

# The Journal of PHARMACOLOGY AND EXPERIMENTAL THERAPEUTICS

Volume 275  
October–December  
1995

A Publication of The American Society  
for Pharmacology and Experimental Therapeutics

Founded by John J. Abel 1909

## EDITOR

John A. Harvey

## ASSISTANT EDITOR

Jay Roberts

## EDITORS FOR SPECIFIC FIELDS

### *Analgesia and Drugs of Abuse*

Alan Cowan  
Billy R. Martin  
Frank Porreca

### *Autonomic Pharmacology*

Suzanne G. Laychock  
Kenneth P. Minneman

### *Behavioral Pharmacology*

Linda A. Dykstra  
Lewis S. Seiden

### *Cardiovascular Pharmacology*

Gregory D. Fink  
Allan M. Lefer  
Benedict R. Lucchesi  
Harry S. Margolius  
R. Clinton Webb

### *Cellular and Molecular Pharmacology*

Toshio Narahashi  
Ronald P. Rubin  
George B. Weiss

### *Chemotherapy/Gene Therapy*

Jonathan Maybaum

### *Developmental Pharmacology*

Hazel H. Szeto

### *Drug Metabolism and Disposition*

Arthur Cho  
David Kupfer  
Grant R. Wilkinson

### *Endocrine Pharmacology*

Paula H. Stern

### *Gastrointestinal Pharmacology*

David R. Brown  
James J. Galligan

### *Immunopharmacology*

John W. Hadden

### *Neuropharmacology*

S. J. Enna  
James W. Gibb  
Barry J. Hoffer  
Michael J. Kuhar  
David R. Manning

### *Prostaglandins, Leukotrienes and Other Eicosanoids*

K. U. Mallik

### *Pulmonary Pharmacology*

Mannfred A. Hollinger

### *Renal Pharmacology*

Margaret A. Acara  
Jack W. Strandhoy

### *Toxicology*

Curtis D. Klaassen

## EDITORIAL ADVISORY BOARD

Martin W. Adler  
Edson X. Albuquerque  
Julius C. Allen  
William D. Atchison  
Leslie Ballou  
Paul Bass  
Bruce P. Bean  
Donald M. Bers  
C. Paul Bianchi  
Vernon S. Bishop  
Floyd E. Bloom  
Peter G. Bradford  
Craig D. Brater  
David Brooks  
Steve R. Childers  
Theodore J. Cicero  
Ronald G. Coffey  
Marlene L. Cohen  
Allan C. Collins  
Charles R. Craig  
Kathryn A. Cunningham  
Cathy A. Davison  
William C. de Groat  
Gary E. DeLander  
Louis Diamond  
Walter R. Dixon  
Thomas V. Dunwiddie  
Jerry M. Farley  
Harold Feinberg  
Dan J. Feller  
John Ferkany  
Kevin Finnegan  
Stephen K. Fisher  
Garret A. FitzGerald  
Stephen F. Flaim

Jerome H. Fleisch  
Alan Frazer  
Peter A. Friedman  
Ray W. Fuller  
Kathleen Giacomini  
Alasdair Gilfillan  
Kathleen Grant  
Thomas P. Green  
Thomas M. Guenther  
Glen R. Hanson  
R. Adron Harris  
Thomas G. Heffner  
J. Paul Hieble  
Ronald Hines  
Paula L. Hoffman  
Jordan Holtzman  
Stephen G. Holtzman  
Jerry B. Hook  
Joseph R. Hume  
Edwin K. Jackson  
E. H. Jeffery  
Kenneth M. Johnson  
Peter W. Kalivas  
George J. Kaloyanides  
Nancy Kanagy  
Robert S. Kass  
Terry Kenakin  
Lewis B. Kinter  
David D. Ku  
Roberto Levi  
George E. Lindenmayer  
James Lohr  
Irwin Lucki  
Joseph Lynch

Robert B. McCall  
John R. McCullough  
Donald E. McMillan  
Kaushik D. Meisheri  
Daniel T. Monaghan  
William H. Morse  
Hasan Mukhtar  
Albert E. Munson  
L. Charles Murrin  
Norton H. Neff  
Kim A. Neve  
Jon A. Norman  
Eliot H. Ohlstein  
Achilles J. Pappano  
Gavril W. Pasternak  
William H. Percy  
Michael Piascik  
Garth Powis  
Kenzie L. Preston  
Russell A. Prough  
Richard A. Rabin  
David Raeburn  
Satish Rattan  
George A. Ricaurte  
Sandra C. Roerig  
Michael C. Sanguinetti  
Saul M. Schanberg  
Christopher J. Schmidt  
Michal L. Schwartzman  
Ronald Shebuski  
Paul J. Silver  
Kenny J. Simansky  
David J. Smith

Philip L. Smith  
Roger P. Smith  
Edward E. Soltis  
Patricia K. Sonsalla  
Roger D. Speakman  
John L. Sutko  
Boris Tabakoff  
David A. Taylor  
Milt Teitler  
Thomas R. Tephly  
Richard E. Tessel  
Martin J. M. C. Thoolen  
Pieter B. M. W. M. Timmermans  
Myron L. Toews  
Theodore J. Torphy  
John T. Turner  
Bradley J. Udem  
Norman J. Uretsky  
Paul M. Vanhoutte  
Robert E. Vestal  
Larry A. Walker  
Martin A. Wasserman  
Margaret T. Weis  
Sandra P. Welch  
H. Steve White  
Michael Williams  
Patricia D. Williams  
Steve Wilson  
Martin M. Winbury  
Raymond J. Winquist  
Jeffrey M. Witkin  
Bryan K. Yamamoto  
Alice M. Young  
Edward J. Zambraski  
Michael J. Zigmond

## BOARD OF PUBLICATIONS TRUSTEES

Kenneth E. Moore, *Chairman*: William O. Berndt, D. Craig Brater, David B. Bylund, William A. Catterall, Marlene L. Cohen, Raymond Dingledine, John A. Harvey, Raymond F. Novak, Marcus M. Reidenberg

## EXECUTIVE OFFICER OF THE SOCIETY

Kay A. Croker

# The Journal of PHARMACOLOGY AND EXPERIMENTAL THERAPEUTICS

A Publication of The American Society  
for Pharmacology and Experimental Therapeutics

Founded by John J. Abel 1909

## EDITOR

John A. Harvey

## ASSISTANT EDITOR

Jay Roberts

## EDITORS FOR SPECIFIC FIELDS

### *Analgesia and Drugs of Abuse*

Alan Cowan  
Billy R. Martin  
Frank Porreca

### *Autonomic Pharmacology*

Suzanne G. Laychock  
Kenneth P. Minneman

### *Behavioral Pharmacology*

Linda A. Dykstra  
Lewis S. Seiden

### *Cardiovascular Pharmacology*

Gregory D. Fink  
Allan M. Lefer  
Benedict R. Lucchesi  
Harry S. Margoliuss  
R. Clinton Webb

### *Cellular and Molecular Pharmacology*

Toshio Narahashi  
Ronald P. Rubin  
George B. Weiss

### *Chemotherapy/Gene Therapy*

Jonathan Maybaum

### *Developmental Pharmacology*

Hazel H. Szeto

### *Drug Metabolism and Disposition*

Arthur Cho  
David Kupfer  
Grant R. Wilkinson

### *Endocrine Pharmacology*

Paula H. Stern

### *Gastrointestinal Pharmacology*

David R. Brown  
James J. Galligan

### *Immunopharmacology*

John W. Hadden

### *Neuropharmacology*

S. J. Enna  
James W. Gibb  
Barry J. Hoffer  
Michael J. Kuhar  
David R. Manning

### *Prostaglandins, Leukotrienes and Other Eicosanoids*

K. U. Malik

### *Pulmonary Pharmacology*

Mannfred A. Hollinger

### *Renal Pharmacology*

Margaret A. Acara  
Jack W. Strandhoy

### *Toxicology*

Curtis D. Klaassen

## EDITORIAL ADVISORY BOARD

Martin W. Adler  
Edson X. Albuquerque  
Julius C. Allen  
William D. Atchison  
Leslie Ballou  
Paul Bass  
Bruce P. Bean  
Donald M. Bers  
C. Paul Bianchi  
Vernon S. Bishop  
Floyd E. Bloom  
Peter G. Bradford  
Craig D. Brater  
David Brooks  
Steve R. Childers  
Theodore J. Cicero  
Ronald G. Coffey  
Marlene L. Cohen  
Allan C. Collins  
Charles R. Craig  
Kathryn A. Cunningham  
Cathy A. Davison  
William C. de Groat  
Gary E. DeLander  
Louis Diamond  
Walter R. Dixon  
Thomas V. Dunwiddie  
Jerry M. Farley  
Harold Feinberg  
Dan J. Feller  
John Ferkany  
Kevin Finnegan  
Stephen K. Fisher  
Garret A. FitzGerald  
Stephen F. Flaim

Jerome H. Fleisch  
Alan Frazer  
Peter A. Friedman  
Ray W. Fuller  
Kathleen Giacomini  
Alasdair Gilfillan  
Kathleen Grant  
Thomas P. Green  
Thomas M. Guenther  
Glen R. Hanson  
R. Adron Harris  
Thomas G. Heffner  
J. Paul Hieble  
Ronald Hines  
Paula L. Hoffman  
Jordan Holtzman  
Stephen G. Holtzman  
Jerry B. Hook  
Joseph R. Hume  
Edwin K. Jackson  
E. H. Jeffery  
Kenneth M. Johnson  
Peter W. Kalivas  
George J. Kaloyanides  
Nancy Kanagy  
Robert S. Kass  
Terry Kenakin  
Lewis B. Kinter  
David D. Ku  
Roberto Levi  
George E. Lindenmayer  
James Lohr  
Irwin Lucki  
Joseph Lynch

Robert B. McCall  
John R. McCullough  
Donald E. McMillan  
Kaushik D. Meisheri  
Daniel T. Monaghan  
William H. Morse  
Hasan Mukhtar  
Albert E. Munson  
L. Charles Murrin  
Norton H. Neff  
Kim A. Neve  
Jon A. Norman  
Eliot H. Ohlstein  
Achilles J. Pappano  
Gavril W. Pasternak  
William H. Percy  
Michael Piascik  
Garth Powis  
Kenzie L. Preston  
Russell A. Prough  
Richard A. Rabin  
David Raeburn  
Satish Rattan  
George A. Ricaurte  
Sandra C. Roerig  
Michael C. Sanguinetti  
Saul M. Schanberg  
Christopher J. Schmidt  
Michal L. Schwartzman  
Ronald Shebuski  
Paul J. Silver  
Kenny J. Simansky  
David J. Smith  
Philip L. Smith

Roger P. Smith  
Edward E. Soltis  
Patricia K. Sonsalla  
Roger D. Speakman  
John L. Sutko  
Boris Tabakoff  
David A. Taylor  
Milt Teitler  
Thomas R. Tephly  
Richard E. Tessel  
Martin J. M. C. Thoolen  
Pieter B. M. W. M. Timmermans  
Myron L. Toews  
Theodore J. Torphy  
John T. Turner  
Bradley J. Udem  
Norman J. Uretsky  
Paul M. Vanhoutte  
Robert E. Vestal  
Larry A. Walker  
Martin A. Wasserman  
Margaret T. Weis  
Sandra P. Welch  
H. Steve White  
Michael Williams  
Patricia D. Williams  
Steve Wilson  
Martin M. Winbury  
Raymond J. Winquist  
Jeffrey M. Witkin  
Bryan K. Yamamoto  
Alice M. Young  
Edward J. Zambraski  
Michael J. Zigmond

## BOARD OF PUBLICATIONS TRUSTEES

Kenneth E. Moore, *Chairman*: William O. Berndt, D. Craig Brater, David B. Bylund, William A. Catterall, Marlene L. Cohen, Raymond Dingledine, John A. Harvey, Raymond F. Novak, Marcus M. Reidenberg

## EXECUTIVE OFFICER OF THE SOCIETY

Kay A. Croker