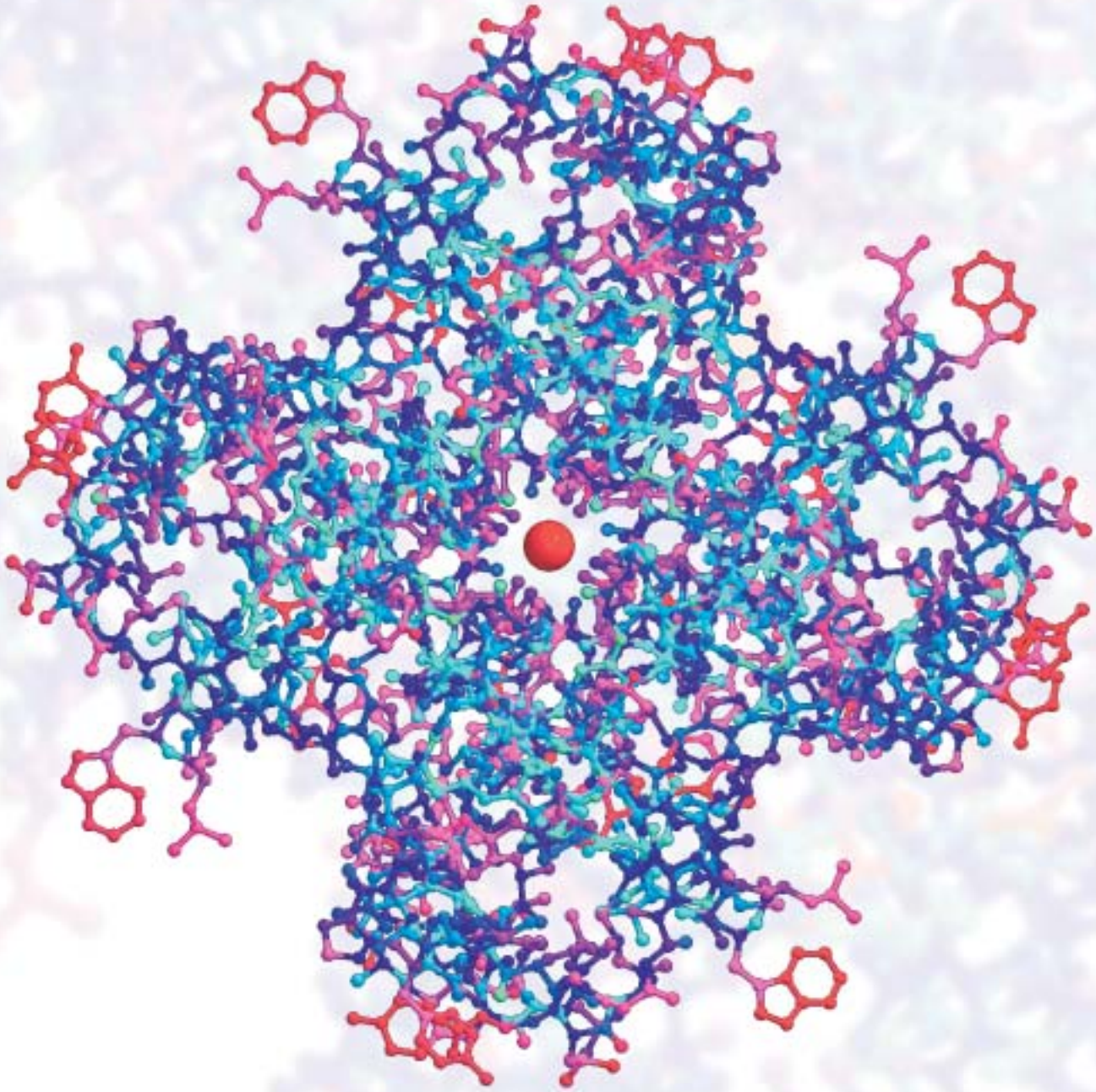
Science and Engineering Indicators 2004

Volume 1



National Science Foundation

NATIONAL SCIENCE BOARD

National Science Board

WARREN M. WASHINGTON
(Chairman), Senior Scientist and Head, Climate Change Research Section, National Center for Atmospheric Research (NCAR)

DIANA S. NATALICIO
(Vice Chair), President, The University of Texas at El Paso

BARRY C. BARISH
Linde Professor of Physics and Director, LIGO Laboratory, California Institute of Technology

STEVEN C. BEERING
President Emeritus, Purdue University

RAY M. BOWEN
President Emeritus, Texas A&M University

DELORES M. ETTER
ONR Distinguished Chair in S&T, Electrical Engineering Department, U.S. Naval Academy

NINA V. FEDOROFF
Willaman Professor of Life Sciences, Director, Life Sciences Consortium and Director, Biotechnology Institute, The Pennsylvania State University

PAMELA A. FERGUSON
Professor and Former President, Grinnell College

KENNETH M. FORD
Director, Institute for the Interdisciplinary Study of Human and Machine Cognition, University of West Florida

DANIEL HASTINGS
Professor of Aeronautics & Astronautics and Co-Director, Technology and Policy Program, Massachusetts Institute of Technology

ELIZABETH HOFFMAN
President, University of Colorado System

ANITA K. JONES
University Professor, Department of Computer Science, University of Virginia

GEORGE M. LANGFORD
Professor, Department of Biological Science, Dartmouth College

JANE LUBCHENCO
Wayne and Gladys Valley Professor of Marine Biology and Distinguished Professor of Zoology, Oregon State University, Corvallis

JOSEPH A. MILLER, JR.
Senior Vice President and Chief Technology Officer, Corning, Inc.

DOUGLAS D. RANDALL
Professor of Biochemistry and Director, Interdisciplinary Plant Group, University of Missouri–Columbia

ROBERT C. RICHARDSON
Vice Provost for Research and Professor of Physics, Department of Physics, Cornell University

MICHAEL G. ROSSMANN
Hanley Distinguished Professor of Biological Sciences, Department of Biological Sciences, Purdue University

MAXINE SAVITZ
General Manager, Technology Partnerships, Honeywell (Retired)

LUIS SEQUEIRA
J.C. Walker Professor Emeritus, Departments of Bacteriology and Plant Pathology, University of Wisconsin, Madison

DANIEL SIMBERLOFF
Nancy Gore Hunger Professor of Environmental Science, Department of Ecology and Evolutionary Biology, University of Tennessee

JO ANNE VASQUEZ
Educational Science Consultant, Gilbert, Arizona

JOHN A. WHITE, JR.
Chancellor, University of Arkansas

MARK S. WRIGHTON
Chancellor, Washington University in St. Louis

RITA R. COLWELL
Member Ex Officio and Chair, Executive Committee, Director, National Science Foundation

MICHAEL P. CROSBY
Executive Officer

National Science Board Subcommittee on Science and Engineering Indicators
Robert C. Richardson, Chair
Maxine Savitz
Daniel Simberloff
John A. White, Jr.
George M Langford, Ex Officio, Chair, Committee on Education and Human Resources
Mary Poats, Executive Secretary (former)
Cathy Hines, Executive Secretary
Norman M. Bradburn, NSF Liaison

Science and Engineering Indicators 2004

Volume 1

National Science Board

Cover Image

Model of the potassium channel in the bacterium *Streptomyces lividans.*

Roderick MacKinnon's discovery of the details of this structure and his explanation for how membranes pass electrical charge through cell walls led to his 2003 Nobel Prize in Chemistry. The potassium ion is shown in red at the center of the channel in the symmetrical structure. The surrounding four identical subunits of the protein are conserved in all known potassium ion channels. MacKinnon's work was supported by the National Institutes of Health at the Cornell High Energy Synchrotron Source (CHESS), a facility developed around an accelerator funded by the National Science Foundation originally built for studies of high-energy physics. (Cover image reprinted with permission from *Science* volume 280, number 5360, issue of 3 April 1998, copyright 1998 AAAS.)

Recommended Citation

National Science Board. 2004. *Science and Engineering Indicators 2004.* Two volumes. Arlington, VA: National Science Foundation (volume 1, NSB 04-1; volume 2, NSB 04-1A).

National Science Board

Letter of Transmittal

January 15, 2004

The Honorable George W. Bush
The President of the United States
The White House
Washington, DC 20500

Dear Mr. President:

It is my honor to transmit to you, and through you to the Congress, the sixteenth in the series of biennial Science Indicators reports, *Science and Engineering Indicators—2004*. The National Science Board submits this report in accordance with Sec. 4(j)1 of the National Science Foundation Act of 1950, as amended.

The Science Indicators series was designed to provide a broad base of quantitative information about U.S. science, engineering, and technology for use by public and private policymakers. Because of the spread of scientific and technological capabilities around the world, this report presents a significant amount of material about these international capabilities and analyzes the U.S. position in this broader context.

Science and Engineering Indicators—2004 contains quantitative analyses of key aspects of the scope, quality, and vitality of the Nation's science and engineering enterprise. The report presents information on science, mathematics, and engineering education at all levels; the scientific and engineering workforce; U.S. and international R&D performance and competitiveness in high technology; and public attitudes and understanding of science and engineering. In response to user demand, it contains a new chapter on state-level science and engineering indicators. An overview chapter presents the key themes emerging from these analyses.

This report demonstrates the strength the United States has derived from the open flow of ideas. Maintaining this openness and the relative advantage it has bestowed on the country remains crucial to the Nation's security and well-being. The proponents of openness, not those who stand ready to subvert science and technology for malevolent ends, are in the best position to exploit the fruits of science.

I hope that you, your Administration, and the Congress will find the new quantitative information and analysis in the report useful and timely for informing thinking and planning on national priorities, policies, and programs in science, engineering and technology.

Respectfully yours,

Warren M. Washington
Chairman

National Science Foundation
4201 Wilson Boulevard • Arlington, Virginia 22230 • (703) 292-7000 • http://www.nsf.gov/nsb • email: NSBoffice@nsf.gov

Acknowledgments

The National Science Board extends its appreciation to the staff of the National Science Foundation for preparing this report. Organizational responsibility for the volume was assigned to the Directorate for Social, Behavioral and Economic Sciences, Norman M. Bradburn, Assistant Director.

Primary responsibility for the production of the volume was assigned to the Science and Engineering Indicators Program under the direction of Rolf Lehming of the Division of Science Resources Statistics (SRS); Lynda T. Carlson, Division Director; Mary J. Frase, Deputy Division Director.

The authors of the manuscript were:

Overview.	Rolf Lehming, SRS
Chapter 1.	Martha Alt, Xianglei Chen, Susan Choy, Jennifer Laird, MPR Associates
Chapter 2.	Jean M. Johnson, SRS, Terry S. Woodin, EHR
Chapter 3.	Mark C. Regets, SRS
Chapter 4.	Francisco A. Moris, Brandon Shackelford, SRS
Chapter 5.	Alan Rapoport, Derek Hill, SRS
Chapter 6.	Lawrence M. Rausch, SRS
Chapter 7.	Melissa F. Pollak, SRS
Chapter 8.	Paula C. Dunnigan, Greg A. Palovchik, Taratec Corporation

Alan Rapoport, John Gawalt, and Rolf Lehming directed the physical production of the volume, which benefited from extensive contributions from SRS staff. The division's senior staff and survey managers assured timely availability of data under often stringent deadlines: Richard J. Bennof, Joan S. Burrelli, Leslie J. Christovich, Mary J. Golladay, Susan T. Hill, John E. Jankowski, Kelly H. Kang, Nirmala Kannankutty, Mary M. Machen, Ronald L. Meeks, John Tsapogas, and Raymond M. Wolfe.

Robert K. Bell, Mary J. Frase, and Judith S. Sunley rendered critical assistance in preparation and review; Ronald S. Fecso provided advice with statistical and data presentation issues. Deborah A. Collins, Raj S. Raut, Tanya R. Gore, Maurya Green, and Terri S. Smith offered support with graphics and logistics.

The preparation of this report has benefited from close involvement of the National Science Board, from the development of narrative outlines to intensive reviews involving all board members. Their generous contribution of time, effort, and expertise under often stringent schedules is gratefully acknowledged. National Science Board staff provided crucial input and assistance at all stages of the project. Michael P. Crosby provided vital coordination, and Cathy Hines ably served as Executive Secretary to the Science and Engineering Indicators Subcommittee, taking over from Mary Poats.

Many others beyond the authors, National Science Board members and NSB and SRS staff provided invaluable assistance as reviewers or offered valuable substantive and statistical comments and expertise to this report. They are listed as Reviewers and Contributors.

The report was edited by Beverly Cook and associates of Aspen Systems Corporation, under the direction of Rolfe W. Larson; Cheryl S. Roesel and Tanya R. Gore provided additional editing services. Eileen Kessler and the staff of OmniStudio, Inc., provided composition and production services for the print and electronic materials. John R. Gawalt and Alan I. Rapoport produced the Information Cards. Web site design, coding, and final production was managed by Peg Whalen and performed by De Q. Vo, Bridget Tuthill, Elise Manalang, Jason Shaffer, Moe Than, and Jennifer Nowak of Compuware Corporation.

NSF's Office of Legislative and Public Affairs (OLPA), under the guidance of Curt Suplee, Director, provided media and Congressional liaison support for the report. Special thanks go to Bill Noxon and David Hart for media support and to David M. Stonner for Congressional relations support. Patricia S. Williams and her staff in the Division of Acquisition and Cost Support provided contractual assistance throughout the project.

Contributors and Reviewers

The following persons contributed to the report by reviewing chapters or otherwise assisting in its preparation. Their help is greatly appreciated.

Stuart Anderson, former Deputy INS Commissioner for Policy
John Armstrong, IBM, retired
Robert K. Bell, National Science Foundation
Dan Berglund, State Science and Technology Institute
Myles Boylan, National Science Foundation
John Bradley, National Science Foundation
Sarah Calderon, MPR Associates
Jill L. Cape, Taratec Corporation
Ann Carlson, Office of Science and Technology Policy
Lynda T. Carlson, National Science Foundation
David Cheney, SRI International
Kathryn Chval, National Science Foundation
James Colby, National Science Foundation
Susan Cozzens, Georgia Institute of Technology
Connie Della-Piana, National Science Foundation
Chip Denman, National Capital Area Skeptics
Doug Devereaux, Department of Commerce
James Duderstadt, University of Michigan
Jules Duga, Battelle Memorial Institute
Janice Earle, National Science Foundation
Karolyn Eisenstein, National Science Foundation
Emerson Elliott, National Council for Accreditation of Teacher Education
Irwin Feller, Pennsylvania State University, emeritus
Michael Finn, Oak Ridge Institute for Science and Education
Amy K. Flatten, Office of Science and Technology Policy
Donna Fowler, MPR Associates
Mary J. Frase, National Science Foundation
Susan Fuhrman, University of Pennsylvania
Carolyn L. Funk, Virginia Commonwealth University
Fred Gault, Statistics Canada
Alan Goodman, Institute of International Education
James A. Griffin, Office of Science and Technology Policy
David Halpern, Office of Science and Technology Policy
Kimberly Hamilton, CHI Research, Inc.
Peter Henderson, National Academy of Sciences
Jim Hirabayashi, U.S. Patent and Trademark Office
John Jankowski, National Science Foundation
Elka Jones, Bureau of Labor Statistics
Kei Koizumi, American Association for the Advancement of Science
Bobbi Kridl, MPR Associates
Karen Laney-Cummings, U.S. Department of Commerce
Michelle Lennihan, Council on Competitiveness
Xiaojie Li, MPR Associates
Lindsey Lowell, Georgetown University
Jane Maienschein, Arizona State University
Charles M. Meadows, Taratec Corporation
Mary Ellen Mogee, Mogee Research & Analysis, LLC
Robert P. Morgan, Washington University, retired
Seth Muzzy, ORC Macro
Fran Narin, CHI Research, Inc.
Jongwon Park, SRI International
Greg Pearson, National Academy of Engineering
Willie Pearson, Jr., Georgia Institute of Technology
Rolf Piekarz, National Science Foundation, retired
Andrew Porter, University of Wisconsin
Susanna Hornig Priest, Texas A&M University
Joan Prival, National Science Foundation
Stacie Propst, Research!America
Senta Raizen, National Center for Improving Science Education/WestEd
Judith Ramaley, National Science Foundation
Lauren Resnick, University of Pittsburgh
Deborah Runkle, American Association for the Advancement of Science
Gerhard Salinger, National Science Foundation
Roland W. Schmitt, Rensselaer Polytechnic Institute, President Emeritus
Susan Sclafani, U.S. Department of Education
William Sibley, Oklahoma Center for the Advancement of Science and Technology
Jennifer Slimowitz, National Academy of Sciences
Thomas Smith, Vanderbilt University
Thomas Snyder, U.S. Department of Education
Paula Stephan, Georgia State University
Judith S. Sunley, National Science Foundation
Larry Suter, National Science Foundation
Peter Syverson, Council of Graduate Schools
Gregory Tassey, National Institute of Standards and Technology
John Taylor, National Venture Capital Association
Albert H. Teich, American Association for the Advancement of Science
Toby Ten Eyck, Michigan State University
Marie Thursby, Georgia Institute of Technology
David Trinkle, Office of Management and Budget
Brigitte van Beuzekom, Organisation for Economic Cooperation and Development
Jean Vanski, National Science Foundation
Nicholas Vonortas, George Washington University
Wanda Ward, National Science Foundation
Charles Wessner, National Academies
Mary Woolley, Research!America

Contents