

Biological Evolution

An Introduction

Biological evolution, the theory of natural selection and of common descent, is a triumph both of human reasoning and scientific undertaking. The biological discipline of evolution contains both a chronicle of human endeavour and the story of life on Earth. This book is concerned with living forms and how they developed from ‘simple and unpromising beginnings’. It considers evolution as both process and product. The author, an experienced teacher and educator, employs a historical narrative, used to convey the idea of ‘change with modification’ and to emphasise the relevance of evolution to contemporary bioscience. Biological evolution has now become part of the scientific orthodoxy, and this accessible text will assist undergraduate students in the biological sciences within any ongoing debate.

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Preface

A textbook is more than a simple source account or provider of information. We live in an information age where factual description and scientific explanation are readily available on-line. And so, the textbook (particularly an introductory text such as this) should also convey ideas, stories, context and controversies as well as fulfilling its primary teaching role.

Inevitably, in discussing biological evolution, there will be overlap between academic disciplines (genomics, molecular biology, history of science, palaeontology, anthropology and zoology) but the outcome remains the same – evolution provides both a profound and true account of life on Earth. Evolution is an accepted fact supported by overwhelming evidence. Rules of scientific evidence apply here in the same way as they do in molecular, physical or chemical studies; and we can note that recent research into genomics and molecular phylogenetics is continuing to yield new insight into biological evolution. History though, if anything, teaches us not to be complacent; scientific principles can be re-examined, repurposed and redefined. It is my hope that this text will inspire the reader to explore further the intricacies of biological evolution and ultimately to understand the origins of ourselves and the world around us.

We learn effectively through stories. And the biological discipline of Evolution contains both a chronicle of human endeavour and the story of life on Earth. This book is concerned with living forms and how they developed from ‘simple and unpromising beginnings’. It considers evolution as both process and product. An historical narrative is employed; used to convey how the idea of ‘change with modification’ developed and what evolution now means to contemporary bioscience. The topic of Evolution is taught in schools, colleges and universities (it has also been included in the UK National Curriculum for Primary schools) and its central role in the study of the Life Sciences is now well understood. Evolution of course provides a unifying theme, a scaffold on which to place our developing understanding of past and present biota.

In an age where students discuss the evolution of the cosmos or the evolution of the mobile phone it was thought appropriate here to use the more correct epithet, *Biological Evolution* as its title.

Biological evolution, the theory of natural selection and of common descent, is a triumph both of human reasoning and scientific endeavour. And although, for most of us, the story begins with Charles Darwin and Alfred Russel Wallace in the mid-

nineteenth century, the idea of biological change over time was not new. Through primitive animism and the later philosophies of the ancient world, the history of evolutionary thought takes in several millennia and several different world views. The Age of Enlightenment, including the Scientific Revolution of the seventeenth and eighteenth centuries, also had a profound influence on evolutionary thought.

Scientific advance may seem to appear rapidly in human history, but the reality is the ‘fine tuning’ of ideas and refinement of major concepts takes many generations. The same is true for biological evolution. The basic ideas of selection and modification were laid down by Darwin and Wallace, but over the subsequent 150 years or so new insight into both macro- and microevolutionary change has become evident. Not least of which are the syntheses of Evolution and Heredity together with Evolution and Development. The new sciences of genomics and bioinformatics are providing even further detail concerning the mechanism of change while advances in palaeontology, embryology, biogeography and geology yield yet more insight.

Through context (how and when ideas were first formed) and through argument and debate the text will both encourage exploration and provide an explanation for evolution. This book is intended as an introduction to the subject of biological evolution for the undergraduate student of biology (along with students of anthropology, psychology, genetics and allied professions). Its text is intended to be both comprehensive and detailed where necessary, but it is hoped that the narrative style and historical context will also appeal to anyone with an eye for a good story.

The book is structured in such a way as to introduce the main ideas initially and then explore details of mechanism (‘how evolution occurs’) and product (‘what has evolution produced’). As far as possible, detailed mathematical accounts and complex chemistry have been omitted. For convenience, important technical terms are written in bold type while in-text citation and references have been kept to a minimum with both a ‘References’ and a ‘Recommended Reading’ section at the end of the book.

The book is arranged into 12 chapters. Early sections deal with a historical account of the major evolutionary figures and the evidence put forward to support their theories. The middle chapters look in detail at microevolutionary processes, while a ‘macro’ approach, the history, origins and progression of life on Earth, follow on. The final chapters on trends, debate and controversies explore recent advances in evolutionary science along with the cultural impact of biological evolution in the nineteenth, twentieth and twenty-first centuries. An analysis of this kind will inevitably explore the bigger issues of science and religion, communicating science and the misuse of scientific theory with evolution as its central theme.

Biological evolution has now become part of the scientific orthodoxy, but it is not, of course, without its detractors. It is hoped that this text will assist students within the on-going debate.

Acknowledgements

The book owes much to past students, friends, family and colleagues, in particular initial conversations with Dr Alec Panchen. My own thinking on the ideas and concepts of evolution has also developed profoundly through tutoring the next generation of biologists and biology teachers both at Warwick and Durham Universities.

I acknowledge, with gratitude, the help of staff at Cambridge University Press. Other colleagues have also assisted in reviewing chapters and allowing permission to use figures; their names (and my thanks) are found at the end of the book.

The completion of this book has been influenced of course by my family, for without them it would not have been possible. My wife and sons have been steadfast in their support; to Jacquelyn, Oscar and Athol for their assistance, perseverance and insight.

There are so many discerning books and inspiring communicators of evolutionary biology – I wouldn't know where to begin thanking them. But I do know that the scientific establishment is so much the better for their presence, and I hope that this text will assist the next generation of life scientists in promoting their own endeavours.

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