

AMERICAN
ASSOCIATION FOR THE
ADVANCEMENT OF
SCIENCE

SCIENCE

15 JULY 1988

\$3.00

VOL. 241 ■ PAGES 265-388



**ECONOMIC
COMPETITIVENESS**
CAN THE U.S. REGAIN
ITS BALANCE?

The Clear Choice

Introducing **REFERENCE UPDATE™** — the enlightened approach to staying abreast of the scientific literature using your personal computer. This weekly service represents a whole new concept in keeping up with current publications in your field.

Each week subscribers will receive a single floppy disk containing the tables of contents from the current issues of more than 300 major journals of biology and medicine. Simply slip the disk into your computer and request any combination of authors, words in the title, and/or journal names. References that fit your retrieval request will immediately appear on the screen. *You pay no line charges* and retrieve only current references — not the ones that you already saw last week or last month.

If you wish, **REFERENCE UPDATE™** will automatically print reprint requests on special cards provided by RIS. Selected references may be entered directly into your *Reference Manager®* database or transferred into a disk file as a Medline formatted text file.

Of course we don't have a weekly cartoon, "Current Comments®", or a "Press Digest". But neither do we require thumbing through page after page of irrelevant journals, or moving awkwardly between cryptic index numbers in the back pages and titles in the body of a booklet. All we do is provide the information that you need, on time, and in a form that is easy to use.

And the biggest surprise is that the new, enlightened way costs less. Our introductory charter subscription price (through September 1, 1988) is only \$69.00 (plus \$20.00 postage and handling) for a 26 week trial. Our regular price will be \$250.00 a year — *less than \$5.00 a week*.

REFERENCE UPDATE™ is available for the IBM-PC and all compatibles as well as for the Apple Macintosh. Also available from RIS: *Reference Manager®* - the leading bibliographic management software, and *Grant Accountant™* - for more efficient management of grant funds.

REFERENCEUPDATE™

Research Information Systems, Inc.

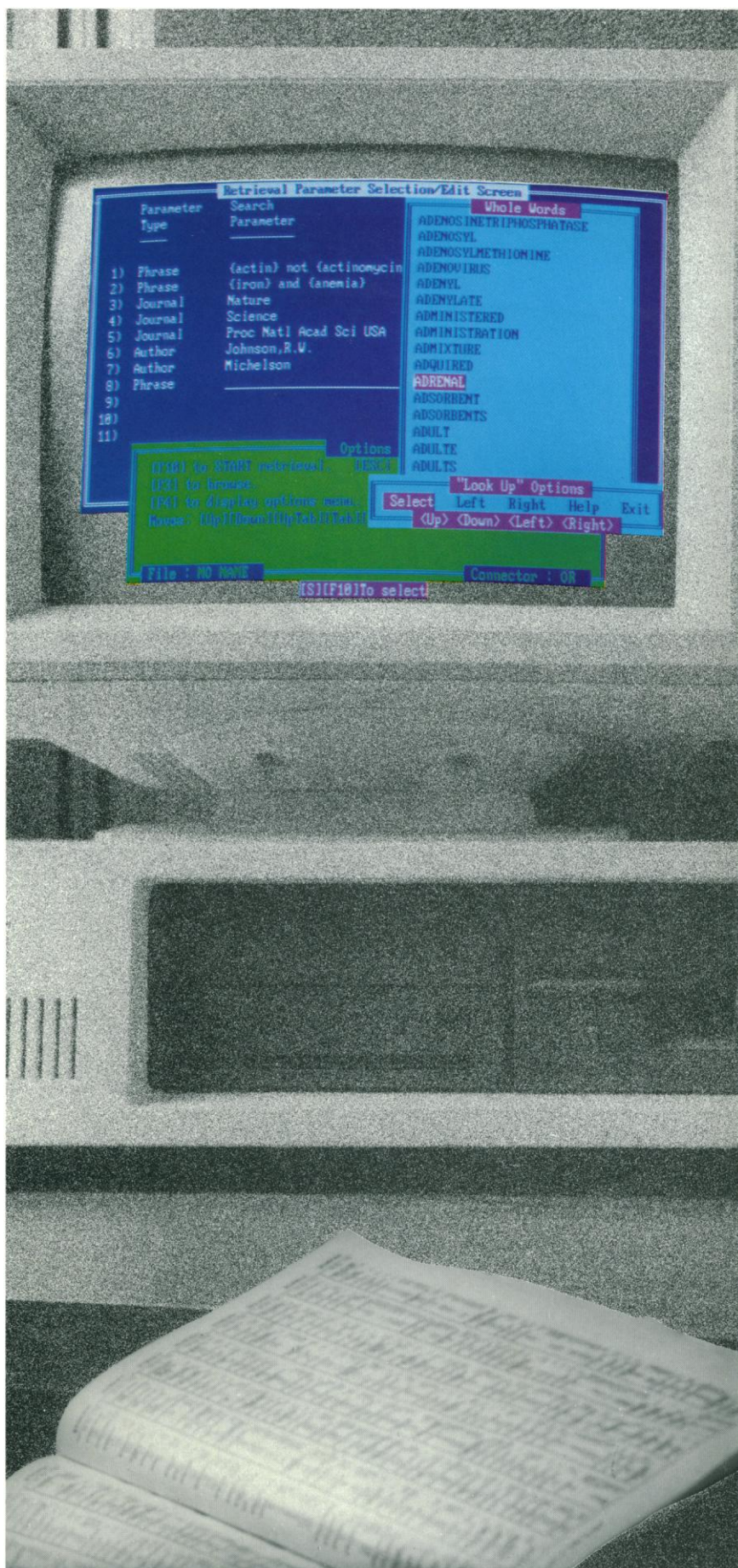
1991 Village Park Way, Suite 205, Encinitas, CA 92024
(800) 722-1227 In California (619) 753-3914

In Western Europe: BILANEY Consultants GmbH Telefon: 02 11/37 60 91

In Australia: AMPL Software Pty., Ltd. Phone: (02) 884 019

Current Comments is a trademark of Institute for Scientific Information

Circle No. 33 on Readers' Service Card



HARVARD APPARATUS ♦ 84 YEARS OF EXCELLENCE



pump **22**

Harvard Precision Infusion Pump

Three Step, 15 Second Ease of Operation

1. Takes any syringe, glass or plastic, from 10 microliters to 140 milliliters (other pumps use only specific brands or types of syringes). Enter the syringe diameter from the card supplied.
2. Enter measurement unit preferred—ml/min, ml/hour, μ l/min or μ l/hour.
3. Enter flow rate required to three significant figures. The range available is an incredible 0.047 μ l/hour to 47.6 ml/min. And you can even change the flow rate while the pump is running!

The microprocessor, high quality stepper motor and its control do the rest.

No other infusion pump offers this ease of operation, breadth of application and depth of quality.

Computer Directed Flexibility

Create feedback systems—profile delivery rates—produce gradients—accumulate delivery data etc. with IBM PC's or compatibles via an RS-232 interface.

At \$1,275.00 priced considerably less than you would have expected. In stock for immediate delivery.

Harvard Apparatus has a wealth of experience providing custom installations to solve unique or complex dispensing problems.

Call (617) 655-7000 and ask for Ken Dunne.

This model, with multiple syringe holder head, costs \$1,525.00. Holds ten syringes from 10 μ l to 10 ml; or six syringes from 20 ml to 50 ml; or four syringes from 100 ml to 140 ml.



HARVARD APPARATUS INC.

22 Pleasant Street, S. Natick, MA 01760 • Tel: (617) 655-7000 • Toll Free: 1-800-272-2775 • FAX: 617-655-6029

Circle No. 86 on Readers' Service Card

271 This Week in *Science*

Editorial

273 Economic Arteriosclerosis and Competitiveness

Letters

275 Psychoanalysis: E. L. WHITE ■ Adrenal Medulla Grafts in Animals: W. J. FREED
■ Federal Budget: T. B. LYNCH ■ Crisis in Systematics: R. J. O'HARA,
D. R. MADDISON, P. F. STEVENS ■ Mesoamerica, Not the New World:
K. V. FLANNERY

News & Comment

283 Politics of the Heart
284 Japan Prodded on the Environment
Biotechnology Investment Lags
285 Perestroika and Détente Boost IASAS's Prospects
286 Panel Completes Interviews in "Baltimore Case"
287 A Bleak Portrait of Soviet Science
Becker to Retain NIH Research Post
288 Debate Warming Up on Legal Migration Policy ■ Effect of 1986 Law Still
Unproven

Research News

291 A Lopsided Look at Evolution
293 Eye Cancer Gene Linked to New Malignancies
295 Molecular Photography with an X-ray Flash
296 Soar: A Unified Theory of Cognition?

Articles

Economic Competitiveness

299 U.S. Competitiveness: Beyond the Trade Deficit: G. N. HATSPOULOS,
P. R. KRUGMAN, L. H. SUMMERS
308 Components of Competitiveness: L. R. KLEIN
313 Technology and Competitiveness: A Key to the Economic Future of the United
States: J. A. YOUNG

Research Articles

317 The *RAD9* Gene Controls the Cell Cycle Response to DNA Damage in
Saccharomyces cerevisiae: T. A. WEINERT AND L. H. HARTWELL
323 Helical Repeat and Linking Number of Surface-Wrapped DNA: J. H. WHITE,
N. R. COZZARELLI, W. R. BAUER

Reports

328 Estimate of Electromagnetic Quantities in Space from Ground Magnetic Records:
Y. KAMIDE
330 Diffusion of Small Solutes in Polymer-Containing Solutions: K. L. YAM,
D. K. ANDERSON, R. E. BUXBAUM

- SCIENCE is published weekly on Friday, except the last week in December, and with an extra issue in February by the American Association for the Advancement of Science, 1333 H Street, NW, Washington, DC 20005. Second-class postage (publication No. 484460) paid at Washington, DC, and at an additional entry. Now combined with *The Scientific Monthly*. Copyright © 1988 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership and subscription (51 issues): \$70. Domestic institutional subscription (51 issues): \$110. Foreign postage extra: Canada \$32, other (surface mail) \$32, air-surface via Amsterdam \$85. First class, airmail, school-year, and student rates on request. Single copies \$3.00 (\$3.50 by mail); back issues \$4.50 (\$5.00 by mail); Biotechnology issue, \$5.50 (\$6 by mail); classroom rates on request; Guide to Biotechnology Products and Instruments \$16 (\$17 by mail). **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 0036-8075/83 \$1 + .10. **Postmaster:** Send Form 3579 to *Science*, 1333 H Street, NW, Washington, DC 20005. *Science* is indexed in the *Reader's Guide to Periodical Literature* and in several specialized indexes.
- The American Association for the Advancement of Science was founded in 1848 and incorporated in 1874. Its objects are to further the work of scientists, to facilitate cooperation among them, to foster scientific freedom and responsibility, to improve the effectiveness of science in the promotion of human welfare, and to increase public understanding and appreciation of the importance and promise of the methods of science in human progress.



COVER Does it matter whether the United States is competitive in the global marketplace? Several articles in this issue of *Science* focus on that question and how economic competitiveness affects not only individuals and government but also our industries, particularly high-technology industry. See page 299. [Cover design by John L. Heinly, Burke, VA 22015]

- 332 Design of a Monomeric Arsinogallane and Chemical Conversion to Gallium Arsenide: E. K. BYRNE, L. PARKANYI, K. H. THEOPOLD
- 334 Congenital Poisoning by Polychlorinated Biphenyls and Their Contaminants in Taiwan: W. J. ROGAN, B. C. GLADEN, K.-L. HUNG, S.-L. KOONG, L.-Y. SHIH, J. S. TAYLOR, Y.-C. WU, D. YANG, N. B. RAGAN, C.-C. HSU
- 336 Molecular Cloning of Odorant-Binding Protein: Member of a Ligand Carrier Family: J. PEVSNER, R. R. REED, P. G. FEINSTEIN, S. H. SNYDER
- 339 GABA_A-Receptor Function in Hippocampal Cells Is Maintained by Phosphorylation Factors: A. STELZER, A. R. KAY, R. K. S. WONG
- 342 Vasopressin mRNA in the Suprachiasmatic Nuclei: Daily Regulation of Polyadenylate Tail Length: B. G. ROBINSON, D. M. FRIM, W. J. SCHWARTZ, J. A. MAJZOUB
- 344 Long Lives for Homozygous Trembler Mutant Mice Despite Virtual Absence of Peripheral Nerve Myelin: E. W. HENRY AND R. L. SIDMAN
- 346 Naturally Occurring Auxin Transport Regulators: M. JACOBS AND P. H. RUBERY
- 350 Negative Regulation by Glucocorticoids Through Interference with a cAMP Responsive Enhancer: I. E. AKERBLUM, E. P. SLATER, M. BEATO, J. D. BAXTER, P. L. MELLON
- 353 Abnormalities in Structure and Expression of the Human Retinoblastoma Gene in SCLC: J. W. HARBOUR, S.-L. LAI, J. WHANG-PENG, A. F. GAZDAR, J. D. MINNA, F. J. KAYE
- 357 Type-Restricted Neutralization of Molecular Clones of Human Immunodeficiency Virus: D. J. LOONEY, A. G. FISHER, S. D. PUTNEY, J. R. RUSCHE, R. R. REDFIELD, D. S. BURKE, R. C. GALLO, F. WONG-STAAI
- 359 Acoustical Detection of High-Density Krill Demersal Layers in the Submarine Canyons off Georges Bank: C. H. GREENE, P. H. WIEBE, J. BURCZYNSKI, M. J. YOUNGBLUTH

Book Reviews

- 363 The International Atomic Energy Agency and World Nuclear Order, *reviewed by* B. SANDERS ■ Charles Darwin's Notebooks, 1836–1844, W. MONTGOMERY ■ The Heritage of Experimental Embryology, J. A. WITKOWSKI ■ Mantle Xenoliths, J. W. SHERVAIS ■ Books Received

Products & Materials

- 368 Flask Rinser ■ Image Analysis System ■ Nucleic Acid Isolation ■ Densitometry Software ■ Video Caliper ■ Automated Peptide Synthesizer ■ Literature

Board of Directors

Sheila E. Widnall
*Retiring President,
Chairman*

Walter E. Massey
President

Richard C. Atkinson
President-elect

Floyd E. Bloom
Mary E. Clutter
Eugene H. Cota-Robles
Mildred S. Dresselhaus
Joseph G. Gavin, Jr.
Beatrix A. Hamburg
Donald N. Langenberg

William T. Golden
Treasurer

Alvin W. Trivelpiece
Executive Officer

Editorial Board

Elizabeth E. Bailey
David Baltimore
William F. Brinkman
E. Margaret Burbidge
Philip E. Converse
Joseph L. Goldstein
F. Clark Howell
James D. Idol, Jr.
Leon Knopoff
Oliver E. Nelson
Helen M. Ranney
David M. Raup
Howard A. Schneiderman
Larry L. Smarr
Robert M. Solow
James D. Watson

Board of Reviewing Editors

John Abelson
Qais Al-Awqati
Don L. Anderson
Stephen J. Benkovic
Floyd E. Bloom
Henry R. Bourne
James J. Bull
Charles R. Cantor
Ralph J. Cicerone
John M. Coffin
Bruce F. Eldridge
Paul T. Englund
Theodore H. Geballe
Roger I. M. Glass

Stephen P. Goff
Robert B. Goldberg
Corey S. Goodman
Jack Gorski
Stephen J. Gould
Richard M. Held
Gloria Heppner
Eric F. Johnson
Konrad B. Krauskopf
Charles S. Levings III
Richard Losick
Karl L. Magleby
Philippa Marrack
Joseph B. Martin
John C. McGiff
Mortimer Mishkin
Jiri Novotny
Gordon H. Orians

Carl O. Pabo
Yeshayau Pocker
Michael I. Posner
Jean Paul Revel
Russell Ross
James E. Rothman
Daniel V. Santi
Ronald H. Schwartz
Vernon L. Smith
Otto T. Solbrig
Robert T. N. Tjian
Virginia Trimble
Geerat J. Vermeij
Harold Weintraub
Irving L. Weissman
George M. Whitesides
Owen N. Witte
William B. Wood

The repeater.



Eppendorf Repeater™ Pipette

Reliable, repetitive pipetting.

With the Eppendorf Repeater* Pipette, dispensing up to 48 samples without a refill is a snap. Just set the selection dial for the volume you need and your choice is locked in place to prevent errors. That means the last sample will be as accurate and precise as the first. And the unique Combipip™ polypropylene/polyethylene reservoir eliminates cleaning, contamination, and carryover because it's disposable.

1-second delivery.

The Repeater makes serial pipetting procedures faster than ever before. Simply press the lever to deliver your samples at 1-second intervals. The volume range is wide enough to accommodate

*U.S. Pat. No. 4406170

almost any procedure. With six Combipip sizes and five dial settings, you choose from 22 different volumes between 10 µL and 5 mL.



Six Combipip sizes

A wide variety of applications.

The Repeater can handle any liquid easily. Even difficult or hazardous liquids aren't a problem, since the liquid contacts only the Combipip—not the instrument itself. The Combipip is available

in nonsterile or sterile packaging for microbiologic and tissue culture techniques. And it can be refilled and reused as long as the same liquid is being pipetted.

For more information: call 800-645-3050; in New York, 516-334-7500. Or write Brinkmann Instruments, Inc., Cantiague Road, Westbury, NY 11590. (In Canada: 416-675-7911; 50 Galaxy Blvd., Rexdale, Ont. M9W 4Y5)

For information circle reader service number 44
For demonstration circle reader service number 45

eppendorf

Shaping the future. **Brinkmann**
INSTRUMENTS, INC.

This Week in SCIENCE

Semiconductor synthesis

THE next generation of integrated circuits will include faster components made from advanced materials such as gallium arsenide. The standard procedure for preparing thin films of gallium arsenide has been cumbersome and depends on a highly toxic starting material, arsine. An alternative technique is now described by Byrne *et al.* by which a precursor arsinogallane is synthesized and then converted to gallium arsenide (page 332). A monomeric structure for the arsinogallane was established both in solution and in the solid state. Monomers apparently then combined into dimers and eventually formed macroscopic gallium arsenide particles, growing in size as a function of time. Studies of the chemistry of these reactions should assist in the design of useful precursors for improved semiconducting materials.

Legacy of oil disease

SOME children in Taiwan have suffered lasting effects from exposure, in utero, to polychlorinated biphenyls (PCBs) and dibenzofurans (PCDFs) (page 334). In 1979, their mothers had "oil disease"; they were poisoned by cooking oil contaminated with PCBs and the more toxic breakdown products PCDFs. Both are fat soluble and persist for years in tissues; they can cross the placenta and enter fetal tissues where they may also persist. Rogan *et al.* describe the physical and behavioral anomalies of the affected children who, along with their mothers and a control group, were evaluated in 1985. Even though the affected children did not directly ingest the toxins and even though many were conceived years after their mothers had been poisoned, they had a high incidence of problems. Many of the pathologic findings involved ectodermal tissue. The children weighed less and were shorter than unexposed children, and they achieved various developmental milestones later than expected. This is not the first report of PCB and PCDF poisoning, but it is the first documenta-

tion of the effects of these toxins on the offspring of exposed women.

Flavonoids and auxins

Two mysteries of plant biology may be closer to being solved: what regulates transport of the plant growth substance auxin and what do flavonoids, the ubiquitous phenolic compounds of plants, do? Auxins are not synthesized where they regulate growth and differentiation but have to be transported to target tissues. Jacobs and Rubery found that in zucchini, corn, and pea plants certain of the flavonoids—quercetin, apigenin, and kaempferol—could regulate auxin transport (page 346). The flavonoids, like some synthetic substances, bind to a receptor in the cell membrane called the NPA receptor; when this receptor is occupied, either by NPA or by a flavonoid, auxin efflux from cells is inhibited, causing auxins to accumulate within cells. A number of structural features that distinguish inhibitory flavonoids from those that do not inhibit auxin transport have been identified. The association of flavonoids with the inhibition of auxin transport may explain earlier observations in wounded or light-exposed plants: increased flavonoid synthesis and binding to local receptors could restrict auxin transport, perhaps concentrating auxins where they could be used for the repair of damaged portions of the plant.

Gene inactivation in lung cancer

SMALL cell lung cancer (SCLC) is a malignancy that can develop in smokers. It appears that associated with the pathogenesis of SCLC is the inactivation of the retinoblastoma gene *Rb*, a gene that may normally be active in most cells (page 353). In cell lines and tumor cells of SCLC and "atypical" pulmonary carcinoid tumors, dysfunctions and structural changes have been found in *Rb* genes; in cells from other types of lung cancers and in normal lung tissues, *Rb* genes do not have

similar alterations. The *Rb* gene had previously been localized to chromosome region 13q14; 13q is one of three chromosomal regions known to be altered in SCLC, and this study confirms that the changes in the gene affect region 13q14. Retinoblastoma (a hereditary disease) and SCLC (not a hereditary disease) have never been associated clinically, although in both neuroendocrine differentiation occurs and the expression of *N-myc* may be deregulated. Harbour *et al.* speculate that cigarette-associated carcinogens in the lungs may induce mutations in *Rb* gene that result in its inactivation and SCLC.

Ocean krill

GEORGES Bank, located off the northeastern North American coast, is one of the world's most productive fisheries. Its productivity may reflect the availability of a ready supply of krill (small crustaceans) in surrounding deep waters (page 359). The density of krill (measured in the water column with acoustic equipment aboard a research submersible) varied throughout the daily 24-hour cycle: during the day, there was a thick layer of krill in the bottom 50 meters of the water column; at night, a portion of the population migrated as much as 400 meters upward. The canyons along Georges Bank may effect the concentration of krill by funneling them during their downward migrations. Greene *et al.* propose that the abundant squid and bottom fish (cod, flounder, redfish, and others) on Georges Bank may feed not only on zooplankton and bottom-dwelling organisms but also on the krill in adjacent deep waters. Local plankton and the productivity at the sea floor cannot account for the abundance of these marine animals, but the krill could make up the difference.

The bottom lines

The United States' eroding economic position is the subject of three articles on competitiveness (pages 299, 308, and 313; see also page 273).

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.

Publisher: Alvin W. Trivelpiece

Editor: Daniel E. Koshland, Jr.

Deputy Editors: Philip H. Abelson (*Engineering and Applied Sciences*); John I. Brauman (*Physical Sciences*)

EDITORIAL STAFF

Managing Editor: Patricia A. Morgan

Assistant Managing Editor: Nancy J. Hartnagel

Senior Editors: Eleanor Butz, Ruth Kulstad

Associate Editors: Martha Coleman, R. Brooks Hanson, Barbara Jasny, Katrina L. Kelner, Edith Meyers, Linda J. Miller, Phillip D. Szurumi, David F. Voss

Letters Editor: Christine Gilbert

Book Reviews: Katherine Livingston, *editor*; Deborah Field Washburn

This Week in Science: Ruth Levy Guyer

Contributing Editor: Lawrence I. Grossman

Chief Production Editor: Ellen E. Murphy

Editing Department: Lois Schmitt, *head*; Mary McDaniel, Patricia L. Moe, Barbara E. Patterson

Copy Desk: Joi S. Granger, Beverly Shields, Anna Victoreen, Barbara Wittig

Production Manager: Karen Schools

Assistant Production Manager: James Landry

Graphics and Production: Holly Bishop, James J. Olivarri, Yolanda M. Rook

Covers Editor: Grayce Finger

Manuscript Systems Analyst: William Carter

NEWS STAFF

News Editor: Barbara J. Culliton

News and Comment: Colin Norman, *deputy editor*; William Booth, Gregory Byrne, Mark H. Crawford, Constance Holden, Eliot Marshall, Marjorie Sun, John Walsh

Research News: Roger Lewin, *deputy editor*; Deborah M. Barnes, Richard A. Kerr, Jean L. Marx, Robert Pool, Leslie Roberts, M. Mitchell Waldrop

European Correspondent: David Dickson

BUSINESS STAFF

Business Staff Manager: Deborah Rivera-Wienhold

Classified Advertising Supervisor: Karen Morgenstern

Membership Recruitment: Gwendolyn Huddle

Member and Subscription Records: Ann Ragland

Guide to Biotechnology Products and Instruments: Shauna S. Roberts

ADVERTISING REPRESENTATIVES

Director: Earl J. Scherago

Traffic Manager: Donna Rivera

Traffic Manager (Recruitment): Gwen Canter

Advertising Sales Manager: Richard L. Charles

Employment Sales Manager: Edward C. Keller

Marketing Manager: Herbert L. Burkland

Sales: New York, NY 10036: J. Kevin Henebry, 1515 Broadway (212-730-1050); Scotch Plains, NJ 07076: C. Richard Callis, 12 Unami Lane (201-889-4873); Chicago, IL 60611: Jack Ryan, Room 2107, 919 N. Michigan Ave. (312-337-4973); San Jose, CA 95112: Bob Brindley, 310 S. 16 St. (408-998-4690); Dorset, VT 05251: Fred W. Dieffenbach, Kent Hill Rd. (802-867-5581); Damascus, MD 20872: Rick Sommer, 24808 Shrubbery Hill Ct. (301-972-9270); U.K., Europe: Nick Jones, +44(0)64752918; Telex 42513; FAX (0392) 31645.

Information for contributors appears on page XI of the 24 June 1988 issue. Editorial correspondence, including requests for permission to reprint and reprint orders, should be sent to 1333 H Street, NW, Washington, DC 20005. Telephone: 202-326-6500.

Advertising correspondence should be sent to Tenth Floor, 1515 Broadway, New York, NY 10036. Telephone 212-730-1050 or WU Telex 968082 SCHERAGO.

Economic Arteriosclerosis and Competitiveness

“How you gonna keep ‘em down on the farm after they’ve seen Paree?” Those lines could be paraphrased today as, “How you gonna get ‘em competing again after the spending spree?” The situation facing the United States is probably the most difficult of all possible political problems: here is a nation with lots of jobs and a good standard of living, but also one with a serious economic arteriosclerosis filling up its fiscal arteries. Complacent people do not like unattractive Cassandras saying, “You are living beyond your means, you must change your ways.” Worse, when the causes are complex, each participant can blame another, saying, “You’ve got to shape up, I don’t need to change.” Management says labor must accept more flexibility and more competitive wages; labor says management must plan more innovatively. Both say politicians must devise tax laws for the future, not just for the short run. Congress says voters want quick fixes, not Spartan self-discipline. Voters say, “Why should I scrimp so that my children can live off the fat of the land?”

The three articles on U.S. economic competitiveness in this issue provide signposts that might help the U.S. economy back onto a more stable pathway. The good news is that the patient is not in a terminal decline, and the malady has been identified.

Hatsopoulos, Krugman, and Summers clearly lay out the dimensions of the problem. The authors point out that over the long haul productivity growth is the main determinant of trends in living standards, and no amount of fiscal legerdemain can obscure a basic weakness. Real wages in this country have steadily decreased, and they will have to diminish further unless productivity and capital investment trends reverse. Capital spending is closely related to the cost of capital. Because the cost of capital is so high here, a U.S. firm that undertakes a project that lowers earnings by \$1 a day requires a payoff of 1.2 constant dollars a day in less than 3 years, whereas a Japanese firm could be willing to make the same sacrifice for the same increment 12 years in the future. It is thus inevitable that the Japanese firm can afford to take a longer view. The cost of capital is in turn related to the savings pattern in a country, and U.S. fiscal policy does not encourage savings, either in the private sector or in the government. A large part of savings in the private sector is tied up in residential real estate, which does nothing to reduce the trade deficit.

That there is no quick fix is illustrated by Klein, who points out that the devaluation of the dollar makes U.S. goods more competitive abroad, but that increases the difficulty of paying off the debt. The good news, as pointed out by Young, is that steps are being taken to improve productivity by improved interactions of manufacturers with the research community and by improved efficiency at the manufacturing level. Cooperation between scientists, engineers, and managers is a key step.

The pinch of the global economy has indeed resulted in the need for discipline at both labor and management levels. The question is whether such discipline can be applied at the political level. Hatsopoulos *et al.* point out that U.S. saving is as low as 2% of national income, in dramatic contrast to the average 13% saving rate of the other advanced countries. If our nation is to become genuinely competitive instead of depending on fiscal gimmicks and mutual recriminations, it will have to take the hard steps necessary to reduce the debt, readjust taxes, and opt for deferred gratification. Fortunately, there are devices that can set the economy on a better course, but they require significant changes in the tax incentives, with emphasis on long-term investments rather than short-term profits. There are tough political choices ahead, and the United States is currently in the middle of a presidential election campaign. That election could present a welcome opportunity if the candidates are asked to speak these economic issues realistically.

“Eat dessert first, life is uncertain.” That T-shirt slogan expresses the fiscal policy of the United States at the moment. It is a prescription that can make the system fat, happy, and dangerously clogged with cholesterol. Economics has been called a dismal science, possibly because, like the second law of thermodynamics, it eventually confronts us with the fact that none of our easy ways out are viable. Nations faced with dilemmas like this have responded well, once a true crisis has developed. The intriguing question in this case is whether the arteries can be unclogged before or after the first major heart attack.

—DANIEL E. KOSHLAND, JR.



The first step in successful amino acid analysis.

First, we need to talk. But not about model numbers and purchase orders.

We need to talk about what you want and need. About how you prefer to run your laboratory — philosophies, methodologies and procedures.

At first, you'll do most of the talking, while we listen. And learn. Then — and not until then — we'll recommend the best answer for your particular analysis needs.

You may need the superior quantitation and reproducibility of the classical ion exchange technique. Or the speed and sensi-

tivity of reversed phase. We offer them both.

For the flexibility of HPLC, we offer System Gold™, the Personal™ Chromatograph. And the System 6300 dedicated ion exchange analyzer for physiological and diagnostic applications.

Whichever your choice, we provide proven methods, too. Complete and *guaranteed*.

You see, we've been involved in automated amino acid analysis since Moore, Stein and Spackman pioneered it in 1958. So you can rely on us for in-depth applications and technical support. Anytime.

For literature circle reader service number 63
To have a sales Representative call circle
reader service number 64

All the time.

That's why you can trust our recommendation. But we won't recommend a thing until we sit down and talk. And listen.

Take the first step in successful amino acid analysis. Contact your local Beckman office in major cities worldwide. In the US, call 800/742-2345.

Beckman Instruments, Inc.,
Altex Division, 2350 Camino Ramon,
P.O. Box 5101, San Ramon, California 94583.

BECKMAN

A SMITHKLINE BECKMAN COMPANY

reason. Systematics is not simply the identification of specimens, it is the reconstruction of evolutionary history; and it should be supported not just because it has practical applications (which it does) but because it is a fundamental scientific discipline.

Systematics is important because all living things are the product of history, and we can understand little about the diversity of organisms without knowledge of their history—the phylogenetic knowledge provided by systematics (1). One might just as well try to understand the current political conflicts in Central America or the Middle East without understanding the history of the people of those areas.

Oliver correctly deplores the placement of major systematics collections in "maintenance storage," and we further deplore the disposal of other collections (2) and the retreat of university biology departments into nonevolutionary disciplines. Many of the biological "laws" that such disciplines discover may be bounded by clade and place, and only systematic research—research on evolutionary history—can discover those bounds.

Other recent calls for the support of systematics (3) have also emphasized its practi-

cal and cataloging aspects. We agree strongly that systematics is insufficiently supported, but we fear that these arguments based exclusively on "usefulness" will backfire in the long run. Systematics will not attract the brightest students—the true innovators of theory and practice—if it is portrayed as an identification service. Systematics must command attention because of the intellectual challenge it represents, in and of itself, as the study of evolutionary history.

ROBERT J. O'HARA
DAVID R. MADDISON
*Museum of Comparative Zoology,
Harvard University,
Cambridge, MA 02138*

PETER F. STEVENS
*Curator, Arnold Arboretum and Gray
Herbarium, Harvard University Herbaria,
22 Divinity Avenue,
Cambridge, MA 02138*

REFERENCES AND NOTES

1. For examples of the importance of phylogenetic knowledge to other disciplines, see J. A. Coddington, *Cladistics* 4, 3 (1988); J. Felsenstein, *Am. Nat.* 124, 1 (1985); W. L. Fink, *Paleobiology* 8, 254 (1982); G. V. Lauder, *ibid.* 7, 430 (1981).
2. C. Holden, *Science* 228, 38 (1985); F. A. Jenkins, Jr., E. L. Simons, M. C. McKenna, P. D. Gingerich, *ibid.* 229, 330 (1985).

3. M. Kosztarab, *ibid.* 223, 443 (1984); M. S. Strauss, *ibid.* 239, 714 (1988) (emphasizes technology); M. Sun, *ibid.* 237, 967 (1987); E. O. Wilson, *ibid.* 230, 1227 (1985).
4. We thank G. C. Mayer and E. E. Williams for their comments.

Mesoamerica, Not the New World

I was enjoying Roger Lewin's essay on agricultural origins (*Research News*, 20 May, p. 984) until I found myself misquoted. Lewin quotes me as seeing no evidence "anywhere in the New World" to suggest that population pressure was responsible for the beginnings of agriculture. What I said was that I saw no such evidence anywhere in Mesoamerica (a culture area stretching roughly from central Mexico to Honduras).

I would never have extended my comments to the whole New World, because I know that some areas, such as the Pacific Coast of Peru, had much higher population densities than Mexico. It is still too early to rule out population pressure in Peru.

KENT V. FLANNERY
*Museum of Anthropology,
University of Michigan,
Ann Arbor, MI 48109*

**Turn your Macintosh into a
paperless 4-channel pen
recorder or
oscillographic
recorder**



...with

MacLab™

*Costs \$2000 to
\$6000 less than
comparable analog
equipment!*

• **Hardware** unit has four input channels and a 12-bit analog-to-digital converter, trigger input, plus a waveform generator for analog output through a 12-bit DAC. Plugs into the modem port of any Macintosh. 40 kHz sampling rate.

• **Software** included: With "CHART," your Mac screen emulates a four-channel paper chart recorder. "SCOPE" turns your Mac into a digital storage oscilloscope. Lets you manipulate and analyze your data files — saving hours or days of manual calculations working with an expensive and cranky polygraph! Resulting plots can be printed out on Apple's ImageWriter or LaserWriter printers.

Runs on any Mac with at least 512K memory and two disk drives

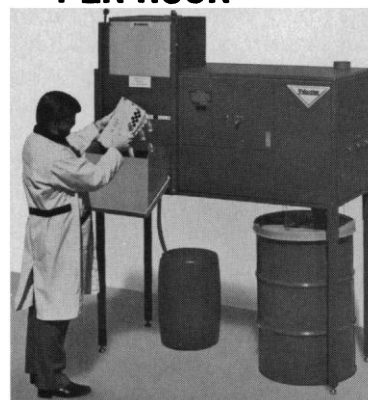


World Precision Instruments, Inc.

375 Quinipiac Ave • New Haven, CT 06513 • 203-469-8281

CRUSHES AND EMPTIES SCINTILLATION VIALS

- GLASS AND PLASTIC
- THOUSANDS PER HOUR



Worker dumps vials from tray into Vyleater's basket, raises it to top, unit does the rest. **Fast.** Vials not handled one by one. **Safe.** Hands never contact liquid. Handles various sizes. Liquid and solids automatically deposited in separate containers. Internal fumes exhausted into building's vent system. **Easy to use, compact and efficient.**



Write for descriptive literature or call
414-464-5310

ENTERPRISES, INC.

5630 N. 91st St., Milwaukee, WI 53225

Circle No. 114 on Readers' Service Card

Circle No. 34 on Readers' Service Card

QUALITY IN QUANTITY.

Repligen introduces a new generation of Immobilized rProtein A™, IPA-300. Designed specifically for the purification of pharmaceutical-grade monoclonal antibodies, IPA-300 is supported by a Drug Master File and rigorous quality assurance testing. The product delivers monoclonal antibodies of ultra-high purity in a single column pass with virtually un-

leakage. Process-scale users will appreciate capacity and availability in multi-liter, single-lot rProtein A™ is already used by leading biotech-firms worldwide. They trust Repligen

protein A products.

Repligen's Immobilized rProtein A™ –for top quality quantities.



RepliGen

Cambridge, Massachusetts
1-800-622-2259

Circle No. 84 on Readers' Service Card



Should the delivery date be any less accurate?

At VWR, we'll give you scheduled appointments that are accurate. Instructions that are precise. Advice that's specific. If you think Mettler balances are exacting, you haven't met the people who sell them. Call (415) 468-7150.

Circle No. 112 on Readers' Service Card

VWR Scientific

For problems involving engineering calculations or scientific analysis,
the answer is MathCAD.®

Transporting an iceberg to Southern California is a formidable task. Calculating the variables is just as demanding. How many tugboats would be needed to tow the ice mass? At what cost? How much fresh water would be lost?

Innovative solutions require extraordinary tools. For problems involving calculations or what-if analysis, the answer is MathCAD.

MathCAD is the only PC-based software package specifically designed to give technical professionals the freedom to follow their own scientific intuition.

Requires IBM® PC or compatible.

You decide how to solve the problem – MathCAD does the "grunt work."

- Ends programming and debugging.
- Recalculates as variables change.
- Generates quick plots.

Easy to learn and use, MathCAD operates interactively in standard math notation. And its built-in functions provide all the power you need to solve real-world problems. MathCAD handles matrix operations, solves simultaneous equations, works with real and complex numbers, does automatic unit conversion, displays Greek characters and

other math symbols, performs FFTs and much more.

There's never been a better way to get fast, accurate solutions to analytical problems. That's why 20,000 engineers and researchers are using MathCAD daily in applications as diverse as fluid mechanics, signal processing and molecular modeling.

To find out what MathCAD can do for you, call us today for a **free demo disk: 1-800-MathCAD** (in MA, 617-577-1017). Or write to MathSoft, Inc., One Kendall Square, Cambridge, MA 02139.

Math Soft
 $\Sigma + \sqrt{-} = \times \int \div \delta$
Software Tools for Calculating Minds

HOW MANY GLASSES OF WATER



IBM® International Business Machines Corporation. MathCAD® MathSoft, Inc. © Copyright MathSoft, Inc. 1988.

CAN THIS ICEBERG SUPPLY TO L.A.?

Circle No. 76 on Readers' Service Card



Improve your image.



The Nikon Optiphot meets and exceeds the most demanding requirement of scientists and researchers: image quality.

Nikon's revolutionary new CFN optics give you the brightness, resolution, color fidelity and contrast that were previously unavailable in any microscope in this class. Newly designed objectives feature higher numerical apertures and greater working distance for faster evaluation of hard-to-see details.

Important advantages of the Optiphot include an objective magnification range from 1X to 100X, true Koehler 12V 50W halogen illumination, and a full range of accessories. The removable five-place revolving nosepiece easily accommodates objectives for such techniques as Nomarski DIC, phase contrast, differential interference, contrast and fluorescence.

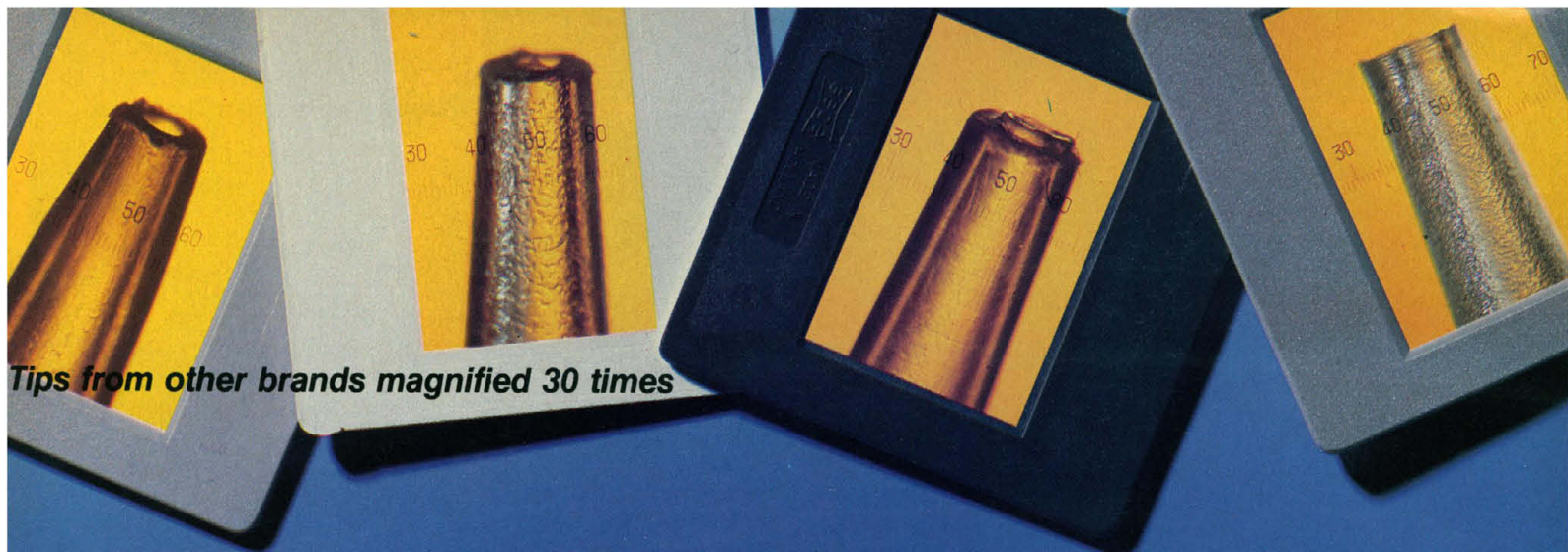
For fast, sure documentation, the optional Nikon FX photomicrographic systems provide microprocessor-controlled exposure accuracy. The results are sharp, clear photos — even low light fluorescence images can be easily captured on film. Every system feature assists in delivering quality photos with a maximum of convenience and confidence.

If you'd like to improve the image you're seeing now, ask to look into the Nikon Optiphot. For information, contact: Nikon Inc., Instrument Group, 623 Stewart Avenue, Garden City, NY 11530. (516) 222-0200.

For information circle reader service number 58. For a demonstration circle reader service number 59.

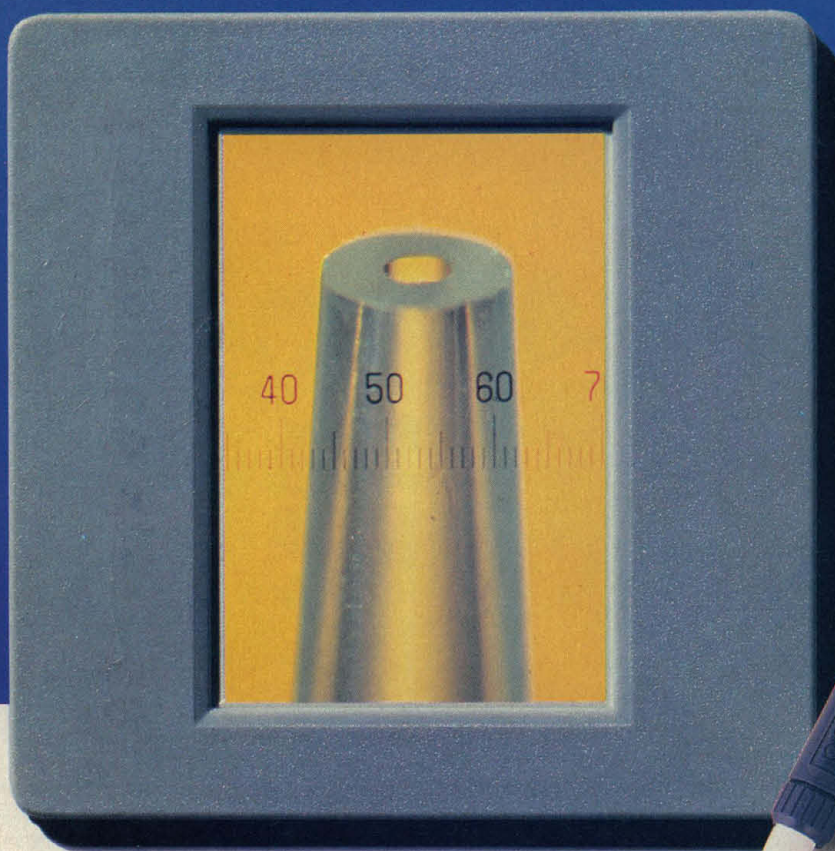
NIKON OPTIPHOT

Nikon
Extending Man's Vision



Tips from other brands magnified 30 times

A GENUINE GILSON PIPETTE TIP



We photographed a Gilson tip under the microscope. Then we compared other manufacturers' copies.

The unprecedented quality you see here has made Pipetman a world reference for superb performance.

- Flash-free orifices, uniform geometry and end finish guarantee repeatability.

- Smooth, clean surfaces entirely free of contamination assure minimal surface wetting.

- Stringent quality controls at every stage of the manufacturing process assure long-term consistency.

Insist on genuine Gilson pipette tips. The results of your work depend on it.

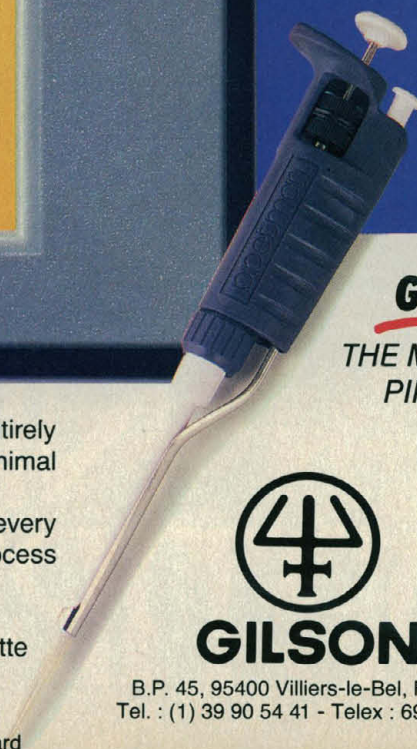
Circle No. 19 on Readers' Service Card

GILSON
THE MAKERS OF
PIPETMAN



GILSON

B.P. 45, 95400 Villiers-le-Bel, France
Tel. : (1) 39 90 54 41 - Telex : 696 682 F



DNA SEQUENCING

SEQUENASE™

THE ACCEPTED STANDARD AND A 50% DISCOUNT.*

- Proven reliability • Gives uniform band intensities • Reduces gel background
- Resolves 500, 600 or more bases • Eliminates compressions • Easy to use

Now you can extend the limits of sequencing with the proven Sequenase™**—while saving on your other biochemical needs.

**Purchase the Sequenase™ Kit, the Sequenase™ Enzyme or related Sequenase™ sequencing products and USB will give you—absolutely free—anything else you order at the same time; up to 50% of the dollar value of your Sequenase™ purchase. There are no restrictions except a September 15, 1988 time limit.*

Just order Sequenase™, the system of choice for sequencing—then choose what you want free from our Molecular Biology Catalog and/or our General Biochemical Catalog with over 6,000 listings.

Sequenase™ Kit, Product #70700; Enzyme only, Product #70722. The convenient Sequenase™ Kit includes everything needed for 100 sequences.

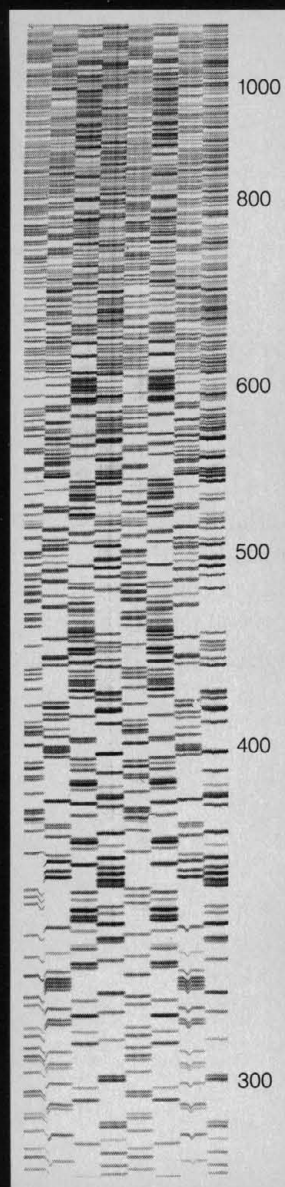
■ Sequenase™ DNA Polymerase ■ Control DNA ■ Buffer ■ Stop solution ■ Pre-mixed nucleotides including dITP ■ Universal Primer ■ Complete protocol booklet.

Check our catalogs and decide what you want, in what combination, to take full advantage of USB's standards of excellence—and our unsurpassed reputation for purity, quality and service. Then get it free; up to 50% of whatever you spend on Sequenase™ in the same order (providing that order is placed by September 15, 1988).

For a free copy of our Molecular Biology or General Biochemical catalogs, write USB at P.O. Box 22400, Cleveland, Ohio 44122. Phone 800/321-9322. From Ohio or Canada, call collect to 216/765-5000. Telex: 980718. FAX: 216/464-5075.

**Patent Pending.

1. Tabor, S. and Richardson, C.C., Proc. Nat. Acad. Sci., USA 84, No. 14, 4767-4771 (1987).



USB



UNITED STATES BIOCHEMICAL CORPORATION

INTERNATIONAL DISTRIBUTORS: Cambridge BioScience – Cambridge, England • Kebo – Spanga, Sweden; Ballerup, Denmark; Oslo, Norway • Lucerna-Chem AG – Lucerne, Switzerland • Maagar – Rehovot, Israel • Renner GmbH – Dannstadt, W. Germany • RIJ – IJssel, Holland • Societa Italiana Chimici – Roma, Italy • Sopar-Biochem SA – Brussels, Belgium • Separation Scientific – Randburg, S. Africa • Touzart et Maignon – Paris, France • Trace Scientific – Baulkham Hills, Australia.

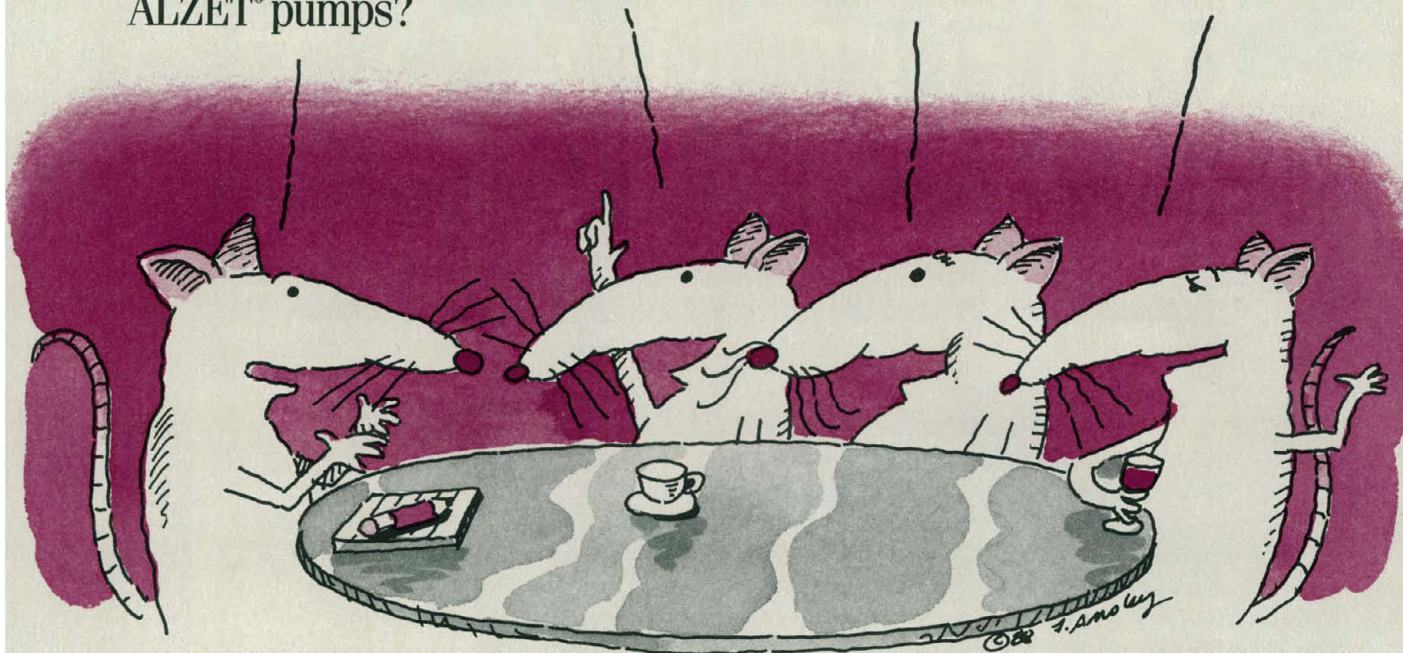
Circle No. 89 on Readers' Service Card

Where in the world
can we get
ALZET® pumps?

Charles River
France

Charles River
Germany

Charles River
Italy



Wherever you are, now that Charles River distributes ALZET® osmotic pumps in Europe, it's easier than ever to get continuous delivery.

And that translates into good news for researchers. Because now you can depend on local availability of all sizes of ALZET pumps, as well as expert technical support and service, from two of the leading companies in the field—ALZA Corporation and Charles River Laboratories.

More than 900 agents have been administered successfully with ALZET osmotic pumps. ALZET pumps eliminate the need for periodic injection and reduce stress or trauma that may interfere with the reliability of test results. Five pump models give you a choice of delivery rates from one to four weeks.

So when you need someone who speaks your language, call the Charles River representative nearest you.

alzet®
OSMOTIC PUMPS

ALZA Corporation, 950 Page Mill Road
P.O. Box 10950, Palo Alto, CA 94303
(415) 494-5323

Charles River
THE INTERNATIONAL STANDARD 

In **France, Belgium, Switzerland, Spain and Portugal**, contact Charles River France, St. Aubin-les-Elbeuf, Tel. (+33)-35-774887, FAX 35/770999 • In **Italy**, contact Charles River Italy, Calco, Tel. (+39)-39-508448, FAX 39/508219 • In **West Germany**, the **Netherlands** and **Austria**, contact Charles River Wiga, Sulzfeld, Tel. (+49)-97-61819, FAX 97/615368 • In the **United Kingdom**, contact Scientific Marketing Associates, LTD, London, Tel. 01/359/5357 • In **Japan**, contact Muromachi Kikai Company, LTD, Tokyo, Tel. 03 241 2444 • In **Scandinavia**, contact ALAB Laboratorietjänst AB, Sollentuna, Tel. 46 8754 00 65 • In the **United States** and other countries, contact ALZA Corporation at (800) 692-2990 or (415) 494-5323, FAX (415) 494-5151.

Circle No. 56 on Readers' Service Card

The New York Academy of Sciences
Announces a Conference

UNDER THE VOLCANO: BIOMEDICAL SCIENCE AND THE THIRD WORLD

October 18-20, 1988

**Caspary Auditorium
The Rockefeller University
New York City**

Conference Chairs:
Barry R. Bloom
Anthony Cerami

The Third World is the place in which 75% of the planet's population lives, where 86% of all children are born, and 98% of all infant and childhood deaths occur. This meeting will explore, from many perspectives, the specific problems of Africa, Asia, and Latin America, the opportunities provided by new scientific approaches to preventing and ameliorating major diseases in the Third World, and will place this scientific discussion in a wider social and economic context.

Topics and Speakers Include:

Third World Perspectives
J. Lederberg, A. Lucas, V. Ramalingaswami
Strategies for Vaccine Development
R. Davis, R. Lerner, L. Miller, B. Moss
Strategies for Drug Design
A. Cerami, C. Walsh, D. Santi
Aids and the Third World
H. Wigzell
Social, Economic, and Epidemiological Impact
B. Abel-Smith, T. P. Schultz, B. Singer, T. Godal

This conference is being held in conjunction with the presentation of The 1988 Biennial L. W. Frohlich Award, Science and the Human Prospect.

For program and registration information, contact:

**Conference Department
The New York Academy of Sciences
2 East 63rd Street
New York, NY 10021
Telephone: (212) 838-0230**

CALL FOR NOMINATIONS

The Roger J. Williams Award in Preventive Nutrition

This award is presented by the Texas College of Osteopathic Medicine for outstanding contributions to the prevention of disease and promotion of health through nutrition. The award, which includes a cash prize of \$5,000, commemorates the pioneering nutritional research of Roger J. Williams, Ph.D., founding director of the Clayton Foundation Biochemical Institute of the University of Texas at Austin. Nominees will be considered in terms of the magnitude of their contributions to any aspect of preventive nutrition. The award is made possible through the generosity of Mr. and Mrs. E. Bruce Street Sr. of Graham, Texas.

Nominations for the award should include: (1) the nominee's name, address and curriculum vitae; (2) a description of the contributions of the nominee relevant to preventive nutrition; and (3) a statement of the social and scientific impact of these contributions. The nomination should be signed by the individual completing it.

Please submit nominations by November 1, 1988 to:

**Screening Committee
The Roger J. Williams Award in Preventive Nutrition
Texas College of Osteopathic Medicine
3500 Camp Bowie Blvd.
Fort Worth, Texas 76107-2690 USA**

An International Conference on the Health and Environmental Consequences of Ozone Depletion

28-29 November 1988 London

*Conference Chairman Lord Zuckerman
Conference Organiser Dr Robin Russell Jones*

The conference will feature an international panel of scientific speakers and will bring together health experts, industrialists, environmentalists, consumer organisations, and politicians; and, all those concerned about the depletion of the ozone layer. Registration fee £120.

For Conference Programme,
Registration Form and details
write to Ozone Depletion
Conference, 2 Marylebone Road,
London, NW1 4DX.



CONFERENCE SPONSORED BY CONSUMERS' ASSOCIATION AND FRIENDS OF THE EARTH

Work Experience and Psychological Development Through the Life Span

Edited by Jeylan T. Mortimer, *University of Minnesota*, and Kathryn M. Borman, *University of Cincinnati*

Only recently have researchers begun to explore the relationship between occupational conditions and psychological development during different phases of life. This book examines a wide range of related issues, including part-time work for adolescents; adjustment of young adults to new work roles; occupational self-direction among different age groups; job satisfaction, age, and gender; women's dual roles at home and at work; loss of "vitality" among midcareer and older workers; and self-concept and job-related disabilities.

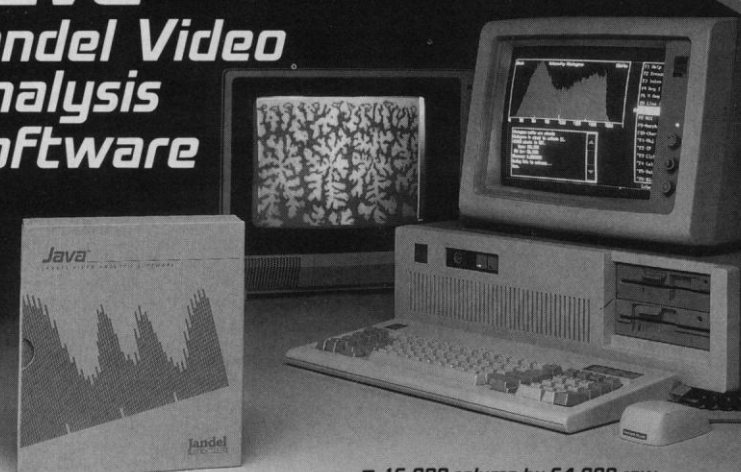
\$29.95; AAAS members \$23.96 (include membership number from *Science*). 306 pp., 1987. AAAS Selected Symposium 107.

Order from: Westview Press, Dept. AAAS, 5500 Central Avenue, Boulder, CO 80301. (Add \$2.50 postage and handling for the first copy, 75 cents for each additional copy; allow 4-6 weeks for delivery.)

Published by Westview Press for AAAS

INTRODUCING
Java™
Jandel Video Analysis Software

IBM XT, AT and compatibles



Now you can use your own computer to measure and analyze nearly any video image at a fraction of the cost of larger systems!

- Density and morphometric measurements
- Automatic edge and line tracking
- Object and grain counting
- Advanced image processing functions

- 16,000 column by 64,000 row worksheet
- User defined transforms
- Standard ASCII data output (For Lotus, dBase, etc.)
- Composite video (RS-170) signal input

An IBM XT, AT or compatible, mouse and video digitizing board (Frame grabber) will put JAVA to work for you. Money-back guarantee.

Free brochure **800-874-1888**
In CA **415-924-8640**
FAX: 415-924-2850/Telex: 4931977
In Europe: R.J.A. Handels GmbH, Germany
Phone: 2101/666268 FAX: 2101/64321

Jandel "Microcomputer Tools for the Scientist"
SCIENTIFIC
■ 65 Koch Road ■ Corte Madera, CA 94925

Circle No. 80 on Readers' Service Card

PC3D™
three dimensional reconstruction software

IBM PC and Compatibles



Reconstruct multi-colored three dimensional computer models of any object from serial section data. Display the reconstructed image, rotating and viewing it from any angle or orientation. Automatically calculate volumes of elements. Output 3-D images to plotter.

Analyze and sort out complex structures (e.g. intertwined neurons). Components may be removed or replaced at will, allowing computer "dissection" of complex objects. Up to 400 polygons per section, 1000 serial sections per image. Applications in electron and optical microscopy, macroscopic sectioning, CAT scans, positron emission tomography, NMR imaging, autoradiographs, and more.

Reconstruction courtesy of E. Effmann, M.D. and B. Smith, Ph.D.

Free brochure **800-874-1888**
In CA **415-924-8640**
FAX: 415-924-2850 / Telex: 4931977
In Europe: R.J.A. Handels GmbH, Germany
Ph #02101/666268

Jandel "Microcomputer Tools for the Scientist"
SCIENTIFIC
■ 65 Koch Road ■ Corte Madera, CA 94925

Circle No. 81 on Readers' Service Card

been brought together between two covers, edited to the highest scholarly standards. The publication of such an edition is well worthwhile. During the period the notebooks cover, Darwin speculated about an enormous range of evolutionary topics, and he changed his mind about many of them as he went along. To capture the full significance of his thinking, one needs to see it all and reflect on the many connections among ideas that he made—or refused to make. Cumulatively, the notebooks yield a more comprehensive picture of Darwin's mind than we see in any of his published works. Not even *On the Origin of Species* matches the breadth of thought reflected in the notebooks, and we will never understand the *Origin* correctly unless we bear this breadth in mind.

The editors group the notebooks into three general categories. The Red Notebook and Notebook A, both edited by Sandra Herbert, deal largely with geological topics. The Glen Roy Notebook, edited by Sydney Smith, Peter Gautry, and the late Paul Barrett, also deals with geology. The lettered Notebooks B through E, edited by David Kohn, the surviving leaves of the Torn Apart Notebook, edited by Kohn and Smith, a portion of Darwin's Account Book entitled Questions and Experiments, edited by Barrett, and two shorter manuscripts deal with species transmutation. Notebooks M and N, a collection of loose manuscript pages Darwin called Old and Useless Notes, and another short manuscript, edited by Barrett, deal with psychology and religion, subjects that Darwin subsumed under the term "metaphysical enquiries."

Darwin made abundantly clear that he considered geology, zoology, botany, and "metaphysics" all integrally relevant to the establishment of his theory. Furthermore, the Notebooks contain the groundwork for books on all these topics. The Red Notebook and Notebook A contain speculations that went into Darwin's geological studies about the *Beagle* voyage but also into the geological portions of the *Origin*. Notebooks B through E, the Torn Apart Notebook, and the Questions and Experiments provided material that went primarily into the *Origin* and *The Variation of Animals and Plants Under Domestication*. Notebooks M and N and the Old and Useless Notes set the stage for the *The Descent of Man* and *The Expression of the Emotions*. The amount of botanical material is limited, but in Notebook E one even finds the early considerations that led to *On the Various Contrivances by Which British and Foreign Orchids are Fertilised*. Darwin worked for years to develop the ideas that he first set down in these documents.

SCIENCE, VOL. 241