Book Reviews

Ninio, J.: Molecular Approaches to Evolution. London: Pitman 1982. 133 pp., 19 figs., 3 tabs. Soft bound £ 5.95.

In this interesting and stimulating book the author explains the fundamental aspects of molecular processes which have been used by the cell in order to evolve. The main objective can be stated as follows: Implications of modern advances in molecular biology for an understanding of evolutionary theory.

In this context two basic aspects must be considered: A) Evaluation of the various possibilities of evolution of life given the state of organization of life at any given moment. B) How to decide if a novelty will be established or rapidly eliminated. These evolutionary problems should be always discussed in relation to the genetic code and the main question must be: Why the code exists ad through what tentative stages could cellular organization have passed.

After reviewing some basic facts (Chapter: 'The chemistry of life') the author proceeds to a well-known aspect of molecular evolution which has already been treated thoroughly: Comparison of molecules from different organisms to deduce ancestral relationships between species (Chapters: 'The discreet charm of the sequences' and 'Can sequences be compared?'). Many new and stimulating ideas are included in the following chapters:

1) Comparisons in three dimensions (Chapter: 'Evolution in three dimensions'), where astonishing analogies have been found between the three-dimensional structures of proteins of seemingly unrelated function and sequence – for example: Similarity of the structure of the terminal lobe of antibodies to that of an enzyme catalysing an oxido-reduction reaction: superoxide dismutase. From the discussion of many other examples the author concludes, that the three-dimensional shape of proteins seems to be dictated by simple principles of folding which lead to a limited number of combinations.

2) Much attention has been paid to the question: Can DNA really replicate without an enzyme? (Chapters: 'Prebiotic replication' and 'Replication and genetic tinkering'). In the author's opinion the concept of prebiotic replication of nucleic acids can be rejected without difficulty. His conception may be cited as follows: "Cellular replication is a makeshift affair in which short segments are synthesized and linked together, then parts are degraded and the holes are filled in immediately. At first, nucleic-acid chains of any sequence whatever fold up or associate in twos or more, matching up any complementary sequences as best they can. Afterwards, the badly paired segments are excised and finally the holes are refilled. Thus any sequence evolves towards a complementary double chain. The chains separate, fold up on themselves and the process starts again."

3) The chapter 'Populations' deals with the well-known controversies from population genetics indicated by the keywords: selectionist/neutralist, deterministic/stochastic and chance/necessity. While discussing these basic problems many stimulating and fascinating insights appear.

4) Starting with a description of nucleic acid and protein structure and the cellular processes (information transfer, replication and genetic translation) several chapters are engaged in different aspects of the genetic code (Chapters: 'The genetic code'; 'The stereochemical hypothesis'; 'The origin of the genetic code'). In this context major emphasis is given to the problem of the stability of the genetic code and regularities in the genetic code can be related to the different stabilities of GC and AU pairs. Concerning Eigen's theory of the origin of the genetic code the author enters a critical and vehement debate using a very provocative vocabulary. Many fascinating original ideas as well as new interpretations, integrations and perspectives of already well-known results have enriched these genetic-code-chapters.

5) Individual chapters deal with 'Acquisitive evolution' and 'Sequence space'.

Maynard Smith's metaphor of Sequence Space (representation of every possible protein sequence by a point in space) turns out to be an extremely useful concept to describe the problems of molecular evolution and their connections.

Many experiments on acquisitive evolution challenging microorganisms to acquire new metabolic abilities have shown the great importance of mutations in regulation if new compounds are to be metabolized by the cells. It is a common finding that two or three point mutations are sufficient for a bacterium to become capable of growth on a new substrate. The consequences for explaining molecular evolution have been intensively discussed.

6) The chapter 'Molecular defences' deals with the fascinating properties of the immune system, which 'responds to the unexpected' – because a given organism can produce antibodies specific for almost any chosen antigen, naturally occurring or artificially made by man. If all these possible organism-adaptions to their antigenic environment have been codified by the DNA, it would be difficult to see how such an enormous gene array can be maintained in the face of random genetic drift. The author extends Talmage's and Inman's 'combinatorial theory of antibody specificity' to explain how an immense potential repertoire of antibodies can be coded for by a small number of genes.

7) Nucleic acid hybridization techniques are used a great deal to evaluate sequence similarities in nucleic acids and many fascinating insights appear, for example: The DNAs of higher organisms contain 'repeating sequences', where three different types of zones may be distinguished: non-repetitive zones, short repetitive zones and long repetitive zones. These three types of zones in DNA differ from one species to another according to laws proper to each class. Long repetitive sequences vary very little from one species to another, much less than non-repetitive sequences. Short repetitive sequences seem to evolve faster than non-repetitive sequences. These interesting facts are discussed in detail in the chapter 'Molecular crosses'.

8) The final chapter 'The great error loop' starts with a criticism of Hoffmann's model on the origin of the genetic code and precedes to new concepts and ideas about the appearance of ordered states from less-ordered ones.

An extensive collection of references has been included – divided into three groups: Works and articles of initiation or culture; Books for higher education and research; Original papers for specialists. The book is excellently written in a very informative, lucid and fascinating style. The text can be read with profit and interest by readers at very different levels. Technical terms as well as details from molecular biology have been kept to a minimum.

Without any doubt and restriction I want to characterize this book as stimulating and fascinating, I enjoyed reading it. I am sure any biologist with an interest in evolution will confirm this opinion.

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