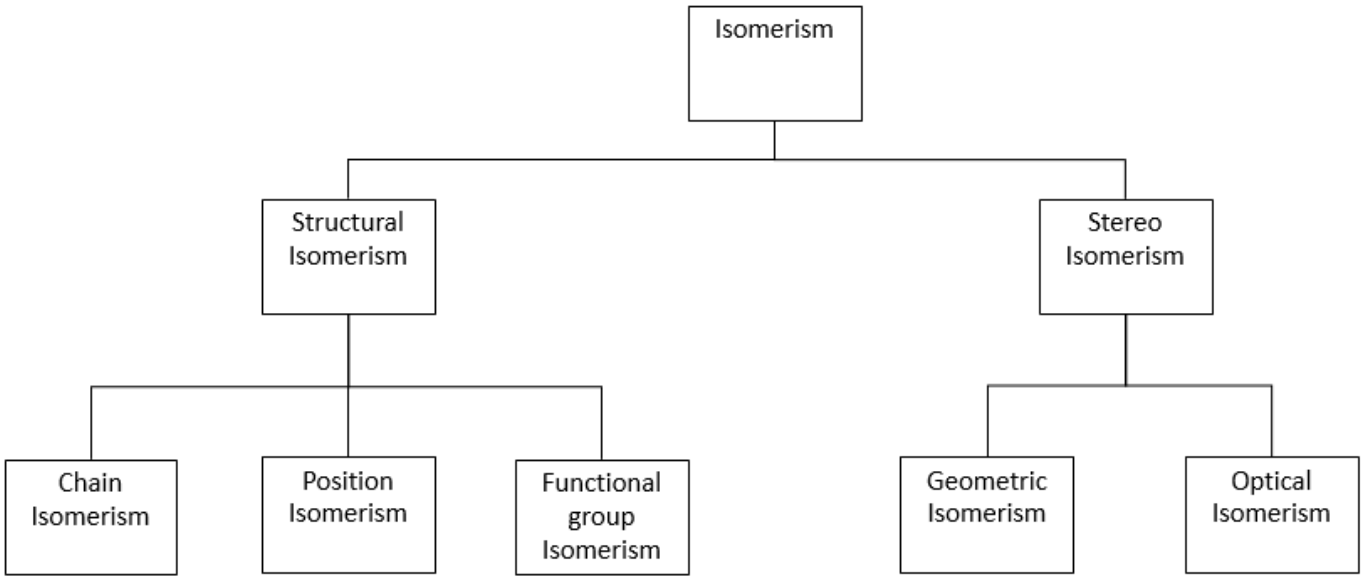
3.7 Optical isomerism

Task:

- Build a molecule using:
- Black moly mod in the centre
- Attach a green, blue, red and white moly mod to the central black moly mod:
- Are they identical?

Stereoisomer:
A Molecule with the same structural formula but its atoms are arranged differently in space

- You are already familiar with stereoisomers from AS – Geometric isomers, E/Z with alkenes.

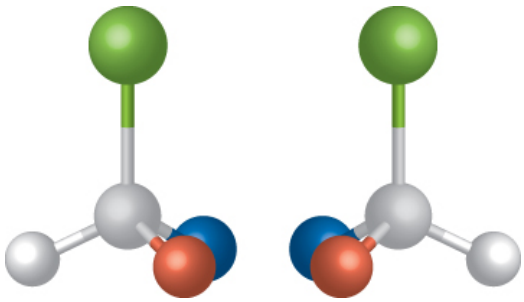


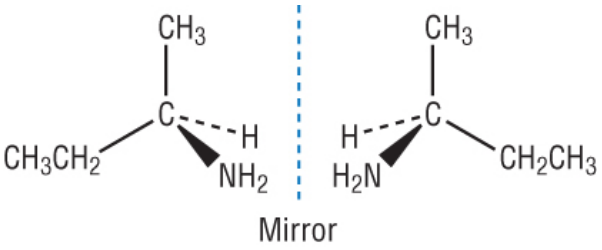
- There is a second type of stereoisomers called **optical isomers:**

Optical isomer:
These are non superimposable mirror images

Optical isomers:

- Mirror images **cannot** be superimposed upon each other.
- These are called **optical isomers**:

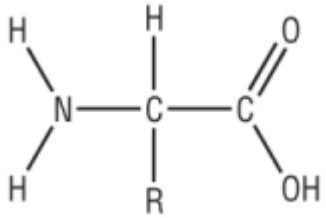




When a carbon atom has 4 different groups attached to it, you get 2 shapes that are mirror images of each other, known as optical isomers. The carbon atom is called the 'Chiral Centre'.

Chirality:

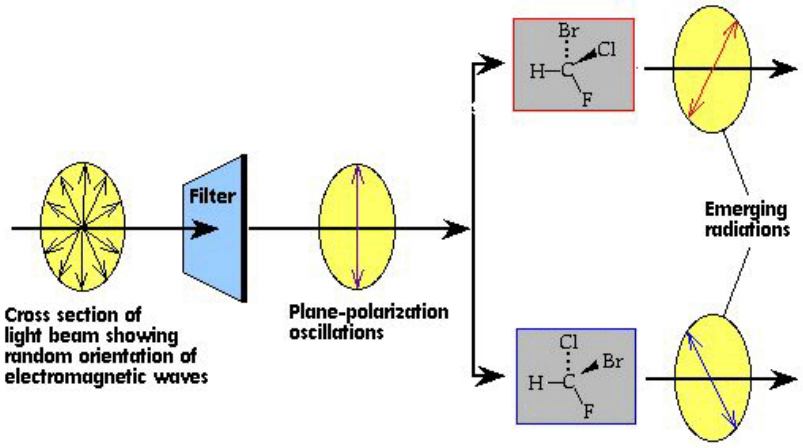
- These molecules are said to be **chiral**. The 2 optical isomers are called **enantiomers**.
- The **carbon** with 4 groups attached is said to be the **chiral centre / asymmetric carbon**.
- An **equal amount** of the of enantiomers in a mixture is called a **racemic mixture / racemate.**
- All α amino acids (except glycine) are chiral:



- Your hands are optical isomers of each other. Both are the same but are not super imposable.

Properties of optical isomers:

- They are called optical isomers due to the ability of each optical isomer to rotate plane polarised light. This is measured through a **polarimeter**
- One isomer rotates it in the **clockwise direction (+)** and the other in the **anticlockwise direction (-)**.

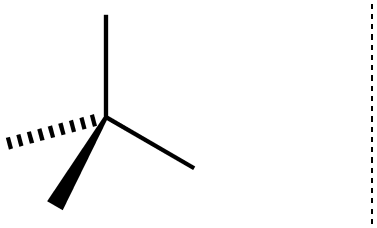


Racemate / Racemic mixture:
Is a mixture of equal amounts of the 2 enantiomers

Questions:

1) 2 – chlorobutane is an optical isomer
    a. Draw the structure of 2 – chlorobutane below:

    b. Complete 3D structure of 2 – chlorobutane below and draw its other optical isomer:



2) For each of the following molecules draw the 3d structure of the enantiomers and put a * on the asymmetric carbon:

    a. Pentan – 2 – ol

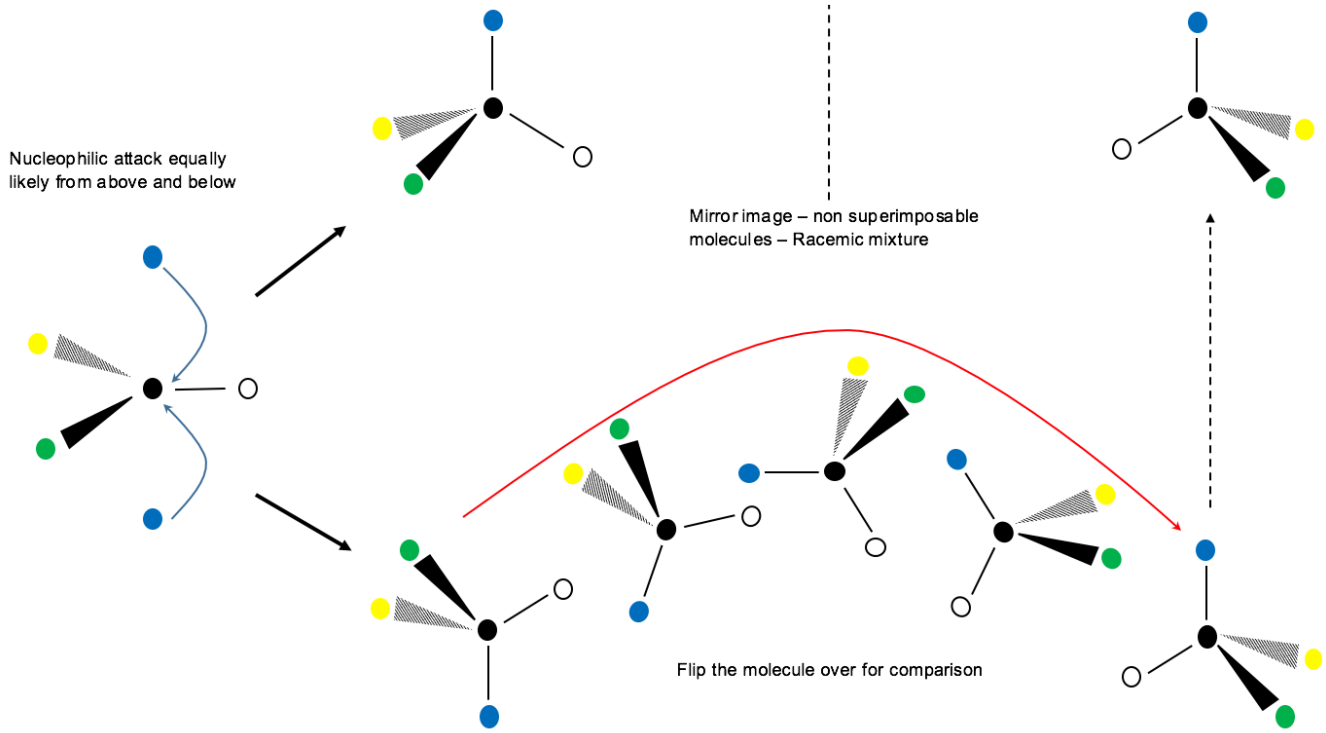
    b. 2 bromobutan – 2 – ol

    c. Lactic acid (2 – hydroxypropanoic acid)

    d. 2 – aminopropanoic acid

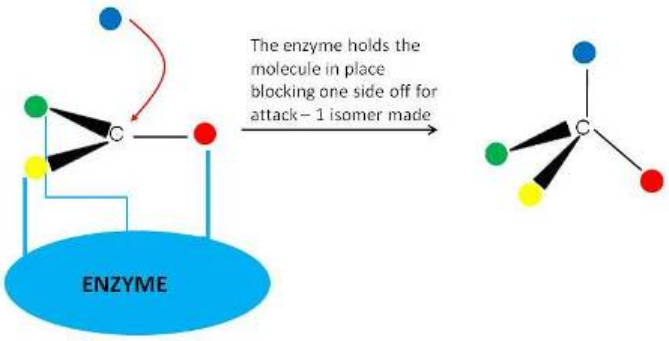
Synthesis:

- For a planar molecule, such as an aldehyde, nucleophilic attack can come from above or below.
- Both of which are equally likely giving a racemic mixture



Nature:

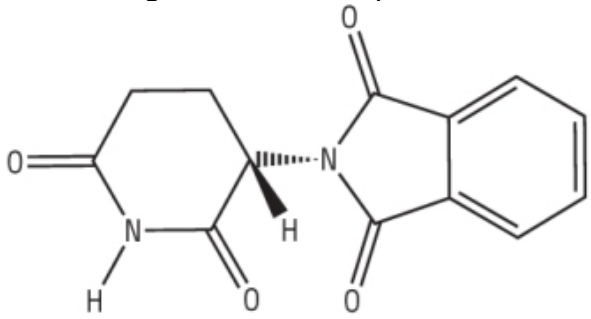
- Only one of the optical isomers are made as synthesis in nature tends to use enzymes which are stereospecific:



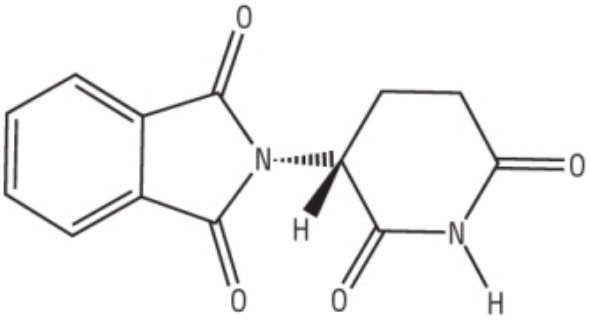
Optical isomers in the drug industry

Thalidomide:

- In the 1950's a drug called thalidomide was produced to combat the effects of morning sickness in pregnant women.
- The drug is a chiral compound:



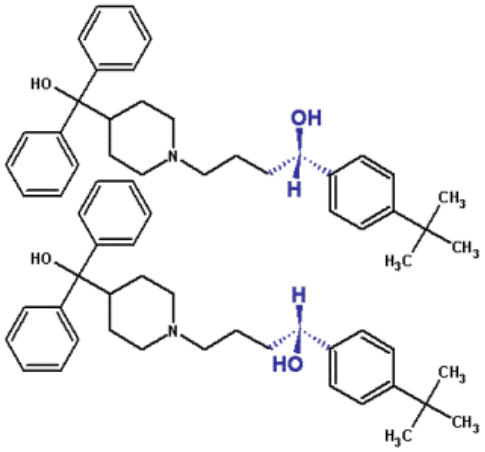
(−)-Thalidomide



(+)-Thalidomide

- While one stereoisomer gave the desired effects - relieving morning sickness.
- The other gave undesirable side effects that lead to deformities in an estimated 10000 babies.

Seldane:

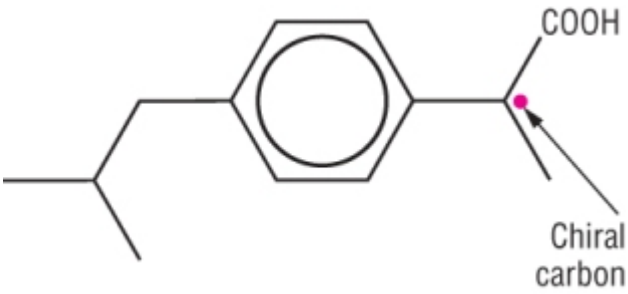


- Seldane was the first antihistamine on the market to combat hay fever.
- The drug is chiral.
- One stereoisomer relieved hayfever.
- The other caused potentially fatal heart conditions.

- Rigorous testing is now carried out on each of the stereoisomers separately, and this is costly.
- It has lead to the development of synthesis of just one of the stereoisomers.

Ibuprofen

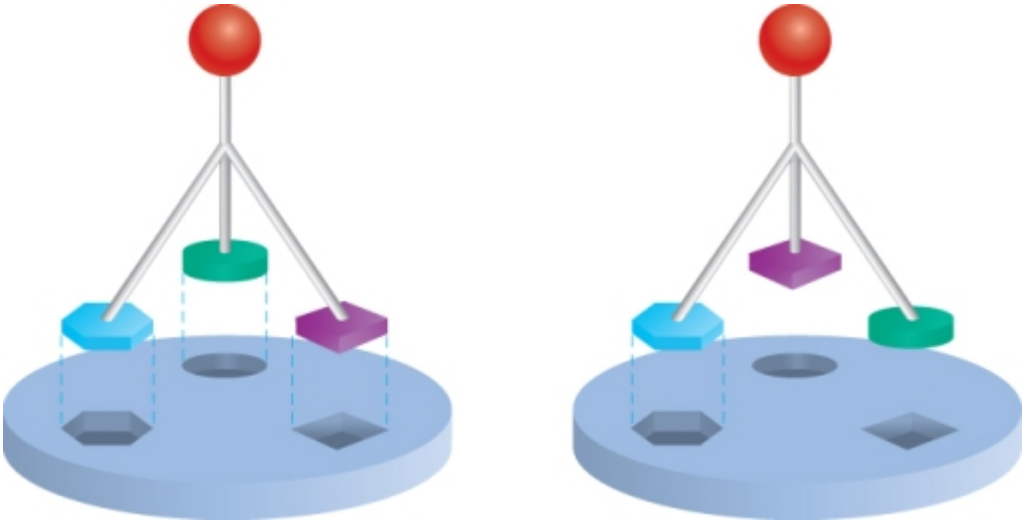
- Anti - inflammatory. It works by blocking the pain messages to the brain:



- As a chiral molecule, one isomer blocks the pain more effectively than the other.
- Unusually - the body converts the less active isomer into the active isomer.
- This minimises side effects and means that the whole dose is effective.

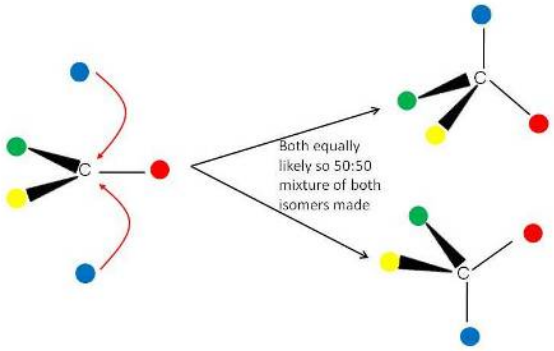
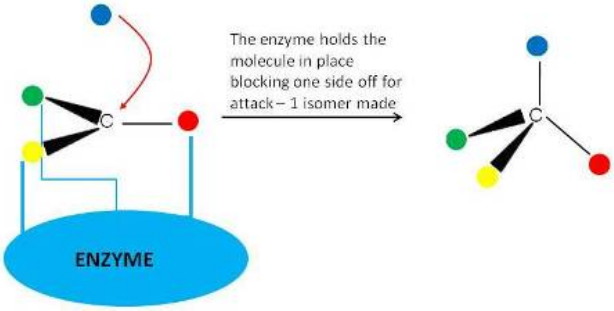
Synthesising drugs:

- Drugs and medicines interact with biological molecules such as proteins etc.
- These have a complex 3D structure that will only bind to a drug molecule with a specific shape.
- The 3D structure of the drug has to 'fit' with the **receptor site** in a biological system:



- This will determine the **pharmacological activity** and whether it will have the desired effect or not.

Synthesis vs Nature

	Synthesis	Nature
		
Isomers	**Both**	**one**
Made	**In the laboratory**	**In the body**
Dose	**Twice needed**	**Half needed**
Side effects	**Probably**	**None**
Cost	**Cheaper**	**Expensive**
Cost of separation in lab	**Expensive - isomers have same physical and chemical properties**	**Cheap as only one isomer made**

Questions:

Draw the mechanism of but – 2 – ene and hydrogen chloride in the space below:

Re draw the carbocation intermediate around the (+)ve carbon atom illustrating the shape around that (+)ve carbon atom

To your re drawn carbocation above show how the chloride ion could attack the intermediate

How does this shape lead to a racemic mixture?

State and explain whether the resulting mixture will rotate plane polarised light?