among them language, make up the fourth dimension.

Having described their four-dimensional model of evolution, Jablonka and Lamb continue by showing how these dimensions interact. As before, it is classical work that is most illuminating. For example, the authors cite Waddington's experiments from the 1940s with heat-shocked *Drosophila* which demonstrated the phenomenon of 'genetic assimilation'. Here, selecting for an inducible phenotype leads to it becoming constitutive and stably heritable after only a few generations.

Today, genetic assimilation as well as many other genetic phenomena are understood in molecular detail and the reader is given some of this information where appropriate. The moderately technical nature of these passages is mitigated by careful avoidance of unnecessary jargon. In addition, each chapter concludes with a delightful dialogue in which the themes introduced in the main section are playfully varied. This makes the book not only thought-provoking, but also fun to read. We may be blind robots, but some of these robots are perceptive enough to see the limited fruitfulness of this point of view. I thoroughly recommend Jablonka and Lamb's book to anyone interested in an exciting alternative.

Details

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The Ancestor's Tale: A Pilgrimage to the Dawn of Life

by Richard Dawkins

Reviewed by Bernhard Haubold, Fachhochschule Weihenstephan, Germany

There is a natural way to tell a tale: begin at the beginning and end at the end. Standard biographies, for example, start with the forebears, in many cases the grandparents, and end with the protagonist's death. So the end is clear, but the beginning is potentially fraught with the difficulty of deciding which ancestors to describe. After all, one person has two parents, four grandparents, and 2^{n+2} n-great-grandparents. An elegant technique to avoid the thicket of ancestors is contained in the Bible, in which Luke, the biographer of Jesus, tells the genealogy of his subject by starting with Jesus and ending with Adam. As a man of his time, Luke only mentions the fathers, thereby converting an exponentially growing, unmanageably large bi-parental genealogy into a lean uni-parental genealogy.

In contrast to human individuals, two animal or plant species are usually derived from a single ancestral species. Biological species therefore naturally form uni-parental genealogies. In his latest book, *The Ancestor's Tale: A Pilgrimage to the Dawn of Life*, Oxford biologist Richard Dawkins takes advantage of this fact by giving a popular but richly detailed account of evolution starting at the end and time-travelling backwards to the beginning of life.

Today, the inversion of the arrow of time has a strong tradition among evolutionary biologists. If we start with, say, three copies of the human alpha-haemoglobin gene and look back in time, we will reach a point at which two of the three genes were derived from a common ancestral gene. At that point, two alpha-haemoglobin lineages fuse. Such a fusion is also known as a coalescence event, and hence the corresponding theory is called coalescent theory. Moving further back in time, we reach a point where the last two remaining lineages fuse in another coalescence event. This is known as the most recent common ancestor of the genes. It is of fundamental importance for evolution, since any mutation that happened further in the past affected all genes equally and hence is invisible in the present copy of the genes.

Consequently, there is no use in pursuing the history of a sample of genes beyond their most recent common ancestor. Similarly, there is no sense in telling the history of life beyond the last common ancestor of all creatures alive today. So, as with biographies, the end of the story is clear, while the beginning is less clear, because evolution has as many ends as there are extant species. But of course, we are mainly interested in ourselves and this is where Dawkins starts his magnificent account.

Moving backward in time, we are joined along our lineage by 39 other branches of the tree of life. These include, among others, apes, mon-

keys, rodents, marsupials, birds, amphibians, fish, protostomes, sponges, fungi, plants, Archaea, and, finally, Eubacteria. At each of these 'rendezvous', the joining branch is displayed together with a time estimate and a description of the biology of the newly arrived pilgrims. The title of the book alludes to Chaucer's 14th century *Canterbury Tales*, which recounts a pilgrimage to the English town. Along the way, the pilgrims are encouraged by their host to wile away the time by each telling a tale. In *The Ancestors's Tale*, Dawkins plays host to the increasingly numerous organisms on their pilgrimage from the present to the past. The real charm of the book lies in the tales he puts into their mouths, beaks, and probosces.

These are lucid essays that take the reader through the great ideas in evolutionary biology. For example, the gibbon's tale explains the reconstruction of phylogenies, following the genealogy of 24 different manuscript versions of the *Canterbury Tales*. The mouse's tale takes issue with the popular analogy between the genome and an organism's 'blueprint', and clarifies that it is misleading to think of a genome as a description of its host organism. The lamprey tells a tale of gene duplication in general and of globin duplication in particular. It is a thought that needs some getting used to, that the human alpha-haemoglobin gene is much more closely related to the chimp alpha-haemoglobin than it is to the human beta-haemoglobin.

The peacock's tale is, of course, about sexual selection and it challenges the reader to contemplate why we are naked (hairless) apes, walking on two legs with heads often too big for our own good. The fruit fly gracefully shows off its developmental master genes, the Hox genes. Originally discovered in the fruit fly, these have now been found in almost all animals, including mammals. The velvet worm's tale is about the radiation of all extant animal forms during the 'Cambrian Explosion' some 500 million years ago, which wasn't so explosive after all. In the epilogue to this tale, Dawkins treats us to a succinct account of the so-called molecular clock hypothesis, which posits that genes accumulate mutations at a roughly constant rate. And on the pilgrimage goes, until it is finally joined by the Eubacteria. There, the tale is by *Thermus aquaticus*, the bacterium which contains a DNA polymerase known to molecular biologists as Taq polymerase. This heat-stable enzyme is the basis of the polymerase chain reaction, with which any region in a genome can be amplified million-fold, thereby greatly facilitating a wide range of genetic engineering tasks.

Until quite recently, Luke's backward approach to genealogy has largely been confined to evolutionary biologists. In picking it up, Dawkins has found a new plot to the oldest story around. It is this originality, combined with the playful but precise descriptions of many of the best ideas in contemporary biology, that makes this book a joy to read.

Details

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DNA interactive

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This award-winning yet inexpensive educational DVD contains numerous short interviews with scientists, many of them Nobel laureates, who have played a major role or continue to work principally in human molecular biology. There are also computer animations showing key techniques and processes. Video clips are grouped in several ways to facilitate their use, e.g. by theme or by interviewee. The material is aimed mostly at 16- to 19-year-old biology students.

Many, if not most, of the clips have been culled from a five-part Channel 4/PBS television series made to coincide with the 50th anniversary of the discovery of the DNA double helix. That series of five 50-minute programmes, *DNA – The story of the pioneers who changed the world*, is available on two DVDs from the production company, Windfall Films Ltd.

The most spectacular and impressive sequences in *DNA interactive* are undoubtedly the molecular animations showing DNA replication, coiling and protein synthesis. These were created by Drew Berry at the Walter and Eliza Hall Institute in Melbourne, Australia. Coupled with the possibility of choosing the level of sophistication of the accompanying spoken commentary, these superb clips form an extremely useful addition to teaching resources.

Other animations taken from the television series vary in quality, and