



# Cancer Research

OFFICIAL JOURNAL OF THE AMERICAN ASSOCIATION FOR CANCER RESEARCH

**American Association for  
Cancer Research, Inc.**

**Publications Staff**

**Managing Editor**  
Margaret Foti

**Assistant Managing Editor**  
Mary Anne Mennite

**Production Manager**  
Heide M. Puszta

**Staff Editor**  
Martha Michael

**Editorial Assistants**  
Mary Elizabeth Barr  
Angela Barry  
Gabrielle Vail  
Linda Pote Musumeci

**Supervisor, Manuscript  
Processing**  
Margaret A. Pickels

**Editorial Secretaries**  
Theresa A. Griffith  
Mary Ellen Piring  
June A. Holloway  
Valerie L. Taylor

**Administrative Staff**  
**Executive Director**  
Margaret Foti

**Associate Director of  
Administration**  
Adam D. Blistein

**Senior Accountant**  
Anthony P. Blengino

**Financial Assistant**  
George L. Moore

**Meetings and Development  
Coordinator**  
Jeffrey M. Ruben

**Executive Assistant for  
Programs**  
Ruth E. Fortson

**Administrative Assistant**  
Elizabeth A. Moore

**Secretary for Member Services**  
Robin E. Felder

**Editorial Secretary**  
Diana F. Certo

**Editor-in-Chief**  
Carlo M. Croce

**Associate Editors**

Stuart A. Aaronson  
Jerry M. Adams  
David S. Alberts  
William M. Baird  
Charles M. Balch  
Allan Balmain  
Mariano Barbacid  
J. Carl Barrett  
Renato Baserga  
William T. Beck  
Thomas L. Benjamin  
John M. Bennett  
June L. Biedler  
Clara D. Bloomfield  
Peter M. Blumberg  
Gianni Bonadonna  
G. Tim Bowden  
Luther W. Brady  
Norman Breslow  
Edward Bresnick  
Samuel Broder  
Sam C. Brooks  
Ronald N. Buick  
C. Patrick Burns  
Bruno Calabretta  
Robert L. Capizzi  
Bruce A. Chabner  
Yung-chi Cheng  
David Colcher  
Allan H. Conney  
Neal G. Copeland  
Joseph G. Cory  
Jeffrey Cossman  
Frank Costantini  
Benoit de Crombrughe  
Riccardo Dalla-Favera  
Richard L. Davidson

Mark M. Davis  
Eugene R. DeSombre  
T. Michael Dexter  
Ralph E. Durand  
Alan Eastman  
Gertrude B. Elion  
Lois B. Epstein  
Leonard C. Erickson  
M. Essex  
Emmanuel Farber  
Nelson Fausto  
Isaiah J. Fidler  
Robert A. Floyd  
Judah Folkman  
Kenneth A. Foon  
Joseph F. Fraumeni, Jr.  
Errol C. Friedberg  
Philip Frost  
Minoru Fukuda  
Philip Furmanski  
Eugene W. Gerner  
Leo E. Gerweck  
Eli Glatstein  
David W. Golde  
Michael M. Gottesman  
Joel S. Greenberger  
J. W. Grisham  
Sen-itiroh Hakomori  
Uli Hammerling  
Philip C. Hanawalt  
Nabil Hanna  
Curtis C. Harris  
Jules E. Harris  
John C. Harshbarger  
Stephen S. Hecht  
Ingegerd Hellstrom  
Brian E. Henderson

Gloria H. Heppner  
Russell Hill  
Richard B. Hochberg  
Tasuku Honjo  
Kay Huebner  
James N. Ihle  
John T. Isaacs  
Mark A. Israel  
Rakesh K. Jain  
Peter A. Jones  
V. Craig Jordan  
Robert F. Kallman  
Ann R. Kennedy  
Robert S. Kerbel  
Young S. Kim  
Tadamitsu Kishimoto  
Alfred G. Knudson, Jr.  
Kurt W. Kohn  
Laurence N. Kolonel  
Donald W. Kufe  
John S. Lazo  
Brigid G. Leventhal  
Jay A. Levy  
Frederick P. Li  
Michael W. Lieberman  
Victor Ling  
Lance A. Liotta  
Martin Lipkin  
Marc E. Lippman  
Gerald Litwack  
Leroy F. Liu  
Kenneth O. Lloyd  
Lawrence A. Loeb  
Dan L. Longo  
Diana M. Lopez  
Reuben Lotan  
James W. Lown

David B. Ludlum  
Tak W. Mak  
Laurence J. Marton  
Michael J. Mastrangelo  
Anna T. Meadows  
Myron R. Melamed  
John Mendelsohn  
Thomas C. Merigan  
Christopher J. Michejda  
John D. Minna  
Malcolm S. Mitchell  
Richard R. Monson  
Harold L. Moses  
Sharon B. Murphy  
Garth L. Nicolson  
Kenneth Nilsson  
Jeffrey A. Norton  
Peter C. Nowell  
Peter J. O'Dwyer  
Kenneth Olden  
Gilbert S. Omenn  
C. Kent Osborne  
Robert F. Ozols  
Michael A. Palladino, Jr.  
Peter L. Pedersen  
Anthony E. Pegg  
Angel Pellicer  
Bice Perussia  
Sidney Pestka  
Cecil B. Pickett  
W. J. Pledger  
Donald J. Reed  
Ralph A. Reisfeld  
Richard A. Rifkin  
Berish Y. Rubin  
Robert T. Schimke  
J. Schlessinger

Jeffrey Schlom  
Manfred Schwab  
Joseph V. Simone  
Beatrice Singer  
Francis M. Sirotnak  
Michael A. Sirover  
Arthur A. Spector  
Martha R. Stampfer  
Eric J. Stanbridge  
Gary S. Stein  
Bernard S. Strauss  
Takashi Sugimura  
Saraswati Sukumar  
James A. Swenberg  
Paul Talalay  
James E. Talmadge  
Masaaki Terada  
Snorri S. Thorgeirsson  
Donald J. Tindall  
George J. Todaro  
Douglass C. Tormey  
Jeffrey M. Trent  
Giorgio Trinchieri  
Peter Vaupel  
Ellen S. Vitetta  
Daniel D. Von Hoff  
Peter A. Ward  
Michael D. Waterfield  
Lee W. Wattenberg  
I. Bernard Weinstein  
Bengt Westermarck  
Raymond L. White  
Walter Willett  
Sheldon Wolff  
Charles W. Young  
Stuart H. Yuspa  
Harald zur Hausen

**Cover Editorial Board**  
Sidney Weinhouse,  
*Cover Editor*

Joseph H. Burchenal  
Nancy H. Colburn

Hugh J. Creech  
George H. Hitchings

Edwin A. Mirand  
John H. Weisburger

Takashi Sugimura

*Cancer Research* is sponsored by the American Association for Cancer Research, Inc. and receives major support from the American Cancer Society, Inc. Publication costs are also met by a grant from the Elsa U. Pardee Foundation.

**Subscription Information**

*Cancer Research* is published twice a month, one volume per year, by the American Association for Cancer Research, Inc. Subscriptions include the *Proceedings of the American Association for Cancer Research*, issued in April of each year. Except for members of the American Association for Cancer Research, all subscriptions are payable in advance to Waverly Press, Inc., 428 E. Preston Street, Baltimore, MD 21202, to which all business communications, remittances (in United States currency or its equivalent), and subscription orders should be sent. In Japan, send orders and inquiries to (sole agent): USACO Corporation, Tsutsumi Bldg., 13-12, Shimbashi-chome, Minato-ku, Tokyo 105, Japan; Tel. (03) 502-6471. Nonmembers of the American Association for Cancer Research within the United States may subscribe to the 1991 volume of *Cancer Research* at the rate of \$350.00 (individual and institutional nonmembers), including postage. Institutional and individual nonmembers outside of the United States should add \$60.00 to their respective rates to offset second-class postage costs. Air mail and other means of delivery are available at extra charge; contact Waverly Press for information. Changes of address notification should be sent 60 days in advance and include both old and new addresses. Member subscribers should send address changes to: Member Services, American Association for Cancer Research, Inc., Public Ledger Building, 620 Chestnut St., Suite 816, Philadelphia, PA 19106. Nonmember subscribers should notify Waverly Press of changes of address. Copies of the journal which are undeliverable because of address changes will be destroyed.

## Notice to Members of the American Association for Cancer Research

### Officers for 1991-1992

*President:* Harold L. Moses, Vanderbilt University School of Medicine, Nashville, TN 37232

*President-Elect:* Lee W. Wattenberg, University of Minnesota, Minneapolis, MN 55455

*Treasurer:* Thomas J. King, Georgetown University Medical Center, Washington, DC 20007

*Executive Director:* Margaret Foti, AACR, Public Ledger Building, 620 Chestnut St., Suite 816, Philadelphia, PA 19106.

### Annual Dues

The annual dues of active members of the American Association for Cancer Research are \$125.00 and they include a subscription to either *Cancer Research* or *Cell Growth & Differentiation*. \$160.00 covers annual dues plus subscriptions to both journals. Corresponding members of the Association should add \$60.00 to this rate to offset postage costs for *Cancer Research*. Payment of dues and changes of address of members of the Association should be sent promptly to: Member Services, American Association for Cancer Research, Inc., Public Ledger Building, 620 Chestnut St., Suite 816, Philadelphia, PA 19106 (215) 440-9300.

---

### Back Issues and Single Copy Sales of the Journal

Copies of back stock of the journal *Cancer Research* may be ordered from Waverly Press, Inc. As long as supplies permit, single copies of *Cancer Research* will be sold by this company at \$22.00 per copy for regular issues and \$22.00 per copy for Supplement issues which contain material from conferences on topics related to cancer. The annual *Proceedings of the American Association for Cancer Research* is available at \$25.00 per copy. Orders outside the U. S. and Canada add \$2.00/copy to offset postage costs.

---

### Advertisements in *Cancer Research*

Advertisement insertion orders and copy must be received 60 days prior to the date of issue in which the advertisement is to be published. The journal is mailed approximately 7 days preceding the date of issue. Inquiries about advertising should be directed to: Elizabeth Mosko, Williams and Wilkins, 428 E. Preston Street, Baltimore, MD 21202. Telephone: (301) 528-4005.

---

### Historical Cover Themes

Readers are invited to submit themes (events, persons, institutions) for consideration for the illustrated covers of *Cancer Research*. Correspondence regarding suggested cover themes, or other matters regarding covers, should be addressed to the Cover Editor, AACR Publications Department.

---

### Submission of Manuscripts

Manuscripts should be sent to the attention of: Dr. Carlo M. Croce, Editor-in-Chief, AACR Publications Department, American Association for Cancer Research, Public Ledger Building, 620 Chestnut St., Suite 816, Philadelphia, PA 19106 (215) 440-9300. If accepted, they will be listed under one of ten categories in the Table of Contents. Please specify in a covering letter which category applies to your submission: Basic Sciences section—biochemistry and biophysics, carcinogenesis, endocrinology, immunology, molecular biology and genetics, preclinical pharmacology and experimental therapeutics, tumor biology, virology; Clinical Investigations section—clinical studies, epidemiological studies. (Final categorization in the Table of Contents is at the discretion of the Editor-in-Chief.) Consult the "Instructions for Authors" printed in the January 1 issue of the journal for other submission requirements. Reprints of the "Instructions" are available upon request.

#### *Manuscript Processing Fee*

Journal policy requires that a manuscript processing fee of \$75.00 be assessed for each paper to defray the expenses incurred in the editorial review process. Each manuscript submitted for publication should be accompanied by a check (drawn on a U.S. bank) or purchase order for \$75.00 in U. S. currency, payable to *Cancer Research* at the above address. Note: If an author resubmits a manuscript that our Editors previously found unacceptable for publication, it is journal policy to consider it a new submission, assign it a new manuscript number, and charge the author another \$75.00 handling fee to cover the cost of review.

#### *Page Charges*

Accepted manuscripts will be published with the understanding that the author(s) will pay a charge of \$65.00 per printed page. Under exceptional circumstances, when no source of grant or other support exists, the author(s) may apply to Dr. Carlo M. Croce, Editor-in-Chief, at the time of submission, for a waiver of the page charges. All such applications must be countersigned by an appropriate institutional official stating that no funds are available for the payment of page charges.

#### *Copyright and Copyright Clearance Center*

The Copyright Revision Act (PL 94-553), which became effective January 1, 1978, states that the copyright of a work is vested in the author from the moment of creation. Therefore, all authors who wish to publish in *Cancer Research* must formally transfer copyright to the proprietor of the journal, the American Association for Cancer Research, Inc. It is understood by this transfer that the authors relinquish all exclusive rights of copyright ownership, including the rights of reproduction, derivation, distribution, sale, and display.

Authors who prepared their articles as part of their official duties as employees of the U. S. Federal Government are not required to transfer copyright to the American Association for Cancer Research, Inc., since these articles are considered to be in the public domain. However, it is necessary for these authors to sign the appropriate section of the transfer form. In the case of articles supported by federal grants or contracts, copyright transfer to the American Association for Cancer Research, Inc., is required. The federal government may retain a nonexclusive license to publish or republish such material.

The duly authorized agent of a commercial firm or commissioning organization must sign the transfer form if the author prepared the article as part of his or her official duties as an employee.

Appropriate forms for transfer of copyright will be sent routinely with acknowledgment of receipt of manuscripts for review. They may also be requested from the AACR Publications Department. The journal will not publish a paper unless the form is properly completed and signed.

Copies of articles for which the American Association for Cancer Research, Inc. owns the copyright may be made for personal or internal use, provided that the copier pay the per-copy fee of \$2.00 through the Copyright Clearance Center, Inc. This Center is a nonprofit organization through which individuals and institutions may reimburse a copyright owner for photocopying journal articles beyond what is defined as "fair use" in Sections 107 and 108 of the Copyright Revision Act of 1978.

Those who wish to photocopy *Cancer Research* articles may report the number of copies they have made, together with the fee code 0008-5472/91 \$02.00, to: Copyright Clearance Center, Inc., 27 Congress St., Salem, MA 01970. Remittances may be sent to the Center at the time of reporting or the Center will bill the user on a monthly basis. Deposit accounts and prepayment plans may also be arranged.

Between June 1978 and August 1983, a fee code appeared on the first page of all articles for which *Cancer Research* owned the copyright. For those issues, it is understood that any articles which did not carry this code are in the public domain.

---

*Cancer Research* is abstracted or indexed in *Biological Abstracts*, *Chemical Abstracts*, *Index Medicus*, *Science Citation Index*, and by the *International Cancer Research Data Bank*.

---

No responsibility is accepted by the Editors, by the American Association for Cancer Research, Inc., or by Waverly, Inc. for the opinions expressed by contributors or for the content of the advertisements.

*Cancer Research* (ISSN 0008-5472) is published twice a month for \$80 per year (for members of the American Association for Cancer Research) or \$350 per year (for nonmembers) by the American Association for Cancer Research, Inc. Second-class postage paid at Baltimore, MD and additional mailing offices. POSTMASTER: Send address changes to *Cancer Research*, c/o Waverly Press, Inc., 428 E. Preston Street, Baltimore, MD 21202.

Copyright 1991 by the American Association for Cancer Research, Inc.