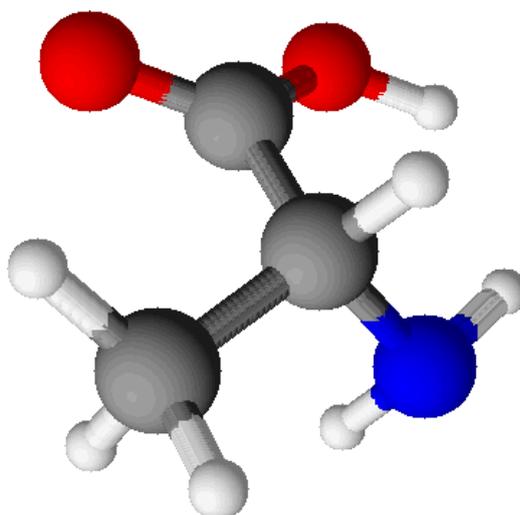


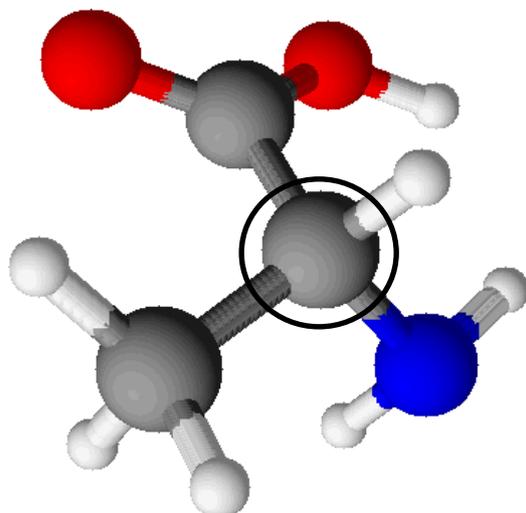


Chirality in Chemistry

You may well have come across chiral molecules in chemistry although you don't know that you have. A really good example of this is with amino acids, all bar one of which are chiral. To spot the chiral centre in a molecule you just have to find a carbon centre with four different things joined to it. For example with the amino acid (alanine) below, try and find the chiral carbon:



Answer:



The circled atom has joined to it:

- 1) H
- 2) CH₃
- 3) COOH
- 4) NH₂



Four different groups, hence it is chiral.

The same is true for other amino acids:

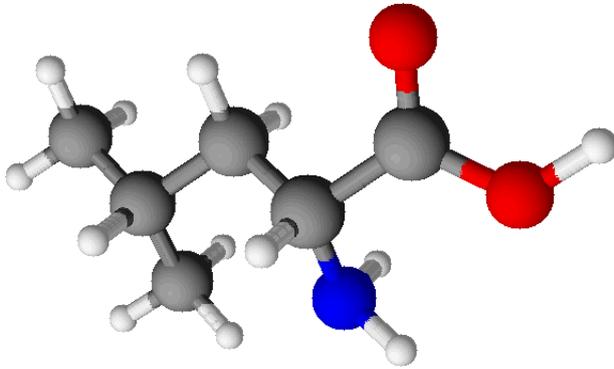


Figure 1. Leucine

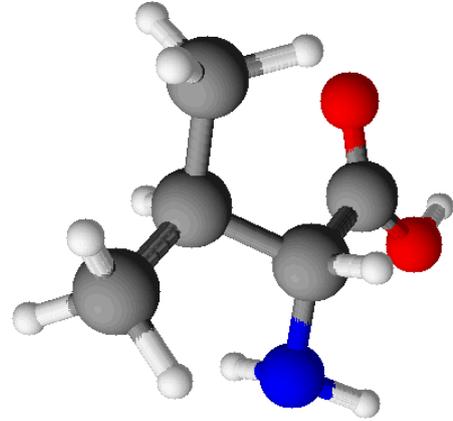


Figure 2. Valine

And the only one which isn't chiral....

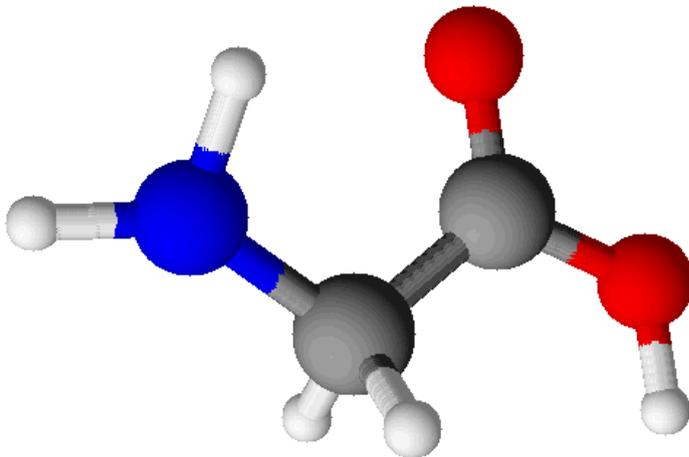


Figure 3. Glycine

Question: Explain why glycine is not chiral.

The fact that amino acids are chiral means that they exist in two forms, the two isomers. These two optical isomers are called enantiomers. In fact, in nature, only one of these enantiomers exists, meaning that all of the amino acids in our cells have the same "handedness" (i.e. they are all like, for example, left hands with none being like right hands). This "handedness" of the amino acids has an influence on all of our cells as the proteins within the cells are composed of these amino acids.

This means that when the chain of amino acids which makes up a protein folds up, forming its secondary structure, the structure is determined by the shape of the amino acids. Hence this "handedness" of the amino acids determines the secondary structures formed.



Examples of secondary structures can be found [here](#).

Why does the shape of this secondary structure matter?

As enzymes, the biological catalysts which allow our cells to work, are made of proteins, the shape of the secondary structure is important in how they can function.

Enzymes work through a “lock and key” mechanism, having an active site which has a shape specific to the substrate/s it interacts with. This shape is determined by the amino acids which make up the chain and the secondary structure which they form. The active site is very specific and will only fit the correct reagents.

An example of this is hexokinase enzyme which turns glucose to glucose 6-phosphate, a form of the sugar very commonly found in cells.

The interesting point about this enzyme is that the active site will only fit one of the enantiomers of glucose. The second enantiomer still tastes sweet, but cannot fit into the active site to be turned into glucose-6-phosphate.

Question: Why might this second enantiomer be useful? Why might it not be used?

The handedness of enzymes has another interesting effect on our cells, that of the form of our DNA. You will have seen that DNA comes as a double helix (it has just been the 60th anniversary of the publication of the structure of DNA by Francis Watson and James Crick – definitely something worth looking into if you are interested in big moments which have changed science), and as this is a spiral just like spiral staircases, it is chiral.

In human cells we have B-DNA and not any of the other forms which might spiral the opposite way.

Question: Why do we only have one form of DNA? Which enzymes are important in DNA synthesis?

Naming chiral compounds

Originally chiral compounds were named depending on whether they could be made from L- or D-glyceraldehyde. These were early chiral compounds to be discovered by looking at how they rotate plane polarised light.

Questions: What is plane polarised light and how do chiral compounds affect it?

L-glyceraldehyde rotates plane polarised light counterclockwise, D- clockwise. Logically you would think therefore that everything which is L- would rotate light counterclockwise, but this is not the case. Because working out whether a compound was made from L- or D-glyceraldehyde is not the easiest way to name it, a clearer way has been devised; the Cahn-Ingold-Prelog rules.