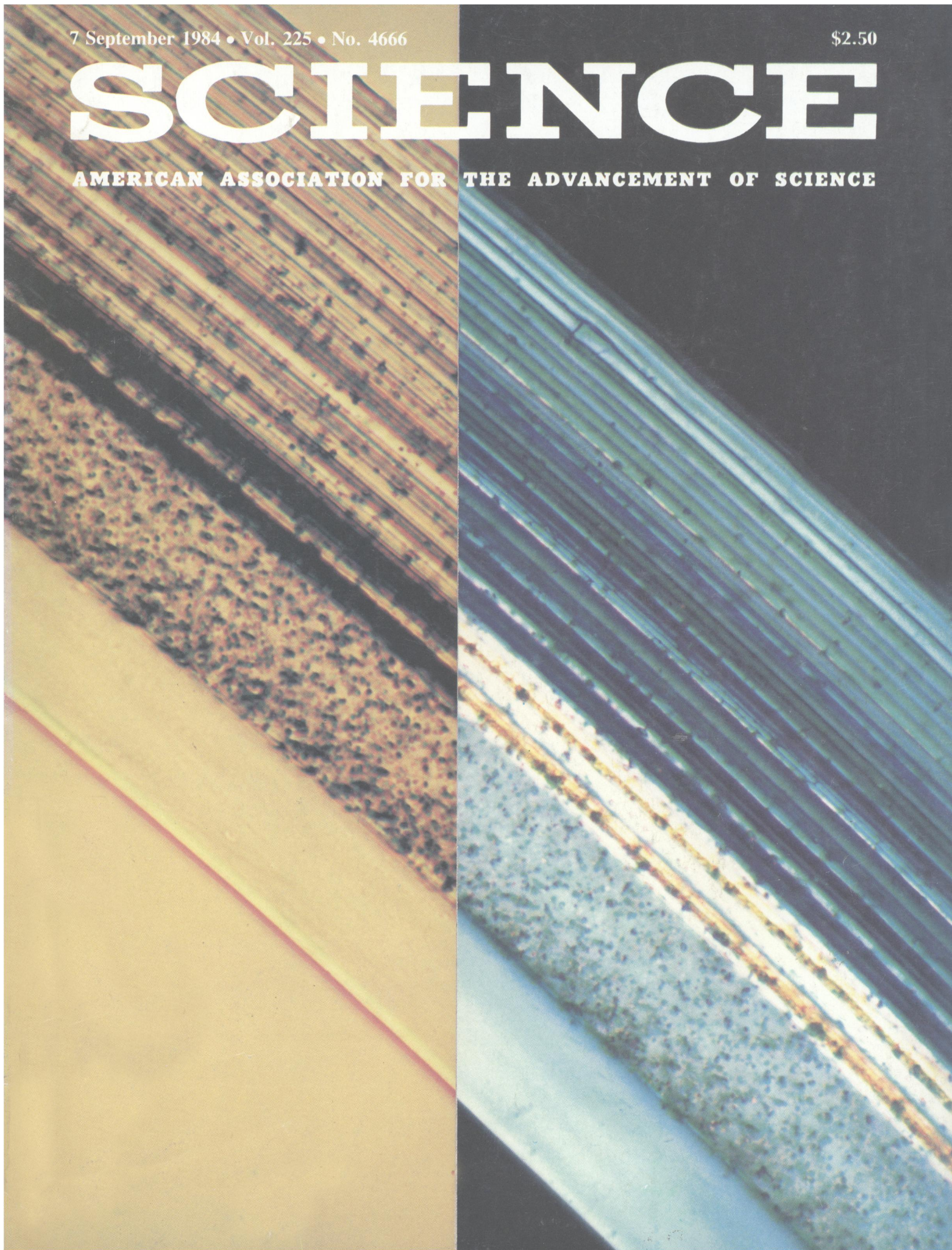


7 September 1984 • Vol. 225 • No. 4666

\$2.50

SCIENCE

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



BIOSYSTEMS UPDATE



• Installed instrument-reagent system
▲ Customer Support

Over 350 laboratories worldwide now use Applied Biosystems products. In just two years, these remarkable instrument-reagent systems have become the standards for performance, reliability and ease of operation.

Protein/Peptide Sequencing, Oligonucleotide Synthesis, and Peptide Synthesis

Our contributions to the chemistries and automation of these techniques will enhance your research, reduce your operating costs and free you for more productive work.

A Commitment to Scientific Contributions

We pioneered automated systems for *gas phase* protein sequencing, *phosphoramidites* in oligonucleotide synthesis and *preactivation of amino acids* in peptide synthesis. Each one of these innovations has resulted in improved performance over conventional approaches.

A Commitment to Reliability

Scientists and researchers in over 350 laboratories will attest to the reliability of our instrument-reagent systems. We design, manufacture and test instruments and reagents

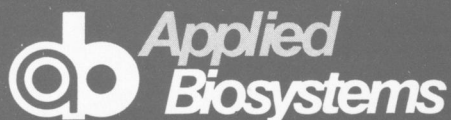
side-by-side to ensure the optimum system performance you expect.

A Commitment to Product Support

The quality of our worldwide product support is unmatched. We install each new system and teach you how to get the best from it. We do not leave your laboratory until your system's performance meets published specifications.

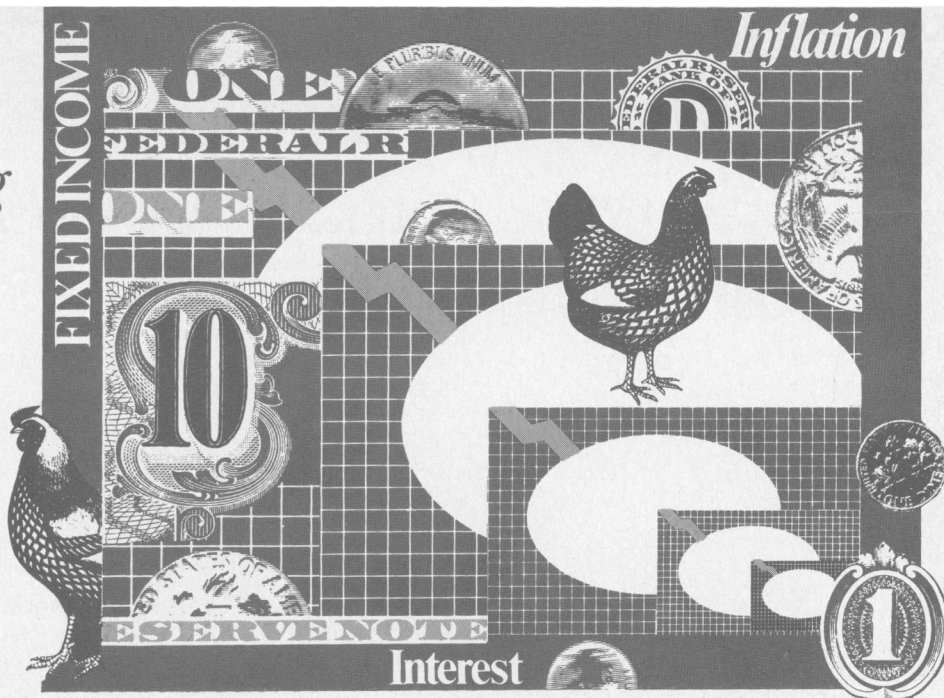
Follow-up service, if needed, is equally thorough and just a telephone call away from our network of product support centers. In addition, our research team is prepared to help you solve problems unique to your own applications—whether in research or in the production of peptides or oligonucleotides.

For more information, ask your local Applied Biosystems representative or contact us at one of the offices listed below.



APPLIED BIOSYSTEMS, INC., 850 Lincoln Centre Drive, Foster City, CA 94404 • (800) 874-9868 • In California (800) 831-3582 Telex: 470052
IN EUROPE: APPLIED BIOSYSTEMS GMBH, Bergstrasse 104, D6102 Pfungstadt, West Germany • 06157-6036 Telex: 4191746

The Case of the Shrinking Nest Egg



Stanley and Anne Winston just couldn't understand why their nest egg was shrinking. They worked hard to keep it nourished—trying everything on the market to help it grow. Yet, mysteriously, it actually seemed to be getting smaller. And they didn't see how they could possibly put any more money into it without cutting their take-home pay.

Building a secure nest egg for the future needn't be a mystery. There *is* a simple solution. Supplemental Retirement Annuities from TIAA-CREF. Or, very simply, SRAs. The flexible tax-deferred annuity plan that can increase your personal retirement savings and reduce your federal taxes *without* cutting your take-home pay.

While your money is growing in SRAs, you won't be paying any taxes on it. Or on the interest and dividends it earns. Contributions are made on a *before-tax* basis and regularly set aside *for you*—directly through your insti-

tution's payroll system. You only pay ordinary income taxes when you withdraw cash or receive benefits from SRAs.

TIAA-CREF's low-risk, high-security approach to investments helps protect your nest egg from economic uncertainties. Funds in TIAA steadily grow at the effective annual interest rate of 11.50%* while those in CREF share in the investment experience of the Fund's broadly diversified common stock portfolio.

And with TIAA-CREF's assets of over \$30 billion and 65 years of experience in retirement plan investing for people in education, you can feel confident that your nest egg will be there when you're ready for it. *Whenever* you're ready for it.

You can withdraw cash or receive income benefits from your SRAs even *before* you retire—without paying any federal penalty tax. And there are a number of *lifetime* income options for you and your spouse.

So if you want to keep your nest egg strong, healthy—and growing—investigate the advantages of Supplemental Retirement Annuities.

SRAs—Simple. Reliable. Accessible. Tax-deferred annuities. From TIAA-CREF.

*Effective March 1, 1984 through February 28, 1985 for funds credited January 1, 1982 or later. This interest rate is not guaranteed after February 28, 1985. A 1.5% expense charge is deducted from SRA premiums. If you would like to know more about SRAs, simply mail the coupon below or write TIAA-CREF, 730 Third Avenue, New York, NY 10017.



TIAA-CREF
730 Third Avenue
New York, NY 10017

SCI 9-7-84 3

Yes! I'd like to increase my retirement savings and protect my nest egg from economic uncertainties. Please send me your free brochure on solving this and other mysteries of my financial future.

Name _____

Name of Institution _____

Address _____

City _____

State _____

Zip _____

SCIENCE

LETTERS	"Nuclear Winter" Studies: <i>V. Aleksandrov; S. L. Thompson; R. Turco</i> ; Care of High-Risk Infants: <i>M. Stahlman, T. Boat, T. Oliver</i> ; Haitians and AIDS: <i>J. W. Pape et al.</i>	978
EDITORIAL	1 + 1 = 0: New Math for a New Age: <i>L. A. Steen</i>	981
ARTICLES	Packing Structures and Transitions in Liquids and Solids: <i>F. H. Stillinger and T. A. Weber</i>	983
	Networking in International Agricultural Research: <i>D. L. Plucknett and N. J. H. Smith</i>	989
	Infectious and Selectable Retrovirus Containing an Inducible Rat Growth Hormone Minigene: <i>A. D. Miller et al.</i>	993
NEWS AND COMMENT	OMB Jeopardizes U.S.-Soviet Satellite Accord	999
	Scientists Warm to the Space Station	1000
	Exxon Builds on Basic Research	1001
	Population Studies Age Prematurely	1003
	<i>Briefing</i> : Details Delay Resumption of Polish-U.S. Exchanges; Is Biotechnology Research Insurable?; Peterson Leaving a Changed Audubon Society; NIH and Hughes Institute Form Training Partnership; FDA Amending Regulations to Reduce LD ₅₀ Testing; Japan Plans to Look to the Stars from Hawaii; Comings and Goings	1004
RESEARCH NEWS	Surprise Proof of an Old Conjecture	1006
	Impacts of Another Kind	1007
	Viruses Yield Clues to Gene Regulation	1008
	Slow Atmospheric Oscillations Confirmed	1010
AAAS NEWS	Professional Ethics Group Reviews Guidelines for Misconduct Investigations: <i>S. Painter</i> ; Lecture Describes Use of Genetics to Establish Grandpaternity; Scientific Freedom and Responsibility Award: Call for Nominations; Help	

BOARD OF DIRECTORS

ANNA J. HARRISON
Retiring President, Chairman

DAVID A. HAMBURG
President

GERARD PIEL
President-Elect

ROBERT W. BERLINER
LAWRENCE BOGORAD

WALTER E. MASSEY
DOROTHY NELKIN

CHAIRMEN AND SECRETARIES OF AAAS SECTIONS

MATHEMATICS (A)
Gail S. Young
Lynn Arthur Steen

PHYSICS (B)
Chen Ning Yang
Rolf M. Sinclair

CHEMISTRY (C)
Fred W. McLafferty
Jeanne M. Shreeve

ASTRONOMY (D)
Patrick Palmer
Donat G. Wentzel

PSYCHOLOGY (J)
Gregory A. Kimble
William N. Dember

SOCIAL, ECONOMIC, AND POLITICAL SCIENCES (K)
Robin M. Williams, Jr.
David L. Sills

HISTORY AND PHILOSOPHY OF SCIENCE (L)
Wesley C. Salmon
David L. Hull

ENGINEERING (M)
Raymond L. Bisplinghoff
W. Edward Lear

EDUCATION (Q)
Marvin Druger
Joseph D. Novak

DENTISTRY (R)
Robert J. Fitzgerald
Harold M. Fullmer

PHARMACEUTICAL SCIENCES (S)
Stuart Feldman
David A. Knapp

INFORMATION, COMPUTING, AND COMMUNICATION
Joseph Becker
Madeline M. Henderson

DIVISIONS

ARCTIC DIVISION

John Davies
President

Gunter E. Weller
Executive Secretary

PACIFIC DIVISION

Barbara Wright
President

Alan E. Leviton
Executive Director

SOUTHWESTERN AND ROCKY MOUNTAIN DIVISION

Charles E. Holley, Jr.
President

M. Michelle Bal
Executive Director

SCIENCE is published weekly on Friday, except the last week in December, by the American Association for the Advancement of Science, 1515 Massachusetts Avenue, NW, Washington, D.C. 20005. Second-class postage (publication No. 464460) paid at Washington, D.C., and at an additional entry. Now combined with **The Scientific Monthly**. Copyright © 1984 by the American Association for the Advancement of Science. Domestic individual membership and subscription (51 issues): \$56. Domestic institutional subscription (51 issues): \$93. Foreign postage extra: Canada \$24, other (surface mail) \$27, air-surface via Amsterdam \$65. First class, airmail, school-year, and student rates on request. Single copies \$2.50 (\$3 by mail); back issues \$3 (\$3.50 by mail); Biotechnology issue, \$5 (\$5.50 by mail); classroom rates on request. **Change of address:** allow 6 weeks, giving old and new addresses and seven-digit account number. Authorization to photocopy material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act is granted by AAAS to libraries and other users registered with the Copyright Clearance Center (CCC) Transactional Reporting Service, provided that the base fee of \$1 per copy plus \$0.10 per page is paid directly to CCC, 21 Congress Street, Salem, Massachusetts 01970. The identification code for *Science* is 0036-8075/84 \$1 + .10. **Postmaster:** Send Form 3579 to *Science*, 1515 Massachusetts Avenue, NW, Washington, D.C. 20005. *Science* is indexed in the *Reader's Guide to Periodical Literature* and in several specialized indexes.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

AAAS Membership Office Stop Repetition; Call for Nominations: 1985
General Election 1012

BOOK REVIEWS Margaret Mead *and With a Daughter's Eye*, reviewed by J. Mark; The Culture of Technology, R. J. Baum; Glimpsing an Invisible Universe, C. S. Gillmor; Glacial Lake Agassiz, R. J. Fulton; Regional Trends in the Geology of the Appalachian-Caledonian-Hercynian-Mauritanide Orogen, J. Laird; Books Received 1014

REPORTS Increasing Atmospheric Carbon Dioxide: Tree Ring Evidence for Growth Enhancement in Natural Vegetation: V. C. LaMarche, Jr., et al. 1019

Periodic Interfacial Precipitation in Polymer Films: K. F. Mueller 1021

Computer Simulations of the Atmospheric Chemistry of Sulfate and Nitrate Formation: C. Seigneur, P. Saxena, P. M. Roth 1028

Disruption of the Terrestrial Plant Ecosystem at the Cretaceous-Tertiary Boundary, Western Interior: R. H. Tschudy et al. 1030

Inhibition of Human Estrogen Synthetase (Aromatase) by Flavones: J. T. Kellis, Jr., and L. E. Vickery 1032

Small Cell Carcinoma of the Lung: Macrophage-Specific Antigens Suggest Hemopoietic Stem Cell Origin: M. R. Ruff and C. B. Pert 1034

Neurophysiological Evidence for a Traveling Wave in the Amphibian Inner Ear: C. M. Hillery and P. M. Narins 1037

Enhanced Arboviral Transmission by Mosquitoes That Concurrently Ingested Microfilariae: M. J. Turell et al. 1039

Isolation, Characterization, and Chromosome Assignment of Mouse N-ras Gene from Carcinogen-Induced Thymic Lymphoma: I. Guerrero et al. 1041

Cadmium-Resistant *Pseudomonas putida* Synthesizes Novel Cadmium Proteins: D. P. Higham, P. J. Sadler, M. D. Scawen 1043

Neurons Generated in the Adult Brain Are Recruited into Functional Circuits: J. A. Paton and F. N. Nottebohm 1046

Flying Squirrels Are Monophyletic: R. W. Thorington, Jr. 1048

Prostaglandin E₂: A Neuromodulator in the Central Control of Gastrointestinal Motility and Feeding Behavior by Calcitonin: M. J. Fargeas, J. Fioramonti, L. Buéno 1050

Prolonged Survival and Remyelination After Hematopoietic Cell Transplantation in the Twitcher Mouse: A. M. Yeager et al. 1052

WIN B. SLAUGHTER
WIN E. SAWYER

SHEILA E. WIDNALL
LINDA S. WILSON

WILLIAM T. GOLDEN
Treasurer

WILLIAM D. CAREY
Executive Officer

GEOLOGY AND GEOGRAPHY (E)

William W. Hay
Thomas Dutro, Jr.

MINERAL SCIENCES (N)

Robert A. Good
Jonathan E. Rhoads

STATISTICS (U)

Barbara A. Bailar
David J. Wegman

BIOLOGICAL SCIENCES (G)

Dorothy M. Skinner
Walter Chavin

AGRICULTURE (O)

John Pesek
Ralph J. McCracken

ATMOSPHERIC AND HYDROSPHERIC (W)

William W. Kellogg
Bernice Ackerman

ANTHROPOLOGY (H)

Priscilla Reining

INDUSTRIAL SCIENCE (P)

J. Kenneth Craver
Robert L. Stern

GENERAL (X)

George C. Sponsler
Rodney W. Nichols

COVER

Photomicrograph showing a cross section of a water-swollen polyvinyl alcohol film (thickness, 0.18 millimeter) containing silver bromide precipitate. The precipitate was formed by immersing a 10-cubic-centimeter polyvinyl alcohol pouch containing 0.05M silver nitrate in 100 cubic centimeters of 0.05M sodium bromide for 16 hours. Silver nitrate-contacting side is up. The photograph was taken in polarized light with crossed (right) and uncrossed (left) polarizers. See page 1021. [K. F. Mueller, CIBA-GEIGY Corporation, Ardsley, New York 10502]

SECOND INTERNATIONAL CONGRESS ON COMPUTERS IN SCIENCE

28 October - 1 November 1984

Washington Hilton, Washington DC

Chairman: Stephen R. Heller
Environmental Protection Agency, Washington DC 20460

THEME: Workstations for the Scientist

OPENING ADDRESS

Computer Education/Literacy for the Scientists – C.D. Martin, George Washington University, Washington, D.C.

SESSION TOPICS

Scientific Data Bases – L. Gevantman, National Bureau of Standards, Washington, D.C.
Computer Aided Molecular Design – R. Potenzzone Jr., American Cyanamid Co., Stamford, Conn.
Artificial Intelligence – P. Friedland, Stanford University, Stanford, CA.
Biological Workstations – P. Armstrong, Intelligenetics, Inc., Palo Alto, CA.
Management of the Electronic Laboratory – R. Dessy, Virginia Polytechnic Institute, Blacksburg, VA.
Laboratory Automation and Robotics – J. Lemanowicz, Exxon Research and Engineering, Annadale, N.J.
Workshops – Joseph L. Modelevsky, Lilly Research Labs.
Molecular Biology Software: Conventions, distribution and exchange
Molecular Biology Computing: Perils, prospects, and payoffs
* Other Workshops to be announced

POSTER SESSIONS: WORKSTATION APPLICATIONS

Participants are invited to submit abstracts for the poster sessions. These abstracts will be reviewed up until the time of the meeting; however, only those accepted by 15 September 1984 will be listed in the conference program. For abstract forms contact address listed below.

SCICOMP EXHIBITION

A large exhibit of state of the art hardware, software and systems will also be part of the overall conference.

**Organized by Scherago Associates, Inc.
in conjunction with SCIENCE Magazine.**

Scherago Associates, Inc., 1515 Broadway, New York, NY 10036, (212) 730-1050

REGISTRATION FEES: Make checks payable to: Scherago Assoc., Inc., COMPUTERS IN SCIENCE

\$200 On-site registration

\$150 ADVANCE REGISTRATION

\$125 Group Registrations – 4 or more received *together* from same organization.

\$ 50 Student Registrations – *Must* have status confirmed in writing by department chairman.

- ☐ Please reserve _____ space(s): Registration Fee of \$ _____ enclosed.
☐ Please send EXHIBIT SPACE information.

Please Print

Name _____ Street _____

Dept. _____ City _____ State _____ Zip _____

Organization _____ Telephone: (_____) _____

Return to: Computers in Science, Scherago Associates, Inc., 1515 Broadway, New York, NY 10036, Tel: (212) 730-1050
All cancellations must be received in writing by Scherago Associates, Inc. no later than September 21, 1984 – no refunds will be given after this date.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Science serves its readers as a forum for the presentation and discussion of important issues related to the advancement of science, including the presentation of minority or conflicting points of view, rather than by publishing only material on which a consensus has been reached. Accordingly, all articles published in *Science*—including editorials, news and comment, and book reviews—are signed and reflect the individual views of the authors and not official points of view adopted by the AAAS or the institutions with which the authors are affiliated.

Editorial Board

FREDERICK R. BLATTNER, BERNARD F. BURKE, ARNOLD DEMAIN, CHARLES L. DRAKE, ARTHUR F. FINDEIS, E. PETER GEIDUSCHEK, GLYNN ISAAC, NEAL E. MILLER, FREDERICK MOSTELLER, ALLEN NEWELL, RUTH PATRICK, BRYANT W. ROSSITER, VERA C. RUBIN, WILLIAM P. SLICHTER, SOLOMON H. SNYDER, PAUL E. WAGGONER, JOHN WOOD

Publisher: WILLIAM D. CAREY

Editor: PHILIP H. ABELSON

Editorial Staff

Assistant Managing Editor: JOHN E. RINGLE
Production Editor: ELLEN E. MURPHY
Business Manager: HANS NUSSBAUM
News Editor: BARBARA J. CULLITON
News and Comment: COLIN NORMAN (deputy editor), JEFFREY L. FOX, CONSTANCE HOLDEN, ELIOT MARSHALL, R. JEFFREY SMITH, MARJORIE SUN, JOHN WALSH
European Correspondent: DAVID DICKSON
Contributing Writer: LUTHER J. CARTER
Research News: ROGER LEWIN (deputy editor), RICHARD A. KERR, GINA KOLATA, JEAN L. MARX, THOMAS H. MAUGH II, ARTHUR L. ROBINSON, M. MITCHELL WALDROP
Administrative Assistant, News: SCHERRAINE MACK;
Editorial Assistant, News: FANNIE GROOM
Senior Editors: ELEANORE BUTZ, MARY DORFMAN, RUTH KULSTAD
Associate Editors: MARTHA COLLINS, SYLVIA EBERHART, CAITILIN GORDON, WILLIAM GREAVES, LOIS SCHMITT
Assistant Editors: STEPHEN KEPPLER, LISA MCCULLOUGH, EDITH MEYERS
Book Reviews: KATHERINE LIVINGSTON, *Editor*; LINDA HEISERMAN, JANET KEGG
Letters: CHRISTINE GILBERT
Copy Editor: ISABELLA BOULDIN
Production: JOHN BAKER; HOLLY BISHOP, ELEANOR WARNER; JEAN ROCKWOOD, SHARON RYAN, BEVERLY SHIELDS
Covers, Reprints, and Permissions: GRAYCE FINGER, *Editor*; GERALDINE CRUMP, CORRIE HARRIS
Guide to Scientific Instruments: RICHARD G. SOMMER
Editorial Administrator: SUSAN ELLIOTT
Assistant to the Associate Publisher: ROSE LOWERY
Assistant to the Managing Editor: NANCY HARTNAGEL
Membership Recruitment: GWENDOLYN HUDDLE
Member and Subscription Records: ANN RAGLAND
EDITORIAL CORRESPONDENCE: 1515 Massachusetts Avenue, NW, Washington, D.C. 20005. Area code 202. General Editorial Office, 467-4350; Book Reviews, 467-4367; Guide to Scientific Instruments, 467-4480; News and Comment, 467-4430; Reprints and Permissions, 467-4483; Research News, 467-4321. Cable: *Advances*, Washington. For "Information for Contributors," write to the editorial office or see page xi, *Science*, 29 June 1984.
BUSINESS CORRESPONDENCE: Area Code 202. Membership and Subscriptions: 467-4417.

Advertising Representatives

Director: EARL J. SCHERAGO
Production Manager: GINA REILLY
Advertising Sales Manager: RICHARD L. CHARLES
Marketing Manager: HERBERT L. BURKLUND
Sales: NEW YORK, N.Y. 10036: Steve Hamburger, 1515 Broadway (212-730-1050); SCOTCH PLAINS, N.J. 07076: C. Richard Callis, 12 Unami Lane (201-889-4873); CHICAGO, ILL. 60611: Jack Ryan, Room 2107, 919 N. Michigan Ave. (312-337-4973); BEVERLY HILLS, CALIF. 90211: Winn Nance, 111 N. La Cienega Blvd. (213-657-2772); SAN JOSE, CALIF. 95112: Bob Brindley, 310 S. 16 St. (408-998-4690); DORSET, VT. 05251: Fred W. Diefenbach, Kent Hill Rd. (802-867-5581).
ADVERTISING CORRESPONDENCE: Tenth floor, 1515 Broadway, New York 10036 (212-730-1050).

1 + 1 = 0: New Math for a New Age

One year ago America read with alarm *A Nation at Risk*, the indictment of public education by the Commission on Excellence in Education. Shortly afterward, the National Science Board issued a parallel, bleak report on education in mathematics, science, and technology. Both reports make the same points: test scores are low, academic requirements are inadequate, and teaching is no longer a prestigious profession.

Slowly, but with gathering momentum, the states are responding. California, Florida, Ohio, Texas, and others are increasing requirements: longer school hours here and more required courses there. Some states are even requiring competency tests—for teachers as well as for students.

As the political momentum of our educational crisis peaks, legislators often gravitate to the quick fix, to a nostalgic return to the good old days of stern requirements and no-nonsense exams. It seems that the new regime in education is committed to the basics, even if it means going backward to get there. But today's students need the science and mathematics of the future, not of the past. The world of today's student is dominated by genetic engineering and computer modeling, by new tools used to solve new problems. Yet the world of school tests and texts, too often, is full of old tools applied to old problems.

Mathematics provides a good example. Traditional school mathematics aims to perfect arithmetic skills (such as percentage calculations and long division) as a basis for algebra, which itself becomes the cornerstone of trigonometry, analytic geometry, and calculus. America was built with these tools, applied by generations of engineers and scientists to the physical environment in which we live.

But today's growth industries are dominated by information, which is abstract and immaterial. Whereas the material world is modeled by calculus, the language of continuous change, the immaterial world of information requires discontinuous, discrete mathematics. Both genetic codes and computer codes are intrinsically discrete. Discrete mathematics basically deals with fancy ways of arranging and counting. It can be used to enumerate genetic patterns and to count the branches in computer algorithms; it can be used to analyze the treelike branching of arteries and nerves, as well as the cascading options in a succession of either-or decisions. It can tell us how many things are there as well as help us find what we want among a bewildering morass of possibilities.

Courses and seminars in discrete mathematics are being introduced in colleges across the land. Many computer scientists are urging beginning students to study discrete mathematics before they study calculus. Recent recommendations for preparation of secondary school teachers of mathematics add both discrete mathematics and computer science to the list of required courses.

Reform of school mathematics must reflect this new mathematics. Requiring more tests is of no use if the tests examine only the old mathematics; increasing time in class is of no benefit if it only reinforces old traditions. Standardized tests must be changed, new textbooks must be written, and teachers must be provided with opportunities in substantive workshops to learn this discrete, computer-oriented mathematics.

In mobilizing for excellence in mathematics education, we must create a new curriculum founded on the principle that mental arithmetic is more valuable than mechanical calculation, that solving problems is more important than solving equations. Mathematics in the computer age must comprehend and supplement the computer, not merely imitate it. Arithmetic in the computer age relies as much on the concept of "bit" as on the concept of number. But inside a computer, bits do not add up, they just flip on and off. The verity of nostalgic arithmetic is that $1 + 1 = 2$; but in the new mathematics of the computer age, we must also teach that $1 + 1 = 0$.
—LYNN ARTHUR STEEN, *Department of Mathematics, St. Olaf College, Northfield, Minnesota 55057*

BIOTECHNOLOGY '85 © *

**NOW IN ITS FIFTH YEAR, IS
ONE OF THE MOST COMPREHENSIVE
BIOTECHNOLOGICAL EQUIPMENT EXHIBITIONS
IN THE WORLD . . . AND GROWING.**

**FEBRUARY 5-7, 1985
San Francisco, California
San Francisco Hilton**

Organized by Scherago Associates, Inc.

Held in conjunction with,
THE FIFTH ANNUAL CONGRESS FOR RECOMBINANT DNA
RESEARCH, THE FOURTH ANNUAL CONGRESS FOR
HYBRIDOMA RESEARCH, and THE SECOND ANNUAL
CONGRESS FOR AUTOMATION, SCALE-UP, AND THE
ECONOMICS OF BIOLOGICAL PROCESS ENGINEERING.

For further information & a booth space prospectus, contact:

Edward B. Ruffing
Scherago Associates, Inc.
1515 Broadway, NY 10036
(212) 730-1050

**Copyright © 1984 Scherago Associates, Inc.*

PORTON INTERNATIONAL



PORTON INTERNATIONAL

THE WORLD STANDARD IN BIOTECHNOLOGY

Porton International is the world's first independent group of biotechnology companies to combine on a fully international basis the required command over resources to produce the complementary skills essential to the commercialisation of biotechnology.

THE WORLD STANDARD IN BIOTECHNOLOGY

PORTON INTERNATIONAL

Commanding resources on a worldwide basis for commercial biotechnology

Porton International is internationally located with offices and operations in the USA, Europe and the Pacific Basin, with group headquarters in London and Washington. As an independent private group whose shareholders include world leading pension fund and institutional investors, Porton International holds a unique position in its freedom to fully exploit biotechnology in its multiple applications to the commercial world.

Porton International is structured into ten divisions, within which there are separate subsidiary companies:

- ENZYMES AND SPECIAL PROTEINS, including **Speywood Laboratories & CAMR***, Porton Projects
- FERMENTATION AND BIOPROCESS, including **LH Fermentation & CAMR**, Porton Projects
- ADVANCED MOLECULAR BIOLOGY, including **IGB Products & CAMR**, Porton Projects
- CLINICAL TESTING AND VALIDATION, including **International Medical Diagnostics**
- DOWNSTREAM PROCESSING
- BIOTECHNOLOGY HARDWARE AND PLANT
- BIOTECHNOLOGY INSTRUMENTATION AND PROCESS CONTROL
- BIOTECHNOLOGY INFORMATION, PATENTS AND PUBLICATIONS, including **OMEC International**
- CASH FLOW PRODUCTS
- STRATEGIC PROJECT CONSULTANCY

*CAMR, is the Centre for Applied Microbiology and Research, based at Porton, U.K.

In an era when biotechnology is moving rapidly from development to commercialisation, this transition is proven and achieved through scale-up using advanced fermentation, bioprocess and bioreactor equipment. Porton International's subsidiary, **LH Fermentation**, is a world leader in the design, supply and installation of this equipment and



L.H. Fermentation 5000 Series Pilot Plant at Eastman Kodak, New York



L.H. 2000 Series Fermenters for research use at CAMR, Porton

advanced control systems. Those shown are examples of equipment used for research, development and high value added production. Porton International is in a prime position to develop and scale up its own processes and as a direct result, provide further advances in scale-up equipment, techniques and products.



L.H. 4000 Series Airlift Fermenters producing monoclonal antibodies in bulk

THE WORLD STANDARD IN BIOTECHNOLOGY

PORTON INTERNATIONAL

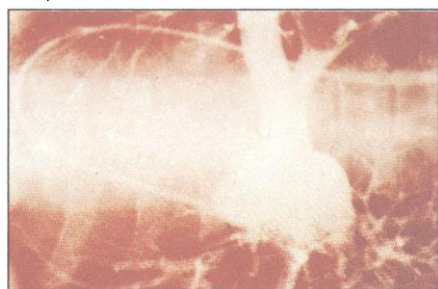
Advanced development and production

It is also recognised that with the current state of the art in bioprocess control systems for development and production, where bioprocessors are primarily controlled on such macroscopic parameters as pH, temperature and dissolved oxygen, the need is now more often for product or process specific monitoring at a cellular level. Porton International's subsidiary, the



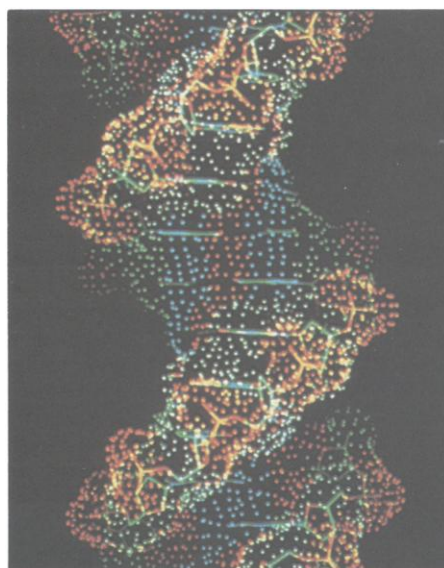
molecular biology research company, **IGB Products** based in San Leandro, California, is concentrating on the requirements for biosensors and other such control systems.

Sensing elements are not only required for bioprocess control but also for diagnostic instruments and kits, also concentrated on DNA

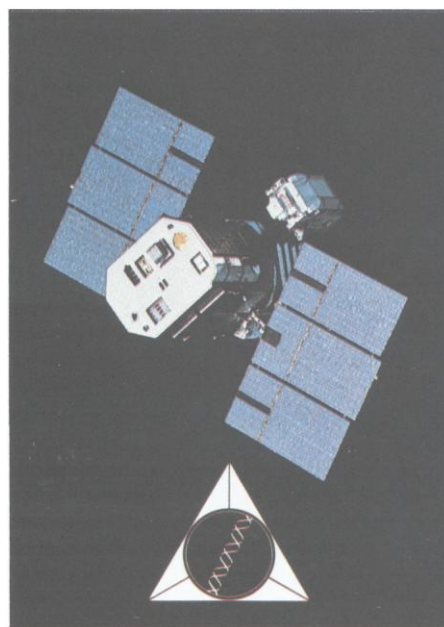


probes, monoclonal antibodies and specific enzymes etc. related to the diagnostic market.

Any diagnostic system needs to be proven, clinically validated and marketed, and Porton International's subsidiary, the clinical reference company, **International Medical Diagnostics** with its headquarters in Los Angeles, not only is able to prove and gain acceptance of the new diagnostic tools emerging from IGB Products' research, but offers a highly sophisticated diagnostic service to the medical community.



Speywood Laboratories' Factor VIII product, HYATE: C



OMEC International — worldwide biotechnology information at the interface: science, technology and commerce

Specific therapeutics are of particular interest to the group especially where successful production is dependent on highly developed, and proprietary, group technology. **Speywood Laboratories**, Porton International's subsidiary, is the only supplier of the high quality Porcine Factor VIII for the treatment of haemophiliacs with inhibitor; their success with this product was completely dependent on the unique capability they have developed in separation and purification of proteins. These skills are now being applied to other protein isolations.



The biotechnology market is rapidly changing and highly competitive and it is essential for any organisation to have a full understanding of the state of the market, development and the competitive position on a world-wide basis. Porton International's subsidiary, the biotechnology information group, **OMEC International**, with headquarters in Washington DC, can rapidly assess the development status, evaluate patent applications and analyse the market situation for any of the group's new products. OMEC also provides a similar information service to companies and organisations outside the group and publishes standard reference works, digests and news information on all aspects of the biotechnology market worldwide.

THE WORLD STANDARD IN BIOTECHNOLOGY

PORTON INTERNATIONAL

Projects at the Centre for Applied Microbiology and Research, Porton UK

The group also has the largest commitment of any company to research and development at CAMR, the Centre for Applied Microbiology and Research, a centre for excellence in applied biotechnology development. Projects funded at CAMR range from genetic engineering to scale-up technology and include an agreement involving the new production centre initially for the production of the Herpes Vaccine developed by the University of Birmingham and CAMR. A world exclusive agreement for this vaccine is held by Porton International.

The Porton International Group

Porton International is led by many of the key people in the field of biotechnology, all totally committed to the unique philosophy and structure of the group.

Porton International, in operating on a truly international basis, with involvements ranging from the forefront of space technology to the ocean depths in marine biology, will be the world standard in the commercialisation of biotechnology.

Porton International has the largest stand at Biotech USA '84 in Washington D.C., 10 - 12 September. A comprehensive display of equipment and services will be shown.

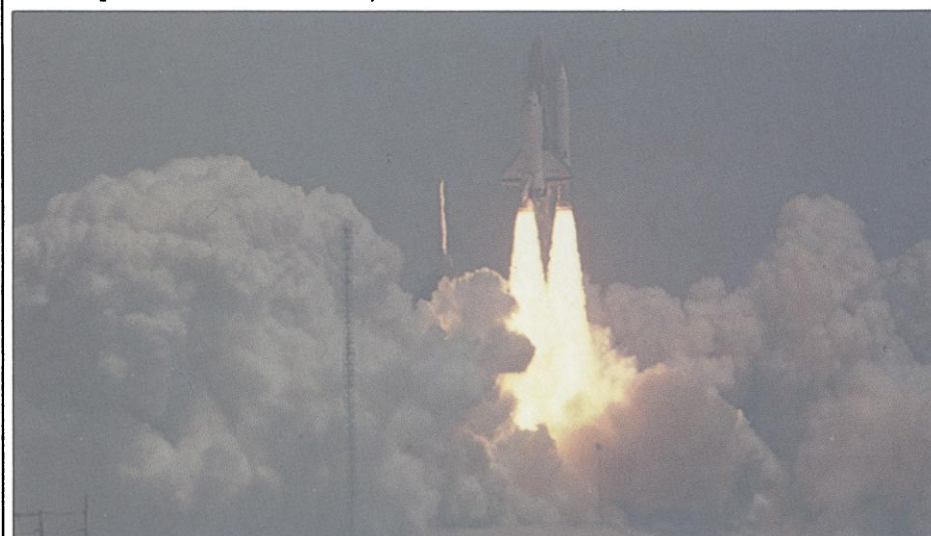
SEE STAND 3 & 4



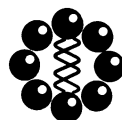
The Centre for Applied Microbiology and Research, Porton



The new production centre at CAMR, Porton



Porton International has its own 200lb five cubic ft. experimental project on the NASA space shuttle 1985 flight program.



PORTON INTERNATIONAL

29 Chesham Place, London, SW1 U.K.

Telephone: 01-245 6144. Telex: 946162 Fax: 01 245 6720.

1128 Sixteenth Street, N.W., Washington DC 20036 U.S.A.

Telephone (202) 833-4344/5/6. Fax: 202 833 4166.

THE WORLD STANDARD IN BIOTECHNOLOGY