

Cancer Research

Driving Innovation to Prevent and Cure Cancer

AAGR

American Association
for Cancer Research

AN OFFICIAL JOURNAL OF THE AMERICAN ASSOCIATION FOR CANCER RESEARCH

Editor-in-Chief

George C. Prendergast

Executive Editor

Judy N. Quong

Meeting Reports

Deputy Editor, Mariano Barbacid

Breaking Advances

Deputy Editor, William A. Weiss

Editors

Paul B. Fisher
Rani George
Johanna Ivaska
Rushika M. Perera
Vijay Ramaswamy
David J. Robbins
Phuoc T. Tran

Reviews

Deputy Editor, Danny R. Welch

Editors

Jeremy R. Graff
Harikrishna Nakshatri

Senior Editors

Molecular & Cellular Pathobiology

Steven P. Balk
Junjie Chen
Mark W. Dewhirst
Masanobu Oshima
Joseph R. Testa

Tumor & Stem Cell Biology

Laura E. Benjamin
David D.L. Bowtell
Rolf A. Brekken
Suzanne D. Conzen
Elsa R. Flores
Nancy E. Hynes
Fumihiko Ishikawa
Marcelo G. Kazanietz
Toshikazu Ushijima

Therapeutics, Targets & Chemical Biology

Rebecca G. Bagley
Robert Clarke
Antonio T. Fojo
Janet A. Houghton
William G. Nelson
Yves Pommier
David B. Solit
Kenneth D. Tew

Microenvironment & Immunology

Hellmut G. Augustin
Christophe Caux
Mario P. Colombo
Yves A. DeClerck
Dmitry I. Gabrilovich
Kornelia Polyak
Mark J. Smyth

Integrated Systems & Technologies

Martin W. Brechbiel
Trachette L. Jackson
Sofia D. Merajver
John Quackenbush
David W. Speicher

Clinical Studies

Theodore S. Lawrence

Prevention & Epidemiology

James R. Cerhan
Saraswati Sukumar

Editorial Staff

Assistant Editor

Amanda Valeta-Magara

Assistant Managing Editor

Jeremy Rosenberg

Editorial Staff

Jamie M. Dunleavy
Julie E. Kostelnik
Catherine Rachfalski
Brittany Rubio

Production Manager

Brenda Roberson

Editorial Office: *Cancer Research* [ISSN: 0008-5472 (Print); ISSN: 1538-7445 (Online)] is published twice a month, one volume per year, by the American Association for Cancer Research, Inc. Periodicals postage paid at Philadelphia, PA, and additional mailing offices. POSTMASTER: Send address changes to *Cancer Research*, Member Services, AACR, 615 Chestnut Street, 17th Floor, Philadelphia, PA 19106-4404 or E-mail: membership@aacr.org. Copyright 2017 the American Association for Cancer Research, Inc. © The paper used in this publication meets the requirements of ANSI/NISO Z39.48-1992 (Permanence of Paper).

Cancer Research

Driving Innovation to Prevent and Cure Cancer

AAGR

American Association
for Cancer Research

AN OFFICIAL JOURNAL OF THE AMERICAN ASSOCIATION FOR CANCER RESEARCH

Editorial Board

Cory Abate-Shen
Kari Alitalo
Shrikant Anant
Alexander R.A. Anderson
Andrea Anichini
Lionel Apetoh
Andrew E. Aplin
Manuela Baccarini
Frances Balkwill
William T. Baumann
Gregory L. Beatty
Fariba Behbod
Simon Bekker-Jensen
Nathalie Bendriss-Vermare
Mohamed Bentires-Alj
Gabriele Bergers
Rupal S. Bhatt
Nelson E. Brown
Kerry L. Burnstein
Lisa H. Butterfield
George A. Calin
Peter T. Campbell
Elias Campo
Jason S. Carroll
Timothy A. Chan
Alain Charest
Murali K. Cherukuri
Soumitra Kumar Choudhuri
Lena Claesson-Welsh
Justin A. Colacino
Michael Cole
David V. Conti
Ryan B. Corcoran
Michele L. Cote
Chi Van Dang
Phillip K. Darcy
Olivier De Wever
Nicholas Denko
Pier Paolo Di Fiore
J. Alan Diehl
Dan A. Dixon
Frank C. Dorsey
Ronny Drapkin
Bertrand Dubois
Jeanette E. Eckel-Passow
Kristin A. Eckert
Wafik El-Deiry
Leisha Emens
Heiko Enderling
Matthias Ernst
Felix Y. Feng
Martin E. Fernandez-Zapico
Adolfo A. Ferrando
Soldano Ferrone
Barbara Fingleton
Paul B. Fisher
David A. Frank
Simone Fulda

Joel R. Garbow
Kevin Gardner
Stephan Gasser
Irwin H. Gelman
Edward P. Gelmann
Francois Ghiringhelli
Silvia Giordano
David Gius
Jeremy R. Graff
Steven Grant
Florian Greten
Tim F. Greten
Heidi E. Greulich
Sergei Grivennikov
Marc J. Gunter
William C. Hahn
Kevin M. Haigis
John Hanover
Reuben S. Harris
Mathias Heikenwälder
Beate Heissig
Kristian Helin
Thomas Helleday
Mary J.C. Hendrix
James G. Herman
Stephan Herzig
Haojie Huang
Ruby Yun-Ju Huang
Ying Huang
Kent Hunter
M. Luisa Iruela-Arispe
Jennifer S. Isaacs
Jean-Pierre J. Issa
Tomoo Iwakuma
Jos Jonkers
Vijai Joseph
David M. Kaetzel
Antoine E. Karnoub
Joseph L. Kissil
Jan K. Kitajewski
Jorg Kleeff
Celina G. Kleer
Alexander L. Klibanov
Gou Young Koh
Mikhail G. Kolonin
Natalia Komarova
Yutaka Kondo
Wilhelm Krek
Guido Kroemer
Kenneth A. Krohn
Marieke L. Kuijjer
Charlotte Kuperwasser
Natasha Kyprianou
James V. Lacey
Marikki Laiho
Lucia R. Languino
John Laterra

Valerie LeBleu
Doron Levy
Claire E. Lewis
Da-Qiang Li
Jonathan Licht
Hui-Kuan Lin
Carlos López-Otin
James B. Lorens
Zhenkun Lou
M. Scott Lucia
David Lyden
Conor C. Lynch
James Lyons-Weiler
David MacPherson
Carlo C. Maley
Richard Marais
Andrea M. Mastro
Masao Matsuoka
Massimiliano Mazzone
Sandra S. McAllister
Cornelis J.M. Melief
Yubin Miao
John D. Minna
Michael A. Morgan
Lindsay M. Morton
Muriel Moser
Hidayatullah G. Munshi
Junko Murai
Maureen E. Murphy
Ruth J. Muschel
Senthil K. Muthuswamy
Harikrishna Nakshatri
Yulia Nefedova
Kenneth P. Nephew
Daniel Normolle
Steffi Oesterreich
Hideho Okada
Monilola A. Olayioye
Gilbert S. Omenn
Arne Östman
Akhilesh Pandey
Klaus Pantel
Gray W. Pearson
Linda Z. Penn
Gerd P. Pfeifer
Wayne A. Phillips
Thuy L. Phung
Kristian Pietras
Sean Post
Ludmila Prokunina-Olsson
Derek C. Radisky
Dan Raftery
Ajay Rana
V. Ashutosh Rao
Gregory J. Riggins
Julien Sage
Jann N. Sarkaria

Dieter Saur
Edward Sausville
Matthew B. Schabath
Andrew E. Schade
Clemens A. Schmitt
Santiago Schnell
Katia Scotlandi
Ralph Scully
Oliver John Semmes
Natalie J. Serkova
Louise C. Showe
Xiao-Ou Shu
Maria Sibilila
Jill M. Siegfried
Pierre Sonveaux
Douglas R. Spitz
M. Sharon Stack
John Stagg
Anil Suri
Hiromu Suzuki
Kristin R. Swanson
Joann B. Sweasy
Russell S. Taichman
Rulla M. Tamimi
Patrick Tan
Eric Tartour
Daniela Taverna
Jeremy M.G. Taylor
Beverly A. Teicher
Rajeshwar R. Tekmal
Anna Teti
Dan Theodorescu
Anish Thomas
Alex Toker
Vladimir Tolmachev
Richard W. Tothill
Danyelle M. Townsend
Claudio Tripodo
Melissa A. Troester
Kenneth Tsai
Viktor Umansky
Pierre van der Bruggen
Guus A.M.S. van Dongen
Jo A. Van Ginderachter
Thierry Walzer
Jeffrey S. Weber
Ashani T. Weeraratna
Wenyi Wei
Alana L. Welm
Jedd D. Wolchok
Gerburg Wulf
Yasuhiro Yamada
Srinivasan Yegnasubramanian
Xiaochun Yu
Lin Zhang
Lee Zou
Weiping Zou

Cancer Research

Publishing Information

AACR

American Association
for Cancer Research

Print ISSN: 0008-5472 • Online ISSN: 1538-7445

AACR Officers

Michael A. Caligiuri, President
Elizabeth M. Jaffee,
President-Elect
Nancy E. Davidson,
Past President
William N. Hait, Treasurer
Margaret Foti, Chief Executive
Officer

Publications Committee

Mary Helen Barcellos-Hoff
Alberto Bardelli
Dafna Bar-Sagi
Michael E. Berens
René Bernards
John D. Carpten
Federic J. de Sauvage
Keith T. Flaherty
Sanjiv Sam Gambhir
Maura L. Gillison
William N. Hait, *Ex officio*
Elizabeth M. Jaffee
Pasi A. Jänne
Roy A. Jensen
Jonathan D. Licht
Steffi Oesterreich
Helen M. Piwnica-Worms
Charles W.M. Roberts
Lillian L. Siu
David B. Solit
Saraswati V. Sukumar
Toshikazu Ushijima
Victor E. Velculescu,
Chairperson

Publishing Staff

Publisher

Christine B. Rullo

Director, Journal Operations and Systems

Daniel S. Evanko

Director, Journal Sales and Marketing

Nicola L. Hill

Director, Digital Publishing

Robert Spanier

Associate Director, Production

Charlene Squibb

Assistant Director, Institutional Sales & Outreach

Karola Rac

Marketing and Creative Services

Senior Director

Paul Driscoll

Design Staff

Susan Moore

Scope

Cancer Research publishes original studies, reviews, and opinion pieces offering significance and broad impact to a diverse audience spanning basic, preclinical, clinical, prevention, and epidemiologic research. *Cancer Research* seeks manuscripts that offer pathobiological and translational impact to inform the personal, clinical, and societal problems posed by cancer. The main scope of the Journal is captured in its primary subsections, which focus on molecular and cellular pathobiology, tumor and stem cell biology, therapeutics and targets, microenvironment and immunology, prevention and epidemiology, and integrated systems and technology.

Cancer Research is abstracted and/or indexed in Current Contents/Clinical Medicine, MEDLINE, Science Citation Index, Scopus, and Web of Science.

Submission of Manuscripts

Online submission of manuscripts is welcomed at <http://can.msubmit.net>. Before submitting a manuscript, please read the Instructions for Authors, which are available from the Journal's home page at <http://cancerres.aacrjournals.org>.

Publication Charges

Beginning with manuscripts submitted January 1, 2016 or after, articles will be published with the understanding that the author(s) will pay both a publication fee plus a color figure handling fee. Please see the Instructions for Authors, which are available from the Journal's home page at <http://cancerres.aacrjournals.org>.

Subscription Information

Nonmember Individuals

Subscriptions include print version with online access. Contacts listed below are for nonmember individual subscriptions.

USA and Rest of World (excluding Japan)
American Association for Cancer Research, 615 Chestnut Street, Philadelphia, PA 19106;
1-855-744-4667; pubsales@aacr.org

Japan

e-support@maruzen.co.jp;
journal@kinokuniya.co.jp; usaco@usaco.co.jp

International print subscriptions include cost of surface mail. Expedited mailing is available. Contact the American Association for Cancer Research for rates.

Site Licenses

For information about institutional site licenses, contact pubsales@aacr.org.

AACR Members

AACR members may opt to receive either a print subscription with online access to content or an online-only subscription. Contact membership@aacr.org or visit the membership page at www.aacr.org for more information.

Single Issue Sales

Subject to their availability, single or back issues may be purchased for \$60 (U.S.) or \$65 (outside the U.S.) each. The cost must be prepaid. Contact pubsales@aacr.org.

Claims

One-time claims for missing issues made within 120 days of the issue's publication will be honored, subject to availability. No credit or refund will be given if an issue is out of print at the time of claim.

AACR Members

membership@aacr.org

Nonmembers and Institutions

pubsales@aacr.org

Advertising Information

For information about advertising in AACR journals, contact Pharmaceutical Media Inc., 30 East 33rd St., 4th Floor, New York, NY, 10016; 212-904-0360; Dsimone@pminy.com.

Copyright and Permissions

Content printed in or disseminated by *Cancer Research* is protected by copyright. Authors who wish to publish material in *Cancer Research* must formally transfer copyright to the AACR. All authors must sign copyright transfer forms before the AACR can proceed with publication.

To read the complete AACR Copyright and Permissions Policy, visit <http://aacrjournals.org/content/authors/copyright-permissions-and-access>.