BOOKS & ARTS

From cell to organism

How genetics unlocked the mysteries of development.

Coming to Life: How Genes Drive Development
by Christiane Nüsslein-Volhard
Kales Press: 2006. 176 pp. $29.95

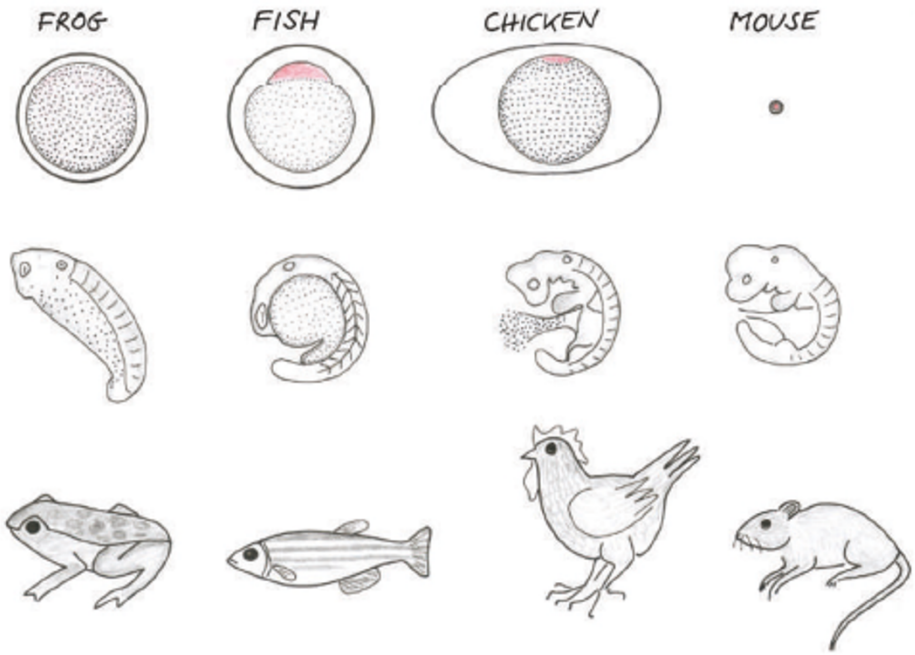
Alfonso Martinez Arias

It is easy to forget how little was known about the development of living organisms just 30 years ago. Today we have whole genome sequences of many species that can be compared, endless patterns of gene expression that are just beginning to be pieced together, and technologies such as RNA interference that allow us to do genetics at amazing speeds and depths. Together these provide an opportunity to understand the mechanics of life and the details of how plants and animals are formed. And yet, at the beginning of the 1970s, the development of an organism from a fertilized egg was still a marvel with a hidden secret.

Yes, there were hints that the secret would soon be unlocked. The uncovering of genetic regulatory circuits in bacteria had famously led Jacques Monod to state that what was true for *Escherichia coli* would also be true for the elephant. However, despite these high hopes, the secret remained out of reach. In the 1980s there was a watershed. It came not from the application of biochemistry to the problem, which had been tried before without much success, but from applying a judicious mixture of genetics and molecular biology to two invertebrates: the nematode *Caenorhabditis elegans* and the fruitfly *Drosophila melanogaster*.

Christiane Nüsslein-Volhard has played a central role in the process of discovery that has enlightened our understanding of how one cell becomes an organism. Her contributions have the virtue of having explored the issue both in invertebrates, with her pioneering studies of the early development of *Drosophila*, and more recently in vertebrates, through her work on the developmental genetics of the zebrafish *Danio rerio*. It is a range allowing her a rare insight into the development of organisms, and this permeates *Coming to Life*, an account of where we stand in our understanding of the process of embryonic development.

The content of the book ranges from history to evolutionary biology, and includes a crash course in molecular biology and insights into the molecular embryology of different organisms. Surprisingly, all this ground is covered in 140-odd pages of main text with a style that is direct, simple and easy to read. The book is carefully produced and the illustrations are hand drawn and full of personal insight.



C. NÜSSLEIN-VOLHARD

Hand-drawn illustrations bring a personal touch to Christiane Nüsslein-Volhard's book on development.

The thread of the book is the importance of genetic analysis as an essential tool to understanding the development of organisms, and the principles that have been derived from this. A second important message is the sense of unity of mechanism that underlies the diversity of animal form. Naturally, *Drosophila* is central to the book, and we have clear accounts of the role that genetics has played, and continues to play, in uncovering developmental principles.

Nüsslein-Volhard highlights some of the barriers that have been broken in the process of establishing the existence of these principles. Nowhere is this better illustrated than in the uncovering of informational gradients and their role in pattern formation. Classical embryological experiments hinted at their existence, but brute-force biochemistry had failed to identify such factors. It was a genetic approach that led to the breakthrough with the *bicoid* gene and its role in early *Drosophila* development. Genetics also provided the logic behind patterning along the axes and revealed that different organisms represent different outputs of a conserved molecular kit made up of transcription factors, such as the Hox proteins, and signalling molecules that allow cells to communicate with each other. Nüsslein-Volhard's book establishes the link between *Drosophila* and vertebrates, and discusses the basic facts of human embryology as another, albeit special, case of vertebrate embryology.

For the most part, the book is an account of a mature field of study with some personal touches. The mostly objective mould is broken in the final chapter, in which Nüsslein-Volhard tackles several sensitive issues concerning the nature of life and its implications for human welfare and reproduction, and the potential of stem cells and genetic therapies. She is not afraid of giving her opinion: "Although the criteria used for the definitions rely on biological events, they are not a scientific but a moral issue. Dignity, right of life and protection are not biological but moral categories … these issues should be decided not by scientists but by our society as a whole through our political representatives." The function of the scientist, as most of us will agree, is to find out how things work and to provide information

that can be used to help others take decisions. Our role is not to cast shadows or to mediate those decisions. This chapter also makes clear what is possible and what, at the moment, is a utopia.

Coming to Life is said to be aimed at "those who are curious and who would like to understand the process of life a little better without having to deal with highly specialized knowledge". The final chapter in particular makes one wonder whether reading this book would not also benefit politicians, social activists and journalists who ponder issues such as cloning and stem-cell or genetic therapies in the public realm. They might find the science rather challenging in places, but it would certainly give them a perspective for their judgements. ■

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Charting an Arabic course

Mathematical Geography and Cartography in Islam and their Continuation in the Occident, Vol. I. Historical Presentation
by Fuat Sezgin, transl. Guy Moore & Geoff Sammon
Institut für Geschichte der Arabisch-Islamischen Wissenschaften, Johann Wolfgang Goethe-Universität: 2005. 636 pp. €175

A. M. Celâl Şengör

Few books in the historiography of science have single-handedly created a revolution in their subject, but this one just might. It is the result of a 15-year effort by the renowned Arabist and science historian Fuat Sezgin. Originally, the book was to be just another volume in the author's *History of Arabic Literature* series, begun in 1967, in which a scholarly historical introduction is followed by a list of authors and critical assessments of their works. *Mathematical Geography and Cartography in Islam and their Continuation in the Occident* retains this format, but the usual introduction is expanded into two massive volumes of 'historical presentation', plus a lavishly illustrated atlas with 209 maps (many in colour). It was originally published in German in 2000, but an English translation of Volume 1 is now available and Volume 2 will follow shortly, along with the final 'authors' section of the German original.

While working on the book, Sezgin found that conventional treatments of the history of mathematical geography and cartography had failed to take into account nearly half of the available material, and it is the narration and analysis of this that fills the bulk of these volumes. He first became aware that something was seriously amiss when he heard about the sudden appearance of some portolan maps, or navigational sea charts, from around 1300, and some remarkably accurate longitude and latitude data in European maps of parts of Asia, dating from times when no European had been there to take any measurements.

A clue to the puzzle lay in the discovery of an annotated version of *Masalik al-abşar fi mamalik al-amşar* by Ibn Fadlallah al-Umari, a representation from 1340 of a lost map of the world prepared by the geographers of the Abbasid caliph al-Ma'mun in the eighth century. The version by al-Umari was drawn on a pre-existing graticule with a globular projection, and not vice versa as had previously been assumed — I can vouch for this, having checked the original myself. This helped Sezgin interpret the data on geographical coordinates that originally accompanied the Ma'munic map. Sezgin found the data preserved in the book *Sûrat al-ard* from the early ninth century, which has commonly, but mistakenly, been considered to be an original work of Abu Ja'far al-Khwârizmî. It is now thought to be a simple register of Ma'munic location data.

Sezgin argues that the collection of all these data necessitated new fieldwork and must have required a large group of observers, rather than being revisions by one hypothetical Syriac author of a Ptolemy translation, as Hans von Mzik had proposed. Sezgin's reconstruction of the Ma'munic map, put together using the only two preserved versions of its coordinate data, shows that the Ma'munic geographers had reverted to the earlier idea, proposed by the Greek scholar Eratosthenes, that the world consisted of inhabited land surrounded by the ocean, as opposed to Ptolemy's view in which oceans appeared as giant lakes. For example, the map shows the Arabic error of considering the Malaysian peninsula to be a vast elongation of southern China, but separated from Africa, as seen in al-Umari's map. An even older version of the map discovered by Joseph Needham corroborates Sezgin's reconstruction.

Once the Ma'munic improvement on Ptolemy was correctly reconstructed, it led to a search for other geodetic improvements, both in methods and in results, by Islamic mathematical geographers and cartographers. Sezgin documents in great detail how the Ptolemaic 'long Mediterranean' was shortened almost to its length today by fixing the positions of Baghdad and Toledo; how the Caspian Sea gradually acquired its correct outlines; how, by a combination of dead reckoning and trigonometry, the Arabs managed to get to grips with longitude at sea; and finally, how the distance between Ghazna and Baghdad was measured with astonishing precision in the eleventh century using astronomical observations and spherical trigonometry.

Sezgin then documents the influence of these achievements in Europe. A number of Western authors, including Marco Polo, Dante, the astronomer Johannes Kepler and the cartographer Nicolas Sanson, seem to have been informed by Arabic–Islamic geography. Sezgin shows how the Muslim maps led to the portolans, as they had to Portuguese maps of the Indian Ocean. He documents and discusses in great detail the information that Muslim geographers gathered on Asia, the

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An Arabic world view: Ibn Fadlallah al-Umari's map from 1340 contains data from the eighth century.