



Sebastian G. B. Amyes

# BACTERIA

A Very Short Introduction

OXFORD



Sebastian G. B. Amyes

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BACTERIA  
A Very Short Introduction  
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     MATHEMATICS Jacqueline Stedall  
 THE HISTORY OF MEDICINE  
     William Bynum  
 THE HISTORY OF TIME  
     Leofranc Holford-Strevens  
 HIV/AIDS Alan Whiteside  
 HOBBS Richard Tuck  
 HORMONES Martin Luck  
 HUMAN EVOLUTION Bernard Wood  
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 NATIONALISM Steven Grosby  
 NELSON MANDELA Elleke Boehmer  
 NEOLIBERALISM Manfred Steger and  
     Ravi Roy  
 NETWORKS Guido Caldarelli  
     and Michele Catanzaro  
 THE NEW TESTAMENT  
     Luke Timothy Johnson  
 THE NEW TESTAMENT AS  
     LITERATURE Kyle Keefer  
 NEWTON Robert Iliffe  
 NIETZSCHE Michael Tanner  
 NINETEENTH-CENTURY  
     BRITAIN Christopher Harvie and  
     H. C. G. Matthew  
 THE NORMAN CONQUEST  
     George Garnett  
 NORTH AMERICAN  
     INDIANS Theda Perdue  
     and Michael D. Green  
 NORTHERN IRELAND  
     Marc Mulholland  
 NOTHING Frank Close  
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     Joseph M. Siracusa  
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     Michael D. Coogan  
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     Martin Bunton  
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     Catherine Belsey  
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     Catherine Osborne  
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and Freda McManus  
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David M. Gwynn  
ROMANTICISM Michael Ferber  
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TERRORISM Charles Townshend  
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Matthew T. Kapstein  
TOCQUEVILLE Harvey C. Mansfield  
TRAGEDY Adrian Poole  
THE TROJAN WAR Eric H. Cline  
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THE U.S. CONGRESS Donald A. Ritchie  
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*For Hilary and Lucy*

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# Preface

It would be understandable if we thought that humans were the principal species on this planet and that we now live in the era where mammals dominate. As we consider previous ages ending with the Cretaceous extinction 65.5 million years ago, we could well be forgiven for thinking that this was the 'Age of the Dinosaurs'. The reason is that we tend to classify each era with what can easily be seen around us or from what palaeontologists have reported and placed in museums of natural history for us to marvel at. The truth is there never have been any dominant organisms other than bacteria and that this planet has been in the 'Age of Bacteria' almost from the very beginning when life emerged. Bacteria are the most numerous of all organisms and their biomass is by far the largest on our planet and has been estimated to be greater than all the rest combined. Even within our own bodies the number of bacterial cells outnumbers our own cells. They can survive almost everywhere on the planet, from the coldest to the hottest places on earth, even to the bottom of the oceans. No other organisms are as adaptable.

# List of illustrations

- 1 Timescale of bacteria emergence **3**
- 2 Structure of a T4 bacteriophage **8**
- 3 Microbiome of the human body **13**
- 4 Electron micrograph of a Gram-negative bacterium **16**  
Photo: Janice Haney Carr. CDC/  
National Escherichia, Shigella, Vibrio  
Reference Unit at CDC
- 5 Pasteur's swan-neck flask **17**
- 6 Cheese production in the 14th century, illuminated page from the *Tacuinum Sanitas* **30**  
Alinari via Getty Images
- 7 Basic flow chart of modern yogurt production **34**
- 8 Diagram of a septic tank **37**
- 9 Diagram of some of the pathogenicity factors associated with bacteria **40**  
Reproduced from *Postgraduate Medical Journal*,  
Wilson, J. W. et al.,  
**78**(918): 216–24, 2002,  
with permission from  
BMJ Publishing  
Group Ltd
- 10 Phagocytosis of bacterial cells by a macrophage **42**
- 11 General comparison of endotoxin and exotoxin action **46**
- 12 Engraving showing the masks used to prevent contracting plague in 1665 **57**  
Courtesy of the Thomas Fisher  
Rare Book Library,  
University of Toronto
- 13 Graph showing the decline of bacterial infections over the last century **60**

- 14 A chest X-ray of a person with pulmonary tuberculosis **62**  
Du Cane Medical Imaging Ltd/  
Science Photo Library
- 15 Sir Alexander Fleming in his laboratory at St Mary's Hospital, London **71**  
Popperfoto/Getty Images
- 16 Diagram showing the stages of the chemical modification of penicillin **77**
- 17 Quorum sensing **85**
- 18 Diagram showing the structure of a biofilm **87**
- 19 Mutant Prevention Concentration **91**  
Data from: Zhao and Karl Drlica (2001) *Clin. Infect Dis.*, **33**: 147
- 20 Major mechanisms of resistance used by bacteria to overcome antibiotics **96**
- 21 eBURST diagram of all the *Staphylococcus aureus* genomic sequences **112**  
Kindly provided by Prof Ed Feil, University of Bath
- 22 Diagram showing the interactions between resistance in animals and in Man **115**  
Phillips, I., Casewell, M., Cox, T., et al. (2004) Does the use of antibiotics in food animals pose a risk to human health? A critical review of published data, *Journal of Antimicrobial Chemotherapy*, **53**, 28–52. With permission from Oxford University Press
- 23 Micrograph of the synthetic bacterium *Mycoplasma mycoides* **128**  
J. Craig Venter Institute



# Contents

Preface xiii

List of illustrations xv

- 1 Origins 1
- 2 Evolution 7
- 3 Discovery 15
- 4 Environment and civilization 26
- 5 Bacterial pathogenesis 39
- 6 Antibiotics 67
- 7 Antibiotic resistance 90
- 8 The future 117

Further reading 130

Index 133

# Chapter 1

## Origins

It would be easy for us to assume that bacteria are the simplest form of life and thus presumably would have been the original life form on this planet. This may be true but it is not a simple equation. Bacteria are single-cell organisms and are what are known as prokaryotic cells. These differ considerably from the cells of both animals and plants inasmuch as there are no visible discrete compartments within the cell. They are also usually considerably smaller than the cells of animals and plants.

So how did bacteria first emerge? This looks like a classic 'chicken and egg' conundrum. Bacteria, like all cells, contain DNA and they function by the decoding of this DNA into proteins, which comprise the enzymes that control all the major processes within the organism. In this respect, they are similar to other cells and thus probably have a common origin. The link between DNA decoding and protein production is RNA. RNA does not differ greatly in structure from DNA and some believe that RNA is the origin of life. This is plausible as RNA is the messenger; it is the molecule that is transcribed from DNA and from which protein is translated. It was the discovery of ribozymes by Thomas Cech, at the University of Colorado, and Sydney Altman of Yale University that strongly suggested that RNA was the origin of life. Ribozymes are RNA molecules that have a 3D (tertiary) structure and they

can act as catalysts, similar to enzymes. Therefore RNA could act not only as the store of genetic material but also as the ‘enzyme’ that decodes it into the structures of life.

We may never be able to confirm this hypothesis but if we assume that it is plausible, then we can start to examine how bacteria emerged and where they fit in the evolutionary tree.

Approximately 4.3 billion years ago, the first cells are thought to have arisen, probably with RNA as an essential catalytic role and later as a self-replicating molecule. The basic integrity of a cell is the formation of a cell membrane, composed of lipid bilayers. As these can form spontaneously, they could have surrounded early RNA molecules. Their continued presence may have been promoted through mutation of the RNA, which would have been passed on to succeeding generations through self-replication. This basic system does have significant disadvantages because a mistake made in the replication of RNA would immediately have an effect not only on the replication of the genetic material but also on the ability to act as a catalyst—largely, it may be assumed, in a detrimental manner. The separation of the self-replicating machinery from the enzymes they encode would have resulted in far fewer abortive stages. Consequently, we must assume that DNA largely took over the role of the carrier for the self-replicating genes and proteins of the enzymes that they eventually encoded. RNA merely remained as the messenger that carried the instructions from DNA to the formation of the proteins.

The early bacteria emerged approximately 1.5 billion years after the creation of the planet. For the next three billion years, bacteria were probably the planet’s sole living inhabitants. The fossil record shows that there were huge numbers of bacteria often collecting in large colonies, attached to many surfaces; their imprint can still be seen. Approximately one billion years ago, however, the numbers of these colonies in the fossil record began to fall and this could be evidence that bacteria had become the source of food for some other life form. Certainly, this was before the Cambrian explosion