



EDITOR IN CHIEF (2016)

**Harold L. Drake**  
*University of Bayreuth*

EDITORS

**Thomas E. Besser**, *Editor* (2020)  
*Washington State University*

**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*

**Charles M. Dozois**, *Editor* (2020)  
*INRS—Institut Armand-Frappier*

**Edward G. Dudley**, *Editor* (2020)  
*Pennsylvania State University*

**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*

**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*

**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* (2020)  
*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*

**Alfons J. M. Stams**, *Editor* (2020)  
*Wageningen University*

**Claire Vieille**, *Editor* (2020)  
*Michigan State University*

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

**Thomas E. Shenk**, *Chairman, Journals Board*

**Stefano Bertuzzi**, *Chief Executive Officer*

**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 M. M. Abd-Alla** (2018)  
**Lorenz Adrian** (2017)  
**Warish Ahmed** (2016)  
**Birgit E. Alber** (2016)  
**Gladys Alexandre** (2018)  
**Michael S. Allen** (2017)  
**Eric Altermann** (2018)  
**Gary L. Andersen** (2016)  
**Matthew J. Arduino** (2016)  
**Arthur I. Aronson** (2018)  
**Fred O. Asiegbu** (2016)  
**Haruyuki Atomi** (2016)  
**Shota Atsumi** (2018)  
**Beate Averhoff** (2016)  
**Abdu F. Azad** (2016)  
**Reha O. Azizoglu** (2018)  
**Charles W. Bacon** (2018)  
**Craig Baker-Austin** (2018)  
**Petr Baldrian** (2016)  
**David A. Baltrus** (2018)  
**Jeffrey A. Banas** (2018)  
**Ravi D. Barabote** (2018)  
**Jeri D. Barak** (2016)  
**Rodolphe Barrangou** (2017)  
**Josefina Barrera-Cortes** (2018)  
**Mirko Basen** (2018)  
**Dennis A. Bazylinski** (2018)  
**Jorge A. Benitez** (2016)  
**Teresa M. Bergholz** (2018)  
**Stefan Bertilsson** (2018)  
**Jennifer F. Biddle** (2018)  
**Kelly A. Bidle** (2016)  
**Linda F. Bisson** (2016)  
**Christopher Blackwood** (2016)  
**Sara E. Blumer-Schuette** (2018)  
**Paul L. E. Bodelier** (2018)  
**Matthias Boll** (2018)  
**Daniel R. Bond** (2018)  
**Kostas Bourtzis** (2018)  
**E. Fidelma Boyd** (2018)  
**Eric S. Boyd** (2018)  
**Alejandra Bravo** (2018)  
**Frederick Breidt** (2017)  
**Nichole A. Broderick** (2018)  
**Peter A. Bron** (2017)  
**Harald Bruessow** (2016)  
**Harry Brumer** (2017)  
**Andreas Brune** (2018)  
**Alison Buchan** (2017)  
**Wolfgang Buckel** (2016)  
**Daniel H. Buckley** (2017)  
**William Burkhardt** (2018)  
**Helen Y. Buse** (2016)  
**Stefan G. Buzoianu** (2017)  
**Douglas R. Call** (2016)  
**Amy V. Callaghan** (2018)  
**Barbara J. Campbell** (2016)  
**Isaac K. O. Cann** (2018)  
**Yiping Cao** (2017)  
**Michelle Q. Carter** (2018)  
**Rick Cavicchioli** (2016)  
**Stéphane Chaillou** (2018)  
**Woo-Suk Chang** (2018)  
**John M. Chaston** (2018)  
**Jinru Chen** (2017)  
**Shicheng Chen** (2017)  
**Wilfred Chen** (2018)  
**Yi Chen** (2017)  
**Yuhuan Chen** (2018)  
**Michael L. Chikindas** (2016)  
**Ludmila Chistosterdova** (2018)  
**Konstantin Chumakov** (2018)  
**Kuang-Ren Chung** (2017)  
**Clifford G. Clark** (2017)  
**John D. Coates** (2016)  
**Luca Cocolin** (2016)  
**J. Douglas Cossar** (2018)  
**Paul D. Cotter** (2016)  
**Donald A. Cowan** (2018)  
**Alison M. Cupples** (2016)  
**Hongyue Dang** (2018)  
**Rolf Daniel** (2018)  
**Steven L. Daniel** (2017)  
**Michelle Danyluk** (2016)  
**Alexandre J. da Silva** (2018)  
**Jennifer M. DeBruyn** (2017)  
**Svetlana N. Dedysh** (2018)

**Zixin Deng** (2016)  
**Tom Desmet** (2018)  
**Mickaël Desvaux** (2018)  
**Francisco Diez-Gonzalez** (2016)  
**Lubbert Dijkhuizen** (2016)  
**Jayna L. Ditty** (2016)  
**Jan Dolfig** (2018)  
**James S. G. Dooley** (2018)  
**Angela E. Douglas** (2016)  
**Irina S. Druzhinina** (2018)  
**Doris d'Souza** (2017)  
**Alain C. Dufour** (2016)  
**Anne K. Dunn** (2018)  
**Jonathan Dworkin** (2017)  
**Daniel C. Eastwood** (2017)  
**Leo Eberl** (2018)  
**Elizabeth A. Edwards** (2016)  
**Henry L. Ehrlich** (2018)  
**Patrick Y. Eichenberger** (2018)  
**Mark A. Eiteman** (2018)  
**Kathryn T. Elliott** (2018)  
**Mostafa S. Elshahed** (2018)  
**David Emerson** (2018)  
**Slava Epstein** (2016)  
**Tobias J. Erb** (2017)  
**Daniilo Ercolini** (2018)  
**Manuel Espinosa-Urgel** (2018)  
**Patrick Fach** (2018)  
**Joseph O. Falkinham** (2017)  
**Séamus Fanning** (2018)  
**Babu Z. Fathepure** (2016)  
**J. Christopher Fenno** (2016)  
**J. Gregory Ferry** (2018)  
**Martin Filion** (2018)  
**Steven E. Finkel** (2016)  
**Steven L. Foley** (2017)  
**Philipp Frank** (2018)  
**W. Florian Fricke** (2017)  
**Michael W. Friedrich** (2018)  
**Barbara E. Funnell** (2018)  
**Vincenzina Fusco** (2018)  
**Shinya Fushinobu** (2018)  
**Cormac G. M. Gahan** (2018)  
**Victor P. J. Gannon** (2016)  
**Michael G. Gänzle** (2016)  
**Beilei Ge** (2016)  
**Elke Genersch** (2018)  
**Johannes Gescher** (2018)  
**Lutz Geue** (2016)  
**Jennifer B. Glass** (2017)  
**Emanuel Goldman** (2016)  
**Mark Gomelsky** (2017)  
**Ramon Gonzalez** (2016)  
**Lawrence D. Goodridge** (2018)  
**Lisa A. Gorski** (2018)  
**Yuval Gottlieb** (2018)  
**David E. Graham** (2017)  
**Jeffrey A. Gralnick** (2018)  
**Stefan J. Green** (2017)  
**Leslie A. Gregg-Jolly** (2017)  
**Amy M. Grunden** (2018)  
**Yitzhak Hadar** (2016)  
**Thomas E. Hanson** (2018)  
**Eiji Haramoto** (2018)  
**Hauke Harms** (2016)  
**Steven D. Harris** (2017)  
**Mark E. Hart** (2017)  
**Valerie J. Harwood** (2018)  
**Anne I. Hatakka** (2016)  
**Jianzhong He** (2018)  
**Qiang He** (2016)  
**Zhili He** (2016)  
**Brian P. Hedlund** (2017)  
**Henry S. Heine** (2018)  
**Thorsten Heinekamp** (2018)  
**Hermann J. Heipieper** (2018)  
**Niels B. Hendriksen** (2018)  
**Kristina L. Hillesland** (2018)  
**Dirk Hoffmeister** (2018)  
**Emily B. Hollister** (2018)  
**Andrew J. Holmes** (2016)  
**Allen L. Honeyman** (2018)  
**Dallas G. Hoover** (2018)  
**David J. Hopper** (2016)  
**Marcus A. Horn** (2017)  
**Adina C. Howe** (2018)  
**John A. Hudson** (2017)

**Jeroen Hugenholtz** (2018)  
**Hor-Gil Hur** (2018)  
**Michael R. Hyman** (2016)  
**Michael F. Hynes** (2016)  
**Kiyohiko Igarashi** (2016)  
**Michele M. Igo** (2018)  
**Masaharu Ishii** (2017)  
**Masahiro Ito** (2017)  
**Javier A. Izquierdo** (2018)  
**Mohamed A. Jamal** (2018)  
**Edward L. Jarroll** (2018)  
**Dieter Jendrosseck** (2018)  
**Michael B. Jenkins** (2018)  
**Ian Jensen** (2017)  
**Zhongjun Jia** (2017)  
**Weihong Jiang** (2018)  
**Nianzhi Jiao** (2017)  
**Zackary I. Johnson** (2018)  
**Jessica L. Jones** (2018)  
**Klaus Jürgens** (2018)  
**Koichi Kamagata** (2018)  
**Boran Kartal** (2017)  
**Matthias Kästner** (2016)  
**James E. Keen** (2016)  
**John J. Kelly** (2018)  
**William R. Kenealy** (2018)  
**Eungbin Kim** (2018)  
**James E. Kirby** (2016)  
**Arnulf Kletzin** (2016)  
**Martin G. Klotz** (2018)  
**Leon D. Kluskens** (2016)  
**Kalmia E. Kniel** (2017)  
**Ryuichi Koga** (2018)  
**Steffen Kolb** (2017)  
**Konstantinos T. Konstantinidis** (2018)  
**Shige Koseki** (2018)  
**Michael Y. Kosoy** (2017)  
**Balasuubrahmanyam Kottapalli** (2017)  
**Sven Krappmann** (2018)  
**Christian P. Kubicek** (2018)  
**Sergei V. Kuchin** (2018)  
**Indira T. Kudva** (2016)  
**Ursula Kües** (2016)  
**Timothy M. LaPara** (2018)  
**Gisèle LaPointe** (2017)  
**Robert A. LaRossa** (2018)  
**Luis F. Larrondo** (2017)  
**Ray A. Larsen** (2018)  
**Peter C. K. Lau** (2018)  
**Jared R. Leadbetter** (2018)  
**Paulo C. Lemos** (2018)  
**Daniel J. Lessner** (2018)  
**Steven Lindow** (2016)  
**Erin K. Lipp** (2018)  
**Wenjun Liu** (2016)  
**Xueduan Liu** (2016)  
**Karen G. Lloyd** (2018)  
**John C. Lonesborough** (2018)  
**Alexander Loy** (2017)  
**Yahai Lu** (2016)  
**Taina K. Lundell** (2018)  
**Yanhe Ma** (2016)  
**Eugene L. Madsen** (2018)  
**Jacques Mahillon** (2017)  
**Mark J. Mandel** (2017)  
**Maria L. Marco** (2018)  
**Julia A. Maresca** (2018)  
**Matthew J. Marshall** (2016)  
**Marta S. L. Martins** (2018)  
**Alfredo Martinez** (2016)  
**Eiji Masai** (2017)  
**Emma R. Master** (2018)  
**Timothy E. Mattes** (2017)  
**Ann G. Matthyse** (2018)  
**Andrew J. McBain** (2018)  
**Timothy R. McDermott** (2018)  
**Quinn S. McFrederick** (2018)  
**Michael J. McInerney** (2016)  
**James McKinlay** (2018)  
**Robert J. C. McLean** (2018)  
**Brian B. McSpadden-Gardener** (2016)  
**Aubrey F. Mendonca** (2018)  
**John S. Meschke** (2017)  
**Chris H. Miller** (2018)  
**Debra L. Milton** (2016)  
**Kiwamu Minamisawa** (2018)  
**Kentaro Miyazaki** (2017)

EDITORIAL BOARD (continued)

- Robert Moore (2018)  
Corrie S. Moreau (2017)  
Paula J. Mouser (2018)  
Rodney A. Moxley (2016)  
Jochen A. Müller (2018)  
T. G. Nagaraja (2018)  
Yuji Nagata (2018)  
Cindy H. Nakatsu (2016)  
Brett A. Neilan (2017)  
Josh D. Neufeld (2018)  
Irene L. G. Newton (2018)  
Nancy N. Nichols (2018)  
Jens Nielsen (2018)  
Brendan A. Niemira (2018)  
Dietrich H. Nies (2018)  
Pablo I. Nikel (2016)  
Nobuhiko Nomura (2017)  
Andrew V. Ogram (2018)  
Julie B. Olson (2018)  
Huib J. M. Op den Camp (2018)  
Ivan J. Oresnik (2017)  
Kelli L. Palmer (2018)  
Konstantinos Papadimitriou (2016)  
Hee-Deung Park (2017)  
Ilenys M. Perez-Diaz (2018)  
Gregg S. Pettis (2017)  
Laurent Philippot (2017)  
Carmen Pin (2018)  
Antonio G. Pisabarro (2017)  
Mircea Podar (2017)  
Shawn W. Polson (2018)  
David L. Popham (2018)  
Rolf A. Prade (2018)  
M. Auxiliadora Prieto (2018)  
Qingsheng Qi (2017)  
Ralf Rabus (2017)  
Mark Radosevich (2017)  
Andreja Rajkovic (2018)  
Gemma Reguera (2018)  
Bernd H. A. Rehm (2018)  
Gregor Reid (2018)  
Peter Richard (2018)  
Christian Riedel (2018)  
Rita V. M. Rio (2018)
- Courtney J. Robinson (2018)  
Daniel D. Rockey (2016)  
Jorge L. M. Rodrigues (2016)  
David Rodríguez-Lázaro (2018)  
Margaret F. Romine (2017)  
Thomas Ross (2016)  
Michael Rother (2018)  
Michael J. Sadovsky (2016)  
Daad A. Saffarini (2017)  
Robert A. Sanford (2018)  
Daisuke Sano (2018)  
Anderson S. Sant'Ana (2018)  
Brian D. Sauders (2016)  
Gary Sawers (2017)  
Frank A. Scannapieco (2017)  
Birgit E. Scharf (2017)  
Jonathan S. Schilling (2018)  
Bernhard Schink (2018)  
John W. Schmidt (2016)  
Michael G. Schmidt (2018)  
Monika Schmoll (2017)  
Hildgund Schrempf (2017)  
Dirk Schüler (2018)  
Wolfgang H. Schwarz (2016)  
Lynne Sehlster (2016)  
Bernhard Seiboth (2017)  
Yuji Sekiguchi (2018)  
David A. Sela (2018)  
Jeremy D. Semrau (2017)  
John M. Senko (2018)  
Peter Setlow (2018)  
Robert M. Q. Shanks (2018)  
Manan Sharma (2018)  
Joshua D. Shrout (2018)  
Mark W. Silby (2018)  
Mitchell H. Singer (2017)  
Steven W. Singer (2018)  
Brajesh K. Singh (2016)  
David R. Singleton (2018)  
Matthias Sipiczki (2016)  
Panos N. Skandamis (2016)  
Evan W. Skowronski (2018)  
J. Leif Smith (2016)  
Mario Soberon (2018)
- Helena M. Solo-Gabriele (2018)  
Greg A. Somerville (2017)  
Andrew J. Spiers (2016)  
Stephen Spiro (2016)  
Eric V. Stabb (2016)  
Lisa Y. Stein (2016)  
Alexander Steinbüchel (2017)  
Ivo Steinmetz (2016)  
Roger Stephan (2017)  
Ann M. Stevens (2016)  
Brian Stevenson (2016)  
George C. Stewart (2018)  
Jill R. Stewart (2018)  
John F. Stolz (2016)  
Wolfgang R. Streit (2018)  
Joseph M. Sturino (2016)  
Garret Suen (2016)  
Matt D. Sweeney (2016)  
Ben D. Tall (2017)  
Takuji Tanaka (2018)  
Ralph S. Tanner (2017)  
Gerald W. Tannock (2017)  
Sam R. Telford (2018)  
Michael G. Thomas (2018)  
Linda S. Thomashow (2018)  
Thomas Thurnheer (2018)  
Ming Tien (2018)  
Nicolas Toro Garcia (2017)  
César I. Torres (2018)  
Effie Tsakalidou (2016)  
Masataka Tsuda (2018)  
Takeharu Tsuge (2018)  
Hidetoshi Urakawa (2017)  
Wouter R. van der Star (2017)  
Tina K. Van Dyk (2018)  
Jan D. van Elsas (2016)  
Jan-Peter van Pijkeren (2018)  
Cristian Varela (2018)  
Michael L. Vasil (2016)  
Marco Ventura (2018)  
Dmitriy V. Volokhov (2018)  
Julia A. Vorholt (2018)  
Stéphane Vuilleumier (2018)  
S. Aljoscha Wahl (2018)
- Judy D. Wall (2018)  
Gejiao Wang (2018)  
Todd J. Ward (2016)  
Keith Warriner (2017)  
J. Scott Weese (2018)  
Laure Weisskopf (2018)  
Derek H. Wells (2018)  
Tingyi Wen (2018)  
Volker F. Wendisch (2018)  
Giovanni Widmer (2016)  
Steven W. Wilhelm (2018)  
Kurt E. Williamson (2017)  
David B. Wilson (2016)  
Charles F. Wimpee (2017)  
Regina-Michaela Wittich (2017)  
Gideon M. Wolfaardt (2016)  
Randy W. Worobo (2016)  
Qinglong Wu (2018)  
Xiao-Lei Wu (2016)  
Chuanwu Xi (2017)  
Hua Xiang (2018)  
Lihua Xiao (2018)  
Luying Xun (2018)  
S. Steve Yan (2016)  
X. Frank Yang (2018)  
Yunfeng Yang (2018)  
Süleyman Yildirim (2017)  
Ken-ichi Yoshida (2018)  
Bo Yu (2018)  
Daniel R. Zeigler (2018)  
Jill H. Zeilstra-Ryalls (2017)  
Karsten Zengler (2017)  
Qijing Zhang (2017)  
Wei Zhang (2018)  
Yu-Zhong Zhang (2017)  
Ning-Yi Zhou (2018)  
Erik R. Zinser (2016)  
Erwin G. Zoetendal (2018)  
Angeles Zorreguieta (2016)  
Sergey B. Zotchev (2018)  
Peter A. Zuber (2017)

*Applied and Environmental Microbiology* (ISSN 1098-5536), 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.

*Applied and Environmental Microbiology* became an online-only journal with volume 82, issue 1 (January 2016). The final print version was volume 81, issue 24 (December 2015). Previous print ISSN: 0099-2240.

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. For subscription prices, contact the Subscriptions Unit, ASM ([asmjournals@subscriptionoffice.com](mailto:asmjournals@subscriptionoffice.com)). Correspondence relating to reprint orders should be directed to ASM Author Services ([ASM.AuthorServicesSupport@cenveo.com](mailto: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>). ASM policies for permissions, commercial reprints, and ePrints can be found at <http://journals.asm.org/site/misc/reprints.xhtml>.

CODEN: AEMIDF

doi:10.1128/AEM.masthead.82-6

Copyright © 2016, American Society for Microbiology. All Rights Reserved.