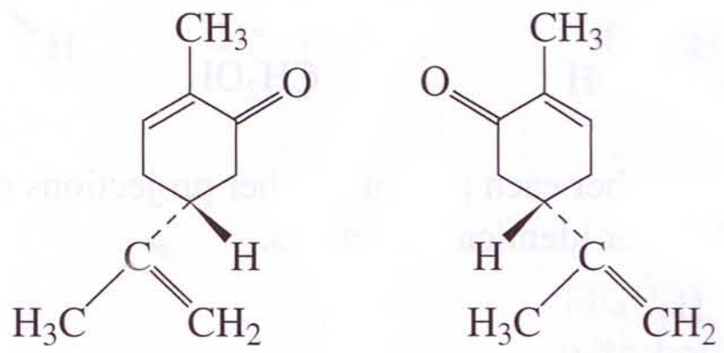
Chemistry Link to Health

ENANTIOMERS IN BIOLOGICAL SYSTEMS

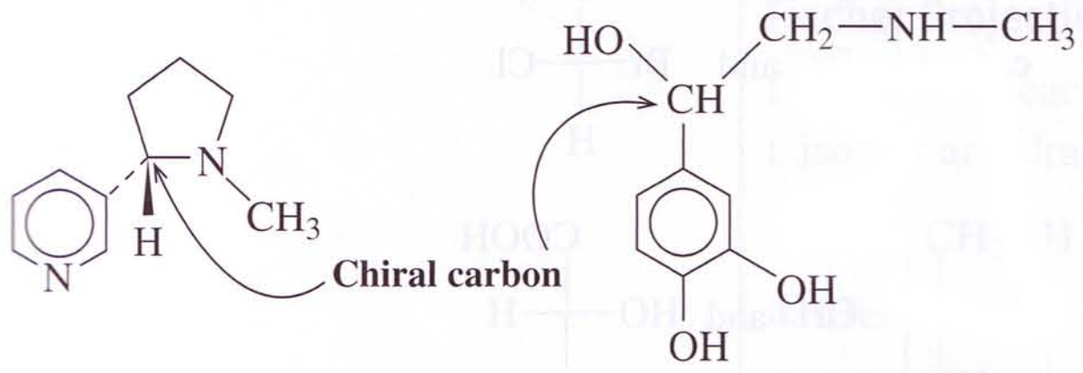
Many substances in biological systems consist of enantiomers. For example, carvone has two enantiomers: One has the odor of spearmint whereas the other gives the odor to caraway seeds. In the olfactory cells in the nasal cavity and the gustatory cells in the taste buds on the tongue, there are receptor sites that fit the shape of only one enantiomer. Thus, our senses of smell and taste are responsive to the chirality of molecules.

Enantiomers of Carvone



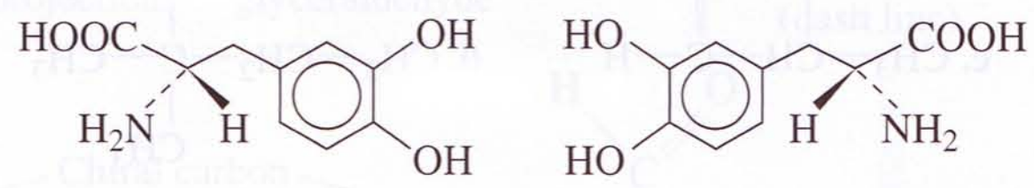
From spearmint oil From caraway seeds

In the brain, one enantiomer of LSD affects the production of serotonin, which influences sensory perception and may lead to hallucinations. However, its enantiomer produces little effect in the brain. The behavior of nicotine and epinephrine (adrenalin) also depends upon only one of their enantiomers. For example, one enantiomer of nicotine is more toxic than the other. Only one enantiomer of epinephrine is responsible for the constriction of blood vessels.



Nicotine Adrenalin (epinephrine)

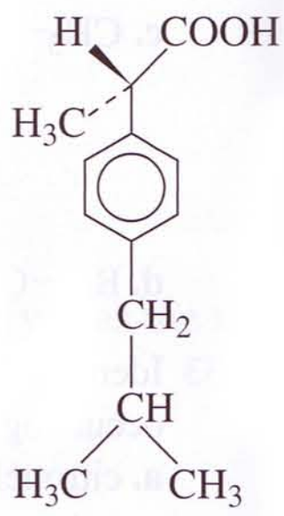
A substance used to treat Parkinson's disease is L-dopa, which is converted to dopamine in the brain, where it raises the serotonin level. However, the D-dopa enantiomer is not effective for the treatment of Parkinson's disease.



L-Dopa D-Dopa

Many compounds in biological systems have only one enantiomer that is active. This happens because the enzymes and cell surface receptors on which metabolic reactions take place are themselves chiral. Thus, only one enantiomer interacts with its enzymes or receptors; the other is inactive. The chiral receptor fits the arrangement of the substituents in only one enantiomer; its mirror image does not fit properly (see Figure 12.14).

For many drugs, only one of the enantiomers is biologically active. However, for many years, drugs have been produced that were mixtures of their enantiomers. Today, drug researchers are using *chiral technology* to produce the active enantiomers of chiral drugs. Chiral catalysts are being designed that direct the formation of just one enantiomer rather than both. The benefits of producing only the active enantiomer include using a lower dose, enhancing activity, reducing interactions with other drugs, and eliminating possible harmful side effects from the nonactive enantiomer. Several active enantiomers are now being produced such as L-dopa and the active enantiomer of the popular analgesic ibuprofen used in Advil, Motrin, and Nuprin.



Ibuprofen

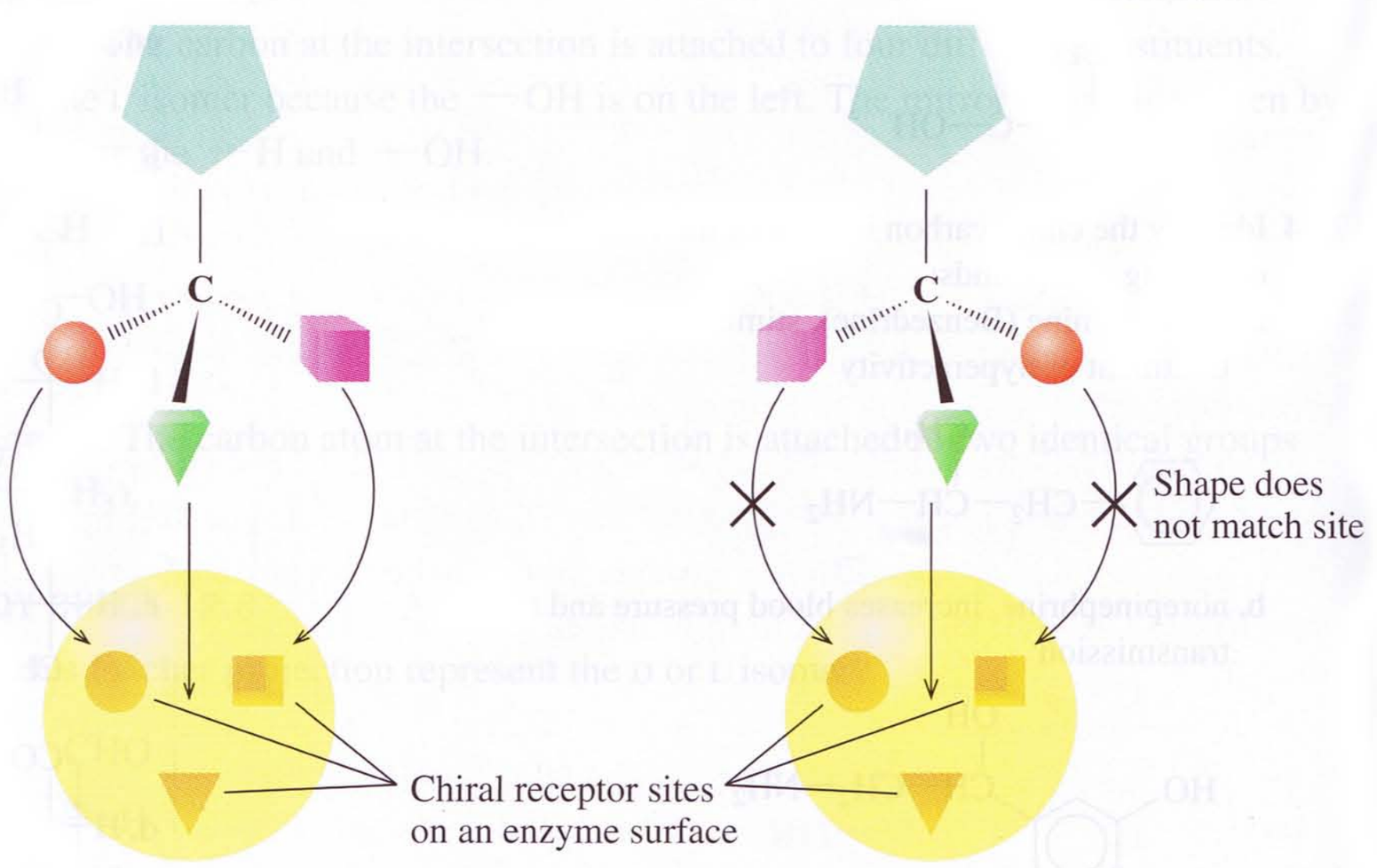


FIGURE 12.14 (**a**) The substituents on the biologically active enantiomer bind to all the sites on a chiral receptor; (**b**) its enantiomer does not bind properly and is not active biologically.

Q Why don't all the substituents of the mirror image of the active enantiomer fit into a chiral receptor site?