

EDITOR IN CHIEF (2016)

Harold L. Drake
University of Bayreuth

EDITORS

Johanna Björkroth, *Editor* (2018)
University of Helsinki

Axel A. Brakhage, *Editor* (2016)
HKI and University of Jena

Daniel Cullen, *Editor* (2017)
USDA Forest Products Laboratory

Christopher A. Elkins, *Editor* (2018)
U.S. FDA Center for Food Safety and Applied Nutrition

Marie A. Elliot, *Editor* (2019)
McMaster University

Heidi Goodrich-Blair, *Editor* (2017)
University of Wisconsin—Madison

Mansel W. Griffiths, *Editor* (2015)
University of Guelph

Robert M. Kelly, *Editor* (2017)
North Carolina State University

Maia Kivisaar, *Editor* (2017)
Tartu University

Joel E. Kostka, *Editor* (2016)
Georgia Institute of Technology

Shuang-Jiang Liu, *Editor* (2016)
Chinese Academy of Sciences

Frank E. Löffler, *Editor* (2018)
University of Tennessee

Charles R. Lovell, *Editor* (2015)
University of South Carolina

George T. Macfarlane, *Editor* (2016)
University of Dundee

Volker Müller, *Editor* (2019)
Goethe University Frankfurt am Main

Hideaki Nojiri, *Editor* (2017)
The University of Tokyo

Rebecca E. Parales, *Editor* (2016)
University of California—Davis

M. Julia Pettinari, *Editor* (2016)
University of Buenos Aires

Donald W. Schaffner, *Editor* (2015)
Rutgers, The State University of New Jersey

Patrick D. Schloss, *Editor and Cover Editor* (2019)
University of Michigan

Janet L. Schottel, *Editor* (2018)
University of Minnesota

Alfred M. Spormann, *Editor* (2016)
Stanford University

Gerrit Voordouw, *Editor* (2017)
University of Calgary

K. Eric Wommack, *Editor* (2017)
University of Delaware

Thomas E. Shenk, *Chairman, Journals Board*

Barbara M. Goldman, *Director, Journals*

Barbara S. Slinker, *Production Editor*

Stephanie L. D'Agostino, *Assistant Production Editor*

Michael E. Lerman, *Assistant Production Editor*

EDITORIAL BOARD

Adly Abd-Alla (2015)
Lorenz Adrian (2017)
Warish Ahmed (2016)
Birgit E. Alber (2016)
Gladys Alexandre (2015)
Kevin J. Allen (2015)
Michael S. Allen (2017)
Eric Altermann (2015)
Gary L. Andersen (2016)
Matthew J. Arduino (2016)
Arthur I. Aronson (2015)
Fred O. Asiegbu (2016)
Haruyuki Atomi (2016)
Shota Atsumi (2015)
Brian Austin (2016)
Beate Averhoff (2016)
Abdu F. Azad (2016)
M. Andrea Azcarate-Peril (2015)
Reha O. Azizoglu (2015)
Charles W. Bacon (2015)
Petr Baldrian (2016)
Jeffrey Banas (2015)
Ravi D. Barabote (2015)
Jeri D. Barak (2016)
Rodolphe Barrangou (2017)
Florian F. Bauer (2015)
Jorge A. Benitez (2016)
Teresa M. Bergholz (2015)
Stefan Bertilsson (2015)
Thomas Besser (2016)
Arvind A. Bhagwat (2015)
Valeria Bianciotto (2015)
Kelly A. Bidle (2016)
Linda F. Bisson (2016)
Christopher Blackwood (2016)
Melanie Blokesch (2016)
Paul L. Bodelier (2015)
Eckhard Boles (2015)
Matthias Boll (2015)
Daniel R. Bond (2015)
Albert Bosch (2015)
Peter Bottomley (2015)
Kostas Bourtzis (2015)
Frederick Breidt (2017)
Peter A. Bron (2017)
Harald Bruessow (2016)
Harry Brumer (2017)
Alison Buchan (2017)
Robert L. Buchanan (2015)
Wolfgang Buckel (2016)
Daniel H. Buckley (2017)
William Burkhardt (2015)
Helen Y. Buse (2016)
Stefan G. Buzoianu (2017)
Douglas R. Call (2016)
Amy Callaghan (2015)
Terri A. Camesano (2015)
Barbara J. Campbell (2016)
Isaac K. O. Cann (2015)
Jennifer L. Cannon (2017)
Yiping Cao (2017)
Michelle Q. Carter (2015)
Rick Cavicchioli (2016)
Shane M. Ceraul (2015)
Woo-Suk Chang (2015)
Jinru Chen (2017)
Shicheng Chen (2017)
Wilfred Chen (2015)
Yi Chen (2017)
Yuhuan Chen (2015)
Michael L. Chikindas (2016)
Ludmila Chistoserdova (2015)
Kuang-Ren Chung (2017)
Clifford G. Clark (2017)
John D. Coates (2016)
Luca Coccolin (2016)
Doug Cossar (2015)
Paul D. Cotter (2016)
Don A. Cowan (2015)
Alison M. Cupples (2016)
Holger Daims (2015)
Rolf Daniel (2015)
Steven L. Daniel (2017)
Michelle Danyluk (2016)
Jennifer M. DeBruyn (2017)
Svetlana Dedysh (2015)
Zixin Deng (2016)

Angelo DePaola, Jr. (2015)
Mickaël Desvieux (2015)
Thomas J. DiChristina (2015)
Francisco Diez-Gonzalez (2016)
Lubbert Dijkhuizen (2016)
Jayna L. Ditty (2016)
Jan Dolfing (2015)
James S. G. Dooley (2015)
Angela E. Douglas (2016)
Charles M. Dozois (2016)
Irina S. Druzhinina (2015)
Doris d'Souza (2017)
Edward Dudley (2015)
Alain C. Dufour (2016)
Jonathan Dworkin (2017)
Daniel C. Eastwood (2017)
Elizabeth A. Edwards (2016)
Henry L. Ehrlich (2015)
Patrick Y. Eichenberger (2015)
Mostafa Elshahed (2015)
David Emerson (2015)
Slava Epstein (2016)
Tobias J. Erb (2017)
Daniilo Ercolini (2015)
Joseph O. Falkinham (2017)
Seamus Fanning (2015)
Babu Z. Fathepure (2016)
J. Christopher Fenno (2016)
Martin Filion (2015)
Steven E. Finkel (2016)
Steven L. Foley (2017)
Philipp Franken (2015)
W. Florian Fricke (2017)
Michael W. Friedrich (2015)
Cormac Gahan (2015)
Victor P. J. Gannon (2016)
Michael G. Gänzle (2016)
Beilei Ge (2016)
Elke Genersch (2015)
Johannes Gescher (2015)
Lutz Geue (2016)
Jennifer B. Glass (2017)
Emanuel Goldman (2016)
Mark Gomelsky (2017)
Ramon Gonzalez (2016)
Lawrence Goodridge (2015)
Lisa A. Gorski (2015)
David E. Graham (2017)
Jeffrey Gralnick (2015)
Stefan J. Green (2017)
Leslie A. Gregg-Jolly (2017)
Richard L. Gregory (2015)
Yitzhak Hadar (2016)
Jan O. Haerter (2015)
Thomas E. Hansson (2015)
Eiji Haramoto (2015)
Hauke Harms (2016)
Steven D. Harris (2017)
Mark E. Hart (2017)
Valerie J. Harwood (2015)
Anne I. Hatakka (2016)
Paul B. Hatzinger (2015)
Qiang He (2016)
Zhili He (2016)
Brian P. Hedlund (2017)
Henry S. Heine (2015)
Niels B. Hendriksen (2015)
Laura Hendrix (2015)
Ute Hentschel (2015)
Salvador Herrero (2015)
Paul S. Hoffman (2015)
Dirk Hoffmeister (2015)
Andrew J. Holmes (2016)
Allen L. Honeyman (2015)
Dallas G. Hoover (2015)
David J. Hopper (2016)
Marcus A. Horn (2017)
John A. Hudson (2017)
Jeroen Hugenholtz (2015)
Hor-Gil Hur (2015)
Michael R. Hyman (2016)
Michael F. Hynes (2016)
Kiyohiko Igarashi (2016)
Michele M. Igo (2015)
Masaharu Ishii (2017)
Masahiro Ito (2017)
Ralph W. Jack (2015)
Paul J. Jackson (2015)
Mohamed A. Jamal (2015)
Edward L. Jarroll (2015)
Dieter Jendrosseck (2015)
Ian Jensen (2017)
Zhongjun Jia (2017)
Nianzhi Jiao (2017)
Zackary I. Johnson (2015)
Yves Jouanneau (2015)
Juan L. Jurat-Fuentes (2015)
Boran Kartal (2017)
Matthias Kästner (2016)
James E. Keen (2016)
John J. Kelly (2015)
William Kenealy (2015)
Eungbin Kim (2015)
James E. Kirby (2016)
Arnulf Kletzing (2016)
Leon D. Kluskens (2016)
Kalmia E. Kniel (2017)
Steffen Kolb (2017)
Konstantinos T. Konstantinidis (2015)
Shige Koseki (2015)
Michael Y. Kosoy (2017)
Balabubrahmanyam Kottapalli (2017)
George Kowalchuk (2015)
Sven Krappmann (2015)
Lee R. Krumholz (2015)
Indira T. Kudva (2016)
Ursula Kües (2016)
Timothy M. LaPara (2015)
Gisèle LaPointe (2017)
Robert A. LaRossa (2015)
Luis F. Larrondo (2017)
Peter C. K. Lau (2015)
Jared R. Leadbetter (2015)
Jeffrey T. LeJeune (2015)
Paulo C. Lemos (2015)
Steven Lindow (2016)
John T. Lisle (2015)
Wenjun Liu (2016)
Xueduan Liu (2016)
Karen Lloyd (2015)
Martin J. Loessner (2015)
John C. Lodesborough (2015)
Alexander Loy (2017)
Yahai Lu (2016)
Tillmann Lueders (2015)
Yanhe Ma (2016)
Sandra Macfarlane (2017)
Robert L. Mach (2015)
Eugene L. Madsen (2015)
Jacques Mahillon (2017)
Mark J. Mandel (2017)
Maria L. Marco (2015)
Helene Marquis (2015)
Matthew J. Marshall (2016)
Stephen Martin (2015)
Alfredo Martinez (2016)
Eiji Masai (2017)
Emma Master (2015)
Timothy E. Mattes (2017)
Ann G. Matthyse (2015)
Andrew J. McBain (2015)
Timothy R. McDermott (2015)
Michael J. McInerney (2016)
James McKinlay (2015)
Robert J. McLean (2015)
Brian B. McSpadden-Gardener (2016)
Rainer U. Meckenstock (2015)
Richard J. Meinersmann (2015)
Aubrey F. Mendonca (2015)
John S. Meschke (2017)
Chris H. Miller (2015)
Patricia D. Millner (2015)
Debra L. Milton (2016)
Kiwamu Minamisawa (2015)
Kentaro Miyazaki (2017)
Corrie S. Moreau (2017)
Rodney A. Moxley (2016)
Jochen A. Mueller (2015)
Yuji Nagata (2015)
Cindy H. Nakatsu (2016)
Brett A. Neilan (2017)
Nancy Nichols (2015)

EDITORIAL BOARD (continued)

- | | | | |
|-----------------------------------|-----------------------------|-------------------------------|--------------------------------|
| Brendan A. Niemira (2015) | Michael J. Sadowsky (2016) | Lisa Y. Stein (2016) | Keith Warriner (2017) |
| Pablo I. Nikel (2016) | Daad A. Saffarini (2017) | Alexander Steinbüchel (2017) | J. Scott Weese (2015) |
| Nobuhiko Nomura (2017) | Maria Sandkvist (2015) | Ivo Steinmetz (2016) | Helge Weingart (2015) |
| R. Sean Norman (2015) | Robert A. Sanford (2015) | Roger Stephan (2017) | Alan Welman (2015) |
| Julie B. Olson (2015) | Anderson S. Sant'Ana (2015) | Ann M. Stevens (2016) | Tingyi Wen (2015) |
| Huub Op den Camp (2015) | Sima Sariaslani (2015) | Brian Stevenson (2016) | Volker F. Wendisch (2015) |
| Ronald S. Oremland (2015) | Brian D. Sauders (2016) | George C. Stewart (2015) | Giovanni Widmer (2016) |
| Ivan J. Oresnik (2017) | Gary Sawers (2017) | John F. Stolz (2016) | Steven W. Wilhelm (2015) |
| Konstantinos Papadimitriou (2016) | Frank A. Scannapieco (2017) | Wolfgang R. Streit (2015) | Kurt E. Williamson (2017) |
| Hee-Deung Park (2017) | Birgit E. Scharf (2017) | Joseph M. Sturino (2016) | David B. Wilson (2016) |
| Ilenys M. Perez-Diaz (2015) | Bernhard Schink (2015) | Garret Suen (2016) | Charles F. Wimpee (2017) |
| Gregg S. Pettis (2017) | John W. Schmidt (2016) | Matt D. Sweeney (2016) | Regina-Michaela Wittich (2017) |
| Jennifer Pett-Ridge (2015) | Monika Schmoll (2017) | Ben D. Tall (2017) | Gideon M. Wolfaardt (2016) |
| Laurent Philippot (2017) | Hildgund Schrempf (2017) | Ralph S. Tanner (2017) | Randy W. Worobo (2016) |
| Allen T. Phillips (2015) | Dirk Schüler (2015) | Gerald W. Tannock (2017) | Qinglong Wu (2015) |
| Carmen Pin (2015) | Wolfgang H. Schwarz (2016) | Sam R. Telford (2015) | Xiao-Lei Wu (2016) |
| Antonio G. Pisabarro (2017) | Lynne Sehulster (2016) | Andreas P. Teske (2015) | Chuanwu Xi (2017) |
| Mircea Podar (2017) | Bernhard Seiboth (2017) | Michael G. Thomas (2015) | Hua Xiang (2015) |
| David L. Popham (2015) | Verena Seidl (2015) | Kai M. Thormann (2015) | Lihua Xiao (2015) |
| Rolf Prade (2015) | Jeremy D. Semrau (2017) | Thomas Thurnheer (2015) | Luying Xun (2015) |
| M. Auxiliadora Prieto (2015) | Peter Setlow (2015) | Nicolas Toro Garcia (2017) | S. Steve Yan (2016) |
| Qingsheng Qi (2017) | Joshua D. Shrout (2015) | Effie Tsakalidou (2016) | X. Frank Yang (2015) |
| Cheryl L. Quinn (2015) | Mark W. Silby (2015) | Masataka Tsuda (2015) | Yunfang Yang (2015) |
| Ralf Rabus (2017) | Mitchell H. Singer (2017) | Hidetoshi Urakawa (2017) | Süleyman Yildirim (2017) |
| Mark Radosevich (2017) | Steven W. Singer (2015) | Wouter R. van der Star (2017) | Daniel R. Zeigler (2015) |
| Andreja Rajkovic (2015) | Brajesh K. Singh (2016) | Tina K. Van Dyk (2015) | Jill H. Zeilstra-Ryalls (2017) |
| Gemma Reguera (2015) | David R. Singleton (2015) | Jan D. van Elsas (2015) | Karsten Zengler (2017) |
| Bernd H. Rehm (2015) | Matthias Sipiczki (2016) | Michael L. Vasil (2016) | Chuanlung Zhang (2015) |
| Gregor Reid (2015) | Panos N. Skandamis (2016) | Marco Ventura (2015) | Qijing Zhang (2017) |
| Christian Riedel (2015) | Evan Skowronski (2015) | Claire Vieille (2015) | Wei Zhang (2015) |
| Kirsti M. Ritalahti (2015) | J. Leif Smith (2016) | Dmitriy V. Volokhov (2015) | Yu-Zhong Zhang (2017) |
| Daniel D. Rockey (2016) | Helena Solo-Gabriele (2015) | Julia A. Vorholt (2015) | Ning-Yi Zhou (2015) |
| Jorge L. M. Rodrigues (2016) | Greg A. Somerville (2017) | Stéphane Vuilleumier (2015) | Erik R. Zinser (2016) |
| David Rodríguez-Lázaro (2015) | Andrew J. Spiers (2016) | S. Aljoscha Wahl (2015) | Erwin G. Zoetendal (2015) |
| Wilfred F. M. Röling (2016) | Stephen Spiro (2016) | Judy D. Wall (2015) | Angeles Zorreguieta (2016) |
| Margaret F. Romine (2017) | Eric V. Stabb (2016) | R. John Wallace (2016) | Sergey B. Zotchev (2015) |
| Thomas Ross (2016) | Alfons J. M. Stams (2016) | Todd J. Ward (2016) | Peter A. Zuber (2017) |

Applied and Environmental Microbiology (ISSN 0099-2240), a publication of the American Society for Microbiology (ASM), 1752 N St., N.W., Washington, DC 20036-2904, is devoted to the advancement and dissemination of applied knowledge as well as ecological knowledge, both applied and fundamental, concerning microorganisms. Instructions to Authors can be found at <http://journalitas.asm.org/t/49536> and are updated throughout the year. *Applied and Environmental Microbiology* is published twice monthly, one volume per year. Nonmember print subscription prices (per year) are: \$1,984, U.S.; \$2,103, Canada (plus GST/HST where applicable); \$2,136, Europe; \$2,189, Latin America; \$2,195, rest of world. Member print subscription prices (per year) are: \$370, U.S.; \$464, Canada (plus GST/HST where applicable); \$479, Europe; \$517, Latin America; \$522, rest of world. Single copies are: \$100, nonmember; \$50, member (Canadians add GST/HST where applicable). For prices of electronic versions or for correspondence relating to subscriptions, defective copies, missing issues, and availability of back issues, contact the Subscriptions Unit, ASM (asmjournals@subscriptionoffice.com). Correspondence relating to reprint orders should be directed to ASM Author Services (ASM.AuthorServicesSupport@cenveo.com), and correspondence relating to disposition of submitted manuscripts, proofs, and general editorial matters should be directed to the Journals Department, American Society for Microbiology, 1752 N St., N.W., Washington, DC 20036-2904. Phone: (202) 737-3600 (see <http://journals.asm.org/site/misc/staffcontacts.xhtml>).

Claims for missing issues from residents of the United States, Canada, and Mexico must be submitted within 3 months after publication of the issues; residents of all other countries must submit claims within 6 months of publication of the issues. Claims for issues missing because of failure to report an address change or for issues "missing from files" will not be allowed.

Periodicals postage paid at Washington, DC 20036, and at additional mailing offices.

POSTMASTER: Send address changes to *Applied and Environmental Microbiology*, ASM, 1752 N St., N.W., Washington, DC 20036-2904.

Made in the United States of America. Printed on acid-free paper. CODEN: AEMIDF

doi:10.1128/AEM.masthead.81-6

Copyright © 2015, American Society for Microbiology. All Rights Reserved.

The code at the bottom of the first page of an article in this journal indicates the copyright owner's consent that copies of the article may be made for personal use or for personal use of specific clients. This consent is given on the condition, however, that the copier pay the stated per-copy fee through the Copyright Clearance Center, Inc., 222 Rosewood Drive, Danvers, MA 01923, for copying beyond that permitted by Sections 107 and 108 of the U.S. Copyright Law. This consent does not extend to other kinds of copying, such as copying for general distribution, for advertising or promotional purposes, for creating new collective works, or for resale.