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Natural maths: the spiral arrangement of seeds in a sunflower head follow Fibonacci's sequence.

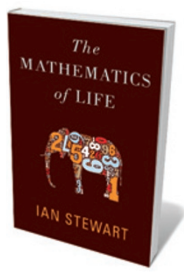
MATHEMATICS

Life models

Biology is too complex to be unified by mathematics, finds **Marc Feldman**.

Ian Stewart is a prolific writer of books about mathematics. His latest volume attempts to put mathematical thinking at the centre of biology. *The Mathematics of Life* is framed around five revolutions: the microscope, the development of taxonomy, evolution, Gregor Mendel's discovery of discrete inherited traits (later found to be genes) and the structure of DNA. Mathematics, which Stewart claims unites these developments, is proposed as a sixth "biological revolution".

These five milestones were indeed major breakthroughs, but Stewart's efforts to situate mathematics at their core seem contrived. His historical style means that there is no up-to-date assessment of, or speculation about, the kind of mathematics that biologists might find useful in the future. A better survey might, for example, have considered Sewall Wright's contributions to the study of small populations or Ronald Fisher's reconciliation of genetics and biometry.



The Mathematics of Life
IAN STEWART
Basic Books: 2011. 368 pp. $27.99

One-third of the book is essentially a fast course in biology, covering the importance of the microscope in discovering microbes; elements of plant development; the contributions of Charles Darwin, Alfred Russel Wallace and Mendel; and an introduction to DNA structure. There is an extensive section on the Fibonacci series and plant growth, but later chapters on the origin of life and astrobiology seem misplaced as these topics lack obvious mathematical underpinnings.

The tremendous progress in computational biology is barely mentioned, and behavioural biology is buried in a description of game theory rather than the mathematics of dynamic systems. Whereas discussions of ecosystem analysis from the 1980s and 1990s are well presented, work from the past 15 years is not: the active theoretical debate on whether ecological communities are neutral or competition-driven is not referred to. Recent theories that address species depletion and climate change are strangely neglected.

Nor does the book describe how Fisher, Wright and J. B. S. Haldane developed the mathematics of evolutionary genetics while laying the foundations for modern data analysis. This is a missed opportunity to unify the chapters on Mendel and Darwin, biologically and mathematically. Modern population genetics, with its wealth of stochastic processes and highly nonlinear dynamics, is ignored.

"The fragmentation of biology and its maths is likely to continue for a long time."

Epidemiology, one of the oldest applications of mathematics to biology, is in the chapter on plankton — in my view, a strange juxtaposition. Given the emphasis on history, the foundational 1927 work of William Kermack and Anderson McKendrick that gave rise to the modern theory of epidemics is a glaring omission. Networks, which are a hot topic in biology and social science, receive a brief but outdated treatment, whereas topological knot theory is expansively discussed as fundamental to the biology of macromolecules.

As a mathematician, it is understandable that Stewart chooses to emphasize the concept of symmetry. But the relationship between the abstract mathematics of symmetry and organismal or molecular biology seems tenuous. I would have preferred to see space devoted to the properties of deterministic or stochastic dynamic systems, for example, that are closer to the interests and needs of practising biologists. The reader is left with Stewart's personal passions rather than the big picture suggested by the book's title.

The extreme diversity between the different disciplines of biological research mitigates against a unification in terms of mathematical modelling. It is not sufficient to claim, as Stewart does, that such a unification could be built around a theory of complexity. Although Stewart's many examples of mathematical models of biological phenomena are interesting to read, each requires a different part of mathematics. The fragmentation of biology and its maths is likely to continue for a long time. ■

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