ing their heels and making design refinements, waiting for some money to appear on the horizon so the instruments can be sent to their destinations.

"Really there's no such thing as a life detector," Sagan says. "There are only detectors for groups of preset assumptions about what life might be like." One of the most interesting of these assumption detectors is called Gulliver. Landed on a distant planet, it fires a series of miniature cannons, each containing a projectile attached to a length of sticky string. After a predetermined period of time, Gulliver reels in its strings, presumably with any nearby microorganisms stuck to them. Once inside the unit, the strings are scraped of any accumulations, which fall into a nutrient solution containing radioactive carbon 14. If there is life present, and if Gulliver's assumptions are correct, the life forms will consume the carbon and give off, as a metabolic by-product, radioactive carbon dioxide which can be measured with a geiger counter.

Other assumption detectors, with names like Diogenes and the Wolf Trap, are intended to observe life processes involving such substances as sulfate, phosphate and adenosine triphosphate (ATP). A detector for ATP would make use of the same chemical reaction that enables a firefly to light up.

In case someone should suddenly decide to send them to Mars, a number of these experiments have even been assembled into an integrated package called the Automated Microbial Metabolism Laboratory. The AMML could be put into flyable form for less than $10 million, according to Dr. Gilbert Levin of Biospherics Research, Inc., in Washington, D.C. The package, he says, would take up less than half a cubic foot, weigh only 15 pounds and could complete all its experiments on less than .0005 kilowatt-hours of power, with a maximum power requirement of 10 watts. NASA also has a multi-experiment design of its own, called the Automated Biological Laboratory.

The wet blanket is again the empty wallet. "The AMML would be an extremely ambitious undertaking right now," says NASA's exobilogy chief, Dr. Richard S. Young, "especially with zero dollars."

It's possible, all of the scientists admit, that everybody's assumption detectors could be based on the wrong assumptions, in which case nothing would show up at all. One oft-suggested possibility is that the target planet might have silicon-based life, instead of the carbon-based variety found on earth. Even today, Isenberg points out, there are some life forms on earth called silico-flagellates which, although carbon-based, contain silicon and can't reproduce without it. This means, he says, that in the earliest days of evolution on this planet, life tried out silicon in its search for a stable foundation.

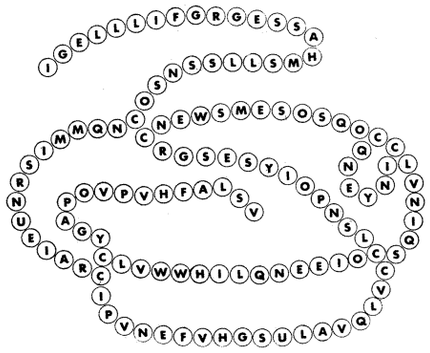
Silicon, however, is not stable enough for earth, or for any relatively warm planet, according to Sagan. At any temperature, he says, silicon compounds are less stable than comparable carbon compounds, and tend to undergo "randomization reactions" at high temperatures that would destroy genetic information needed for future generations. On low-temperature worlds, Sagan says, silicon-based life might, however, be a possibility.

There seems to be an abundance of ideas regarding what to do in the search for extraterrestrial life, almost as though everything has already been thought of. And it's almost true. "Conceptually we're fine," Sagan says. "It's the implementation that's holding us up." ◇

AN AAAS REPORT

Sequenator Opens Evolutionary Doors

Modern systems of species classification are based upon phylogeny — evidence of the evolutionary history of the organisms involved. The difficulty with this is that by "phylogeny" biologists mean genetic relationships between species and, at this point, these relationships are charted by inadequate, interpretative methods.



Jon Ahlquist

The sequenator spells out structure.

"There are no absolutes in this area," Dr. Charles G. Sibley of Yale University told the American Association for the Advancement of Science. "But," he said, "comparative protein studies will provide them."

The studies Dr. Sibley anticipates will be possible within three or four years when development of an automatic protein sequenator is completed. The protein machine offers scientists a new and precise technology for translating the genetic history books of life into real understanding of man's evolution. Speculative theories of evolution will be replaced by facts when researchers sort out the genetic web from which all living organisms come by reading the genetic history locked in proteins.

"With the aid of the protein machine we can compare the actual genetic recipes of living species," Dr. Sibley said. "We should be able to obtain an accurate index of their genetic similarities and of at least part of their evolutionary history. Even 10 years ago this would have been pointless daydreaming. Now we're on the brink of a new universe."

Development of a model protein sequenator which fulfills the daydreams of hundreds of scientists was announced several months ago (SN: 8/12/67) in the EUROPEAN JOURNAL OF BIOCHEMISTRY by Dr. Par Edman of St. Vincent's School of Medical Research, Melbourne, Australia. Now American scientists and instrument makers are perfecting the technology for mass production.

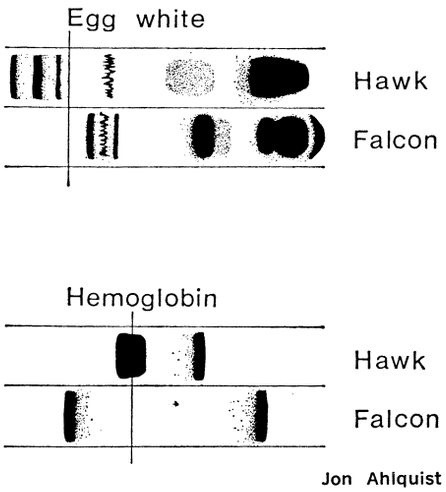
A protein is a large molecule made up of anywhere from 50 to several thousands of smaller amino acid molecules that can be assembled in an infinite variety of combinations. The amino acid sequence of each protein is a highly specific one, dictated by the gene that directs its manufacture. Knowing the sequence, scientists can read back to the gene that ordered it, and by comparing like proteins from various species, they can correlate sequence variations with genetic differences.

According to Dr. Sibley, many animals are placed in the same family on the basis of behavorial or physical similarities that may have evolved simply because the animals underwent the same process of environmental adaptation. Hence, fish and whales, birds and bats were once thought to belong in the same families. Contemporary research on genetic relatedness of falcons and hawks, often linked as "diurnal birds of prey," suggests they may actually be entirely separate species. "Their true relatives are as yet unknown," Dr. Slbley says. However, protein sequence comparisons will probably uncover their family trees.

Until now, scientists studying evolution have been plagued by barriers of technology. The tedious effort involved in analyzing and comparing protein sequences by hand methods has been simply too overwhelming to consider.

But recognizing the value of approaching the problem through protein studies, scientists have resorted to protein analysis by a method called electrophoresis. In this process proteins are indentified according to the visual patterns they make when suspended in a liquid under the influence of an applied electric field. Useful as the method is, it is not precise and gives no detailed information on protein structure — hence, no proof. The protein machine will do away with this imprecision.

Following Dr. Edman's diagrams, instrument makers at the federally supported Oak Ridge National Laboratory



Electrophoresis: imprecise image.

in Tennessee and at a private firm in Chicago are working out production problems on the machine.

Amino acid molecules are split off proteins in a series of chemical reactions by various reagents and solvents that have to be fed into the system at just the right time and in just the right amounts. Although Dr. Edman's machine unquestionably works, it is a hand-built instrument that engineers believe can be simplified and perfected before going into mass production at $22,500 apiece.

One of the scientists consulting on this project — Dr. Emanuel Margoliash of Abbott Laboratories, Chicago — points out that the machine's potential extends beyond the laboratories of evolutionists. By speeding protein analysis, it can lead to the synthesis of proteins for treatment of disease. So far, insulin, a short molecule only 51 amino acids long, is the only synthetically available protein.

Actually, complete blueprints have been mapped for only a very few proteins—insulin, myoglobin, ribonuclease and lysozyme — primarily because the determination of amino acid sequences is so time-consuming. To get an accurate three-dimensional model of a protein, scientists first find the sequence and then use X-ray crystallography to learn how the long-chain molecule twists itself into a compact protein.

Rockefeller University's Dr. Stanford Moore, who spent 10 years unraveling the 124 amino acids in ribonuclease—a protein that deactivates RNA or ribonucleic acid—predicts ribonuclease synthesis within the year.

Dr. David Harker of Roswell Park Memorial Institute, Buffalo, who did the X-ray crystallography work on ribonuclease, suggests that structural defects in critical proteins including ribonuclease may have a relationship to cancer. If so, structure analysis of proteins from both normal and diseased cells will shed a great deal of light on the disease.

Geneticists, too, are among scientists lining up for the first protein sequenators. They, like evolutionists, will use amino acid sequence as a route back to genetic information coded in genes or DNA (deoxyribonucleic acid). If they can both spot the defects leading to inherited diseases and synthesize proteins to replace defective ones, they'll be able to regulate, and perhaps eventually to eliminate, these disorders. ◇

AN AAAS REPORT

After 10 Years: Thyroid Damage

Iodine is an essential element for the proper operation of the thyroid, a gland which produces growth-regulating hormones. But when the iodine absorbed by the thyroid is radioactive I-131—a product of nuclear fission—damage to the gland from beta radiation can take place.

In large quantities, I-131 radiation destroys the thyroid tissue; it is used medically for this purpose in cases of overactive thyroid. In lesser quantities, the effect of the radiation is quite undetermined, but the evidence suggests that cell chromosomes are damaged, and the reproduction of cells in the gland is reduced.

Recent studies are filling in the gaps in knowledge about the effects of iodine fallout from nuclear tests, showing that heavy exposure definitely causes thyroid damage. But the effect of lesser exposure remains in doubt.

Until 1962, iodine 131 fallout was dismissed as a threat to health because it lasts such a short time: its half-life is eight days. At that time, venting from an underground test in Nevada produced sizable quantities of the isotope, which showed up in local milk supplies. If such a small accident could cause significant pollution, earlier tests, it was argued, could have had a more serious effect.

Two areas which received large accidental doses of fallout in the early days of testing were the Marshall Islands atoll of Rongelap, which was exposed in March 1954, and Washington County, Utah, which received considerable fallout from a test in May 1953.

The Rongelap islanders, according to a study reported at the AAAS meeting in New York, are now, more than a decade after exposure, developing nodules on their thyroid glands, as well as signs of growth retardation associated with abnormal thyroid operation. According to Dr. Robert A. Conard of the medical department of Brookhaven National Laboratory, the thyroid abnormalities clearly come from the radiation exposure, since they showed up only in islanders who were present during the exposure, and not to nearby inhabitants who received less fallout.

Results from a study of 1,000 Utah children exposed in Washington County, also reported at the AAAS meeting, were negative: no more thyroid abnormalities were detected among them than among a similar number of Arizona children who hadn't been exposed.

But, says Dr. Edward S. Weiss of the U.S. Public Health Service, the question of delayed reaction still hasn't been settled. If the Rongelap islanders, who received about 1,200 rads of I-131 radiation, developed symptoms only after a decade, the Utah children might take longer. According to studies by Dr. Arthur R. Tamplin of the University of California's Lawrence Radiation Laboratory, the Utah exposure was on the order of 120 rads.

One school of thought holds that a threshold level of exposure would have to be reached before any serious effect would ever develop. But another approach, based on the long-term effect of damage to cell reproduction mechanisms, indicates that even relatively small amounts of the radioactive element could have longterm effect.

The possibilities of studying the Utah children won't be good much longer, says Dr. Weiss, since most of them will soon be getting out of high school and scattering. And separating actual abnormalities from temporary changes can be a long process: up to two years in some cases.

So the ultimate effects of small I-131 dosage are not likely to be learned. As an aftermath of the 1962 scare, the Government is still taking particular precautions to avoid exposure, as evidenced by the restriction of tests such as the Cabriolet (SN: 12/19/67) cratering experiment to the winter season when possible radioactivity won't contaminate grazing areas. ◇