SCIENCE NEWS OF THE WEEK

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.

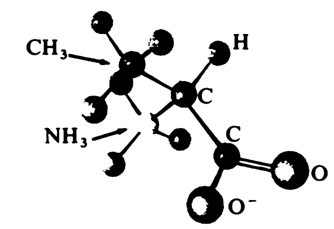
A National Bureau of Standards physicist, Raymond W. Hayward, suggests that a bit of physics previously considered of no biological interest may be responsible. Hayward has studied the doings of the weak interaction for many years (his NBS career goes back to 1950). In a lecture at the NBS headquarters 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.

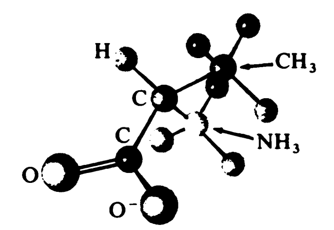
Such importance, in Hayward's thesis about the left-handedness of our basic biophysics, attaches to the weak interaction. The weak interaction affects all particles, but its range is so short (very much less than the diameter of a nucleus) that it used to be dismissed out of hand by atomic physicists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



L-(S)-Alanine



D-(R)-Alanine

The two forms of an amino acid, alinine.

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 organisms. 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.

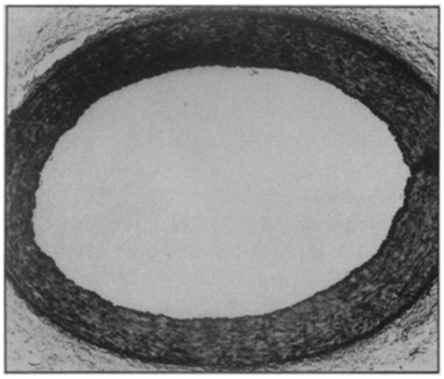
Once the left-handed preponderance got established and living organisms got going, history followed the laws of thermodynamics, which tended to enhance such assymetries until terrestrial life arrived at its present totally left-handed state.

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." □

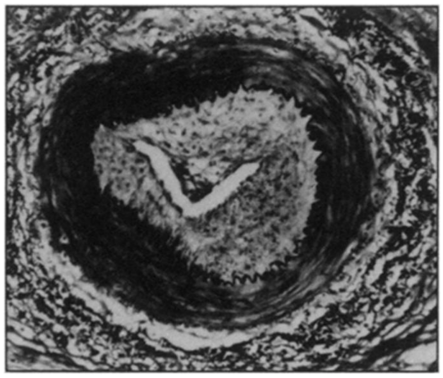
New drug for atherosclerosis

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



A healthy heart artery (no fatty deposits).



National Institutes of Health

A hardened heart artery (blocked by fats).

arteries.

Wissler and his team fed 25 monkeys radioactively labeled, high-cholesterol diets for a year. Five of the monkeys were then autopsied to establish that the diet had truly triggered atherosclerosis and to establish the extent and location of atherosclerotic plaques in coronary arteries. The remaining monkeys were divided into four groups. One group continued for another year on the high-fat, high-cholesterol diet; one was treated with a low-fat, cholesterol-free diet; one with the low-fat, low-cholesterol diet plus cholestyramine, and one with the high-fat, high-cholesterol diet plus cholestyramine. All of these animals were then autopsied.

The results indicated that the drug could reduce cholesterol in the blood by 20 to 25 percent, more than drugs already on the market can achieve (5 to 15 percent). More crucial, the results showed that the drug could actually reverse atherosclerosis—evidence that has been weak for other cholesterol-lowering drugs on the market, at least in primates. Specifically, there was a five-sixth reduction in plaques in animals fed the low-cholesterol diet and the drug, substantial, but lesser, reduction in those monkeys given the low-cholesterol diet but no drug, and even some reduction in the plaques of animals given the drug with the disease-producing diet.

"I think cholestyramine is the most effective drug now available [for] lowering serum cholesterol," Wissler concludes. "It's logical that it would be safer because it isn't absorbed by the body."

Basil M. Rifkind of the National Heart and Lung Institute is also enthusiastic about cholestyramine. Three years ago, Wissler and his co-workers used high-cholesterol diets to induce artherosclerosis in primates, then made the atherosclerosis regress by putting the animals back on a normal diet. "This was the first evidence from primates that we could reverse atherosclerosis," Rifkind told SCIENCE NEWS. "Now we are getting more evidence that we can do it not only with diet, but with a drug."

Rifkind is now setting up a study to see whether cholestyramine can reverse atherosclerosis in people. He is in the final stages of recruiting some 3,500 men, all of whom have a pattern of high cholesterol and other blood fats that put them in a high-risk category for heart attacks.

Still another important question is whether cholestyramine can reverse old, calcified arterial plaques as well as ones produced over a relatively short time by a severe diet. Wissler and his colleagues are now tackling this problem. □

Seedlings in search of the dark

Two biologists studying insects and banana trees in the Costa Rican jungle have discovered a phenomenon that some dirt farmers claim is common knowledge.

"Hell, my daddy has known that for years," one Florida farmer told biologist Donald R. Strong Jr. "We call it beans chasing poles." Strong calls it "skototropism," growth toward darkness. But regardless of who found it first, it is an important and previously undescribed adaptation that helps climbing vines find host trees.

Strong, an insect ecologist, and his student Thomas S. Ray Jr. from Florida State University in Tallahassee report skototropism in the Nov. 21 SCIENCE. They discovered it while walking through the tropical rain forest toward their banana patch to study insect infestations. For two days, Strong says, he walked by a *Carapa* tree and noticed a tangle of vine seedlings converging on the dark trunk from the surrounding leaf litter. For two nights, he thought about this siege-in-slow-motion, and finally, together, Strong and Ray came up with a theory: Rather than growing toward light, the climbing vine seedlings might actually be growing toward the darkness (the tree trunk). This adaptation, if true, would help young plants find a host on which to start their slow ascent toward the lighter forest canopy.

Strong and Ray conducted a number of experiments with *Monstera gigantea* seedlings to see whether the philodendron-like vines grow *toward* the dark or *away from* the light. They found that the seedlings will turn and grow toward a dark object, regardless of its relationship to the brightest sector of the horizon and that the object's silhouette must fill more than a few degrees of that horizon. The sko-Strong says, "skototropism is not an odd curiosity. We don't appreciate it in the temperate regions, but vines are an extremely important life form, comprising a substantial portion of the biomass of the tropical forest. Skototropism is probably a fairly common phenomenon, he says, and any climbing vine would be a reason-totropic response ceases, they found, when a seedling finds the object, and it is replaced by positive phototropism, movement toward the light.

"Although it might seem like it," able test of the theory. What about pole beans, SCIENCE NEWS wondered? It seems as if they would exhibit skototropism, too, but this is unknown, Strong says. Ray, now an undergraduate, would like to find out and switch the answer from "common knowledge" to science during his graduate work. □

Ozone from orbit: A lowdown look

The latest device to probe the uncertain state of the atmosphere's ozone layer was launched Nov. 19 as part of the fifth Atmosphere Explorer satellite, AE-E. Called a backscatter ultraviolet spectrometer, it will make direct measurements of ozone concentrations, from an orbit that can be altered to bring it to within 130 kilometers of the earth.

The satellite follows only six weeks behind its predecessor, AE-D (SN: 10/18/75, p. 245), which carries a sensor to measure nitric oxide, believed to be a significant factor in atmospheric ozone balance. Although AE-D is in a polar orbit and AE-E is in a near-equatorial one (ranging from 20°N to 20°S), the places where the orbits cross will enable scientists to compare ozone and nitric-oxide measurements from the same regions.

This will not be the first time that ozone data have been gathered from orbit. The Nimbus 4 satellite has been doing just that (from much higher altitudes) with the same kind of sensor ever since it was launched in 1970. The AE-E probe's sensor, in fact, was originally a spare from the Nimbus program. Early this year, with Nimbus long in orbit, the sensor was being modified for use in balloon-borne measurements when researchers at the National Aeronautics and Space Administration's Goddard Space Flight Center suddenly decided that it could be better used in the low-orbit AE-E.

"In 1970," says Donald Heath of Goddard, the principal AE-E ozone investigator, "we knew ozone measurement was necessary, but until scientists began to become alarmed about the possible depletion of the ozone layer some 22 to 25 kilometers above us, we were not aware of the critical necessity to understand what is happening there." In what, by the murky calendars of high-technology man-