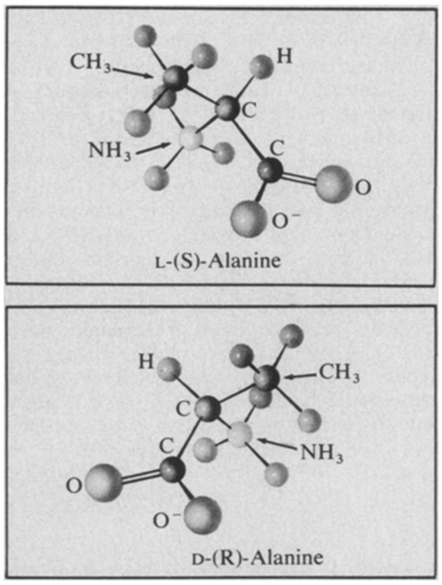
Physics and the Left Hand of Life

Most people are right-handed, but the basis for life on earth is exclusively left-handed. The structure of many molecules can come in two forms that are mirror images of each other. The 20 amino acids that go into the structure of proteins are always found to be of the L, or left-handed form in terrestrial organisms. This is strange because amino acids synthesized in the laboratory come out a 50-50 mixture of left- and right-handed configurations.

Why terrestrial life selected only left-handed amino acids—the enzymes that control protein production will quickly destroy a right-handed one if it should stray into the organism—is one of the most important standing mysteries of biophysical chemistry.



The two forms of an amino acid, alinine.

A National Bureau of Standards physicist, Raymond W. Hayward, suggests that a bit of physics previously considered of no biological interest may be responsible. Hayward has studied the doings of the weak interaction for many years (his NBS career goes back to 1950). In a lecture at the NBS headquarters last week, he proposed that the weak interaction is responsible for the left-handed building blocks of our proteins.

Physics recognizes four interactions or classes of force: the strong, the weak, the electromagnetic and the gravitational. Until recently, chemistry was concerned with only one of these, electromagnetism. It used to be said, Hayward points out, that quantum mechanics and electromagnetism could describe all of chemistry. It's not so any more, he asserts: "Other interactions show up in chemical effects." These effects are small, but important.

Such importance, in Hayward's thesis about the left-handedness of our basic biophysics, attaches to the weak interaction. The weak interaction affects all particles, but its range is so short (very much less than the diameter of a nucleus) that it used to be dismissed out of hand by atomic physicists and physical chemists. But lately some changes have been made.

Theoretical physicists have been devising a field theory that unifies the weak and electromagnetic interactions and makes them two parts of the same basic entity. Both physical and mathematical reasons are behind the development, and some of its most striking predictions are being confirmed. What this means is that wherever electromagnetism goes, so goes its little brother, the weak interaction. Thus, the equations can be used to calculate small but significant differences between left- and right-handed atoms and molecules because of a peculiarity of the weak interaction.

The weak interaction violates parity, or space-reflection symmetry. Most of the processes of particle physics are even-handed, treating right- and left-handed particles equally. (The handedness of particles can show up in the orientation of their spins or the direction of their flight.) But in 1956 it was discovered at the National Bureau of Standards that some weak-interaction processes show a preference for one hand over the other. Putting this preference into the mathematics leads to small differences in total energy between left- and right-handed atoms and molecules. (These differences are being searched for experimentally, but so far have not been found.)

An energy difference between two classes of things, such as our right-handed and left-handed amino acids, provides a handle by which physical processes can select one kind from the other.

So what did the selecting? There is a period of about a billion years between the era when amino acids first appeared on earth and the emergence of living oɪganisms. Originally there must have been a 50-50 mixture of left- and right-handed ones. Evidence for this is both the evenness of laboratory synthesis and the statistics of amino acids found inside meteorites, which date to about that epoch.

Some paleobiologists have suggested that life began where there were a lot of left-handed quartz crystals because left-handed amino acids are preferentially adsorbed on left-handed quartz. But there is also right-handed quartz around. Others suggest that some cataclysm did away with the right-handed amino acids. The objection to this is that after the cataclysm, chemical processes would have tended to restore the 50-50 balance.

No, says Hayward, it would have to be a continuous selection process. He suggests that polarized radiation coupling to the energy difference between the two kinds of amino acids could have kept down the population of right-handed ones while tending to spare the left-handed ones. There is laboratory evidence that a 50-50 sample exposed for a long time to polarized radiation comes out with mostly one handedness. For the primeval earth, says Hayward, we have Melvin Calvin's estimate that 26 percent of the radiation it received from space was beta rays. Beta rays happen to be produced in one of the parity-violating, weak-interaction processes and so come polarized.

Once the left-handed preponderance got established and living organisms got going, history followed the laws of thermodynamics, which tended to enhance such assymetries until terrestrial life arrived at its present totally left-handed state.

Hayward ends by saying: "I believe that we are all affected by this interaction that is present—a sinister [left-sided] force acting on all of us." □

New drug for atherosclerosis

Atherosclerosis (hardening of the arteries) is a principal risk factor in heart disease. In fact, it is the leading cause of death among both female and male Americans. A drug that promises to be superior to those on the market for reversing atherosclerosis was reported last week at the 1975 Scientific Sessions of the American Heart Association in Anaheim, Calif.

The drug, called cholestyramine, is a resin. It is already sold under various trade names by drug companies to remove bile salts and acids from the gastrointestinal tracts of gallstone victims. Cholesterol, a major contributor to atherosclerosis, is made from bile salts and acids. Several years ago Richard J. Jones of the University of Chicago found that cholestyramine can reduce cholesterol in the bloodstream. So Robert W. Wissler, a pathologist at the University of Chicago, and his colleagues decided to see whether cholestyramine might not only reduce cholesterol in the blood of atherosclerotic victims, but also actually reverse atherosclerosis. They believed the drug might reverse the disease because if cholesterol circulating in the bloodstream is reduced to a minimum, the body will withdraw cholesterol from internal cholesterol pools, such as atherosclerotic plaques in