

APPLIED MICROBIOLOGY

VOLUME 26 • NUMBER 2 • AUGUST 1973

EDITORIAL BOARD

Marvin P. Bryant, *Editor-in-Chief* (1976)
University of Illinois, Urbana

Albert Balows, *Editor* (1975)
Center for Disease Control,
Atlanta, Ga.

R. H. Deibel, *Editor* (1976)
University of Wisconsin, Madison

A. L. Demain, *Editor* (1976)
Massachusetts Institute of Technology, Cambridge

Nathalie J. Schmidt, *Editor* (1975)
California State Department of
Public Health, Berkeley

Libero Ajello (1973)
Milton J. Allison (1974)
Francis F. Busta (1975)
Alex Ciegler (1974)
Rita R. Colwell (1974)
Marjorie A. Darken (1973)
Walter R. Dowdle (1973)
Martin S. Favero (1975)
John C. Feeley (1974)
James D. Fenters (1973)
Maxwell Finland (1975)
Anthony F. Gaudy, Jr. (1973)
Edwin E. Geldreich (1976)
S. E. Gilliland (1974)
Morris A. Gordon (1975)
Richard S. Hanson (1975)
James L. Hardy (1975)
Paul A. Hartman (1974)
Melvin T. Hatch (1975)
Clifford W. Hesseltine (1974)

John J. Iandolo (1974)
Henry D. Isenberg (1974)
Holger W. Jannasch (1975)
S. S. Kalter (1975)
Lloyd L. Kempe (1973)
George E. Kenny (1973)
Morton Klein (1975)
Hubert Lechevalier (1973)
John Liston (1974)
Warren Litsky (1975)
Robert Mah (1974)
William J. Martin (1975)
Joseph L. Melnick (1973)
William I. Metzger (1974)
Thomas L. Miller (1973)
C. F. Niven, Jr. (1973)
David Paretsky (1973)
D. Perlman (1974)
David Pramer (1974)

E. L. Schmidt (1974)
Oldrich K. Sebek (1974)
Warren S. Silver (1973)
Louis DS. Smith (1975)
Peter B. Smith (1973)
S. S. Socransky (1975)
Alex C. Sonnenwirth (1975)
Mortimer P. Starr (1975)
Christian Stoll (1973)
Guenther Stotzky (1974)
M. J. Thirumalachar (1973)
Marvin Turck (1974)
Hamao Umezawa (1973)
D. I. C. Wang (1975)
Lewis W. Wannamaker (1975)
Sydney J. Webb (1975)
R. P. Williams (1975)
Benjamin J. Wilson (1975)
G. N. Wogan (1974)
Alan G. Wolin (1974)

Robert A. Day, *Managing Editor*, 1913 I St., N.W., Washington, D.C. 20006

EX OFFICIO

L. Leon Campbell, *President* (1973-1974)

Donald E. Shay, *Secretary*

Philipp Gerhardt, *Vice-President* (1973-1974)

T. J. Carski, *Treasurer*

Applied Microbiology, a publication of the American Society for Microbiology, 1913 I St., N.W., Washington, D.C. 20006, is devoted to the advancement and dissemination of applied knowledge concerning microorganisms. *Applied Microbiology* is published monthly, two volumes per year. The subscription price is \$60 (foreign, \$61) per year. Single copies are \$6.00 (foreign, \$6.25). Members of the American Society for Microbiology may receive *Applied Microbiology* as part of their dues. Correspondence relating to subscriptions, nonreceipt of journals, reprints, defective copies, availability of back issues, and lost or late proofs should be directed to the ASM Publications Office, 1913 I St., N.W., Washington, D.C. 20006 (area 202 833-9416). Correspond-

ence from ASM members relating to membership dues, member subscriptions, changes of address, incorrect address, incorrect journals, etc., should be directed to the Executive Secretary, American Society for Microbiology, 1913 I St., N.W., Washington, D.C. 20006. Published monthly by the ASM at 428 E. Preston St., Baltimore, Md. 21202.

Second-class postage paid at Baltimore, Md. 21202, and at additional mailing offices. Made in the United States of America. Copyright © 1973, American Society for Microbiology. All Rights Reserved.

Author Index

- Akers, T. G., 146
Bacon, C. W., 155
Balows, A., 215
Brodsky, M. H., 219
Burdick, D., 155
Cliver, D. O., 149
Coote, G. G., 206
Coriell, Lewis L., 167
Counter, Fred T., 211
Craig, William A., 196
Crawford, R. L., 176
DeGroot, Jane, 196
Dubovi, E. J., 146
Facklam, R. R., 138
Fogarty, William M., 185, 191
Griffin, Patrick J., 185, 191
Harkin, J. M., 176
Hrazdina, G., 161
Jackson, Sally, 129
Kirk, T. K., 176
Kirk, T. Kent, 173
Kostenbader, K. D., Jr., 149
Kunin, Calvin M., 196
Lillehoj, E. B., 202
Lorenz, L. F., 173
McCoy, C. J., 217
McCoy, Elizabeth, 176
McGarrity, Gerard J., 167
Marshall, Betty J., 206
Milburn, M. S., 202
Molloy, Mary E., 213
Nixon, M. C., 219
Obst, J. R., 176
Poole, George M., 211
Prato, C. M., 146
Rhoden, D. L., 215
Robbins, J. D., 155
Salkin, I. F., 134
Schwartz, Robert D., 217
Scott, W. J., 206
Smith, P. B., 215
Stamer, J. R., 161
Stottmeier, K. D., 213
Stoyla, B. O., 161
Sweeney, J. G., 155
Tomfohrde, K. M., 215
Zey, Pinina, 129

APPLIED MICROBIOLOGY

INSTRUCTIONS TO AUTHORS

Correspondence. Submit manuscripts in duplicate (original and one carbon) to ASM Publications Office, 1913 I St., N.W., Washington, D.C. 20006.

General policy. Any manuscript submitted must be a report of unpublished original research, which is not being considered for publication elsewhere. Each manuscript should present the results of an independent, cohesive study; "series" papers are discouraged. A manuscript accepted and published by *Applied Microbiology* must not be published again in any form without the consent of ASM.

A charge of \$25 per printed page is assessed for publication. Most institutions and granting agencies in the United States permit the payment of publication charges as a part of their general research support. It is recognized, however, that such funds are not always available to laboratories outside the United States. In such cases, the cost of publication will be borne by the American Society for Microbiology.

The "editorial style" of *Applied Microbiology* essentially follows the *CBE Style Manual* (3rd ed., AIBS, 1972). Genetics symbols should essentially follow the recommendations of Demerec et al. (*Genetics* 54:61, 1966). Biochemical abbreviations and nomenclature should essentially follow "Biochemical Nomenclature" in *Handbook of Biochemistry* (2nd ed., 1970, H. A. Sober, ed., The Chemical Rubber Co., Cleveland, p. A4-A24). Normally, abbreviations (except those of standard units of measurement and symbols of the elements) should be defined and introduced parenthetically at first use in the text. Enzyme activity should be expressed in terms of international units (*Enzyme Nomenclature*, Elsevier Publishing Co., 1965), and the EC number should be given parenthetically at first use in the text. In expressing lengths, weights, and volumes, the prefixes nano (n) and pico (p) should be used instead of millimicro (m μ) and micromicro ($\mu\mu$). Express lengths in nanometers (nm; 10⁻⁹ m) or in micrometers (μ m; 10⁻⁶ m) instead of millimicrons (m μ ; 10⁻⁶ m), microns (μ ; 10⁻⁶ m), or Angstroms (Å; 10⁻¹⁰ m). Express parts per million (ppm) as micrograms per milliliter (μ g/ml), micrograms per gram (μ g/g), or microliters per liter (μ liters/liter), as appropriate. In general, measurements should be expressed in terms of standard international metric units. *Applied Microbiology* reserves the privilege of editing manuscripts to make them conform with the adopted style.

Form of manuscript. All parts of the manuscript should be typed double-space or, preferably, triple-space. Most manuscripts can and should be divided into the following sections: Abstract, Introduction, Materials and Methods, Results, Discussion, Acknowledgements, and Literature Cited. Only one weight of heading (paragraph lead-in) should be used within each section.

Title. A single statement of the subject of a paper is preferred to a main title-subtitle arrangement.

Abstract. An Abstract appears at the beginning of each paper. The Abstract should not exceed 250 words.

Literature Cited. In the text, references are cited by number. The Literature Cited section should be typed in alphabetical order, by first author, and numbered. Names of journals are abbreviated according to *Chemical Abstracts Service Source Index* (American Chemical Society, 1970). Literature citations should be restricted to closely pertinent papers. Citations of abstracts, theses, "unpublished data," "personal communications," and "in press" will not be accepted in the Literature Cited.

Tables. Each table should be typed on a separate page. The data should be arranged so that columns of like material read down, not across. The headings should be sufficiently clear so that the meaning of the data will be understandable without reference to the text. Explanatory footnotes are permitted, but detailed descriptions of the experiments are not. The materials and methods used to gain the data should properly remain in the section of that name.

Figures. A complete set of figures, preferably glossy photographs, should accompany each of the two copies of the manuscript. Graphs (*submit as photographs*) should be finished drawings not needing further artwork or type-setting. Absolutely *no* part of a graph should be typewritten (except the legend, which should be typed on a separate page). Each figure should be numbered and should include the name of the author, either in the margin or on the back (marked lightly with a *soft* pencil). All lettering should be done with a lettering set. Most graphs will be reduced to 6.6 cm in width, and *all* elements in the drawing should be prepared to withstand this reduction. The legend of the figure should provide enough information so that the figure is understandable without reference to the text. Experimental details from Materials and Methods should not be repeated in figure legends.

Nomenclature of microorganisms. In general, the nomenclature for bacteria presented in *Bergey's Manual of Determinative Bacteriology* (7th ed., 1957) is used. If an author challenges this nomenclature, his own judgment will be followed, but the name in *Bergey's Manual* should follow in parentheses the first time the name is used in the text and in the Abstract.

Notes. The accepted form for Notes is somewhat different from the foregoing. Contributors should consult a recent issue of *Applied Microbiology* for style. Notes should not exceed 500 words. The abstract should not exceed 25 words.

Copyright. Once a paper has been published in *Applied Microbiology*, which is a copyrighted publication, the legal ownership of all parts of the paper, including the illustrations, has passed from the author to ASM. If the same author, or any author, wishes to republish material previously published in *Applied Microbiology*, he must first receive written permission from ASM.

Reprints. Reprints (in multiples of 100) may be purchased by contributors. A table showing the cost of reprints, and an order form, will be sent with the proof.

Active Membership — American Society for Microbiology

1913 "Eye" St., N. W., Washington, D. C. 20006

NOMINATION FOR MEMBERSHIP

The Society welcomes to active membership any person who is interested in its objects, and who holds a bachelor's degree in microbiology or a related field (or who has had training and experience equivalent to that represented by a bachelor's degree).

The Society has seven scientific journals: (1) *Journal of Bacteriology* (JB), in which are found original communications on all branches of fundamental microbiology; (2) *Applied Microbiology* (AM), which contains original communications dealing mainly with industrial and applied applications of microbiology; (3) *Journal of Virology* (JVI), which is devoted to articles on fundamental knowledge of viruses of bacteria, plants, and animals; (4) *Infection and Immunity* (IAI), which contains original communications on all aspects of medical microbiology and immunology; (5) *Antimicrobial Agents and Chemotherapy* (AAC), which includes all aspects of antimicrobial agents and chemotherapy, including cancer chemotherapy; (6) *Bacteriological Reviews* (BR), a quarterly review journal containing articles on subjects of current microbiological interest, and (7) *International Journal of Systematic Bacteriology* (IJSB), a quarterly journal devoted to bacterial nomenclature, published for the IAMS. In addition, the Society publishes the monthly ASM NEWS, which is sent to all members and contains news and announcements of concern to all microbiologists.

The Society holds an Annual Meeting where the latest results of research in all branches of microbiology are presented, and where members have opportunities to become acquainted and to discuss work in progress. The abstracts of papers presented at the meetings are published.

The annual Interscience Conference on Antimicrobial Agents and Chemotherapy provides opportunity for an exchange of information among all scientific disciplines interested in chemotherapeutic agents and infectious disease.

The minimum annual membership fee is \$20 which includes \$5 dues, \$2 for subscription to *ASM News*, and \$13 for a year's subscription to any one of the Society's journals listed in No. 1 below. You must fill in No. 1. For additional journals, fill in No. 2.

Memberships are initiated and renewed as of January 1 each year. Unless there are directions to the contrary, membership nominations received prior to November 1 will be credited to the current year, and back issues of the selected publications for the current year will be furnished. Nominations received after November 1 will become effective on the following January 1.

FIRST NAME	Initial	LAST NAME
First line of Address		
Second line of Address		
City	State	ZIP CODE
Phone no. _____	Yr of Birth _____	Sex _____
Highest Degree _____	Year _____	Major _____
Granting Institution _____		
Position _____		
Experience _____		
Signature of Nominee _____		
Nominated by (1) _____		
(Signatures of Society members) (2) _____		

1. First Journal (\$13), *ASM News* (\$2), and dues (\$5). Circle one journal choice:

JB	AAC	AM	JVI	BR	IAI		
				08	<i>ASM News</i>	\$2	
				10	Dues	\$5	
					Journal	\$13	

If you want only one journal remit total of..... \$20

2. Additional Journals may be purchased as follows: Circle choices and remit amount shown for each.

AAC	02	\$10	_____
AM	03	\$10	_____
IJSB	04	\$8	_____
JVI	05	\$10	_____
BR	07	\$4	_____
IAI	09	\$10	_____

3. Total and Remit (You must remit at least \$20) _____