

# American Journal of Physiology- Gastrointestinal and Liver Physiology

Editor: P. K. LUND

---

**Associate Editors:**

A. GIRAND  
R. LIDDLE

K. S. MURTHY  
D. M. NEY

D. SCHUPPAN  
S. V. SITARAMAN

---

**Editorial Board:**

H. AKBARALI  
S. ALEXANDER  
D. H. ALPERS  
G. ALPINI  
M. S. ANWER  
G. W. APONTE  
J. A. APPLETON  
T. Y. AW  
Q. AZIZ  
K. E. BARRETT  
A. BAUER  
M. C. BERIN  
P. BERK  
C. L. BEVINS  
D. D. BLACK  
J. BOYER  
S. BROOKES  
N. BUNNETT  
M. CAMILLERI  
H. V. CAREY  
N. CERF-BENUSSAN  
D. CHEN  
D. E. COHEN  
S. P. COLGAN  
F. COMINELLI  
H. COOKE  
S. CROWE  
M. CZAJA  
L. DeLEVE

A. DIEHL  
M. DIENER  
R. N. DuBOIS  
P. K. DUDEJA  
L. ECKMANN  
L. EGAN  
G. FARRUGIA  
R. P. FERRARIS  
C. FIOCCHI  
J. J. GALLIGAN  
L. R. GAWENIS  
F. GHISHAN  
G. GORES  
R. GOYAL  
D. N. GRANGER  
L. E. GREENBAUM  
J. GRIDER  
K. HARNETT  
J. M. HOUGHTON  
H. W. JAESCHKE  
R. T. JENSEN  
C. JOBIN  
L. JOHANNES  
M. KAGNOFF  
J. D. KAUNITZ  
S. KEELEY  
C. KELLY  
C. KEVIL  
S. KHURANA

R. KIM  
S. I. KOO  
P. KUBES  
J. KUEMMERLE  
S. P. LEE  
A. LEITER  
W. LENCER  
E. LI  
H. C. LIN  
R. LORENZ  
B. MACKENZIE  
W. K. MacNAUGHTON  
C. MANSBACH  
J. MATO  
J. B. MATTHEWS  
G. M. MAWE  
L. MAYER  
C. McCLAIN  
D. McKAY  
J. L. MERCHANT  
J. C. MILLS  
T. MORAN  
M. NATHANSON  
A. NEISH  
A. NUSRAT  
C. OWYANG  
A. PAGE  
J. PANDOL  
S. PANG

R. M. PEEK  
J. PISEGNA  
T. PIZARRO  
E. RAZ  
R. RIPPE  
S. ROBINE  
R. ROGERS  
H. M. SAID  
G. SALEN  
K. SHARKEY  
F. SIMON  
S. SITARAMAN  
C. TAYLOR  
A. B. R. THOMSON  
A. TODISCO  
R. A. TRAVAGLI  
J. TURNER  
J. VALENTINE  
M. VORE  
J. WALLACE  
J.-Y. WANG  
S. WARD  
C. H. WEBER  
D. C. WHITCOMB  
J. A. WILLIAMS  
M. WOLFE  
G. D. WU  
H. YEE  
C. H. C. YUN

---

**Publications Committee**

K. E. BARRETT, *Chair*  
D. GUTTERMAN  
T. LOHMEIER  
P. PERSSON  
C. SLADEK

**Ex officio**

R. SCHEMAN  
*Director of Publications  
and Executive Editor*  
G. SIECK, *President*  
M. FRANK, *Executive Director*

M. L. GOODWIN

*Editorial Manager*  
E. KESTNBAUM  
*Journal Supervisor*  
K. E. CONCANNON  
*Copy Editor*

---

The *American Journal of Physiology-Gastrointestinal and Liver Physiology* (ISSN-0193-1857) is published monthly (two volumes a year) by the American Physiological Society, 9650 Rockville Pike, Bethesda, MD 20814-3991 and online at [www.ajpgi.org](http://www.ajpgi.org) (ISSN 1522-1547). *Subscription Prices (post-paid)*: Institutions (print and online): \$575.00, US; \$635.00, Canada and Mexico; \$635.00, elsewhere. Institutions (print only) \$545.00 U.S.; \$605.00 Canada and Mexico; \$603.00 elsewhere. Institutions (online only): \$470.00. Nonmember individuals (print and online): \$380.00, US; \$440.00, Canada and Mexico; \$440.00, elsewhere. Nonmember individuals (print only) \$365.00 U.S.; \$425.00 Canada and Mexico; \$425.00 elsewhere. Nonmember individuals (online only) \$315.00. APS members (print and online): \$140.00 US. \$200.00 Canada & Mexico; \$200.00 elsewhere. Subscriptions from outside the United States are payable in US currency or full equivalent. Subscriptions are accepted on a calendar-year basis only. *Single Copies*

*and Back Issues*: When available, Subscriber, \$30.00 each; Nonsubscriber, \$60.00 each postpaid. Periodicals postage paid at Bethesda, MD and at additional mailing offices. POSTMASTER: Send address changes to the American Journal of Physiology-Gastrointestinal and Liver Physiology, 9650 Rockville Pike, Bethesda, MD 20814-3991.

Copyright © 2009 by the American Physiological Society. Printed in the United States of America by Cadmus Communications—Lancaster Division, Lancaster, PA 17601. The code at the bottom of the first page of an article indicates the copyright owner's consent that copies of that article may be made beyond that permitted by sections 107 and 108 of the US Copyright Law—unless the copies are for general distribution, for advertising, for creating new works, or for resale—provided the per-copy fee is paid through the Copyright Clearance Center, Inc., 222 Rosewood Dr., Danvers, MA 01923. 0193-1857/09 \$8.00.

*Change of Address*: The Journal must be advised of a change of address at least 6 weeks prior to date of issue, with both the subscriber's old and new address given. Undelivered copies resulting from address change will not be replaced.

*Editorial and Business Correspondence*: AJP-Gastrointestinal and Liver Physiology, 9650 Rockville Pike, Bethesda, MD 20814-3991.

**Disclaimer**: The statements and opinions contained in the articles of the *American Journal of Physiology-Gastrointestinal and Liver Physiology* are solely those of the individual authors and contributors and not of the American Physiological Society. The appearance of advertisements in the journal is not a warranty, endorsement, or approval of the products or their safety. The American Physiological Society disclaims responsibility for any injury to persons or property resulting from any ideas or products referred to in any article or advertisement.