New Horizons in Science

The Code of Life Finally Cracked

By Earl Ubell
Science Editor

Bruecke and I have sworn to make the truth prevail: no forces are effective in the organism other than the purely physical-chemical — Emil Du Bois-Reymond, 1847.

Eventually, physiology must completely dissolve into organic physics and chemistry— Emil Du Bois-Reymond, 1848.

* * *

When Du Bois-Reymond set those brave words down as a thirty-year-old biologist in Berlin more than a century ago, they seemed as revolutionary as the Communist Manifesto of those same years. His call for a physical-chemical basis for life hammered at the prevailing theory of vitalism: the "old men" believed an unseen, immeasurable vital force gave the spark to life.

In typical revolutionary fashion and in keeping with the times, the young men in science rallied to the young Berliner's side. Bruecke was Ernst Bruecke, who later became Sigmund Freud's physiology teacher in Vienna. Hermann von Helmholtz, then twenty-seven and a founder of the law of conservation of energy, and Karl Ludwig, thirty-two, a physiologist, joined the fight. Of course, with their methods they failed to prove their biological manifesto.

Last week another group of predominantly young men announced they had come closer than ever to proving the Germans right. They had tapped one of the innermost secrets of living things. They had found the key to the chemical code of life: they had learned the basic chemical language of heredity and of the living chemistry by which protoplasm regenerates itself. They had given more reason than ever to believe that at bottom the life force is chemistry and physics.

Credit for the fundamental crack in the code goes to Dr. Marshall W. Nirenberg, thirty-two, of the National Institute of Arthritis and Metabolic Diseases, Bethesda, Md. Working with Dr. J. Heinrich Matthaei, Dr. Nirenberg six months ago deciphered the first "word" of that code.

The News Leaks Out

When Dr. Nirenberg announced his achievement in Moscow at the International Biochemical Congress last August, he set the world of biochemistry abuzz. However, the news did not leak into the newspapers until last week. A group of four researchers from New York University announced they had taken Dr. Nirenberg's code-breaking procedure several steps further and deciphered fourteen out of twenty words of the code of life, and had thus effectively broken it.

After this announcement by the NYU group headed by Nobel Prize winner Dr. Servo Ochoa, Dr. Nirenberg's institute announced that he and Dr. Matthaei had also deciphered as many words. At week's end, it seemed it would be only a short time before the full code was known, now that its basic secret was revealed.

What is this code? What is the "language" involved? What are the "words?" These are but metaphorical ways of expressing the great modern question in biology: how does a living thing transmit its characteristic to its offspring?

In the mood of 1848 transferred to today, biologists and chemists know the transfer is chemical. They know that when sperm unites with egg, chemicals are joined. When an amoeba or a cell or a germ splits in two, chemicals are distributed.

It was only a few generations ago that biologists traced the site of those important chemicals to the nucleus, the central core of the cell; and in the nucleus to the chromosomes, microscopic rods.

Twenty years ago, they identified the chemical that carries the hereditary information—it was called deoxynucleic acid (dee-*OXY-NOO-KLEE*-ik), and known as *DNA* for short. The past two decades have been spent trying to understand its chemistry and its role in the hereditary mechanism.

Composed of two long strings of four basic molecules, permuted thousands of times, the DNA holds the information for the manufacture of proteins in cells. The type and variety of proteins make an animal the size, shape and color it is. The proteins, composed of twenty different aminoacids, carry on the basic life chemistry.

Still Unknown

But the biologists did not know how the information from the DNA moves from the nucleus of the cell into the protein manufacturing region, the cytoplasm, and into the ribosomes, the microscopic protein factories. Recently they found the role of the transfer agent played by another chemical, ribonucleic acid (RYE-bo-NOO-KLEE-ik), a cousin to DNA and known as RNA.

Unknown: What sequence of submolecules in RNA (as transferred from the DNA) produced the proper sequence of amino acids in the proteins? The whole sequence of RNA submolecules—identified by letters representing the 4 chemicals, G, C, U, A—is the language of life; each three-letter combination is a "word." Each word—UUU, UAA, CUA, etc.—controls the addition of a particular amino acid to a particular protein.

Dr. Nirenberg fed artificial RNA to the ribosomes. This artificial RNA had but one word —UUU—UUU—UUU—repeated over and over. The ribosomes read the code and produced a protein containing only one amino acid, phenylalanine. This was the news last August in Moscow.

The NYU group tried other RNAs and worked out—with some ambiguities still—the code words for fourteen of the twenty amino acids. Dr. Nirenberg has also done so.

Future Uses

This work has great practical implications. If biologists know the whole hereditary code and learn how to change it at will, they may be able to control heredity by chemical means. They could raise plants and animals of almost any desired character, and do it in a hurry.

In human beings, it could lead to control of hereditary diseases like diabetes and gout, to name but two. Some scientists are even worried that it could be applied to control the intelligence of large human populations wholesale; i. e., breed a super-race. But all this is in the distant future.

At the moment, the biological manifesto of 1848 looks very good indeed.