

**Online Supplemental Material for**  
*Soil Microbiology, Ecology, and*  
*Biochemistry*

---



# Online Supplemental Material for *Soil Microbiology, Ecology, and Biochemistry*

---

Fourth edition

Edited by

**Eldor A. Paul**

Natural Resource Ecology Laboratory and  
Department of Soil and Crop Sciences  
Colorado State University  
Fort Collins, CO 80523  
USA



ELSEVIER

AMSTERDAM • BOSTON • HEIDELBERG • LONDON  
NEW YORK • OXFORD • PARIS • SAN DIEGO  
SAN FRANCISCO • SINGAPORE • SYDNEY • TOKYO

Academic Press is an imprint of Elsevier





# Contents

<b>1. Soil Microbiology, Ecology, and Biochemistry: An Exciting Present and Great Future Built on Basic Knowledge and Unifying Concepts</b>	<b>e1</b>
<i>Eldor A. Paul</i>	
<b>2. The Soil Habitat</b>	<b>e5</b>
<i>R.P. Voroney and R.J. Heck</i>	
<b>4. The Soil Fungi: Occurrence, Phylogeny, and Ecology</b>	<b>e7</b>
<i>D. Lee Taylor and Robert L. Sinsabaugh</i>	
I. A Primer on Fungal Systematics	e7
II. Fungal Life Cycles	e10
III. Glossary of Terms	e11
<b>9. The Metabolic Physiology of Soil Microorganisms</b>	<b>e17</b>
<i>Alain F. Plante, Maddie M. Stone and William B. McGill</i>	
I. The Basics of Redox Reactions and Bioenergetics	e17
II. Online Videos	e17
III. Glossary	e18
<b>10. The Ecology of the Soil Biota and their Function</b>	<b>e21</b>
<i>Sherri J. Morris and Christopher B. Blackwood</i>	
Glossary of Terms	e21
<b>12. Carbon Cycling: The Dynamics and Formation of Organic Matter</b>	<b>e27</b>
<i>William Horwath</i>	
I. Atmospheric CO <sub>2</sub> since the Devonian Era	e27
II. Origins of Fossil Fuels	e28
III. Greenhouse Properties of Carbon Dioxide and Methane	e29
IV. Units of the Global C Cycle	e29
V. Photosynthesis	e30
VI. Plant Sugars	e30
VII. Supplemental References	e31

- 13. Methods for Studying Soil Organic Matter: Nature, Dynamics, Spatial Accessibility, and Interactions with Minerals** e33  
*Claire Chenu, Cornelia Rumpel and Johannes Lehmann*
- 15. Biological N Inputs** e39  
*Peter J. Bottomley and David D. Myrold*
- 17. Modeling the Dynamics of Soil Organic Matter and Nutrient Cycling** e45  
*William J. Parton, Stephen J. Del Grosso, Alain F. Plante, E. Carol Adair and Susan M. Lutz*
- 18. Management of Soil Biota and Their Processes** e49  
*Jeffrey L. Smith, Harold P. Collins, Alex R. Crump and Vanessa L. Bailey*

# Contributors

- Vanessa L. Bailey**, Pacific Northwest Laboratory, Richland, WA, USA
- Christopher B. Blackwood**, Department of Biological Sciences, Kent State University, Kent, OH, USA
- Peter J. Bottomley**, Department of Crop and Soil Science, Oregon State University, Corvallis, OR, USA
- E. Carol Adair**, Rubenstein School of Environment and Natural Resources, University of Vermont, Burlington, Vermont, USA
- Claire Chenu**, Agro Paris Tech, UMR Bioemco, Thiverval Grignon, France
- Harold P. Collins**, USDA-Agriculture Research Service, Temple, TX, USA
- Alex R. Crump**, Department of Crop and Soil Sciences, Washington State University, Pullman, WA, USA
- Stephen J. Del Grosso**, Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO, USA; USDA Agricultural Research Service and Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO, USA
- R.J. Heck**, School of Environmental Sciences, University of Guelph, Ontario, Canada
- William Horwath**, Department of Land, Air, and Water Resources, University of CA, Davis, CA, USA
- D. Lee Taylor**, Department of Biology, University of New Mexico, Albuquerque, NM, USA
- Johannes Lehmann**, Department of Crop and Soil Sciences, Cornell University, Ithaca, NY, USA
- Susan M. Lutz**, Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO, USA
- William B. McGill**, Department of Earth and Environmental Science, University of Pennsylvania, Philadelphia, PA, USA
- Sherri J. Morris**, Biology Department, Bradley University, Peoria, IL, USA
- David D. Myrold**, Department of Crop and Soil Science, Oregon State University, Corvallis, OR, USA
- William J. Parton**, Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO, USA

**Eldor A. Paul**, Natural Resource Ecology Laboratory and Department of Soil and Crop Sciences, Colorado State University, Fort Collins, CO, USA

**Alain F. Plante**, Department of Earth and Environmental Science, University of Pennsylvania, Philadelphia, PA, USA

**Cornelia Rumpel**, CNRS, UMR Bioemco, Thiverval Grignon, France

**Robert L. Sinsabaugh**, Department of Biology, University of New Mexico, Albuquerque, NM, USA

**Jeffrey L. Smith**, USDA-Agriculture Research Service, Pullman, WA, USA (deceased)

**Maddie M. Stone**, Department of Earth and Environmental Science, University of Pennsylvania, Philadelphia, PA, USA

**R.P. Voroney**, School of Environmental Sciences, University of Guelph, Ontario, Canada