

# Dose-Response

(Formerly *Nonlinearity in Biology, Toxicology, and Medicine*)

[www.Dose-Response.com](http://www.Dose-Response.com)

## Editors-In-Chief

**Edward J. Calabrese**  
Environmental Health Sciences  
Morrill I, N344  
University of Massachusetts  
Amherst, MA 01003  
*edwardc@schoolph.umass.edu*  
Telephone: 413-545-3164

**Barbara G. Callahan**  
School of Public Health  
University of Massachusetts  
P. O. Box 1579  
Grantham, NH 03753  
*bcalla@adelphia.net*  
603-863-9854

## Managing Editor

**Denise Leonard**  
Environmental Health Sciences  
Morrill I, N344  
University of Massachusetts  
Amherst, MA 01003  
*dleonard@schoolph.umass.edu*  
413-545-1239

## Editorial Board

John Ashby  
*Syngenta Central  
Toxicology Laboratory  
United Kingdom*

Michael P. Bolger  
*Food and Drug  
Administration  
USA*

John A. Bukowski  
*ExxonMobil Biomedical  
Sciences, Inc.  
USA*

James S. Bus  
*Dow Chemical Company  
USA*

Lu Cai  
*University of Louisville  
USA*

Rory Conolly  
*CIIT  
USA*

J. Michael Davis  
*Environmental  
Protection Agency  
USA*

David J. Doolittle  
*R.J. Reynolds Tobacco  
Company  
USA*

Max Eisenberg  
*Research Management  
Group  
USA*

James E. Gibson  
*The Brody School of  
Medicine  
USA*

Mary E. Gilbert  
*Environmental  
Protection Agency  
USA*

Jay I. Goodman  
*Michigan State  
University  
USA*

A.Wallace Hayes  
*ENVIRON International  
Corporation  
USA*

Jae-Shyong Hong  
*NIFHS/NIH  
USA*

Annie M. Jarabek  
*Environmental  
Protection Agency  
USA*

Zbigniew Jaworowski  
*Central Laboratory for  
Radiological Protection  
Poland*

Norbert Kaminski  
*Michigan State  
University  
USA*

Roger O. McClellan  
*Albuquerque, NM  
USA*

Ron Mitchel  
*Atomic Energy of  
Canada Limited  
Ontario, Canada*

D. James Morré  
*Purdue University  
USA*

### Editorial Board

Kenneth L. Mossman <i>Arizona State University USA</i>	Gregorio Olivieri <i>Università di Roma La Sapienza Italy</i>	James T. Oris <i>Miami University USA</i>	Peter A. Parsons <i>Unley Australia</i>
Henry C. Pitot <i>University of Wisconsin USA</i>	Gary M. Rand <i>Florida International University USA</i>	Stephen M. Roberts <i>University of Florida USA</i>	Lu Rongzhu <i>Jiangsu University China</i>
Karl K. Rozman <i>University of Kansas Medical Center USA</i>	Heikki Savolainen <i>Department of Occupational Safety &amp; Health Finland</i>	Eric D. Schneider <i>Hawkwood Institute USA</i>	Bobby Scott <i>Lovelace Respiratory Research Institute New Mexico USA</i>
Oliver Toussaint <i>University of Namur Belgium</i>	Edwin van Wijngaarden <i>University of Rochester Medical Center USA</i>	Frederick S. vom Saal <i>University of Missouri USA</i>	Jae-Ho Yang <i>Catholic University of Daegu Korea</i>

### Associate Editors

John F. Acquavella <i>Monsanto Company USA</i>	Klaus Becker <i>Radiation, Science and Health, Inc. Germany</i>	Richard A. Bond <i>University of Houston USA</i>	Giovanni Carelli <i>Catholic University of the Sacred Heart Italy</i>
David M. Diamond <i>University of South Florida USA</i>	Philippe Duport <i>University of Ottawa Canada</i>	Valery Forbes <i>Roskilde University Denmark</i>	Johan Gabriellsson <i>AstraZeneca Sweden</i>
Wayne Jonas <i>Uniformed Services University of the Health Sciences USA</i>	Ralph L. Kodell <i>National Center for Toxicological Research USA</i>	Walter J. Kozumbo <i>Department of the Air Force USA</i>	Steven C. Lewis <i>Lewis Environmental Consulting Services USA</i>
Shu-Zheng Liu <i>Norman Bethune University of Medical Sciences China</i>	Werner K. Lutz <i>University of Wuerzburg Germany</i>	Gary E. Marchant <i>Arizona State University USA</i>	Kenneth A. Mundt <i>ENVIRON International Corporation USA</i>
Giovanni Pagano <i>Istituto Nazionale Tumori Italy</i>	Harris Pastides <i>University of South Carolina USA</i>	Suresh Rattan <i>University of Aarhus Denmark</i>	Kiyohiko Sakamoto <i>Tohoku Radiological Science Center Japan</i>
Keith R. Solomon <i>University of Guelph Canada</i>	Edward J. Stanek <i>University of Massachusetts USA</i>	Thomas B. Starr <i>TBS Associates USA</i>	David G. Thomassen <i>Department of Energy USA</i>

**Abstracted/Indexed in:** Academic Search Complete, Biological Abstracts, BIOSIS Previews, Chemical Abstracts, Environmental Issues & Policies Index with FullTEXT, Google Scholar, Infotrieve, Minerva, STN Easy, SciFinder, SciFinder Scholar, STN International, Swetswise, and Toxicology Abstracts. (More indexers pending.)

**Aims and Scope:** *Dose-Response* is a quarterly peer-reviewed electronic journal dedicated to the publication of original findings on the occurrence of dose-response relationships across a broad range of biological disciplines including physiology, biochemistry, molecular biology, toxicology, radiation biology, pharmacology, medicine, neuroscience, immunology, developmental biology, ecology, experimental psychology, plant biology, and environmental and related sciences. In addition to descriptive experimental findings of dose-responses, particular interest will focus on experimental evidence providing mechanistic understanding of nonlinear dose-response relationships. The journal also welcomes the submission of biologically motivated statistical modeling of dose-response relationships. While the emphasis of the journal is on the publication of experimental findings, population-based epidemiological studies relating to nonlinearity are encouraged. *Dose-Response* encourages the submission of mini-reviews on topics at the forefront of research interest, and the journal is particularly interested in receiving manuscripts that apply the concept of nonlinearity to current developments in drug and chemical testing procedures as well as in environmental, occupational and medical risk assessment.

*Dose-Response* (Formerly *Nonlinearity in Biology, Toxicology, and Medicine*) (USPS Permit #022787) is electronically published quarterly by the University of Massachusetts, 639 North Pleasant Street, Amherst, MA USA 01003-9298.

**Annual Subscription** (Online Only)

Online ISSN – 1559-3258

Institutional/Corporate Subscribers: US \$395

Individual Subscribers: US \$295

All online subscriptions include: keyword, article, subject, and table of content active searches of subscriber's choosing along with automatic alerts when "Articles in Press" and complete issues are published.

**Alternate Subscription Option:** Membership in the International Hormesis Society includes a free subscription to *Dose-Response*. Individual memberships are \$125/year. Other levels of membership including retiree, student, corporate, and supporting memberships are also available. Please visit: [www.HormesisSociety.org](http://www.HormesisSociety.org) for more information on the International Hormesis Society.

**To Subscribe to *Dose-Response* or Join the International Hormesis Society online please visit:** <http://www.hormesisociety.org/membership.htm>

**Websites:** Please visit [www.Dose-Response.com](http://www.Dose-Response.com) for instructions for authors, reprint ordering, sample issues, and to access journal articles. All manuscript submissions, peer-review, and correspondences for *Dose-Response* are done electronically. Please visit [www.HormesisSociety.org](http://www.HormesisSociety.org) for more information on the International Hormesis Society.

**Production Offices:** International Hormesis Society/BELLE, Environmental Health Sciences, Morrill 1, N 344, 639 North Pleasant Street, University of Massachusetts, Amherst, MA USA 01003  
Managing/Production Editor: Denise Leonard: 413-545-1239, [dleonard@schoolph.umass.edu](mailto:dleonard@schoolph.umass.edu)  
Business Manager: Charlene Galica: 413-545-2288, [cgalica@hormesisociety.org](mailto:cgalica@hormesisociety.org)

**Reprints:** Reprints in small and large quantities are available for purchase to authors and non-authors alike at [www.Dose-Response.com](http://www.Dose-Response.com)

**Copyright © University of Massachusetts.** All rights reserved. Single photocopies of single articles may be made for personal use as allowed by national copyright laws. Permission and payment of a fee are required for all other photocopying, including multiple or systematic copying for advertising or promotional purposes, resale, and all forms of document delivery. Special rates are available for educational and non-profit institutions. **For permission to photocopy, reprint, or use any material electronically from *Dose-Response*, ISSN – 1559-3258, please access [www.copyright.com](http://www.copyright.com) or contact the Copyright Clearance Center, Inc. (CCC), 222 Rosewood Drive, Danvers, MA 01923, 978-750-8400. The CCC is a not-for-profit organization that provides licenses and registration for a variety of users.** The publisher of *Dose-Response* (formerly *Nonlinearity in Biology, Toxicology, and Medicine*) assumes no responsibility for any statements of fact or opinion expressed in the published papers. The appearance of advertising in this journal does not constitute an endorsement or approval by the publisher, the editors, or the editorial board of the quality of the product advertised or of the claims made for it by its manufacturer.