

# Journal of Pharmaceutical Sciences

## EDITOR IN CHIEF

**Kenneth L. Audus**

Department of Pharmaceutical  
Chemistry  
University of Kansas  
2095 Constant Avenue  
Lawrence, KS 66047  
Tel: 785-864-3550  
E-mail: audus@ku.edu

## MANAGING EDITOR

**Mickie Cathers**

(mcathers@aphanet.org)

## JOURNALS MANAGING EDITOR

**Robert Dawdy**

(rdawdy@aphanet.org)

## EDITORIAL ADVISORY BOARD

**Anjali M. Agrawal**

Bristol Myers Squibb  
Basking Ridge, NJ

**Hidetaka Akita**

Tohoku University  
Sendai, Japan

**Shin-ichi Akanuma**

University of Toyama  
Toyama, Japan

**Sreedhara Alavattam**

Genentech, Inc.  
San Francisco, CA

**Carmen Alvarez-Lorenzo**

Universidade de Santiago  
de Compostela  
Santiago de Compostela, Spain

**Gregory E. Amidon**

University of Michigan  
Ann Arbor, MI

**Thomas J. Anchordoquy**

University of Colorado  
Aurora, CO

**Pieter P. Annaert**

KU Leuven  
Leuven, Belgium

**Robert D. Arnold**

Auburn University  
Auburn, AL

**Per Artursson**

Uppsala University  
Uppsala, Sweden

**Marianne Ashford**

AstraZeneca  
Macclesfield, UK

**Bruce J. Aungst**

AUC Sciences  
Newark, DE

**Alejandro Pedro Ayala**

Universidade Federal do Ceará  
Fortaleza, Brazil

**Steven W. Baertschi**

Baertschi Consulting, LLC  
Carmel, IN

**Jane P.F. Bai**

Silver Spring, MD

**Annette Bak**

Astra Zeneca  
Mölndal, Sweden

**James G. Bann**

Wichita State University  
Wichita, KS

## EDITORS EMERITUS

**William Higuchi**

**Ronald T. Borchardt**

## EDITORS

**Guohua An**

University of Iowa, Iowa City, IA

**Sathy Balu-Iyer**

SUNY – University at Buffalo  
Buffalo, NY

**Harry G. Brittain**

Center for Pharmaceutical  
Physics Milford, NJ

**John F. Carpenter**

University of Colorado Denver  
Denver, CO

**Ferdinando Giordano**

Torre d'Isola (Pavia), Italy

**Michael J. Hageman**

The University of Kansas  
Lawrence, KS

**Bruno C. Hancock**

Pfizer, Inc.  
Groton, CT

**Filippos Kesisoglou**

Merck & Co., Inc.  
West Point, PA

**Hanns-Christian Mahler**

University of Frankfurt  
Frankfurt, Germany

**Christoph Saal**

Boehringer Ingelheim Pharma  
GmbH & Co. KG, Biberach an  
der Riss, Germany

**Christian Schöneich**

The University of Kansas  
Lawrence, KS

**Tetsuya Terasaki**

University of Eastern  
Finland School of Pharmacy  
Kuopio, Finland

## EDITOR

**of Reviews, Minireviews,  
General Commentaries, and  
Commentaries on Special  
Topics and Global Health**

**John F. Carpenter**

University of Colorado Denver  
Denver, CO

E-mail: john.carpenter@  
cuanschutz.edu

**Arvind K. Bansal**

National Institute of Pharmaceutical  
Education and Research  
Punjab, India

**Jared S. Bee**

MacroGenics, Inc.  
Rockville, MD

**Christel Bergström**

Uppsala University  
Uppsala, Sweden

**Cory Berkland**

University of Kansas  
Lawrence, KS

**Akhilesh Bhambhani**

Merck & Co., Inc.  
West Point, PA

**Jeffrey T. Blue**

Merck & Co., Inc.  
West Point, PA

**Joshua Boateng**

University of Greenwich  
Kent, UK

**Robin H. Bogner**

University of Connecticut  
Storrs, CT

**Birger Brodin**

University of Copenhagen  
Copenhagen, Denmark

**Ira S. Buckner**

Duquesne University  
Pittsburgh, PA

**James M. Butler**

GlaxoSmithKline R&D  
Essex, UK

**Mino R. Caira**

University of Cape Town  
Rondebosch, South Africa

**Shawn Cao**

Amgen  
Thousand Oaks, CA

**Carla M. Caramella**

University of Pavia  
Pavia, Italy

**Matteo Cerea**

University of Milan  
Milan, Italy

**Jennifer S. Chadwick**

BioAnalytix Inc.  
Cambridge, MA

**Sayantana Chattoraj**

GlaxoSmithKline  
Pharmaceuticals R&D  
Collegeville, PA

**Bodhisattwa Chaudhuri**

University of Connecticut  
Storrs, CT

**Wei Cheng**

University of Michigan  
Ann Arbor, MI

**Po-Chang Chiang**

Genentech Inc.  
South San Francisco, CA

**Merry Christie**

Voisin Consulting Life Sciences  
Silver Spring, MD

**Adeola O. Coker**

University of the Incarnate Word  
San Antonio, TX

**Duncan Q.M. Craig**

University of Bath  
Bath, UK

**Tapan K. Das**

Bristol-Myers Squibb  
New Brunswick, NJ

**Sudip K. Das**

Butler University  
Indianapolis, IN

**Vivek S. Dave**

St. John Fisher College  
Rochester, NY

**Melgardt M. de Villiers**

University of Wisconsin  
Madison, WI

**Yoshiharu Deguchi**

Teikyo University  
Tokyo, Japan

**Michael DeHart**

Carolina Medical Products Co  
Farmville, NC

**Nunzio Denora**

University of Bari "Aldo Moro"  
Bari, Italy

**Roberto DePaz**

Horizon Therapeutics  
Gaithersburg, MD

**Rukman De Silva**

U.S. Food and Drug Administration  
Silver Spring, MD

**James C. DiNunzio**

Merck & Co., Inc.  
Rahway, NJ

**Jin Dong**

AstraZeneca  
Gaithersburg, MD

**Jennifer Dressman**

Goethe University  
Frankfurt, Germany

**Christine Dufes**

University of Strathclyde  
Glasgow, UK

**Carsten Ehrhardt**

Trinity College Dublin  
Dublin, Ireland

**David Elder**

David P. Elder Consultancy  
Hertford, UK

**Reza Esfandiary**

Astra Zeneca,  
Gaithersburg, MD

**Davide Fissore**

Politecnico di Torino  
Torino, Italy

**Camilla Foged**

University of Copenhagen  
Copenhagen, Denmark

**Anastasia Foppoli**

Università degli Studi di Milano  
Milan, Italy

**Wolfgang Friess**

Ludwig-Maximilians-Universität  
München, Germany

**Ryoichi Fujiwara**

Northeast Ohio Medical University  
Rootstown, OH

**John F. Gamble**

Bristol-Myers Squibb  
Merseyside, UK

**Giuseppina Sandri**

University of Pavia  
Pavia, Italy

**David J. Goldfarb**

Merck & Co., Inc.  
Rahway, NJ

**Igor Gonda**

Respidex LLC  
Dennis, MA

## EDITORIAL ADVISORY BOARD *(Continued)*

**Sarah Gordon**  
Liverpool John Moores University  
Liverpool, UK

**Monica M. Goss**  
Amgen  
Thousand Oaks, CA

**Henrik Gréen**  
Linköping University and National  
Board of Forensic Medicine  
Linköping, Sweden

**Manish Gupta**  
GlaxoSmithKline Plc  
Collegeville, PA

**Richard H. Guy**  
University of Bath  
Bath, UK

**David Harris**  
Merck & Co., Inc.  
Rahway, NJ

**David J. Hauss**  
Regeneron Pharmaceuticals, Inc.  
Colts Neck, NJ

**David B. Hayes**  
International Solidarity of Scientists  
Danbury, CT

**Xiaorong He**  
Boehringer-Ingelheim  
Southbury, CT

**Yan He**  
Sanofi  
Waltham, MA

**Anthony J. Hickey**  
RTI International, Research  
Triangle Park, NC

**Kazutaka Higaki**  
Okayama University  
Okayama, Japan

**René Holm**  
Janssen Pharmaceutica  
Beerse, Belgium

**Sarah Hook**  
University of Otago  
Dunedin, New Zealand

**Ken-ichi Hosoya**  
University of Toyama  
Toyama, Japan

**Munir A. Hussain**  
MAH Pharma Consulting LLC  
Belle Mead, NJ

**Katsuhisa Inoue**  
Tokyo University of Pharmacy and  
Life Sciences  
Tokyo, Japan

**Tatsuhiro Ishida**  
Tokushima University  
Tokushima, Japan

**Akiko Ishii-Watabe**  
National Institute of Health Sciences  
Kanagawa, Japan

**Nazrul Islam**  
Queensland University of Technology  
Brisbane, Queensland

**Kousei Ito**  
Chiba University  
Chiba, Japan

**Shingo Ito**  
Kumamoto University  
Kumamoto, Japan

**Yasunori Iwao**  
University of Shizuoka  
Shizuoka, Japan

**Ken-ichi Izutsu**  
National Institute of Health  
Sciences, Tokyo, Japan

**David S. Jones**  
Queen's University Belfast  
Northern Ireland, UK

**LaToya Jones-Braun**  
Regis University  
Denver, CO

**Marisa K. Joubert**  
Amgen, Inc.  
Thousand Oaks, CA

**Mouhannad Jumaa**  
Astura Therapeutics  
San Jose, CA

**Gerald B. Kasting**  
University of Cincinnati  
Cincinnati, OH

**Yukio Kato**  
Kanazawa University  
Kanazawa, Japan

**Bruce A. Kerwin**  
Just-Evotec Biologics  
Seattle, WA

**Tarik Khan**  
F. Hoffmann-LaRoche Ltd.,  
Basel, Switzerland

**Vitaliy V. Khutoryanskiy**  
University of Reading  
Reading, UK

**Sandra Klein**  
University of Greifswald  
Greifswald, Germany

**Peter Kleinebudde**  
Heinrich-Heine-Universität  
Duesseldorf, Germany

**Gregory T. Knipp**  
Purdue University  
West Lafayette, IN

**Kaoru Kobayashi**  
Meiji Pharmaceutical University  
Kiyose, Japan

**Lakshmi Prasanna Kolluru**  
Capstone Development Services  
Rosemont, IL

**Yoshiyuki Kubo**  
Teikyo University  
Itabashi, Japan

**Mary Krause**  
Bristol Myers Squibb  
New Brunswick, New Jersey  
United States of America

**Ozan Kumru**  
University of Kansas  
Lawrence, KS

**Yurong Lai**  
Gilead Sciences Inc.  
Foster City, CA

**William J. Lambart**  
Module 3 Pharmaceutical Consulting  
Incline Village, NV

**Margaret Landis**  
Pfizer, Inc.  
Cambridge, MA

**Robert S. Langer**  
Massachusetts Institute of  
Technology, Cambridge, MA

**Devalina Law**  
Abbvie Inc.  
North Chicago, IL

**David Lechuga-Ballesteros**  
AstraZeneca Pharmaceuticals LP  
South San Francisco, CA

**Woojin Lee**  
Seoul National University  
Seoul, Korea

**S. Kevin Li**  
University of Cincinnati  
Cincinnati, OH

**Wilna Liebenberg**  
North-West University  
Potchefstroom, South Africa

**Thorsteinn Loftsson**  
University of Iceland  
Reykjavik, Iceland

**Antonio Lopalco**  
University of Bari  
Bari, Italy

**Kazuya Maeda**  
Kitasato University  
Tokyo, Japan

**Krishna Mallela**  
University of Colorado  
Aurora, CO

**Amedeo Marini**  
CSGleUniversity of Pavia  
Pavia, Italy

**Alessandra Maroni**  
Università degli Studi di Milano  
Milano, Italy

**Patrick J. Marsac**  
University of Kentucky  
Lexington, KY

**Satoshi Masuda**  
Himeji Dokkyo University  
Himeji, Japan

**Michael B. Maurin**  
Maurin Healthcare Consulting  
Wilmington, DE

**Gary McGeorge**  
Bristol-Myers Squibb  
New Brunswick, NJ

**Patrick J. McNamara**  
University of Kentucky  
Lexington, KY

**Natalie Medlicott**  
University of Otago  
Dunedin, New Zealand

**Alice Melocchi**  
University of Milan  
Milan, Italy

**Danforth P. Miller**  
Respira Therapeutics  
Burlingame, CA

**Saliha Moutaharrik**  
University of Milan  
Milan, Italy

**José Ramón Moyano-Méndez**  
University of Seville  
Seville, Spain

**Qingxin Mu**  
University of Washington  
Seattle, WA

**Anette Müllertz**  
University of Copenhagen  
Copenhagen, Denmark

**Eric Munson**  
Purdue University  
West Lafayette, IN

**Miki Nakajima**  
Kanazawa University  
Kanazawa, Japan

**Takeo Nakanishi**  
Takasaki University of Health and  
Welfare,  
Takasaki, Japan

**Ashwini Nangia**  
University of Hyderabad  
Hyderabad, India

**Ajit S. Narang**  
ORIC Pharmaceuticals, Inc.,  
South San Francisco, CA

**Padma Narayan**  
SAGE Therapeutics, Inc.  
Cambridge, MA

**Linda Owers Narhi**  
Genentech Inc.  
Camarillo, CA

**Marino Nebuloni**  
University of Parma  
Parma, Italy

**Joseph A. Nicolazzo**  
Monash University  
Parkville, Australia

**Haichen Nie**  
Teva Pharmaceutical Industries Ltd  
West Chester, PA

**Tomohiro Nishimura**  
Keio University  
Tokyo, Japan

**Noriko Ogawa**  
Aichi Gakuin University  
Aichi, Japan

**Satoshi Ohtake**  
Pfizer, Inc.  
Chesterfield, MO

**Sumio Ohtsuki**  
Kumamoto University  
Kumamoto, Japan

**Tomoyuki Okuda**  
Meijo University  
Nagoya, Japan

**Takashi Okura**  
Teikyo University  
Tokyo, Japan

**Tetsuya Ozeki**  
Nagoya City University  
Nagoya, Japan

**Luca Palugan**  
University of Milan  
Milan, Italy

**Jayanth Panyam**  
University of Minnesota  
Minneapolis, MN

**Yvonne Perrie**  
University of Strathclyde  
Glasgow, Scotland

**Christopher J.H. Porter**  
Monash University  
Melbourne, Australia

**Ashana Puri**  
East Tennessee University  
Johnson City, TN

**Wei Qi**  
Amgen Inc.  
Thousand Oaks, CA

**Thomas Rades**  
Copenhagen University  
København, Denmark

**Amber Haynes Raines**  
KBI Biopharma  
Pickens, SC

**Roger A. Rajewski**  
University of Kansas  
Lawrence, KS

**Radha Ramakrishnan**  
Bristol-Myers Squibb  
Lawrenceville, NJ

**Theodore W. Randolph**  
University of Colorado  
Boulder, CO

**Jukka Rantanen**  
University of Copenhagen  
Copenhagen, Denmark

**Christopher J. Roberts**  
University of Delaware  
Newark, DE

**Mark C. Rogge**  
Takeda Pharmaceutical Company  
Concord, MA

**Brian Rohrs**  
Bausch & Lomb  
Rochester, NY

## EDITORIAL ADVISORY BOARD (Continued)

---

**Larry Rosen**  
VenatoRx Pharmaceuticals  
Malvern, PA

**Amy S. Rosenberg**  
EpiVax, Inc., Providence, RI

**Silvia Rossi**  
University of Pavia  
Pavia, Italy

**Alfred C.F. Rumondor**  
Bristol-Myers Squibb  
Raritan, NJ

**Anna Schwendeman**  
University of Michigan  
Ann Arbor, MI

**Abu T. M. Serajuddin**  
St. John's University  
Queens, NY

**Teruna J. Siahaan**  
University of Kansas  
Lawrence, KS

**William James Smith**  
Merck & Co., Inc.  
West Point, PA

**Tomas Sou**  
Uppsala University  
Uppsala, Sweden

**Pierre Souillac**  
Shire, Lexington, MA

**David Spencer**  
Ipsen  
Wrexham, UK

**William C. Stagner**  
Campbell University  
Apex, NC

**Robert M. Straubinger**  
University at Buffalo, SUNY  
Buffalo, NY

**Robert G. Strickley**  
Pliant Therapeutics  
San Mateo, CA

**Yongchao Su**  
Merck & Co.  
Kenilworth, NJ

**Changquan Calvin Sun**  
University of Minnesota  
Minneapolis, MN

**Raj G. Suryanarayanan**  
University of Minnesota  
Minneapolis, MN

**David R. Taft**  
Long Island University  
Brooklyn, NY

**Yun K. Tam**  
Sinoveda Canada Inc.  
Edmonton, Alberta, Canada

**Ikumi Tamai**  
Kanazawa University  
Kanazawa, Japan

**Lynne S. Taylor**  
Purdue University  
West Lafayette, IN

**Ravindra Tejwani**  
ACADIA Pharmaceuticals Inc.  
Princeton, NJ

**Allen C. Templeton**  
Merck Research Laboratories  
Rahway, NJ

**Frank-Peter Theil**  
UCB Biopharma  
Brussels, Belgium

**Mike Tobyn**  
Bristol-Myers Squibb  
Moreton, UK

**Masatoshi Tomi**  
Keio University  
Tokyo, Japan

**Natalie Trevaskis**  
Monash University  
Parkville, Australia

**Francesco Trotta**  
University of Torino  
Torino, Italy

**Nicolas Tsapis**  
Université Paris-Saclay  
Châtenay-Malabry, France

**Yasuo Uchida**  
Tohoku University  
Sendai, Japan

**Susumu Uchiyama**  
Osaka University  
Osaka, Japan

**Marco van de Weert**  
University of Copenhagen  
Copenhagen, Denmark

**Guy Van den Mooter**  
University of Leuven (KU Leuven)  
Leuven, Belgium

**Michel Vert**  
University of MontpellierCNRS  
Montpellier, France

**David Volkin**  
University of Kansas  
Lawrence, KS

**Jan L. Wahlstrom**  
Amgen, Inc.  
Thousand Oaks, CA

**Paul Walsh**  
AbbVie Inc.  
North Chicago, IL

**Nicholas Warne**  
Pfizer  
Andover, MA

**Adrian C. Williams**  
University of Reading  
Reading, UK

**Desmond B. Williams**  
University of South Australia  
Adelaide, Australia

**Gerhard Winter**  
LMU München  
München, Germany

**Tian Wu**  
Affamed Therapeutics  
Thousand Oaks, CA

**Qingguo Xu**  
Virginia Commonwealth University  
Richmond, VA

**Samuel H. Yalkowsky**  
University of Arizona  
Tucson, AZ

**Fumiyoshi Yamashita**  
Kyoto University  
Kyoto, Japan

**Mehran Yazdani**  
Teva Pharmaceuticals  
West Chester, PA

**Etsuo Yonemochi**  
Hoshi University  
Shinagawa-Ku, Japan

**Kouichi Yoshinari**  
University of Shizuoka  
Shizuoka, Japan

**Bi-Botti Celestin Youan**  
University of Missouri-Kansas City,  
Kansas City, MO

**Hiroaki Yuasa**  
Nagoya City University  
Nagoya, Japan

**J. Axel Zeitler**  
University of Cambridge  
Cambridge, UK

**Lucia Zema**  
Università degli Studi di Milano  
Milan, Italy

**Ming Zhang**  
SUNY Buffalo  
Amherst, NY

**Qi (Tony) Zhou**  
Purdue University  
West Lafayette, IN