Chapter 3

Evolutionary Aside 3.1--Homochirality in Living Organisms

One distinguishing feature of living systems is the homochirality of important carbon-containing molecules. Carbon can form four single bonds, so whenever you have four different atoms or molecules attached to a central carbon, the molecule will be chiral (see figure 3.3). The homochirality seen in living systems involves the use of L-amino acids, and D-sugars. If these molecule were synthesized via non-enzyme-catalyzed organic reactions, a mixture of D and L types would be produced, called a racemic mixture. Thus the homochirality found in living systems is particularly noteworthy.

Although the origin of this molecular asymmetry is not known, it is part of the compelling evidence that all life on this planet is descended from the same initial origin event. The last universal common ancestor (LUCA) produced L-amino acids and D-sugars, and this selective use of particular stereoisomers remains with us today. The use of specific stereoisomers is self-propagating because the enzymes that make these compounds in living systems are selective for the appropriate stereoisomers.

Outside of the evidence for a common origin for all life, the existence of biological homochirality provides an important constraint on hypotheses of the origin of life. Possible explanations for biological homochirality fall into two categories: external and internal. External explanations suggest mechanisms that selectively destroy one enantiomer, selectively adsorb onto a mineral substrate, or posit the arrival of a predominant enantiomer from extraterrestrial sources. The internal explanations utilize selection processes provided by the molecules themselves. Note that these are not mutually exclusive since an external initial disparity can be amplified by internal selection.

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