essential evolutionary function that instead, at war, partially finds its destructive end. A balance founded on fear is, for its own nature, strongly precarious. It is always going to break. It is a source of recurring unbalances and concretely contains the danger of the world civilization's self-destruction.

At present, the level of risk is very high. Indeed, it has been calculated that in the world, there is more explosive material, in pounds per person, than food (Sivard, 1980). In front of these evidences, it seems clearer and clearer, on the one hand, how good intentions are vain and on the other hand how the sole desire of peace is insufficient. As expression of the cultural evolution, war can be overcome only through culture. That is to say, it is necessary to change some universal human dispositions—aggressiveness, the disposition to defend the group, the aspiration after domination, territorial tendency, the disposition to answer agonistic signals of extraneous people, and also the universe of fear caused by war—into a pacific order of individual and social relationships. If, in order to cause a war, an enormous and obsessive indoctrination, which wins the biological inhibitions and traditional resistances, is essential then in order to defend or create pacific relationships, a non-unnatural education, founded on vital biological dispositions, on needs and choices of cooperation and of a different competition against other biological phenomena like aggressive instincts and irrational fear, is necessary.

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BOOK REVIEW

ATTILA GRANDPIERRE

Information Theory, Evolution and The Origin of Life: The Origin and Evolution of Life as a Digital Message: How Life Resembles a Computer, Second Edition. Hubert P. Yockey, 2005, Cambridge University Press, Cambridge: 400 pages, index; hardcover, US $60.00; ISBN: 0-521-80293-8.

> The reason that there are principles of biology that cannot be derived from the laws of physics and chemistry lies simply in the fact that the genetic information content of the genome for constructing even the simplest organisms is much larger than the information content of these laws. Yockey in his previous book (1992, 335)

In this new book, *Information Theory, Evolution and The Origin of Life,* Hubert Yockey points out that the digital, segregated, and linear character of the genetic information system has a fundamental significance. If inheritance would blend and not segregate, Darwinian evolution would not occur. If inheritance would be analog, instead of digital, evolution would be also impossible, because it would be impossible to remove the effect of noise. In this way, life is guided by information, and so information is a central concept in molecular biology. The author presents a picture of how the main concepts of the genetic code were developed. He was able to show that despite Francis Crick's belief that the Central Dogma is only a hypothesis, the Central Dogma of Francis Crick is a mathematical consequence of the redundant nature of the genetic code. The redundancy arises from the fact that the DNA and mRNA alphabet is formed by triplets of 4 nucleotides, and so the number of letters (triplets) is 64, whereas the proteome alphabet has only 20 letters (20 amino acids), and so the translation from the larger alphabet to the smaller one is necessarily redundant. Except for Tryptohan and Methionine, all amino acids are coded by more than one triplet, therefore, it is undecidable which source code letter was actually sent from mRNA. This proof has a corollary telling that there are no such mathematical constraints for protein-protein communication. With this clarification, Yockey contributes to diminishing the widespread confusion related to such a central concept like the Central Dogma. Thus the Central Dogma prohibits the origin of life "proteins first." Proteins can not be generated by "self-organization." Understanding this property of the Central Dogma will have a serious impact on research on the origin of life.

Based on the idea that mutual entropy is the suitable measure of information content (or complexity) of protein families, Yockey derives a relatively simple equation (see eq. 5.12 in the text). Unfortunately, the information content of proteins is not derived here from the given equation in enough detail. Instead, the information content of iso-1-cytochrome is presented as 371.42 bits, referring to Table 6-3 (Sect. 6-4); that is not easy to follow. This point weakens the transparency of the book because the calculated information content has a central significance for the main consequences of the work.

What does this information content mean? Is it reasonable that proteins are generated by self-organization processes from amino acid residuals? These questions, unfortunately, are not discussed in Yockey's present book; he refers only to his previous publications. In Yockey (1977) he presents a simple example showing that the complexity of living organisms are related not to physical order, but biological organization. The work of Kolmogoroff, Chaitin, and Solomonoff is based on the idea that a long sequence of heads or tails can be described by a rule or algorithm much shorter than the sequence. The simplest cases like "heads (H), n times" or "tails (T), n times" are the most ordered ones and having the smallest information content. The next more complicated sentences HTHT—and THTH—require more information to specify HT or TH. In general, the more complex the pattern the longer is the message describing it. In the limit of complexity when there is no discernible pattern, one must specify each symbol in turn indefinitely. Such a message is as long as the sequence it describes. Therefore, the most complex sequences (corresponding to the complexity of living organisms' constituents) are in the same class where random numbers are. With detailed, impressive calculations Yockey determines that even with a *deus ex machina* who rolls the icosahedral dice for 10^9 years and each second arranged all the 10^{44} amino acid residues in sequences of 101 sites each, the probability that a member of the cytochrome *c* family will appear is (much) less than 10^{-10}. He estimated that even the *deus ex machina* would be enough only for an amino acid sequence with (much) less than 49 members. Therefore, the "warm little pond" scenario does not generate even one molecule of the biopolymers from which the nonlinear processes of evolution could start. It was shown that even the origin of a simple genetic code is so extremely improbable that all the sound scientific evidence presented by Yockey found them extremely unrealistic.

Moreover, self-organization, if it could be at work, presents structural constraints and physical ordering that are an impediment of biological self-organization, which leads to informational biomolecules and from thence to a genome. Moreover, he points out that the paradox is seldom mentioned that enzymes are required to define or generate the reaction network, and the network is required to synthesize the enzymes and their component amino acids. Another fact against the "warm little pond" speculation is that the Earth had a meteorite bombardment at the suspected origin of life period 3.8 billon years before, more than 17,000 large impact events with larger than 1000 km in diameter in the critical 200 million years period. The lunar tides, tidal currents, and tsunamis, washing over the low continents, were enormously greater (up to 1–2 km) than those of today, because the Moon was close to the rapidly spinning Earth; consequently, there were no "warm little ponds."

The hypothesis of the RNA world of Rich, Woese, Orgel, and Crick is untenable in the face of evidences shown here. There is only one plausible synthesis of ribose

(a component of RNA) that may be considered in the prebiotic milieu, namely, the polymerization of the formaldehyde. Actually, such a polymerization requires a well-educated chemist acting as *deus ex machina.* Furthermore, nonbiological reactions lead to different isomers that are not typical of biochemical products. What is more, RNA is not as versatile a catalyst as protein enzymes. Even more striking is the newly revealed fact that at 100°C the half lives of the components of RNA are very small, some lower than 12 years, others lower than 19 days.

The main conclusion of the book is *Omne vivum ex vivo*. This is an all-important piece of knowledge that is presented here with an outstanding degree of clarity. This clarity is, indeed, really necessary, regarding the long-time accustomed beliefs in "warm little pond" theories. Although the question "how life resembles a computer" was illustrated in enough details, and are of fundamental significance, we think it may still allow the possibility that living organisms and computers, although sharing substantial traits like digital, segregated, and linear codes, may have a fundamentally different nature; namely, if living organisms have, for example noncomputable properties as it is suggested already by Rosen, Hameroff, Penrose, and others. In sum: this book is a highly recommended reading for anyone interested in the most fundamental questions of science. For scientists of this field, this book is a must.