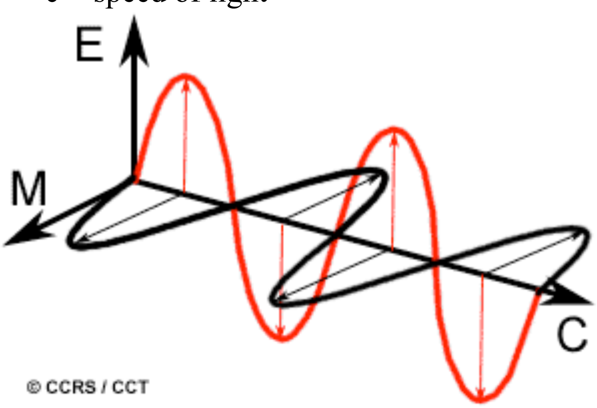
Optical Activity

- Absolute rotation is 0 ^{o} for achiral molecules
- Rotation of polarized light
  - Dextrorotatory (right) (+) (clockwise)
  - Levorotatory (left) (-) (counter-clockwise)
- Pure enantiomers show equal but opposite rotation

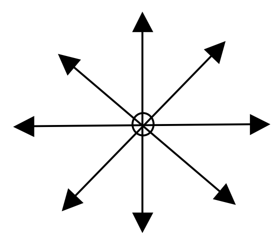
Light: Electromagnetic radiation

Light → $E = h\upsilon = \dfrac{hc}{\lambda}$

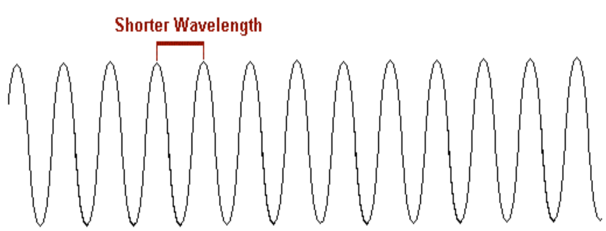
υ = frequency   E = energy   h = Planck's constant λ = wavelength
c = speed of light



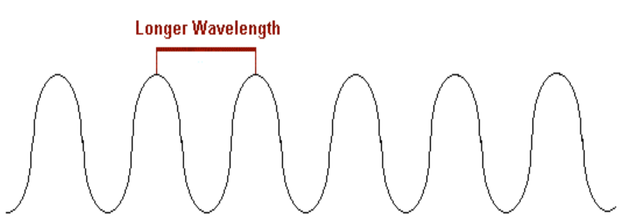
Light has an oscillating electric field (red) combined with a magnetic field (black)



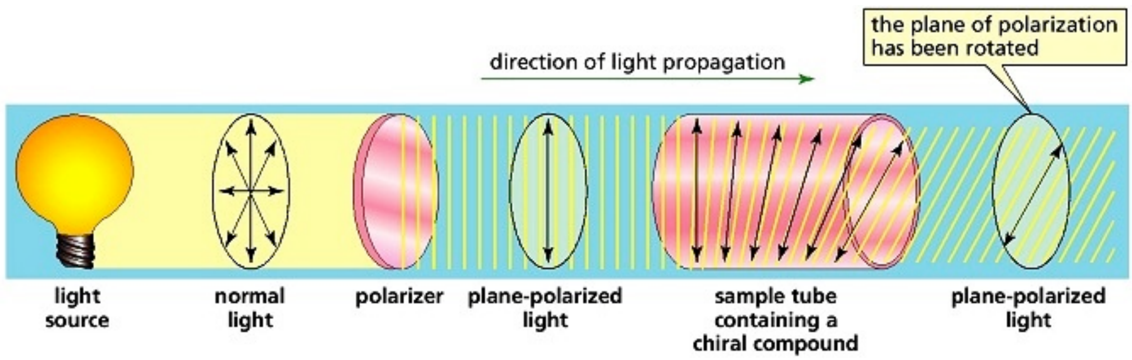
End on view of vector components of normal light. It is possible to polarize light and remove some of those vectors.



- Shorter Wavelength
- Higher Energy
- Higher Frequency



- Longer Wavelength
- Low Energy
- Low Frequency



<u>Optical Rotation</u>

$[\alpha]_D$ = Absolute rotation at the D line of sodium (589 nm or 5890 Å)

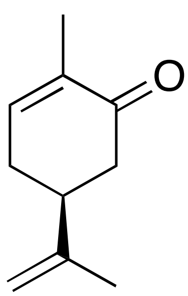
$$[\alpha]_D = \frac{\alpha}{c \bullet l}$$

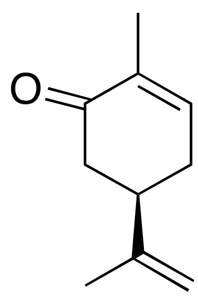
α = measured rotation (^{o})   c = concentration (g/cm^3)   l = path length (dm)
D = D-line of sodium light $[\alpha]$ = absolute rotation

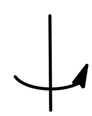
Degrees (^{o}) = + : Clockwise
- : Anticlockwise

<u>Example: Carvone</u>

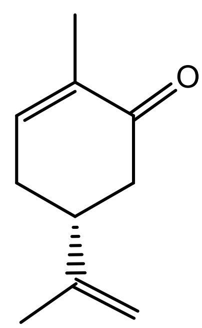
$[\alpha]_D = + 100^o$ $[\alpha]_D = - 100^o$







the same



enantiomers

D-carvone (caraway)   L-carvone (spearmint)
D = dextrorotatory (clockwise)   L = levorotatory (counter clockwise)

- R/S indicate nomenclature (naming convention) and
- D/L indicate optical activity (physical property)

They cannot be easily correlated theoretically (there is no reliable method to predict that a D or L compound would have certain R or/and S stereogenic center designation).

Optical purity (experimental) = enantiomeric excess = e.e. (theoretical)

Optical purity is the excess of one enantiomer over the other

$[\alpha]_D$ = Absolute rotation of a compound

Calculating Optical Purity
For this example for D and S-carvone, assume the pure S enantiomer has +100^o rotation

R	**S**	**Rotation (^{o})**	**Optical Purity (%)**
100 %	0 %	-100 ^{o}	100 %
75 %	25 %	-50 ^{o}	50 %
50 %	50 %	0 ^{o}	0 %
25 %	75 %	+50 ^{o}	50 %
0 %	100 %	+ 100 ^{o}	100 %

If a solution is an equivalent mix of 1:1 R + S enantiomers, α measured = 0 ^{o}

A 50:50 mixture of enantiomers is called a *racemic mixture* (or racemate)