Biological coded information

Excerpts from the writings of Dr. Marcello Barbieri

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In the 1950s and 1960s, molecular biology uncovered two fundamental components of life - biological information and the genetic code - that are totally absent in the inorganic world, which means that information is present only in living systems, that chemistry alone is not enough, and that a deep divide does exist between life and matter. This is the information paradigm, the idea that “life is chemistry plus information”.

Quoting Yockey: “Chemical reactions in non-living systems are not controlled by a message. There is nothing in the physico-chemical world that remotely resembles reactions being determined by a sequence and codes between sequences.”

Yockey, Hubert P. January 2000. Origin of life on Earth and Shannon’s theory of communication. Computers & Chemistry, Vol. 24, No. 1, pp.105–123. DOI:10.1016/S0097-8485(00)80010-8)

Matter is made of spontaneous objects whereas life is made of manufactured objects.

Genes and proteins are not produced by spontaneous processes in living systems. They are produced by molecular machines that physically stick their subunits together and are therefore manufactured molecules. This in turn means that all biological structures are manufactured.

Molecular biology has discovered that genes and proteins require not only catalysts but also templates. The catalysts join the subunits together, and the templates provide the order in which the subunits are assembled.

In spontaneous molecules, the order of the components comes from within the molecules, from internal factors, whereas in genes and proteins it comes from without, from external templates. It is an experimental fact that genes and proteins are template-dependent objects.

Both the sequence of nucleotides in a gene and the sequence of letters in a book are carrying information: hereditary information in genes and syntactic information in language. In both cases, the information is digital (because it is made of discrete units) and linear (because the units are arranged in a linear order). The order of the units is the information carried by the sequence.

Life is based on the copying of genes and on the coding of proteins that require sequences and coding rules.

A code is a small set of arbitrary rules selected from a potentially unlimited number in order to ensure a specific correspondence between two independent worlds.

The Morse code, for example, is a correspondence between groups of dots and dashes with the letters of the alphabet, and the genetic code is a correspondence between groups of nucleotides and amino acids.

Since the 1960s we know that a true molecular code exists in every cell: the molecular code called the genetic code, which translates the four-letter nucleotide sequence of DNA into the 20-letter amino acid sequence in proteins.

This is the code paradigm, the idea that ‘life is chemistry plus information plus codes’. How can we explain the existence of symbols and codes in the cell by relying only on known physical principles?

A new code brings into existence something that has never existed before. Only a process that employs a code has the potential to produce genuine novelties in Nature, because only a code can establish arbitrary links between independent objects.

Any code is based on meaning, and a genetic code does exist in every cell. The rule of the genetic code that a group of three nucleotides (a codon) corresponds to an amino acid is equivalent to saying that the amino acid is the organic meaning of that codon.

Unfortunately, modern biology has accepted the concept of organic information but not the concept of organic meaning, and this is equivalent to

saying that genetic information is real but the genetic code is not. Any code involves meaning.

Meaning does not belong to physical theory. Introducing the concept of meaning in biology seems equivalent to reintroducing the old specter of vitalism, and this is something that biologists simply are not prepared to consider.

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Barbieri, Marcello. 13 March 2016. What is information? Philosophical Transactions of the Royal Society A, 374, No. 2063 20150060 DOI.ORG:10.1098/rsta.2015.0060

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