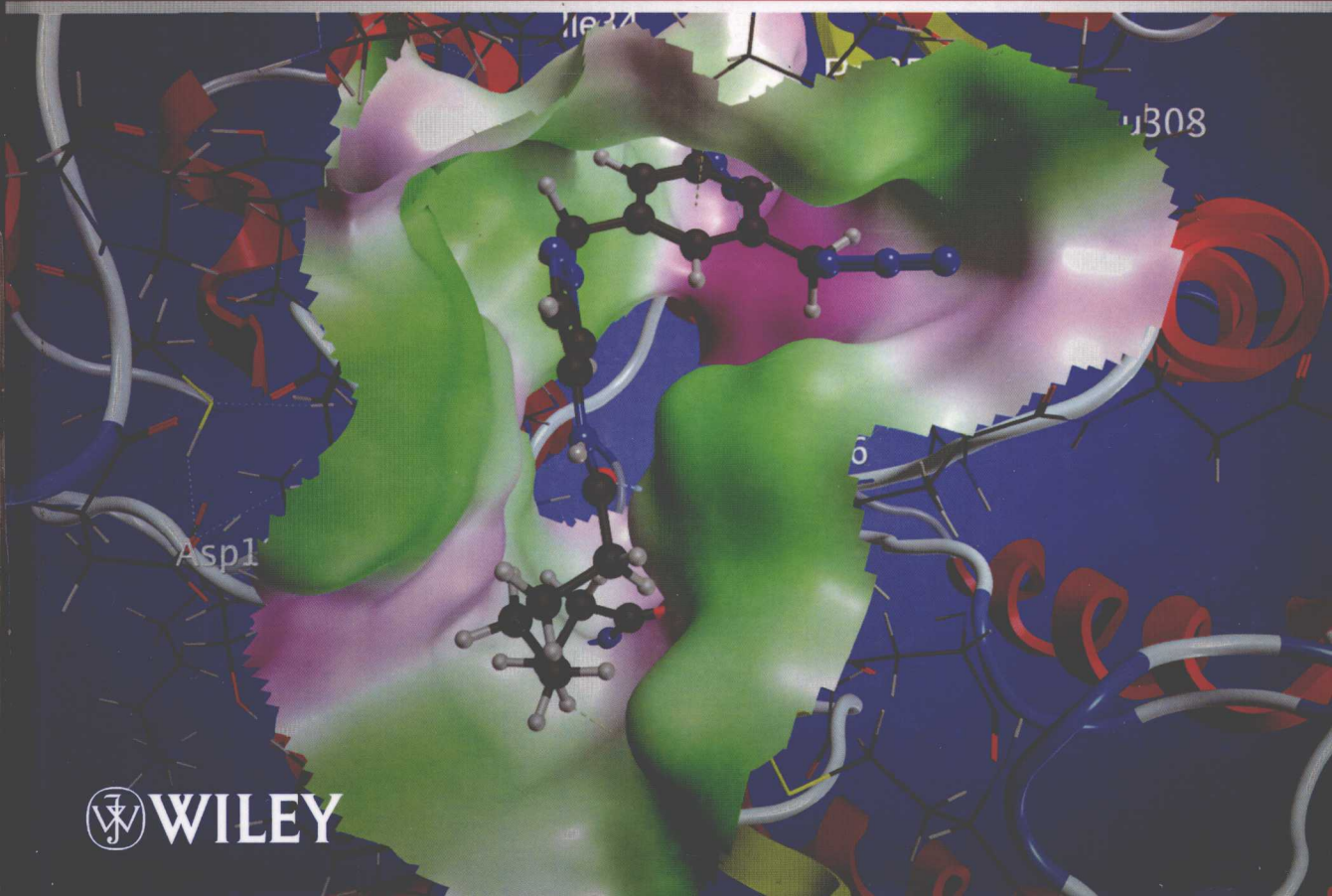


ALEXANDER V. LYUBIMOV, EDITOR-IN-CHIEF
LUCINDA H. COHEN AND DAVID C. MUDDIMAN, ASSOCIATE EDITORS

ENCYCLOPEDIA OF DRUG METABOLISM AND INTERACTIONS

VOLUME 5

BIOANALYTICAL APPROACHES



 **WILEY**

ENCYCLOPEDIA OF DRUG METABOLISM AND INTERACTIONS

Volume 5

Bioanalytical Approaches

Editor-in-Chief

Alexander Lyubimov

*Toxicology Research Laboratory
The University of Illinois
Chicago, Illinois, USA*

Associate Editors

Lucinda H. Cohen

*Merck Research Laboratories
Rahway, New Jersey, USA*

David C. Muddiman

*North Carolina State University
Raleigh, North Carolina, USA*



 **WILEY**

A JOHN WILEY & SONS, INC., PUBLICATION

Copyright © 2012 by John Wiley & Sons, Inc. All rights reserved

Published by John Wiley & Sons, Inc., Hoboken, New Jersey

Published simultaneously in Canada

No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, scanning, or otherwise, except as permitted under Section 107 or 108 of the 1976 United States Copyright Act, without either the prior written permission of the Publisher, or authorization through payment of the appropriate per-copy fee to the Copyright Clearance Center, Inc., 222 Rosewood Drive, Danvers, MA 01923, (978) 750-8400, fax (978) 750-4470, or on the web at www.copyright.com. Requests to the Publisher for permission should be addressed to the Permissions Department, John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, (201) 748-6011, fax (201) 748-6008, or online at <http://www.wiley.com/go/permission>.

Limit of Liability/Disclaimer of Warranty: While the publisher and author have used their best efforts in preparing this book, they make no representations or warranties with respect to the accuracy or completeness of the contents of this book and specifically disclaim any implied warranties of merchantability or fitness for a particular purpose. No warranty may be created or extended by sales representatives or written sales materials. The advice and strategies contained herein may not be suitable for your situation. You should consult with a professional where appropriate. Neither the publisher nor author shall be liable for any loss of profit or any other commercial damages, including but not limited to special, incidental, consequential, or other damages.

For general information on our other products and services or for technical support, please contact our Customer Care Department within the United States at (800) 762-2974, outside the United States at (317) 572-3993 or fax (317) 572-4002.

Wiley also publishes its books in a variety of electronic formats. Some content that appears in print may not be available in electronic formats. For more information about Wiley products, visit our web site at www.wiley.com.

Library of Congress Cataloging-in-Publication Data

Encyclopedia of drug metabolism and interactions / editor-in-chief, Alexander V. Lyubimov.
p. ; cm.

Includes index.

ISBN 978-0-470-45015-4 (cloth)

I. Lyubimov, Alexander V.

[DNLM: 1. Pharmaceutical Preparations—metabolism—Encyclopedias—English. 2. Drug Discovery—Encyclopedias—English. 3. Drug Interactions—Encyclopedias—English. 4. Drug Toxicity—Encyclopedias—English. QV 13]

615.1'9003—dc23

2012025747

**ENCYCLOPEDIA OF DRUG
METABOLISM AND INTERACTIONS**

Volume 5

*This encyclopedia is dedicated to my family whose patience and support helped me
find time and strength not only to start but also to complete this book.*

ALEXANDER LYUBIMOV,
Editor-in Chief

CONTRIBUTORS

IAN N. ACWORTH, ESA - A Dionex Company, Chelmsford, MA, USA

TAUSIF AHMED, Piramal Healthcare, Translational Research (M&S), Mumbai, Maharashtra, India

KAREL ALLEGAERT, Neonatal Intensive Care Unit, University Hospitals Leuven, Herestraat, Leuven, Belgium

JOCHEM ALSENZ, pRED Formulation Research, Preformulation R&D NCE, F. Hoffmann-La Roche Ltd., Basel, Switzerland

BENNY M. AMORE, Pharmacokinetics and Drug Metabolism, Amgen, Inc., Seattle, WA, USA

SHELBY ANDERSON, Advion BioSciences, Indianapolis, IN, USA

DANIEL J. ANTOINE, Department of Pharmacology and Therapeutics, University of Liverpool, Liverpool, UK

THOMAS A. BAILLIE, University of Washington, Seattle, WA, USA

RAY BAKHTIAR, Merck & Co., Whitehouse Station, NJ, USA

SUDIPTA BASU, Pharmacology & Toxicology, Sai Advantium Pharma Ltd, Hinjewadi, Pune, Maharashtra, India

JONATHAN N. BAUMAN, Pharmacokinetics, Dynamics, and Metabolism Department, Pfizer Global Research and Development, Groton, CT, USA

KEVIN BEAUMONT, Department of Pharmacokinetics, Dynamics and Metabolism, Pfizer Worldwide Research and Development, Sandwich Laboratories, Cambridge, MA, USA

IHOR BEKERSKY, Antioch, IL, USA

GRAHAM BENCH, Center for Accelerator Mass Spectrometry, Lawrence Livermore National Laboratory, Livermore, CA, USA

CRAIG BENSON, Department of Pharmacology and Therapeutics, University of Liverpool, Liverpool, UK

MICHAEL S. BEREMAN, Department of Genome Sciences, University of Washington, Seattle, WA, USA

FRAN BERLIOZ-SEUX, Vertex Pharmaceuticals, Cambridge, MA, USA

ANDREW BESSIRE, Pharmacokinetics, Dynamics & Metabolism, Pfizer Worldwide Research & Development, Groton, CT, USA

ANAHITA BHATHENA, Global Pharmaceutical Research and Development, Abbott Laboratories, Abbott Park, IL, USA

IAN A. BLAIR, Centers for Cancer Pharmacology and Excellence in Environmental Toxicology, University of Pennsylvania, Philadelphia, PA, USA

PHILIP G. BOARD, John Curtin School of Medical Research, Australian National University, Canberra, ACT, Australia

TONIKA BOHNERT, Department of Drug Metabolism and Pharmacokinetics, Biogen Idec, Cambridge, MA, USA

FRÉDÉRIC Y. BOIS, INERIS, METO, Verneuil en Halatte, France; Technological University of Compiègne, Chair of Mathematical Modeling for Systems Toxicology, Compiègne, France

BRUCE A. BUCHHOLZ, Center for Accelerator Mass Spectrometry, Lawrence Livermore National Laboratory, Livermore, CA, USA

PETER L. BULLOCK, Intertek Pharmaceutical Services, San Diego, CA, USA

JANET CACERES-CORTES, Bristol-Myers Squibb Co., Princeton, NJ, USA

JOHN R. CASHMAN, Human BioMolecular Research Institute, San Diego, CA, USA

MATTHEW A. CERNY, Drug Discovery DMPK, Boehringer-Ingelheim Pharmaceuticals, Inc., Ridgefield, CT, USA

SILVI A. CHACKO, Department of Biotransformation, Bristol-Myers Squibb, Princeton, NJ, USA

THOMAS K. H. CHANG, Faculty of Pharmaceutical Sciences, The University of British Columbia, Vancouver, British Columbia, Canada

EDWIN C. Y. CHOW, University of Toronto, Toronto, Ontario, Canada

LUCINDA H. COHEN, Merck Research Laboratories, Drug Metabolism & Pharmacokinetics, Rahway, NJ, USA

MICHAEL D. COLEMAN, School of Life and Health Sciences, Aston University, Birmingham, UK

DEEPAK K. DALVIE, Pfizer, Inc., Groton, CT, USA; Pfizer, Inc., La Jolla, CA, USA; Pfizer Global Research and Development, San Diego, CA, USA; Pharmacokinetics, Dynamics and Metabolism, Pfizer Global Research and Development, San Diego, CA, USA

ANAGHA A. DAMRE, Drug Metabolism and Pharmacokinetics, Piramal Healthcare Limited, Goregaon East, Mumbai, India

BIPLAB DAS, Department of Drug Metabolism and Pharmacokinetics, Biogen Idec, Cambridge, MA, USA

- RICHARD C. DAW, Analytical Chemistry and Pharmaceuticals, RTI International, Research Triangle Park, NC, USA
- ANDRÉ M. DEELDER, Department of Parasitology, Leiden University Medical Center, Leiden, The Netherlands
- JOSHUA G. DEKEYSER, Pharmacokinetics and Drug Metabolism, Amgen Inc., Thousand Oaks, CA, USA
- JOHN M. DESESSO, Exponent, Alexandria, VA, USA; Georgetown University School of Medicine, Washington, DC, USA
- LI DI, Pharmacokinetics, Dynamics and Metabolism, Pfizer Inc., Groton, CT, USA
- RICHARD J. DIMELOW, Scientific Computing Group, Cyprotex Discovery Ltd, Macclesfield, Cheshire, UK; Modelling and Simulation, DMPK, AstraZeneca Ltd, Macclesfield, Cheshire, UK
- STUART DOMBEY, QuatRx Pharmaceuticals, Ann Arbor, MI, USA
- LAHOMA EASTERWOOD, ABC Laboratories, Inc., Columbia, MO, USA
- AYMAN F. EL-KATTAN, Pfizer Global Research and Development, Pfizer Inc., Groton, CT, USA
- DAVID C. EVANS, Drug Safety Sciences, Janssen, Pharmaceutical Companies of Johnson & Johnson, Raritan, NJ, USA
- JIANGHONG FAN, University of Toronto, Toronto, Ontario, Canada
- ALI SAID FAQI, MPI Research, Mattawan, MI, USA
- OLIVIER FARDEL, Université de RENNES1, IFR140, Rennes, France; Département HITC, Hopital Pontchaillou, CHU Rennes, France
- BO FENG, Pharmacokinetics, Dynamics and Metabolism, Pfizer Inc., Groton, CT, USA
- MEIHUA ROSE FENG, University of Michigan, Ann Arbor, MI, USA
- ERIC LE FERREC, Université de RENNES1, IFR140, Rennes, France
- MARK FIELDEN, Comparative Biology and Safety Sciences, Amgen Inc., Thousand Oaks, CA, USA
- KIM E. FIFER, Department of Pharmaceutical Sciences, College of Pharmacy, University of Arkansas for Medical Sciences, Little Rock, AR, USA
- MICHAEL B. FISHER, ProPharma Services, Oxford, CT, USA
- ROBERT S. FOTI, Department of Pharmacokinetics and Drug Metabolism, Amgen Inc., Seattle, WA, USA
- EMILY A. FRASER, Division of Cancer Research, University of Dundee, Medical Research Institute, Ninewells Hospital & Medical School, Dundee, UK
- PAUL H. GAMACHE, ESA - A Dionex Company, Chelmsford, MA, USA

BENTE GAMMELGAARD, Department of Pharmaceutics and Analytical Chemistry,
University of Copenhagen, Copenhagen, Denmark

PATRICIA E. GANEY, Department of Pharmacology and Toxicology, Michigan State
University, East Lansing, MI, USA

RAJEEV GANGAL, Pharmacology & Toxicology, Sai Advantium Pharma Ltd,
Hinjewadi, Pune, Maharashtra, India

ZÖE GARDNER, Department of Plant, Soil, & Insect Sciences, University of
Massachusetts, Amherst, MA, USA

HARRY V. GELBOIN, Laboratory of Metabolism, National Institutes of Health,
Bethesda, MD, USA

GARY L. GLISH, Department of Chemistry, University of North Carolina, Chapel
Hill, NC, USA

CHRISTOPHER GOLDRING, Department of Pharmacology and Therapeutics, University
of Liverpool, Liverpool, UK

RAKESH GOLLEN, Drug Metabolism and Pharmacokinetics, Translational Sciences,
Novartis Institutes for BioMedical Research, East Hanover, NJ, USA

VANESSA GONZÁLEZ-PÉREZ, Department of Pharmacotherapy and Experimental
Therapeutics, Eshelman School of Pharmacy, University of North Carolina at
Chapel Hill, Chapel Hill, NC, USA

CODY R. GOODWIN, Department of Chemistry, Vanderbilt University, Nashville, TN,
USA

MEGAN GRABENAUER, Analytical Chemistry and Pharmaceutics, RTI International,
Research Triangle Park, NC, USA

RUSSELL GRANT, Research and Development, LabCorp, Burlington, NC, USA

SUSAN GREPPER, Life Technologies, Durham, NC, USA

MARK P. GRILLO, Department of Pharmacokinetics and Drug Metabolism, Amgen,
Inc., South San Francisco, CA, USA

F. PETER GUENGERICH, Department of Biochemistry, Vanderbilt University School
of Medicine, Nashville, TN, USA

JIANJUN GUO, 3D BioOptima Co. Ltd., Suzhou, China

BILL GURLEY, Department of Pharmaceutical Sciences, College of Pharmacy,
University of Arkansas for Medical Sciences, Little Rock, AR, USA

KURT W. HAACK, Center for Accelerator Mass Spectrometry, Lawrence Livermore
National Laboratory, Livermore, CA, USA

ROGER N. HAYES, Department of Drug Metabolism and Pharmacokinetics, MPI
Research, Mattawan, MI, USA

HANDAN HE, Drug Metabolism and Pharmacokinetics, Translational Sciences,
Novartis Institutes for BioMedical Research, East Hanover, NJ, USA

TYCHO HEIMBACH, Drug Metabolism and Pharmacokinetics, Translational Sciences,
Novartis Institutes for BioMedical Research, East Hanover, NJ, USA

M. HELEN GRANT, Bioengineering Unit, University of Strathclyde, Wolfson Centre,
Glasgow, UK

COLIN J. HENDERSON, Division of Cancer Research, University of Dundee, Medical
Research Institute, Ninewells Hospital & Medical School, Dundee, UK

JACK HENION, Advion BioSciences, Inc., Ithaca, NY, USA

RONALD N. HINES, Departments of Pediatrics and Pharmacology/Toxicology,
Medical College of Wisconsin, and Children's Research Institute, Children's
Hospital and Health Systems, Milwaukee, WI, USA

KARSTEN A. HOLM, Experimur, Chicago, IL, USA

CORNELIS E. C. A. HOP, Department of Drug Metabolism & Pharmacokinetics,
Genentech, South San Francisco, CA, USA

MAHMUD HOSSAIN, Department of Chemistry, University of Cincinnati, Cincinnati,
OH, USA

STELLA HUANG, Bristol-Myers Squibb Co., Princeton, NJ, USA

YEA MIN HUH, University of Michigan, Ann Arbor, MI, USA

W. G. HUMPHREYS, Department of Biotransformation, Bristol-Myers Squibb,
Princeton, NJ, USA

SUSAN HURST, Pharmacokinetics, Dynamics & Metabolism, Pfizer Worldwide
Research & Development, Groton, CT, USA

MATTHEW J. HUTZLER, Drug Discovery DMPK, Boehringer-Ingelheim
Pharmaceuticals, Inc., Ridgefield, CT, USA

COSTAS IOANNIDES, University of Surrey, Surrey, UK

MASAHITO IWAKI, Department of Pharmacy, Kinki University, Osaka, Japan

KRISHNA R. IYER, Department of Pharmaceutical Chemistry, Bombay College of
Pharmacy, Kalina, Mumbai, India

CATHERINE F. JACOBSON, 3M Company, St. Paul, MN, USA

MASOUD JAMEI, Simcyp Limited, Sheffield, UK

SHALU JHAJRA, Department of Pharmaceutical Analysis, National Institute of
Pharmaceutical Education and Research (NIPER), S.A.S. Nagar, Punjab, India

DALE E. JOHNSON, Emiliem Inc., Emeryville, CA, USA; Department of Nutritional
Science and Toxicology, University of California, Berkeley, CA, USA

KIM JOHNSON, Bristol-Myers Squibb Co., Princeton, NJ, USA

EMRYS A. JONES, Department of Parasitology, Leiden University Medical Center,
Leiden, The Netherlands

JONATHAN L. JOSEPHS, Department of Biotransformation, Bristol-Myers Squibb, Princeton, NJ, USA

AMIT S. KALGUTKAR, Pharmacokinetics, Dynamics, and Metabolism Department, Pfizer Global Research and Development, Groton, CT, USA

PING KANG, Pharmacokinetics Dynamics and Metabolism, Pfizer Inc., La Jolla, CA, USA

CHRISTINE KARBOWSKI, Comparative Biology and Safety Sciences, Amgen Inc., Thousand Oaks, CA, USA

DAVID A. KATZ, Global Pharmaceutical Research and Development, Abbott Laboratories, Abbott Park, IL, USA

ALEXIS KAUSHANSKY, Seattle Biomedical Research Institute, Seattle, WA, USA

MORTEZA G. KHALEDI, Department of Chemistry, North Carolina State University, Raleigh, NC, USA

ERICK KINDT, Pfizer Global Research and Development, La Jolla, CA, USA

KATHLEEN M. KNIGHTS, Department of Clinical Pharmacology, Flinders University, Bedford Park, Australia

HIROSHI KOMURA, Drug Metabolism & Pharmacokinetics Research Laboratories, Central Pharmaceutical Research Institute, Japan Tobacco Inc., Osaka, Japan

WALTER A. KORFMACHER, Exploratory Drug Metabolism, Merck Research Laboratories, Kenilworth, NJ, USA

MELISSA A. KRAMER, Bristol-Myers Squibb Company, Wallingford, CT, USA

KRISTOPHER W. KRAUSZ, Laboratory of Metabolism, National Institutes of Health, Bethesda, MD, USA

DAVID J. KROLL, Genomics and Microbiology Research Laboratory, Nature Research Center, North Carolina Museum of Natural Sciences, Raleigh, NC, USA

KRISTEN S. KULP, Biosciences and Biotechnology Division, Lawrence Livermore National Laboratory, Livermore, CA, USA

YURONG LAI, Department of Pharmacokinetics and Drug Metabolism, Pfizer Global Research and Development, Groton, CT, USA

BRIAN G. LAKE, University of Surrey, Surrey, UK; LFR Molecular Sciences, Surrey, UK

NICOLA LANE, Department of Pharmacology and Therapeutics, University of Liverpool, Liverpool, UK

ELIZABETH M. LAURENZANA, Department of Veterinary & Biomedical Sciences, The Pennsylvania State University, University Park, PA, USA

HUGH LAVERTY, Department of Pharmacology and Therapeutics, University of Liverpool, Liverpool, UK

- EDWARD LECLUYSE, The Hamner Institutes for Health Sciences, Research Triangle Park, NC, USA
- CAROLINE A. LEE, Pharmacokinetics, Dynamics & Metabolism, Pfizer Worldwide Research & Development, San Diego, CA, USA
- CAROLINE G. LEE, Department of Biochemistry, National University of Singapore, Singapore; Division of Medical Sciences, National Cancer Center, Singapore; DUKE-NUS Graduate Medical School, Singapore
- CAROLINE LEE, DMPK Solutions Inc., Carlsbad, CA, USA
- CHOON-MYUNG LEE, Department of Pharmacology, Emory University School of Medicine, Atlanta, GA, USA
- Ji YOUNG LEE, Celsis In vitro Technologies, Baltimore, MD, USA
- MARTIN S. LENNARD, Academic Unit of Medical Education, The University of Sheffield, Sheffield, UK
- JING LI, Wayne State University, Detroit, MI, USA
- PATRICK A. LIMBACH, Department of Chemistry, University of Cincinnati, Cincinnati, OH, USA
- JIUNN H. LIN, 3D BioOptima Co. Ltd., Suzhou, China
- TSUHAN LIN, Drug Metabolism and Pharmacokinetics, Translational Sciences, Novartis Institutes for BioMedical Research, East Hanover, NJ, USA
- JOHN LITCHFIELD, Pfizer Global Research and Development, Pfizer Inc., Groton, CT, USA
- HONG LIU, Department of Drug Metabolism, Abbott Laboratories, Abbott Park, IL, USA
- CHO-MING LOI, Pfizer Global Research and Development, San Diego, CA, USA
- PATRICIA LORUSSO, Wayne State University, Detroit, MI, USA
- DEBRA LUFFER-ATLAS, Eli Lilly and Company, Indianapolis, IN, USA
- BENNETT MA, Pharmacokinetics, Pharmacodynamics and Drug Metabolism, Merck and Co., West Point, PA, USA
- KAZUYA MAEDA, Department of Molecular Pharmacokinetics, Graduate School of Pharmaceutical Sciences, The University of Tokyo, Bunkyo-ku, Tokyo, Japan
- HAN-JOO MAENG, University of Toronto, Toronto, Ontario, Canada; Inje University, Gimhae, Gyeongnam, Korea
- MICHAEL A. Malfatti, Biosciences and Biotechnology Division, Lawrence Livermore National Laboratory, Livermore, CA, USA
- SANDHYA MANDLEKAR, Syngene International Ltd., Bangalore, India; Bristol-Myers Squibb India Pvt. Ltd., Bangalore, India
- JODY C. MAY, Department of Chemistry, Vanderbilt University, Nashville, TN, USA

LIAM A. McDONNELL, Department of Parasitology, Leiden University Medical Center, Leiden, The Netherlands

JOHN A. MCLEAN, Department of Chemistry, Vanderbilt University, Nashville, TN, USA

PAUL D. METCALFE, Scientific Computing Group, Cyprotex Discovery Ltd, Macclesfield, Cheshire, UK

JOHN O. MINERS, Department of Clinical Pharmacology, Flinders University, Bedford Park, Australia

JAMES M. MCKIM Jr., CeeTox, Inc., Kalamazoo, MI, USA

TIMOTHY A. MOELLER, Celsis In vitro Technologies, Baltimore, MD, USA

CHARLOTTE MØLLER, Department of Pharmaceutics and Analytical Chemistry, University of Copenhagen, Copenhagen, Denmark

EDWARD T. MORGAN, Department of Pharmacology, Emory University School of Medicine, Atlanta, GA, USA

SIDNEY D. NELSON, Department of Medicinal Chemistry, School of Pharmacy, University of Washington, Seattle, WA, USA

DEBORAH A. NICOLL-GRIFFITH, Merck Research Laboratories, Drug Metabolism & Pharmacokinetics, Rahway, NJ, USA

BEATRICE A. NYAGODE, Department of Pharmacology, Emory University School of Medicine, Atlanta, GA, USA

SCOTT R. OBACH, Pfizer, Inc., Groton, CT, USA; Pfizer, Inc., La Jolla, CA, USA; Pharmacokinetics Dynamics and Metabolism, Pfizer Inc., Groton, CT, USA

JESSICA OESTERHELD, Washington State University School of Pharmacy, Pullman, WA, USA

SHIN OGITA, Wayne State University, Detroit, MI, USA

TED J. OGNIBENE, Center for Accelerator Mass Spectrometry, Lawrence Livermore National Laboratory, Livermore, CA, USA

CURTIS J. OMIECINSKI, Department of Veterinary & Biomedical Sciences, The Pennsylvania State University, University Park, PA, USA

PAUL R. ORTIZ DE MONTELLANO, Department of Pharmaceutical Chemistry, University of California, San Francisco, CA, USA

GUY E. PADBURY, Pharmacokinetics and Drug Metabolism, Amgen, Thousand Oaks, CA, USA

SHEELA PAIBIR, San Marga Consulting, Carlsbad, CA, USA

JYOTI PALIWAL, Department of Pharmaceutics, National Institute of Pharmaceutical Education and Research (NIPER), S.A.S. Nagar, Punjab, India

K. SANDY PANG, University of Toronto, Toronto, Ontario, Canada

ANDRÉ PANNATIER, Department of Pharmacy, University Hospital Centre (CHUV), Lausanne, Switzerland; School of Pharmaceutical Sciences (EPGL), University of Geneva and University of Lausanne, Switzerland

B. KEVIN PARK, Department of Pharmacology and Therapeutics, University of Liverpool, Liverpool, UK

MARY PAT KNADLER, Eli Lilly and Company, Indianapolis, IN, USA

PRASHANT PATOLE, Pharmacology & Toxicology, Sai Advantium Pharma Ltd, Hinjewadi, Pune, Maharashtra, India

PHILIP N. PATSALOS, Department of Clinical and Experimental Epilepsy, UCL Institute of Neurology, Queen Square, London, UK; Epilepsy Society, Chalfont Centre for Epilepsy, Chalfont St Peter, UK

JAKIR PINJARI, Pharmacology & Toxicology, Sai Advantium Pharma Ltd, Hinjewadi, Pune, Maharashtra, India

CHANDRA PRAKASH, Department of Drug Metabolism and Pharmacokinetics, Biogen Idec, Cambridge, MA, USA

BHAGWAT PRASAD, Department of Pharmaceutical Analysis, National Institute of Pharmaceutical Education and Research (NIPER), S.A.S. Nagar, Punjab, India; Department of Pharmaceutics, University of Washington, Seattle, WA, USA

RUSSELL A. PROUGH, Department of Biochemistry & Molecular Biology, University Louisville School of Medicine, Louisville, KY, USA

ZAHER A. RADI, Pfizer Global Research and Development, Pfizer Inc., Groton, CT, USA

LOUIS L. RADULOVIC, Drug Development Preclinical Services, LLC, Ann Arbor, MI, USA

SADAYAPPAN V. RAHAVENDRAN, Pharmacokinetics, Dynamics & Metabolism Department, Pfizer Inc., Worldwide Research and Development, La Jolla, CA, USA

RAGU RAMANATHAN, Department of Biotransformation, Bristol-Myers Squibb, Princeton, NJ, USA

NINAD RAMESH VARKHEDE, Department of Pharmaceutical Analysis, National Institute of Pharmaceutical Education and Research (NIPER), S.A.S. Nagar, Punjab, India

DIANE B. RAMSDEN, Boehringer Ingelheim Pharmaceuticals Inc., Ridgefield, CT, USA

INDRANIL RAO, Biocon Bristol-Myers Squibb R&D Center (BBRC), Bangalore, India; Syngene International Ltd., Bangalore, India

HIMANSHU RASTOGI, Pharmacology & Toxicology, Sai Advantium Pharma Ltd, Hinjewadi, Pune, Maharashtra, India

SELVAN RAVINDRAN, Pharmacology & Toxicology, Sai Advantium Pharma Ltd,
Hinjewadi, Pune, Maharashtra, India

SOPHIE REGAN, Department of Pharmacology and Therapeutics, University of
Liverpool, Liverpool, UK

SUSAN REID, Department of Clinical Pharmacology, Lundbeck Inc., Deerfield, IL;
Hospira, Lake Forest, IL, USA

MICHAEL D. REILY, Bristol-Myers Squibb Co., Princeton, NJ, USA

ALEXANDRA VAN REMOORTERE, Department of Parasitology, Leiden University
Medical Center, Leiden, The Netherlands

MARC W. RETTER, Department of Pharmacokinetics and Drug Metabolism, Amgen
Inc., Seattle, WA, USA

MARK E. RIDGEWAY, Department of Chemistry, University of North Carolina,
Chapel Hill, NC, USA

DAN A. ROCK, Department of Pharmacokinetics and Drug Metabolism, Amgen Inc.,
Seattle, WA, USA

HAOJING RONG, Pharmacokinetics, Dynamics and Metabolism, Pfizer Inc., Groton,
CT, USA

ROBERT A. ROTH, Department of Pharmacology and Toxicology, Michigan State
University, East Lansing, MI, USA

CHARLES J. ROTTER, Pfizer Global Research and Development, Pfizer Inc., Groton,
CT, USA

JASMINDER SAHI, Jazz Consulting LLC, Ann Arbor, MI, USA

GARY A. SALAZAR QUINTERO, Center for Accelerator Mass Spectrometry, Lawrence
Livermore National Laboratory, Livermore, CA, USA

MIRANDA J. SARACHINE FALSO, Center for Accelerator Mass Spectrometry, Lawrence
Livermore National Laboratory, Livermore, CA, USA

RONALD E. SAVAGE, Department of Preclinical Development and Clinical
Pharmacology, ArQule, Inc., Woburn, MA, USA

THOMAS D. SCHIANO, Division of Liver Diseases, The Mount Sinai Medical Center,
New York, NY, USA

MICHAEL L. SCHRAG, ProPharma Services, Westminster, CO, USA

ROB SHIPMAN, NoAb BioDiscoveries Inc., Mississauga, Ontario, Canada

MAGANG SHOU, Pharmacokinetics and Drug Metabolism, Amgen Inc., Thousand
Oaks, CA, USA

YUE-ZHONG SHU, Bristol-Myers Squibb Co., Princeton, NJ, USA

SARANJIT SINGH, Department of Pharmaceutical Analysis, National Institute of
Pharmaceutical Education and Research (NIPER), S.A.S. Nagar, Punjab, India

- MICHAEL SINZ, Pharmaceutical Candidate Optimization, Bristol-Myers Squibb, Wallingford, CT, USA
- J. GREG SLATTER, Pharmacokinetics and Drug Metabolism, Amgen Inc, Seattle, WA, USA
- CORNELIA SMITH, Life Technologies, Durham, NC, USA
- DENNIS A. SMITH, Pharmacokinetics, Dynamics and Metabolism, Pfizer Global R&D, Sandwich, Kent, UK
- ERIC G. SOLON, QPS, LLC, Newark, DE, USA
- ABHISHEK SRIVASTAVA, Department of Pharmacology and Therapeutics, University of Liverpool, Liverpool, UK
- PHILIP STARKEY-LEWIS, Department of Pharmacology and Therapeutics, University of Liverpool, Liverpool, UK
- BENJAMIN J. STEWART, Center for Accelerator Mass Spectrometry, Lawrence Livermore National Laboratory, Livermore, CA, USA
- JULIA STINGL, Institute of Pharmacology of Natural Compounds and Clinical Pharmacology, University Ulm, Ulm, Germany
- STEFAN STÜRUP, Department of Pharmaceutics and Analytical Chemistry, University of Copenhagen, Copenhagen, Denmark
- MURALI SUBRAMANIAN, Department of Experimental and Clinical Pharmacology, College of Pharmacy, University of Minnesota, Minneapolis, MN, USA; Pharmaceutical Candidate Optimization, Biocon Bristol-Myers Squibb Research Center, Syngene International Ltd, Bangalore, India
- RAJU SUBRAMANIAN, Pharmacokinetics and Drug Metabolism, Amgen Inc, Seattle, WA, USA
- SUCHA SUDARSANAM, Emiliem Inc., Emeryville, CA, USA
- YUICHI SUGIYAMA, Department of Molecular Pharmacokinetics, Graduate School of Pharmaceutical Sciences, The University of Tokyo, Bunkyo-ku, Tokyo, Japan
- DEEPAK SURESH AHIRE, Department of Pharmaceutical Analysis, National Institute of Pharmaceutical Education and Research (NIPER), S.A.S. Nagar, Punjab, India
- GABRIELLA SZEKELY-KLEPSE, Allergan Inc., Irvine, CA, USA
- HUI-HUI TAN, Department of Gastroenterology & Hepatology, Singapore General Hospital, Singapore
- WEI TANG, Department of Drug Metabolism and Pharmacokinetics, Merck & Co., Inc., Rahway, NJ, USA
- BERNARD TESTA, Department of Pharmacy, University Hospital Centre (CHUV), Lausanne, Switzerland
- BRIAN F. THOMAS, Analytical Chemistry and Pharmaceutics, RTI International, Research Triangle Park, NC, USA

SIMON THOMAS, Scientific Computing Group, Cyprotex Discovery Ltd, Macclesfield, Cheshire, UK

DWAIN TOLBERT, Department of Clinical Pharmacology, Lundbeck Inc., Deerfield, IL, USA

TIMOTHY S. TRACY, Department of Experimental and Clinical Pharmacology, College of Pharmacy, University of Minnesota, Minneapolis, MN, USA; Department of Pharmaceutical Sciences, College of Pharmacy, University of Kentucky, Lexington, KY, USA

OLGA V. TRUBETSKOY, VIOS Consulting, Madison, WI, USA

MIIA TURPEINEN, Department of Pharmacology and Toxicology, University of Oulu, Oulu, Finland

KENNETH W. TURTELTAUB, Biosciences and Biotechnology Division, Lawrence Livermore National Laboratory, Livermore, CA, USA

JACK P. UETRECHT, University of Toronto, Toronto, Ontario, Canada

STEVE E. UNGER, Worldwide Clinical Trials Drug Development Solutions - Bioanalytical Sciences, Austin, TX, USA

SUBRAHMANYAM VANGALA, Ridgeview Clinical Consulting, Ringoes, NJ, USA

MANTHENA V. S. VARMA, Pfizer Global Research and Development, Pfizer Inc., Groton, CT, USA

KARTHIK VENKATAKRISHNAN, Clinical Pharmacology, Millennium Pharmaceuticals Inc., Cambridge, MA, USA

THORSTEN VERCH, Merck & Co., Whitehouse Station, NJ, USA

BUKKE VIDYASAGAR NAIK, Department of Pharmaceutical Analysis, National Institute of Pharmaceutical Education and Research (NIPER), S.A.S. Nagar, Punjab, India

VINAY HK, Biocon Bristol-Myers Squibb R&D Center (BBRC), Bangalore, India; Syngene International Ltd., Bangalore, India

RICHARD VOORMAN, Department of Drug Metabolism, Abbott Laboratories, Abbott Park, IL, USA

JAN L. WAHLSTROM, Department of Pharmacokinetics and Drug Metabolism, Amgen Inc., Seattle, WA, USA

GREGORY S. WALKER, Pfizer, Inc., Groton, CT, USA

GILLIAN C. WALLACE, Life Technologies, Paisley, UK

RACHEL J. WALSH, Department of Pharmacology and Therapeutics, University of Liverpool, Liverpool, UK

MARK WALZER, Department of Clinical Pharmacology, Lundbeck Inc., Deerfield, IL, USA; Astellas Pharma Global Development, Inc., Deerfield, IL, USA