Optical isomers for healthcare (teacher guide to exercises and experiments)

AIM

- For students to appreciate that optical isomers have the same connectivity, but different spatial organisation.
- For students to understand that optical isomers rotate plane polarised light, in opposite directions, by building a simple polarimeter and observing the rotation themselves.
- For students to appreciate that optical isomers are very important in healthcare, due to their prevalence in biological systems, such as proteins (including receptors, enzymes), hormones and DNA. Many pharmaceutical compounds are chiral molecules which can be synthesised as a 50:50 mix of stereoisomers, and often the two isomers interact differently with chiral receptors in the body.

EXPERIMENT QUESTIONS—answer guide for teachers

1. The $R$-(-)carvone (spearmint oil) rotates the plane of the light’s polarisation anticlockwise, hence ‘(-)’ (the angle depends upon the depth of the solution in the vial). When looking down from the top of this experiment, you will rotate the beaker clockwise, as the light you are rotating is coming from the bottom!
2. The $S$-(+)carvone (spearmint oil) rotates the plane of the light’s polarisation anticlockwise, hence ‘(+)’ (the angle depends upon the depth of the solution in the vial). When looking down from the top of this experiment, you will rotate the beaker clockwise, as the light you are rotating is coming from the bottom!
3. The two isomers will rotate the linearly polarised light in opposite directions.
4. The two isomers smell different, because they interact with chiral receptors in your nose, and the interactions are therefore different.
5. Many of the receptors/proteins/DNA etc in the body have centres of chirality, and therefore can interact differently with each isomer. If a drug is made as a racemic mixture, and is tested for its effects (efficacy) as a mixture, it is not possible to tell if the effect of each isomer is the same or not. A very good example of this is the thalidomide story: In the 1950s pharmacists and doctors did not realise that $R$-(+)thalidomide was the effective sedative, but $S$-(+)thalidomide was in fact a teratogen (affecting foetal development). The drug was prescribed to pregnant women suffering from morning sickness but tragically thousands of babies were born with physical abnormalities. It is important to separate isomers and test them individually; separation is often quite difficult!