

## PHILOSOPHY OF MICROBIOLOGY

Microbes and microbiology are seldom encountered in philosophical accounts of the life sciences. Although microbiology is a well-established science and microbes the basis of life on this planet, neither the organisms nor the science have been seen as philosophically significant. This book will change that. It fills a major gap in the philosophy of biology by examining central philosophical issues in microbiology. Topics are drawn from evolutionary microbiology, microbial ecology and microbial classification. These discussions are aimed at philosophers and scientists who wish to gain insight into the basic philosophical issues of microbiology.

MAUREEN A. O'MALLEY is a Senior Researcher in the Department of Philosophy at the University of Sydney.

# PHILOSOPHY OF MICROBIOLOGY

MAUREEN A. O'MALLEY

*University of Sydney*



CAMBRIDGE  
UNIVERSITY PRESS

Cambridge University Press  
 978-1-107-02425-0 — Philosophy of Microbiology  
 Maureen O'Malley  
 Excerpt  
[More Information](#)

## CAMBRIDGE UNIVERSITY PRESS

University Printing House, Cambridge CB2 8BS, United Kingdom  
 One Liberty Plaza, 20th Floor, New York, NY 10006, USA  
 477 Williamstown Road, Port Melbourne, VIC 3207, Australia  
 314-321, 3rd Floor, Plot 3, Splendor Forum, Jasola District Centre, New Delhi - 110025, India  
 79 Anson Road, #06-04/06, Singapore 079906

Cambridge University Press is part of the University of Cambridge.  
 It furthers the University's mission by disseminating knowledge in the pursuit of  
 education, learning and research at the highest international levels of excellence.

[www.cambridge.org](http://www.cambridge.org)  
 Information on this title: [www.cambridge.org/9781107024250](http://www.cambridge.org/9781107024250)

© Maureen A. O'Malley 2014

This publication is in copyright. Subject to statutory exception  
 and to the provisions of relevant collective licensing agreements,  
 no reproduction of any part may take place without the written  
 permission of Cambridge University Press.

First published 2014

*A catalogue record for this publication is available from the British Library*

*Library of Congress Cataloging in Publication data*

O'Malley, Maureen, A., 1959–

Philosophy of microbiology / Maureen A. O'Malley, University of Sydney.  
 pages cm

ISBN 978-1-107-02425-0 (hardback) – ISBN 978-1-107-62150-3 (paperback)

1. Microbiology–Philosophy. I. Title.

QR41.2.O43 2014

579.01–dc23

2014014063

ISBN 978-1-107-02425-0 Hardback

ISBN 978-1-107-62150-3 Paperback

Cambridge University Press has no responsibility for the persistence or  
 accuracy of URLs for external or third-party internet websites referred to in  
 this publication, and does not guarantee that any content on such websites is,  
 or will remain, accurate or appropriate.

Cambridge University Press  
978-1-107-02425-0 — Philosophy of Microbiology  
Maureen O'Malley  
Excerpt  
[More Information](#)

---

‘Microbiology is a beautiful science. Someone should do some  
philosophical work on it’. (W. Ford Doolittle, 2003)

Contents

<i>List of figures and tables</i>	<i>page viii</i>
<i>Acknowledgements</i>	<i>x</i>
An introduction to philosophy of microbiology	i
1 Philosophy in microbiology; microbes in philosophy	16
2 Philosophical debates in high-level microbial classification	45
3 Philosophical debates in species-level microbial classification	65
4 Philosophical issues in microbial evolution	95
5 Microbial ecology from a philosophical perspective	132
6 Microbes as model biological systems	173
Conclusion: further philosophical questions	201
<i>Glossary</i>	<i>219</i>
<i>References</i>	<i>222</i>
<i>Index</i>	<i>261</i>

# *Figures and Tables*

The majority of illustrations are new graphics, drawn by Michel Durinx ([www.centimedia.org](http://www.centimedia.org)). Permission was granted to use several copyrighted images (see Reference List for full citations).

Figure 1.1:	A prokaryote cell.	<i>page</i> 2
Figure 1.2:	A eukaryote cell.	3
Figure 1.3:	The evolutionary importance of microbes.	9
Figure 1.1:	Evolutionary transitions defined metabolically. From Falkowski (2006), used with permission from AAAS/ <i>Science</i> .	22
Figure 1.2:	Magnetotactic bacteria in northern and southern hemispheres.	27
Figure 1.3:	A metabolic function for the magnetosome?	30
Figure 1.4:	Early microscopists. Hooke image by Rita Greer.	36
Figure 2.1:	Whittaker's five kingdoms, modified by Lynn Margulis (1971). Used with permission from John Wiley and Sons.	49
Figure 2.2:	Three domains: Archaea, Bacteria, Eukarya. Based on Pace (2006).	52
Figure 2.3:	Five kingdoms with Monera now split into Bacteria and Archaea.	53
Figure 2.4:	The eocyte tree. Based on Cox et al. (2008).	56
Figure 2.5:	Eukaryote supergroups (Adl et al. 2012). Used with permission from John Wiley and Sons.	62
Figure 3.1:	Some major historical figures in bacterial classification. David Bergey's image used with permission from the Bergey's Manual Trust.	67
Figure 3.2:	The three main mechanisms of LGT. Based on Furuya and Lowy (2006).	73

*List of figures and tables* ix

Figure 3.3:	LGT versus gene duplication and differential loss. Based on Gogarten and Townsend (2005).	81
Figure 3.4:	Phylogenetic versus ecological representations of the three domains. Based on a sketch by Moselio Schaechter (2012a).	92
Figure 4.1:	<i>Paenibacillus vortex</i> and social IQ distribution. Used with permission from Eshel Ben-Jacob, Tel Aviv University.	109
Figure 4.2:	Organisms and other social entities. Based on Queller and Strassmann (2009).	114
Figure 5.1:	Some major historical figures in microbial ecology. Baas Becking image courtesy of <i>Biografisch Woordenboek van Nederland</i> ; van Niel used with permission from Edward Weston/Viscopy; ZoBell used with permission from Scripps Institute of Oceanography Archives, University of California San Diego library; Jannasch used with permission of Woods Hole Oceanographic Institute.	134
Figure 5.2:	Species-area relationships and the $z$ -slope. Based on Horner-Devine et al. (2004).	163
Figure 6.1:	Major figures in early molecular bacterial genetics. Lederberg used with permission from University of Wisconsin (Madison) Archives; Tatum courtesy of <a href="http://www.nobelprize.org">www.nobelprize.org</a> ; Luria courtesy of <a href="http://profiles.nlm.nih.gov">profiles.nlm.nih.gov</a> ; Hayes used with permission from Australian National University Archives; Zinder used with permission from Cold Spring Harbor Laboratory Archives.	178
Figure 6.2:	Schematic view of a chemostat.	185
Figure 6.3:	Feedback loops between the gut microbiota and human brain. Based on Cryan and Dinan (2012).	199
Figure C.1:	An impressionistic tree of life, putting humans in phylogenetic context.	202
Figure C.2:	The balance of conservation.	204
Figure G.1:	Monophyletic, paraphyletic and polyphyletic groups.	220
Table I.1:	Terminology for microbes	2

## *Acknowledgements*

For reading and commenting on various chapters, my grateful thanks to: Ford Doolittle and Elio Schaechter (who read several chapters each), plus Sam Baron, Pierrick Bourrat, David Braddon-Mitchell, Adrian Currie, Michael Duncan, John Dupré, Matthias Grote, Adam Hochman, Andrew Holmes, Gladys Kostyrka, Maria Kronfeldner, Arnon Levy, Alan Love, Staffan Müller-Wille, Tom Richards, Susan Spath and Mike Travisano. Anonymous reviewers, at both the preliminary and later stages of writing, were tremendously helpful in shaping this book. Numerous discussions over the last decade, especially at Dalhousie University, Halifax (Nova Scotia), provided valuable material and philosophical insight into microbiology. Feedback from audiences and co-participants at several ISHPSSB and SANU Philosophy of Biology meetings was crucial to the development of the book. Comments from Departmental colleagues during a seminar I gave at the University of Sydney had a formative influence on the concluding chapter. I also wish to acknowledge the many hundreds of references that I have been unable to cite here for space reasons but which have informed my writing. For illustrations and help with finding copyright-free images, thanks to Michel Durinx ([www.centimedia.org](http://www.centimedia.org)). The Australian Research Council and University of Sydney funded most of the research and writing time it took to produce this book.