

APPLIED AND ENVIRONMENTAL MICROBIOLOGY

VOLUME 61 • SEPTEMBER 1995 • NUMBER 9

Judy D. Wall, *Editor in Chief* (2000)
*University of Missouri
Columbia*

Robert A. Bender, *Editor* (1997)
*University of Michigan
Ann Arbor*

Cecil W. Forsberg, *Editor* (1999)
*University of Guelph
Guelph, Ontario*

Jane Gibson, *Editor* (1999)
*Cornell University
Ithaca, N.Y.*

Kenneth W. Nickerson, *Editor* (1997)
*University of Nebraska
Lincoln*

Jim C. Spain, *Editor* (1997)
*U.S. Air Force
Tyndall Air Force Base, Fla.*

Barrie F. Taylor, *Editor* (1999)
*University of Miami
Miami, Fla.*

Linda S. Thomashow, *Editor*
(2000)
*ARS, Washington State University
Pullman, Wash.*

Richard F. Unz, *Editor* (2000)
*Pennsylvania State University
University Park*

EDITORIAL BOARD

Michael J. Adang (1997)
Donald G. Ahearn (1996)
Jose A. Amador (1997)
Jan R. Andreesen (1997)
Daniel Arp (1996)
Hubert Bahl (1997)
Tamar Barkay (1995)
Paul Baumann (1997)
David R. Benson (1995)
Claire M. Berg (1997)
Deepak Bhatnagar (1996)
Linda F. Bisson (1995)
Robert Blanchette (1995)
Hans Blaschek (1995)
David R. Boone (1996)
Robert E. Brackett (1995)
Gunnar Bratbak (1996)
James Brierley (1997)
Douglas G. Capone (1996)
David A. Caron (1996)
Arun Chatterjee (1995)
G. Rasul Chaudhry (1995)
Tyrrell Conway (1997)
Everly Conway de Macario (1997)
Donald A. Cooksey (1997)
Keith E. Cooksey (1996)
Tim Coolbear (1997)
Kurt Dahlberg (1995)
Donald H. Dean (1997)
Edward F. DeLong (1996)
Richard Devereux (1995)
Letty A. De Weger (1997)
Martin Dickman (1996)
Harold Drake (1997)
David W. Emerich (1995)
Stanley L. Erlandsen (1996)

Samuel R. Farrah (1996)
Scott Feighner (1997)
Gerald F. Fitzgerald (1997)
Graham H. Fleet (1997)
James C. Fogleman (1996)
Brian Folsom (1997)
Larry Forney (1996)
James Fredrickson (1996)
Michael S. Gilmore (1996)
Bonita Glatz (1995)
James Gossett (1996)
Richard V. Greene (1995)
Charles N. Haas (1996)
Max Haggblom (1997)
Bärbel Hahn-Hägerdal (1997)
Kenneth E. Hammel (1995)
Caroline S. Harwood (1996)
George Hegeman (1997)
Walter E. Hill (1995)
Alan Hooper (1996)
Christon J. Hurst (1997)
Robert W. Hutkins (1995)
Michael R. Hyman (1996)
Lonnice O. Ingram (1995)
Michael G. Johnson (1995)
Ronald D. Jones (1996)
Eva Kashket (1996)
Ronald P. Kiene (1996)
Brian K. Kinkle (1995)
John M. Kuchta (1995)
Cletus Kurtzman (1997)
R. Victor Lachica (1995)
Thomas Langworthy (1995)
Robert A. LaRossa (1997)
Jane A. Z. Leedle (1997)
Susan B. Leschine (1997)

John F. Leslie (1997)
Derek R. Lovley (1995)
Paul W. Ludden (1997)
Peter Lüthy (1995)
Eugene L. Madsen (1995)
Robert E. Marquis (1996)
Edward O. Mason, Jr. (1996)
Thomas L. Mason (1996)
Ann G. Matthyse (1995)
Michael J. McInerney (1995)
Charles P. Moran, Jr. (1996)
Donald A. Morrison (1996)
Mark Morrison (1996)
Charles R. Myers (1997)
David P. Nagle, Jr. (1997)
James P. Nakas (1996)
Kenneth H. Nealson (1997)
Louise M. Nelson (1995)
Walter G. Niehaus, Jr. (1997)
J. Martin Odom (1996)
Fergal O'Gara (1995)
Ronald Olsen (1996)
Tairo Oshima (1996)
William J. Page (1995)
Leo Parks (1995)
Bruce Paster (1997)
Christine Paszko-Kolva (1997)
John H. Paul (1997)
Gary Payne (1995)
Ian L. Pepper (1997)
James J. Pestka (1995)
Allen T. Phillips (1995)
Wesley O. Pipes (1995)
John I. Pitt (1996)
Malcolm Potts (1996)
J. T. Pronk (1995)

Robert Ramaley (1995)
Donald J. Reasoner (1995)
John N. Reeve (1996)
Gregor Reid (1996)
Ian D. Reid (1997)
Donald C. Robertson (1996)
Joseph A. Robinson (1996)
Michael Jay Sadowsky (1997)
Abigail A. Salyers (1995)
Francis Schmidt (1997)
Peter M. Scott (1996)
James Steele (1995)
Linda D. Stetzenbach (1997)
Michael E. Stiles (1995)
John B. Sutherland (1995)
Mark L. Tamplin (1997)
P. G. Thiel (1997)
Edward Topp (1995)
Thomas Tosteson (1996)
Peter Van Berkum (1995)
Vincent H. Varel (1997)
Pieter T. Visscher (1997)
Edward Voss (1996)
Larry Wackett (1997)
Marleen Wekell (1995)
Carol L. Wells (1997)
Bryan A. White (1996)
Juergen Wiegand (1997)
Michael G. Wolfersberger
(1997)
Stephen H. Zinder (1997)
David A. Zuberer (1995)
Gerben Zylstra (1996)

Barbara H. Iglewski, *Chairman, Publications Board*
John N. Bell, *Production Editor*

Linda M. Illig, *Director, Journals*
Diane Smith, *Assistant Production Editor*

Applied and Environmental Microbiology, a publication of the American Society for Microbiology (ASM), 1325 Massachusetts Ave., N.W., Washington, DC 20005-4171, is devoted to the advancement and dissemination of applied knowledge as well as ecological knowledge, both applied and fundamental, concerning microorganisms. Instructions to authors are published in the January issue each year; reprints are available from the editors and the Journals Department. *Applied and Environmental Microbiology* is published monthly, one volume per year. The nonmember print subscription prices are \$274 (U.S.) (Canadians add 7% GST) and \$325 (other countries) per year; single copies are \$43 (Canadians add 7% GST). The member print subscription prices are \$51 (U.S.) (Canadians add 7% GST) and \$91 (other countries); single copies are \$11 (Canadians add 7% GST). For prices of CD-ROM versions, contact the Subscriptions Unit, ASM. Correspondence relating to subscriptions, defective copies, missing issues, and availability of back issues should be directed to the Subscriptions Unit, ASM; correspondence relating to reprint orders should be directed to the Reprint Order Unit, ASM; and correspondence relating to disposition of submitted manuscripts, proofs, and general editorial matters should be directed to the Journals Department, American Society for Microbiology, 1325 Massachusetts Ave., N.W., Washington, DC 20005-4171. Phone: (202) 737-3600.

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.

Second-class postage paid at Washington, DC 20005, and at additional mailing offices.

POSTMASTER: Send address changes to *Applied and Environmental Microbiology*, ASM, 1325 Massachusetts Ave., N.W., Washington, DC 20005-4171.

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

Copyright © 1995, American Society for Microbiology.

All Rights Reserved.

ISSN 0099-2240

CODEN: AEMIDF

The code at the top 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.