Misinformation

Hermann Haken

Information Theory and Molecular Biology. By Hubert P. Yockey. *Cambridge University Press: 1992. Pp. 408. £55, $69.95.*

INFORMATION theory and molecular biology are both large and important fields. In this book, H. P. Yockey tries to link the two. Quite often the word 'information' is used with different meanings, but from the very beginning he sticks to a single interpretation — Shannon information. This information does not carry meaning; rather it is a measure of the scarcity of an event or message. Yockey's starting point is laudable — but how far does it get him?

He begins with a sound presentation of basic principles of probability theory and then discusses the concept of entropy, including that of genetic sequences. There follows a short chapter on the principle of maximum entropy, which regrettably lacks a discussion of the crucial role of constraints. An outline of codes and coding theory provides the main basis for the author's later conclusions. In the chapter on source, transmission and reception of information, he emphasizes the analogies between information transfer and the genetic code.

It is in the second part of the book that Yockey extends this theory to problems in molecular biology. He begins by presenting the information content of several protein families and goes on to deal with a variety of subjects, such as the evolution of the genetic code, neurobiology, the primaeval soup, black holes and cosmology.

In several places the author states that although molecular biology must be consistent with chemical and physical processes, biological principles cannot be derived from physics and chemistry alone. This statement holds still more for the relationship between mathematics and molecular biology (or any other branch of science). But Yockey repeatedly conveys the impression that the laws of molecular biology can be derived from mathematics. In addition, information theory by itself does not contain any dynamics: in order to understand the genetic code, the study of the underlying dynamics of its self-organization is essential. So the author's polemic against the seminal work of Manfred Eigen, who clearly recognized and formulated the fundamental role of these dynamics, is not only unfounded but misleading.

Undoubtedly, information theory has its uses in molecular biology, in particular by giving insights into the way genes code for proteins. But instead of sticking to this problem, which is interesting in itself, Yockey makes wild extrapolations in a futile attempt to show how the classical concept of information can be applied to problems in *generating* information. He would have been wiser to have published only the first part of this book. □

Hermann Haken is in the Institute of Theoretical Physics and Synergetics, University of Stuttgart, Pfaffenwaldring 57-IV, 7000 Stuttgart-80, Germany.

Elusive concept

Michael E. Akam

Evolutionary Developmental Biology. By Brian K. Hall. *Chapman and Hall: 1992. Pp. 275. £29.95, £47.50.*

WHEN walking across the upland fells of Britain, it is not uncommon to find the whitened jawbone of a long-dead sheep, teeth rattling in its sockets. Food for thought on a wet day, for both the developmental and evolutionary biologist. What mechanisms built the jaw's distinctive pattern, each tooth unique, the bone an asymmetric array of lumps and bumps? What mix of selective forces and developmental constraints moulded the mandible, honed the teeth? Here, *par excellence*, is the meeting of the ways for developmental and evolutionary biology.

The mandible is a favourite subject for Hall. His discussion of the forces that shape it is one of the best parts of his book. He approaches his theme — the interplay of developmental and evolutionary biology — first as historian, then reviewer and finally, in the context of the mammalian mandible, as modeller.

As an annotated bibliography, the book is superb. There are nearly a thousand references, spanning the literature from palaeontology to molecular biology, much of it recent, but with good coverage of the eighteenth and nineteenth centuries (12 references for Geoffroy Saint-Hilaire!) and, perhaps most valuable, a survey of the extensive but scattered literature of the twentieth century. Here you will find pointers to classic studies, still pertinent, but not accessible from compact disc databases or minireviews: Waddington on developmental canalization, Gilbert on cyclomorphosis, and Etheridge on kidney development.

But the book aims to be more. It aims to re-examine key concepts — hierarchy, epigenesis, archetype, homology. As a developmental geneticist, I hoped for a personal synthesis of the subject viewed from a different perspective. For the first 160 pages I was disappointed. Haeckel's views, de Beer's definitions, Waddington's ideas, yes; but only glimpses of a personal perspective. These chapters are not easy to read. Sentences running to 70 or so words don't help. The ideas shine out most clearly from the frequent and well chosen quotations: Owen — "Homologue . . . . The same organ in different animals under every variety of form and function. Analogue . . . . A part or organ in one animal that has the same function as another part or organ in a different animal" (1843); Bateson (on late nineteenth century biology) — "Morphology was studied because it was the material believed to be the most favourable for the elucidation of the problems of evolution, and we all thought that in embryology the quintessence of morphological truth was most palpably presented" (1922); Whitman (on developmental constraint) — "But if organisation and the laws of development exclude some lines of variation and favour others, there is certainly nothing supernatural in this, and nothing which is incompatible with natural selection" (1919). Pithy stuff. But elsewhere, if the original author is not quoted, the ideas often fail to jump off the page.

It is too easy to criticize a book of this scope for errors of detail. But in places, Hall fails to do justice to the very logic of the subject. Under the heading "Key innovations as single gene mutations" we find a discussion of torsion in gastropods. Sturtevant showed in 1923 that the handedness of coiling in snails is controlled by a single pair of genes. Hall seems to endorse a proposal made some years ago by Stanley that, on the basis of this simple genetic control, "Torsion, and with it the class Gastropoda, arose through a single gene mutation." It is a profound error to equate a mutation that changes the symmetry of torsion with a mutation that invents the mechanism of torsion itself. This is like saying that all the genetic differences between male and female, oogenesis and spermatogenesis, are specified by a single gene on the Y chromosome. This may be true at the population genetic level, but it tells us absolutely nothing about the developmental complexity of the process itself. This error is common enough in the literature, but it is disturbing here to find even a hint of support for such thinking.

The book becomes gripping once Hall allows his own interests and opinions to come closer to the surface. Does the idea of homology apply only to morphological patterns, he asks, or can it be applied to developmental processes? He follows the topic from Darwin and E. B. Wilson to Hinchcliffe, Oster, Roth, Alberch and Wagner. For once, we are