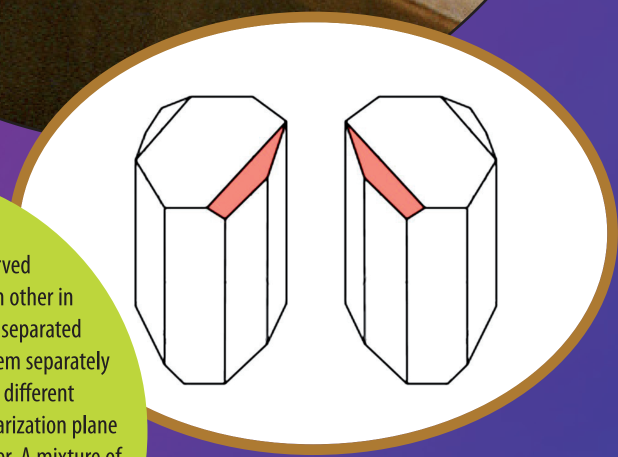
Crystals, chirality and Pasteur

The concept of chirality is very important in many branches of science. It exists in certain crystals and compounds. It is responsible for properties such as the direction of rotation plane polarized light, the taste and smell of chiral compound and it is fundamental to the chemistry of living organisms.



By examining crystals of tartaric acid, **Louis Pasteur** observed that two crystal forms, images of each other in a mirror, coexist in the same sample. He separated the crystals by hand and, by dissolving them separately in water, he found that the two forms have different optical properties: one form rotates the polarization plane of light in the opposite direction to the other. A mixture of the two solutions does not deviate that light. These two forms are called enantiomers (Greek *enantios* "opposite").

Table from Albert Edelfelt 1885
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Chiral comes from the Greek word *chiro* which means 'hand'. When the palms are turned towards the sun, the left hand cannot be superimposed on to the right hand.

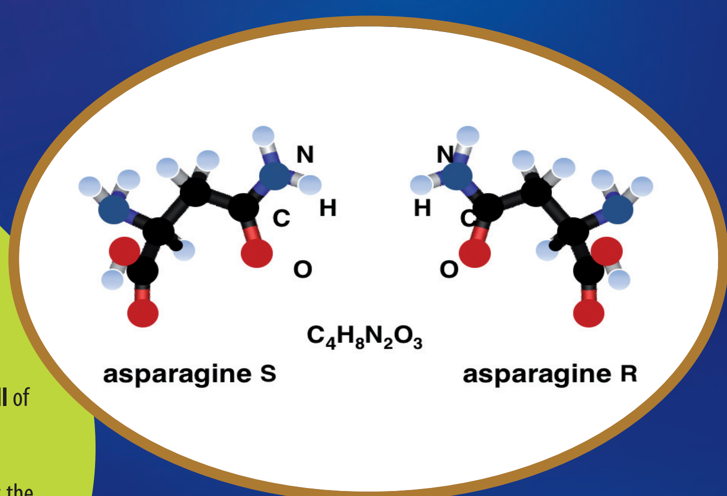
The chirality of molecules

In 1848, **Pasteur** commented that crystals can have two identical and yet opposing forms, a mirror image of each other. He interpreted it as the existence of two chiral molecules. The chirality of crystals is primarily due to the manner in which the constituent atoms or molecules are arranged. Asymmetric molecules have two chiral forms, generally in nature one of these two forms is dominant.

Our body is made up of basic chiral structures: amino acids, sugars…

A chiral molecule in one form or another will not have the same effect on our bodies. This is the case with many drugs and medicines, as well as in the perception of tastes and smells.

All children have been faced with a problem of chirality by putting the right foot in the left shoe. Like a left hand is not superimposed on a right hand, a shoe is a **chiral** object as both shoes are not superimposable.



Two enantiomers have identical physical and chemical properties in a symmetrical way. However, they are perceived differently by living organisms. In other words, depending on whether the molecule is in one form or another it will not have the same effect.
- This explains why a molecule of R-carvone can have a **smell** of mint green, while that of carvone-S has a scent of cumin, our olfactory receptors are sensitive to chirality.
- It is the same for the **taste**: a molecule of asparagine-S has the bitter taste of the asparagus while asparagine-R has a sweet taste.
- These differences in properties can be dramatic for drugs: the case of **thalidomide** in one form gives pain relief and the other causes of fetal malformations.

Source : Institut Néel-CNRS