Book review

The Triplet Genetic Code: Key to Living Organisms

LEH Trainor
World Scientific Publishing Co Pte Ltd., London; 2001.
122 pp. £17.00, paperback. ISBN 981-02-4468-1

The mid-20th century discoveries that created molecular biology's 'central dogma' provided a conceptual framework that subsequent technological innovations have clothed in data at an astonishing rate. This data is accumulating faster than current research resources can mine it for new scientific and technological insights, let alone for socio-political and ethical implications.

Against this backdrop, Trainor's book starts from an excellent premise: at the center of our conceptual framework for parsing molecular biological data lies the genetic code, the system of rules by which inert genetic information is processed into the protein fabric of living organisms. A thorough understanding of genetic coding, and of its evolution, forms a solid foundation for the scientific bridges that will span the reservoirs of data, for the analytical platforms from which they will be explored, and thus (ultimately) for the new technologies that will bring new challenges to our society. Moreover, as Trainor reminds us, the molecular basis of life is so conceptually simple, so wonderfully understandable, that anyone with an interest can grasp its basics within an afternoon: and who should not spend this afternoon for a scientific revolution with implications that range from health insurance to human cloning, from cosmology to genetically modified foods?

With a stated target audience of high-school teachers, community college professors (and students) and other non-specialists, Trainor has done a praiseworthy job of creating succinct, readable and clear prose. The book develops three logically sequential themes: (1) a summary of last century's discoveries regarding the genes that form one side of the code, the proteins that emerge from the other side and the nature of the genetic code itself; (2) one particular line of research into how the structure of the genetic code illustrates its evolution and provides analytical links to composition of genomes; and (3) a discursive exploration of a bigger picture into which genetic coding may be placed.

Unfortunately, the resulting book consistently disappoints in terms of content. The genetic code is an interface, literal and conceptual, between numerous aspects of biology. Though a short book for non-experts is necessarily limited to capturing the flavor (rather than detail) of this interface, it must not actively mislead through omissions and inaccuracies: otherwise it descends into irony of synthesizing a multifaceted, fast developing research theme in isolation from its contemporary research context.

Such problems are most clear-cut within the first section of the book (chapters 1–7), which seeks to summarize existing genetic code knowledge. Some are straightforward scientific misconceptions (eg, we are told that RNA necessarily exists only in single-stranded form because it uses ribose instead of deoxyribose: this will be news to double-stranded RNA viruses, for example). Others are simple historical inaccuracies (eg, Crick's discovery of non-overlapping triplet coding is conflated with his erroneous theory of a comma-less code (Crick *et al*, 1957); in fact it was Brenner who first ascertained that the codons could not be overlapping (Brenner, 1957). However, the most important flaws are those relating to general themes of genetic code knowledge and research. For example, we read that the code is universal except for the mitochondria of yeast and vertebrates: NCBI's public database currently has records of some 23 different codes spread across several hundred taxa (http://www.ncbi.nlm. nih.gov/htbin-post/Taxonomy/wprintgc?mode=c). Similarly hard to justify is the dismissal of the RNA world hypothesis by the observation that nucleic acids cannot replicate in the absence of biological catalysts: this completely overlooks the extensive, vibrant field of ribozyme research (Yarus, 1999). The chapter on genetic code evolution has not progressed, in content, beyond Crick's 1968 review of the topic: it misses most contemporary branches of research on the topic, including theoretical and empirical evidence for a stereochemical origin for coding, the biosynthetic theories of code growth and the adaptive theories of code organization (see, for example, Knight *et al*, 1999; Szathmary, 1999).

For the second section (chapter 8), the book changes direction from a précis of mainstream thinking to a summary of the authors' work and that of one of his students. Whilst this work is interesting, and (I must admit) new to this reviewer, it is difficult to justify this shift in focus for the target audience of non-specialists: the Trainor/Rowe work is presented in isolation from related, pre-existing research. In places, it apparently overlaps with other scientists' work to an extent that should be worthy of consideration (eg, Lobry's seminal studies of base composition patterns: Lobry, 1997; and references therein). In others, the Trainor/Rowe thinking apparently lies in direct conflict with mainstream thinking about genetic code evolution (eg, the underlying assumption is that DNA preceded the genetic code in evolutionary time: an inversion of the widely held view that DNA arrived as a final complement to an RNA/protein world). Though mainstream thinking is not necessarily correct, the oversights of the previous section do not aid the credibility of radical claims and non-specialists should at least be made aware that significant differences of opinion exist. All in all, it is hard to escape the feeling that this section would be better served as a monograph aimed at a specialist audience, where its relevance and relationship to pre-existing research could be explored in depth.

The final book section is again laudable in aim: we are

reminded that reductionism has its limitations and that a holistic interpretation of the genetic code will do much to advance our science. Unfortunately, as is so often the case with arguments for holism, the reader is offered no discernable, practical action to be taken.

In summary, whilst this book contains a lot of interesting and well-written material, it is compromised (especially for the intended, non-specialist audience) by errors, omissions and unusual emphases. The book does, however, make a useful and thought-provoking addition to the shelves of those actively engaged in genetic code research who will not be unwittingly misled by these problems.

SJ Freeland
The Department of Biological Sciences
University of Maryland, Baltimore County
1000 Hilltop Circle, Baltimore, MD 21250, USA
E-mail: freeland@umbc.edu

References

Brenner S (1957). On the impossibility of lal overlapping triplet codes in information transfer fromnucleic acid to proteins. *Proc Natl Acad Sci USA* **43**: 687–694.

Crick FHC, Griffith JS, LE Orgel (1957). Codes without commas. *Proc Natl Acad Sci USA* **43**: 416–421.

http://www.ncbi.nlm.nih.gov/htbin-post/Taxonomy/wprintgc?mode=c

Knight RD, Freeland SJ, Landweber LF (1999). Selection, history and chemistry: the three faces of the genetic code. *Trends Biochem Sci* **24**: 241–247.

Lobry JR (1997). Influence of genomic G+C content on average amino-acid composition of proteins from 59 bacterial species. *Gene.* **205**: 309–316.

Szathmary E (1999). The origin of the genetic code: amino acids as cofactors in an RNA world. *Trends Genet* **15**: 223–229.

Yarus M (1999). Boundaries for an RNA world. *Curr Opin Chem Biol* **3**: 260–267.