

# diabetes®

**EDITOR IN CHIEF**

Martin G. Myers Jr., MD, PhD

**SENIOR ASSOCIATE EDITORS**

David A. D'Alessio, MD

Maureen A. Gannon, PhD

Randy J. Seeley, PhD

**ASSOCIATE EDITORS**

Karin Bornfeldt, PhD  
 Frank C. Brosius, MD  
 Charles F. Burant, MD, PhD  
 Alessandro Doria, MD, PhD  
 James Granneman, PhD  
 Maria B. Grant, MD, FARVO

Kevan C. Herold, MD  
 Jeffrey F. Horowitz, PhD  
 Jiandie D. Lin, PhD  
 Carey Nien-Kai Lumeng, MD, PhD  
 Ormond A. MacDougald, PhD  
 Massimo Pietropaolo, MD

Rodica Pop-Busui, MD, PhD  
 Leslie Satin, PhD  
 Mansur E. Shomali, MD, CM  
 Doris A. Stoffers, MD, PhD  
 Morris F. White, PhD

**EDITORIAL BOARD**

Laura C. Alonso, MD  
 David A. Antonetti, PhD  
 Alan D. Attie, PhD  
 Julio E. Ayala, PhD  
 Manuela Bartoli, PhD  
 Bryan C. Bergman, PhD  
 David A. Bernlohr, PhD  
 Pengpeng Bi, PhD  
 Shawn C. Burgess, PhD  
 Julia V. Busik, PhD  
 Lu Cai, MD, PhD  
 Nigel A. Calcutt, PhD  
 Jonathan E. Campbell, PhD  
 William P. Cawthorn, PhD  
 Sheila Collins, PhD  
 Robert V. Considine, PhD  
 Marc Y. Donath, MD  
 Lena Eliasson, PhD  
 Sven Enerback, MD, PhD  
 Carmela Evans-Molina, MD, PhD  
 Jorge Ferrer, MD, PhD, FMedSci  
 Patrick Fueger, PhD  
 Katherine A. Gallagher, MD  
 Adolfo Garcia-Ocaña, PhD  
 Paula Goforth, PhD

Maria L. Golson, PhD  
 Bret H. Goodpaster, PhD  
 Laurie J. Goodyear, PhD  
 Struan F.A. Grant, PhD  
 Susan B. Gurley, MD, PhD  
 Eric Hajduch, PhD  
 Alyssa Hasty, PhD  
 Mark A. Herman, MD  
 Ken Inoki, MD, PhD  
 Masao Kaneki, MD, PhD  
 Young-Bum Kim, PhD  
 Michelle E. Kimple, PhD  
 Brian T. Layden, MD, PhD  
 Chih-Hao Lee, MD  
 Moshe Levi, MD, MS  
 Xiaoying Li, MD, PhD  
 Susanne Mandrup, PhD  
 Kieren J. Mather, MD, FRCPC  
 Clayton Mathews, PhD  
 Rory J. McCrimmon, MD, MBChB  
 Aaron W. Michels, MD  
 Daniel J. Moore, MD, PhD  
 Gregory J. Morton, PhD  
 Rama Natarajan, PhD  
 David P. Olson, MD, PhD  
 Edwards A. Park, PhD

Subramaniam Pennathur, MD  
 Diego Perez-Tilve, PhD  
 Vincent Poitout, DVM, PhD  
 Matthew J. Potthoff, PhD  
 Matthew Rodeheffer, PhD  
 Patrick Rorsman, PhD  
 Liangyou Rui, PhD  
 Darleen Sandoval, PhD  
 Gaetano Santulli, MD, PhD  
 Philipp E. Scherer, PhD  
 Gary J. Schwartz, PhD  
 Show-Ling Shyng, PhD  
 Scott Soleimanpour, MD  
 Andreas Stahl, PhD  
 Jacqueline M. Stephens, BS, PhD  
 Lori Sussel, PhD  
 Anders Tengholm, PhD  
 Peter Tontonoz, MD, PhD  
 Vincenzo Trischitta, MD  
 Fumihiko Urano, MD, PhD  
 Adrian Vella, MD  
 Matthew Watt, PhD  
 Li Wen, MD, PhD  
 Christian Wolfrum, PhD  
 Yang Kevin Xiang, PhD

**AMERICAN DIABETES ASSOCIATION OFFICERS**

**CHAIR OF THE BOARD**  
 David J. Herrick, MBA

**PRESIDENT, MEDICINE & SCIENCE**  
 Louis H. Philipson, MD, PhD, FACP

**PRESIDENT, HEALTH CARE & EDUCATION**  
 Gretchen Youssef, MS, RD, CDE

**SECRETARY/TREASURER**  
 Brian Bertha, JD, MBA

**CHAIR OF THE BOARD-ELECT**  
 Umesh Verma

**PRESIDENT-ELECT, MEDICINE & SCIENCE**  
 Robert H. Eckel, MD

**PRESIDENT-ELECT, HEALTH CARE & EDUCATION**  
 Mary de Groot, PhD

**SECRETARY/TREASURER-ELECT**  
 Martha Parry Clark, MBA

**CHIEF EXECUTIVE OFFICER**  
 Tracey D. Brown, MBA, BChE

**CHIEF SCIENTIFIC, MEDICAL & MISSION OFFICER**  
 William T. Cefalu, MD



*The mission of the American Diabetes Association is to prevent and cure diabetes and to improve the lives of all people affected by diabetes.*

# diabetes®

## Mission Statement for *Diabetes*

*Diabetes* publishes original research about the physiology and pathophysiology of diabetes mellitus. Submitted manuscripts can report any aspect of laboratory, animal, or human research. Emphasis is on investigative reports focusing on areas such as the pathogenesis of diabetes and its complications, normal and pathological pancreatic islet function and intermediary metabolism, pharmacological mechanisms of drug and hormone action, and biochemical and molecular aspects of normal and abnormal biological processes. Studies in the areas of diabetes education or the application of accepted therapeutic and diagnostic approaches to patients with diabetes are not published. More information about the journal can be found online at [diabetes.diabetesjournals.org](http://diabetes.diabetesjournals.org).

Copyright © 2019 by the American Diabetes Association, Inc. All rights reserved. Printed in the USA. Requests for permission to reuse content should be sent to Copyright Clearance Center at [www.copyright.com](http://www.copyright.com) or 222 Rosewood Dr., Danvers, MA 01923; phone: (978) 750-8400; fax: (978) 646-8600. Requests for permission to translate should be sent to Permissions Editor, American Diabetes Association, at [permissions@diabetes.org](mailto:permissions@diabetes.org).

The American Diabetes Association reserves the right to reject any advertisement for any reason, which need not be disclosed to the party submitting the advertisement.

Commercial reprint orders should be directed to Sheridan Content Services, (800) 635-7181, ext. 8065.

Single issues of *Diabetes* can be ordered by calling toll-free (800) 232-3472, 8:30 A.M. to 5:00 P.M. EST, Monday through Friday. Outside the United States, call (703) 549-1500. Rates: \$75 in the United States, \$95 in Canada and Mexico, and \$125 for all other countries.

*Diabetes* is available online at [diabetes.diabetesjournals.org](http://diabetes.diabetesjournals.org). Please call the numbers listed above, e-mail [membership@diabetes.org](mailto:membership@diabetes.org), or visit the online journal for more information about submitting manuscripts, publication charges, ordering reprints, subscribing to the journal, becoming an ADA member, advertising, permission to reuse content, and the journal's publication policies.

PRINT ISSN 0012-1797

ONLINE ISSN 1939-327X

PRINTED IN THE USA

Periodicals postage paid at Arlington, VA, and additional mailing offices.

---

## AMERICAN DIABETES ASSOCIATION PERSONNEL AND CONTACTS

ASSOCIATE PUBLISHER,  
SCHOLARLY JOURNALS  
Christian S. Kohler

TECHNICAL EDITORS  
Theresa Cooper  
Donna J. Reynolds

Tina Auletta  
Senior Account Executive  
[tauletta@diabetes.org](mailto:tauletta@diabetes.org)  
(703) 549-1500, ext. 4809

EDITORIAL OFFICE DIRECTOR  
Lyn Reynolds

DIRECTOR, MEMBERSHIP/  
SUBSCRIPTION SERVICES  
Donald Crowl

PHARMACEUTICAL/DEVICE DIGITAL ADVERTISING  
The Walchli Tauber Group  
Maura Paoletti  
National Sales Manager  
[maura.paoletti@wt-group.com](mailto:maura.paoletti@wt-group.com)  
(443) 512-8899, ext. 110

PEER REVIEW MANAGER  
Jane Castner

SENIOR ADVERTISING MANAGER  
Julie DeVoss Graff  
[jgraff@diabetes.org](mailto:jgraff@diabetes.org)  
(703) 299-5511

ASSOCIATE MANAGERS, PEER REVIEW  
Joan Garrett  
Larissa Pouch

ADVERTISING REPRESENTATIVES  
AMERICAN DIABETES ASSOCIATION  
Paul Nalbandian  
Associate Publisher, Advertising & Sponsorships  
[pnalbandian@diabetes.org](mailto:pnalbandian@diabetes.org)  
(703) 549-1500, ext. 4806

DIRECTOR, SCHOLARLY JOURNALS  
Heather Norton Blackburn