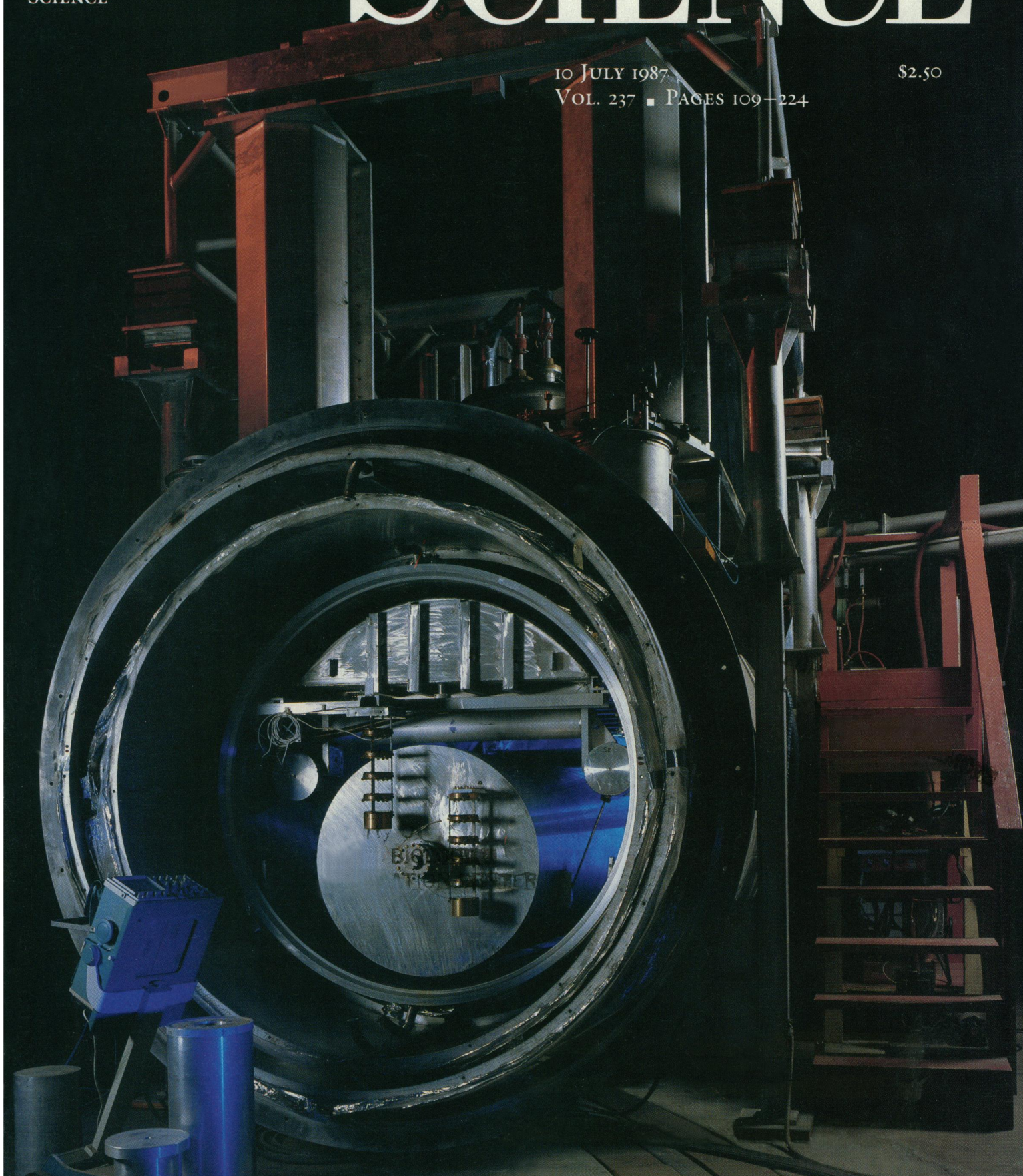


AMERICAN  
ASSOCIATION FOR THE  
ADVANCEMENT OF  
SCIENCE

# Science

10 JULY 1987  
VOL. 237 ■ PAGES 109-224

\$2.50





# NEW GP SERIES CENTRIFUGES: UNDER, OVER, AND BEYOND!



Presenting the space-saving GP Series from Beckman, with models that fit under as well as on top of a lab bench and provide capabilities beyond those of other general purpose centrifuges.

*For high reliability* and quality separations, the GP's have a Beckman-designed drive, automatic "soft-start" and two-stage disc brake. These quiet-running centrifuges are available with or without refrigeration.

*For fast separations*, the horizontal rotor—of corrosion resistant stainless steel—spins 3 Liters at 3750 rpm/3200 g. You can spin microplates, blood bag cups, aerosol cannisters, even 250-mL conical-tip plastic bottles. Modular disk adapters accommodate every



Available Summer 1987.



Available Spring 1987.



popular size tube—as many as 56 15-mL tubes, for example.

There also are two fixed angle rotors—10x 50-mL and 24x 15-mL—rated for 6400 rpm/5642 g.

The new GP's—under, over, beyond. *And at a great price!* In the USA, available through your local VWR Scientific office and Beckman Instruments, Inc., Spinco Division, 1050 Page Mill Road, Palo Alto, CA 94304. Offices worldwide.

## BECKMAN

A SMITHKLINE BECKMAN COMPANY

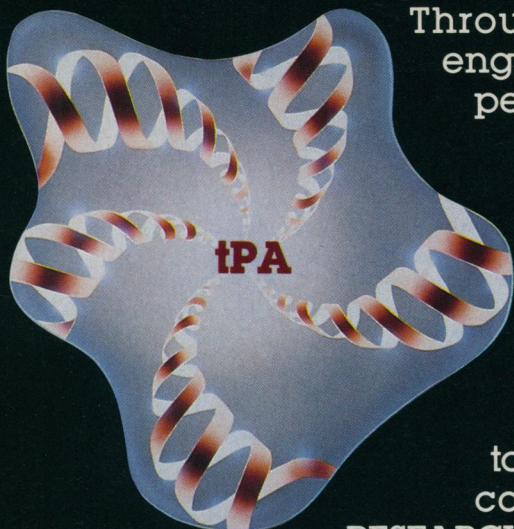
Circle No. 59 on Readers' Service Card



# INVITRON RESEARCH PRODUCTS INTRODUCES:

— rtPA —

## A NEW STANDARD FOR tPA RESEARCH



Through the combination of proprietary genetic engineering techniques and patented large-scale perfusion bioreactor technology, Invitron scientists have developed a revolutionary process for manufacturing recombinant human tissue plasminogen activator (tPA). The tPA manufactured by this new process is characterized by very high purity, excellent *in vitro* enzymatic activity and most importantly, very high lot-to-lot consistency. INVITRON

RESEARCH PRODUCTS now offers recombinant human tPA for *in vitro* and laboratory animal research use only.



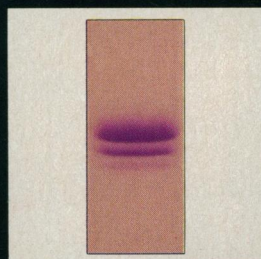
### Product Availability:

- available in 2-chain form in the following vialled amounts as a liquid or active, carrier protein-free lyophilized product:  
50  $\mu$ g      1 mg      10 mg      50 mg
- customized buffering and aliquotting available for orders ranging in size from one gram to one kilogram
- larger quantities (multi Kg.) and one-chain form available upon request

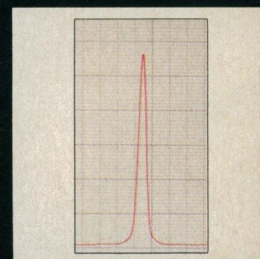
### Product Specifications:

- purity >95%
- activity approx. 500,000 IU/mg
- endotoxin <0.5 EU/mg

### Representative of 2-Chain tPA



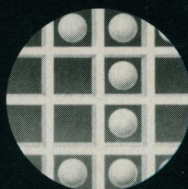
Reduced 10% SDS-PAGE



Gel Filtration Profile

**Caution: For research use only in laboratory animals or *in vitro* testing. Not for diagnostic or human use. Not available for sale in the U.K. or Japan**

For more information  
and ordering call:  
Toll Free: 800 323-2752



**INVITRON**  
**RESEARCH PRODUCTS**  
4649 Le Bourget Drive  
St. Louis, MO 63134  
314-426-5000



115 This Week in *Science*

## Editorial

117 Petroleum Research Centers

## Letters

119 Scientific Enlightenment: Whose Responsibility?: J. D. ROBINSON ■ Nuclear Reactor Risk Estimates: A. M. WEINBERG ■ ACS Journals and Prices: D. H. M. BOWEN; C. HOLDEN ■ Volts and Bolts: R. B. STANDLER

## News & Comment

120 Companies Vie over New Heart Drug  
122 Research Council Critiques NASA's Booster Redesign  
123 NRC's Political Meltdown  
124 *Briefing*: Head of AIDS Panel Named ■ Goslin Leaves NAS  
125 IBM's Zurich Lab Is "Flower" in Europe  
126 U.K. Lifts Veto on Plans for EEC  
127 Weapons Designers Challenge SDI Report

## Research News

128 Debate over Potential AIDS Drug  
131 Has Stratospheric Ozone Started to Disappear?  
133 Associations or Rules in Learning Language?

## Articles

143 Human Aging: Usual and Successful: J. W. ROWE AND R. L. KAHN  
150 Resonant-Mass Detectors of Gravitational Radiation: P. F. MICHELSON, J. C. PRICE, R. C. TABER  
157 Cellular Mechanisms of Epilepsy: A Status Report: M. A. DICHTER AND G. F. AYALA

## Research Articles

164 Laser-Stimulated Luminescence Used to Measure X-ray Diffraction of a Contracting Striated Muscle: Y. AMENIYA, K. WAKABAYASHI, H. TANAKA, Y. UENO, J. MIYAHARA

- **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 © 1987 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): \$65. Domestic institutional subscription (51 issues): \$98. Foreign postage extra: Canada \$32, 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 \$4 (\$4.50 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** Resonant-mass gravitational radiation detector. Energetic astrophysical events, such as supernovae, can produce gravity wave pulses that may induce small mechanical strains in the 4800-kilogram aluminum bar. The bar is suspended in a vacuum chamber and cooled to 4.2 kelvins to reduce background noise. See page 150. [Photography by John Long, Palo Alto, CA 94301]

## Reports

- 169 Speech Perception Takes Precedence over Nonspeech Perception: D. H. WHALEN AND A. M. LIBERMAN
- 171 Precipitation Fluctuations over Northern Hemisphere Land Areas Since the Mid-19th Century: R. S. BRADLEY, H. F. DIAZ, J. K. EISCHEID, P. D. JONES, P. M. KELLY, C. M. GOODESS
- 175 Detection of Minimal Residual Cells Carrying the t(14;18) by DNA Sequence Amplification: M.-S. LEE, K.-S. CHANG, F. CABANILLAS, E. J. FREIREICH, J. M. TRUJILLO, S. A. STASS
- 178 *erbB-2* Is a Potent Oncogene When Overexpressed in NIH/3T3 Cells: P. P. DI FIORE, J. H. PIERCE, M. H. KRAUS, O. SEGATTO, C. R. KING, S. A. AARONSON
- 182 Variable Occurrence of the *rrdB* Intron in the T-Even Phages Suggests Intron Mobility: J. PEDERSEN-LANE AND M. BELFORT
- 184 The Inversion of Sensory Processing by Feedback Pathways: A Model of Visual Cognitive Functions: E. HARTH, K. P. UNNIKRISHNAN, A. S. PANDYA
- 187 Localization, Secretion, and Action of Inhibin in Human Placenta: F. PETRAGLIA, P. SAWCHENKO, A. T. W. LIM, J. RIVIER, W. VALE
- 190 A Reassessment of *Astraspis desiderata*, the Oldest North American Vertebrate: D. K. ELLIOTT
- 192 Mapping Patterns of *c-fos* Expression in the Central Nervous System After Seizure: J. I. MORGAN, D. R. COHEN, J. L. HEMPSTEAD, T. CURRAN

## Book Reviews

- 201 Untold Lives, reviewed by M. B. PARLEE ■ The Vertebrate Neuromuscular Junction, S. SCHUETZE ■ Neurobiology of Taste and Smell, J. G. HILDEBRAND ■ Development as an Evolutionary Process, G. FREEMAN ■ Behavioral Biology of Killer Whales, P. O. THOMAS ■ Books Received

## Products & Materials

- 206 Classification and Indexing Software ■ Biological Sample Concentrator ■ Flat-Screen Computer Monitor ■ Thermal Video Line Printer ■ Synthetic Genes ■ Molecular Biology Computer Network ■ Botanic Electronic Bulletin Board ■ Image Analysis System for Photographs ■ Literature

### Board of Directors

Lawrence Bogorad  
*Retiring President,  
Chairman*

Sheila E. Widnall  
*President*

Walter E. Massey  
*President-elect*

Robert McC. Adams  
Floyd E. Bloom  
Mary E. Clutter  
Mildred S. Dresselhaus  
Beatrix A. Hamburg  
Donald N. Langenberg  
Frank von Hippel  
Linda S. Wilson  
William T. Golden  
*Treasurer*  
Alvin W. Trivelpiece  
*Executive Officer*

### Editorial Board

Elizabeth E. Bailey  
David Baltimore  
William F. Brinkman  
Philip E. Converse  
Joseph L. Goldstein  
James D. Idol, Jr.  
Leon Knopoff  
Seymour Lipset  
Oliver E. Nelson  
David V. Ragone  
David M. Raup  
Vera C. Rubin  
Larry L. Smarr  
Solomon H. Snyder  
Robert M. Solow  
James D. Watson

### Board of Reviewing Editors

John Abelson  
Qais Al-Awqati  
James P. Allison  
Don L. Anderson  
Elizabeth H. Blackburn  
Floyd E. Bloom  
Charles R. Cantor  
James H. Clark  
Bruce F. Eldridge  
Stanley Falkow  
Theodore H. Geballe  
Roger I. M. Glass  
Stephen P. Goff  
Robert B. Goldberg

Corey S. Goodman  
Stephen J. Gould  
Richard M. Held  
Gloria Heppner  
Eric F. Johnson  
Konrad B. Krauskopf  
I. Robert Lehman  
Karl L. Magleby  
Joseph B. Martin  
John C. McGiff  
Alton Meister  
Mortimer Mishkin  
Peter Olson  
Gordon H. Orians  
Carl O. Pabo  
John S. Pearce

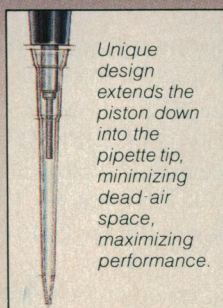
Yeshayau Pocker  
Jean Paul Revel  
James E. Rothman  
Thomas C. Schelling  
Ronald H. Schwartz  
Stephen M. Schwartz  
Otto T. Solbrig  
Robert T. N. Tjian  
Virginia Trimble  
Geerat J. Vermeij  
Martin G. Weigert  
Harold Weintraub  
Irving L. Weissman  
George M. Whitesides  
Owen N. Witte  
William B. Wood



# Eppendorf Ultra Micro Pipettes

## From 0.5 $\mu\text{L}$ ...ultra micro accuracy by design.

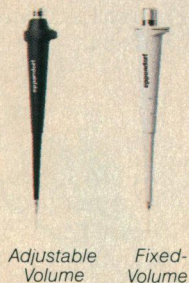
Eppendorf brings superior performance *and* the convenience of air displacement to ultra micro pipetting. All Eppendorf Ultra Micro Pipettes feature a unique extended piston design that reduces dead-air volume and assures *no carryover* between samples. The result? Great accuracy at ultra micro settings.



## Guaranteed performance in continuously adjustable and fixed-volume models.

The Eppendorf Ultra Micro Digital Pipette is the *only* continuously adjustable air displacement pipette with guaranteed performance from 0.5 to 10  $\mu\text{L}$ . Just twist the control button at the top of the pipette to select the desired volume, and

a "click-set" ratchet mechanism will lock the volume in place—making accidental changes practically impossible. Four Eppendorf Ultra Micro Fixed-Volume Models, with built-in tip ejector, handle volumes of 1, 2, 5, and 10  $\mu\text{L}$ .



## For your other pipetting needs...up to 1000 $\mu\text{L}$ .



For volumes from 2.0 to 1000  $\mu\text{L}$ , three additional Eppendorf Digital Pipettes give you direct digital display of the set volume to assure precise, reproducible results every time. And all Eppendorf Digital Pipettes feature a "click-set" ratchet mechanism, maintenance-free seals, and a tip ejector.

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)

**eppendorf**

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

## Top performance starts at the bottom.

For literature circle reader service number 56  
For a demonstration circle reader service number 55



## This Week in SCIENCE

### Successful aging

MUCH research on aging has concentrated on normal, or average, changes that take place in older people, while the substantial heterogeneity among the elderly of the same age has been overlooked (page 143). Losses in cognitive and physiologic function have been attributed to the aging process, but they might more properly be attributed to factors extrinsic to aging. Rowe and Kahn emphasize that many of these age-associated changes that have been viewed as normal and natural are subject to purposeful modification and can lead to successful rather than usual aging. Desirable interventions might include modification of exercise and diet, training programs to prevent or reverse cognitive loss, and provision of social support for health care and reduction of stress at times of bereavement and relocation. Research that links the psychosocial and physiologic aspects of aging could help promote health and prevent disease.

### Gravitational wave astronomy

ACCORDING to Einstein's theory, gravity waves are ripples in the curvature of space-time and carry energy and momentum at the speed of light. For more than two decades, physicists have been trying to detect gravitational waves from astrophysical sources by use of massive antennas, usually solid cylinders of aluminum with a fundamental resonance frequency near 1 kilohertz (cover). Astrophysical sources such as supernovae or the gravitational collapse or coalescence of solar-mass size objects are expected to emit gravitational radiation at frequencies near this spectral region. Michelson *et al.* (page 150) review the progress that has been made in the design of resonant-mass gravity wave detectors and outline efforts under way to improve the sensitivity of detectors by five orders of magnitude. These include reduction of thermal and amplifier noise, isolation of vibration, and use of cryogenic techniques. The ultimate sensitiv-

ity that might be reached in a few years would enable detectors to be sensitive to mechanical strains of about  $10^{-20}$ , which should be adequate to open a new branch of astronomy, gravitational wave astronomy.

### Duplex perception of speech sounds

ACOUSTIC patterns sufficient to synthesize syllables such as "da" and "ga" on a computer contain a frequency sweep called a transition that represents changing resonances as the tongue and jaw move from a consonant to a vowel (page 169). Heard in isolation, this transition sweep is perceived as a "chirp." Embedded in a syllable, it provides the information necessary for distinguishing between "da" and "ga." Whalen and Liberman found that if the sound intensity of the transition is increased relative to the base, it is possible to hear both a speech sound and a chirp at the same time. This is a form of duplex perception in which speech and nonspeech components are heard at once. At low transition intensities only speech is heard; at higher levels both speech and chirp are heard. These results are consistent with a theory of speech which holds that the processing of speech sounds take precedence over nonspeech, as if the phonetic mode of perception takes precedence over the auditory mode, a reflection of the profound biological significance of speech.

### Records of precipitation fluctuations

THE potential climatic effects of increasing amounts of carbon dioxide and other greenhouse gases in the atmosphere have focused attention on the record of surface temperatures (page 171). Most general circulation models of the atmosphere predict that surface temperatures will rise in response to increasing  $\text{CO}_2$ , and there is evidence in the historic records that such a rise has already occurred. The models do not give a clear answer to the question of how precipitation patterns

might change, and there has not been a corresponding effort to determine what changes might have taken place already. Bradley *et al.* have compiled precipitation records for the last 100 to 130 years from more than 1400 stations in the continental regions of the Northern Hemisphere and have compared the results with predictions of general circulation models of increases in greenhouse gases. Significant increases in precipitation have occurred at mid-latitudes and decreases at low latitudes during the last 30 to 40 years. This pattern is in accord with predictions of some of the models. However, the pattern may indicate natural climatic variability and not necessarily represent the effect of anthropogenic increases in  $\text{CO}_2$ .

### Seizure-induced expression of c-fos

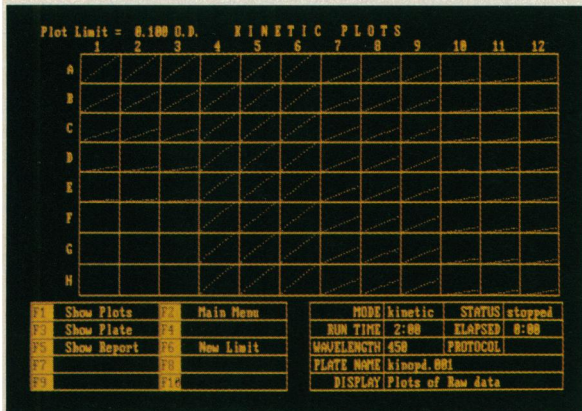
EXPRESSION of the *c-fos* gene in the brains of mice may be regulated by neuromodulators and neurotransmitters (page 192). The gene *c-fos* is the cellular homolog of the oncogene *v-fos*, which is carried by some osteogenic sarcoma viruses of mice. It encodes a protein (Fos) that is associated with chromatin and exhibits DNA-binding activity. Treatment of mice with Metrazole (pentylentetrazole), a convulsant agent used to study epilepsy, caused a rapid and dramatic increase in *c-fos* messenger RNA in the brain. Morgan *et al.* studied the time course and distribution in the brain of the expression of the *c-fos* gene in mice injected with Metrazole. Increased levels of the Fos protein were found in the dentate gyrus and in the pyriform and cingulate cortices, and later, throughout the cortex, hippocampus, and limbic systems. Expression of *c-fos* messenger RNA reached a peak in about 60 minutes and then declined to basal levels by 180 minutes. The mice were refractory to reinduction of *c-fos* during this period and for some time afterward but were still susceptible to seizure induction by Metrazole. The *c-fos* protein can be used as a marker to follow the temporal and spatial involvement of subsets of neurons during epileptic seizures.



# Don't buy any microplate reader until you've seen its software.

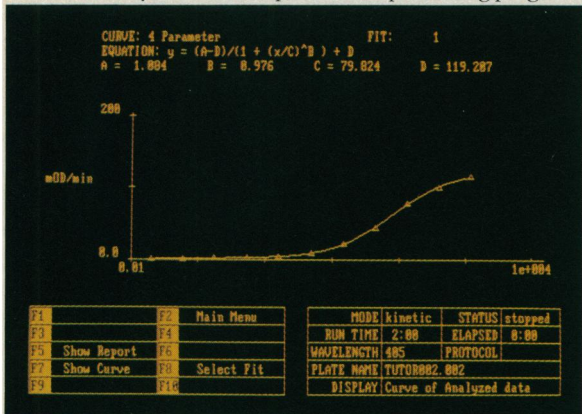
Watch all 96 kinetic plots appear as the reactions proceed.

Adjust your OD plot limit (y-axis): shorten it for fast reactions, extend it for slower ones. SOFTmax™ will replot the data and recalculate rates using only the initial linear portion of the reaction.



For quantitation, try any of 5 standard curve-fitting algorithms.

Linear. Quadratic. Semi-log. Log/logit. 4-parameter logistic. SOFTmax can also format your data in ASCII for use with Lotus 1-2-3® or your own compatible data processing program.



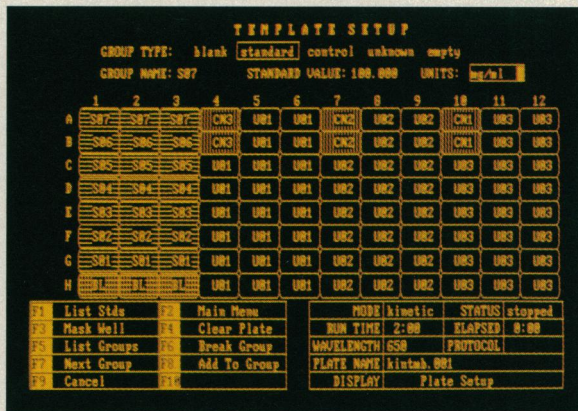
Moving from data to results requires more than instrumentation. The new SOFTmax™ controls the Vmax™ Kinetic Microplate Reader, collects and analyzes endpoint and kinetic data, and delivers many useful options for computing, plotting, displaying, printing and managing microplate assay data. All in one simple, menu-driven package.

Evaluate SOFTmax on your IBM® or IBM® compatible microcomputer. And find out how our powerful microplate assay software can make a difference in managing data *and* results. Contact Molecular Devices today for a free SOFTmax demonstration diskette.

Vmax and SOFTmax are trademarks of Molecular Devices Corporation. IBM is a registered trademark of International Business Machines Corporation. Lotus 1-2-3® is a registered trademark of Lotus Development Corporation.

TEMPLATE SETUP works like a chemical spreadsheet.

Assign wells to group types (blank, standard, control, unknown, empty). Run your assay or overlay the template on existing data and recalculate. Use it to mask outliers and set up multiple standard curves on the same microplate.



Flexible data displays.

Use Grey Scale for cytoproliferation studies, Ranged data for hybridoma screening, Threshold display for serology. All display options may be used with kinetic and endpoint data.



**Molecular Devices**

Molecular Devices Corporation  
3180 Porter Drive  
Palo Alto, CA 94304  
(415) 493-0166  
(800) 635-5577  
(800) 635-5588 (within California)



## 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 Editors:** Nancy J. Hartnagel, John E. Ringle

**Senior Editors:** Eleanore Butz, Ruth Kulstad

**Associate Editors:** Martha Collins, Barbara Jasny, Katrina L. Kelner, Edith Meyers, Phillip D. Szuroni, David F. Voss

**Letters Editor:** Christine Gilbert

**Book Reviews:** Katherine Livingston, *editor*; Deborah F. 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, Barbara E. Patterson

**Copy Desk:** Lyle L. Green, Sharon Ryan, Beverly Shields, Anna Victoreen

**Production Manager:** Karen Schools

**Assistant Production Manager:** James Landry

**Graphics and Production:** Holly Bishop, James J. Olivarri, Eleanor Warner

**Covers Editor:** Grayce Finger

**Manuscript Systems Analyst:** William Carter

## NEWS STAFF

**News Editor:** Barbara J. Culliton

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

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

**European Correspondent:** David Dickson

## BUSINESS STAFF

**Associate Publisher:** William M. Miller, III

**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

**Marketing Manager:** Herbert L. Burklund

**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(0647)52918; Telex 42513; FAX (0392) 31645.

**Information for contributors** appears on page XI of the 26 June 1987 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, NY 10036. Telephone 212-730-1050 or WU Telex 968082 SCHERAGO.

## Petroleum Research Centers

In terms of resource potential for liquid fuels, the United States is extremely well endowed. It has huge reserves of coal that could be liquefied and vast deposits of oil shale. The estimated resource of petroleum is 625 billion barrels, which far exceeds the present reserves of Saudi Arabia. However, the tasks of converting U.S. resources into reserves involve large expenditures and long delays. In general, the costs far exceed the \$18 per barrel price established by the Organization of Petroleum Exporting Countries. Because of this low price, the major oil companies have downgraded the coterminous 48 states as an area for exploration. Instead they are emphasizing offshore, frontier areas and foreign prospects.

There are good reasons to believe that targeted R&D could go far to reduce costs of converting an important fraction of the 625-billion-barrel resource to producible reserves. However, the small independent companies who will drill for and find most of the oil that is discovered do not have research competence. The major companies have dispersed much of their research staffs. The federal government retains the outdated policy that the majors will do what is needed. Consequently, only tiny federal support has been available for improving the efficiency of petroleum exploration and practically nothing for advancing the technology of obtaining synthetic fuels from coal or shale. This year \$43 billion for imports; small change for liquid fuel research.

It has long been known that only about a third of the oil that has been discovered has been produced. During the period from 1979 to 1985, it became evident that a larger fraction could be extracted. Earlier, wells were spaced as much as a mile apart. It was assumed that reservoir strata were sufficiently porous and uniform that the mobile oil in place would flow to the wells either under existing pressure or as a result of a water drive. To take advantage of the high prices existing in the early 1980s additional so-called infill wells were drilled in existing fields. Many of these were good producers, thus showing that reservoir rocks are often heterogeneous and compartmentalized. On average, the successes were such that it was profitable to drill when oil was \$30 per barrel, but not \$18.

Improvements in the knowledge of what to expect in heterogeneous reservoirs could enhance the success rate for drilling and thus lower costs. It would also improve the effectiveness of technologies for enhanced oil recovery based on carbon dioxide or on detergents. If such an opportunity exists, why have the major companies not exploited it? The answer seems to be that the large companies have emphasized discovery and production from giant fields. Their R&D has been aimed chiefly at improved discovery of large deposits.

A recent report of the Energy Research Advisory Board (ERAB) urges studies that address the problems of reservoir heterogeneity.\* It calls for enhanced integration of sedimentology, geophysics, geochemistry, hydrogeology, petroleum and chemical engineering, and geostatistics to define the origin and distribution of heterogeneities within petroleum reservoirs. The information available to address this problem includes drilling cores, logs, and seismic and engineering data. This would be supplemented by seismic tomography, three-dimensional reflection seismology, and measurements of variations in shear or S waves. This and other information would be incorporated in models relating geologic measurements to engineering factors. The objective would be to understand enough about heterogeneities to provide a scientific basis for predicting well spacing and enhanced oil recovery potential.

To implement such an effort the ERAB report recommends the creation of oil and gas research centers within each of the six major oil and gas provinces of the United States. These centers would conduct and coordinate the necessary interdisciplinary problem-oriented research. Some of the work would be conducted in university-based centers.

William Fisher of the University of Texas has stated that with greater efficiency of discovery of oil, as much as 80 billion barrels of oil could be produced for less than \$25 per barrel. In view of the sums of money we will be spending on imports, the effort to attain greater efficiency should be supported.—PHILIP H. ABELSON

\*Energy Research Advisory Board, *Geoscience Research for Energy Security* (U.S. Department of Energy, Washington, DC, February 1987).

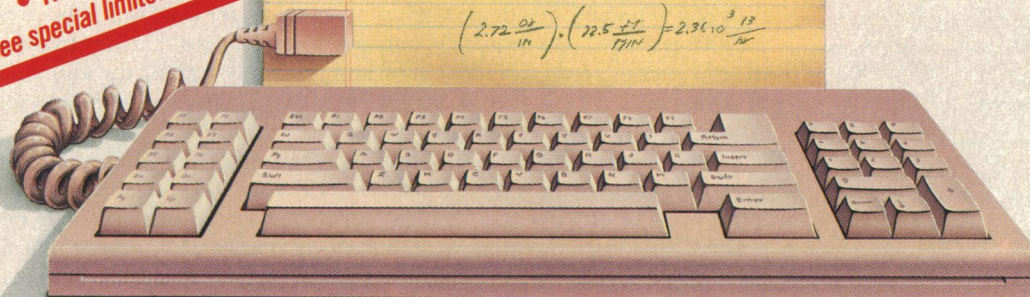
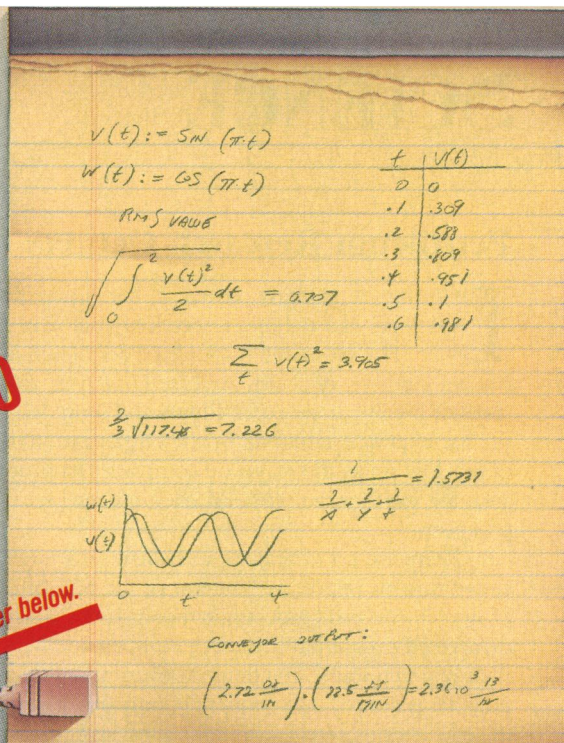


**FREE UPGRADE  
to MathCAD 2.0**

Featuring:

- Matrices
- Equation Solving
- And more

See special limited time offer below.



## Now you can calculate on your PC with the same freedom you have on paper.

MathCAD.™ The first software that lets you do calculations on your PC as simply as on a scratchpad. Just define your variables and enter your formulas anywhere on the screen. MathCAD not only formats your equations as they're typed, it instantly calculates the results, and displays your work in real math notation.

But MathCAD is more than an equation solver. In addition to the usual trigonometric and exponential functions, it includes built-in statistical functions, cubic splines, Fourier transforms, Bessel functions, and more. It also handles complex numbers and unit conversions in a completely transparent way.

And here's the best news. Even with all this power, MathCAD is so easy to learn, you'll be using it in an hour. With MathCAD you can concentrate immediately on your problem, not your computer.

What kind of calculations can you do with MathCAD? Anything you have a formula for—from working out your mortgage payments to solving a heat transfer problem, or modeling electrical circuit parameters.

You can display your results as numbers, tables, or graphs, and combine them just like you do on paper. Add text

anywhere to support your work.

And try an unlimited number of "what-ifs."

MathCAD lets you see and record every step. Then print your entire calculation in standard math notation as an integrated document that anyone can understand.

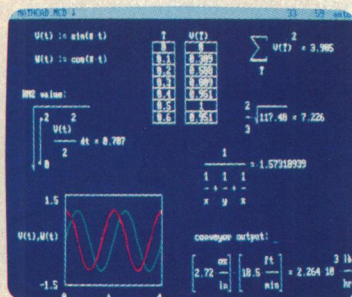
Why spend another minute doing calculations by hand or writing and debugging programs? Put MathCAD to work for you now. Call today for further information and the name of a MathCAD dealer near you.

**1-800-MathCAD**  
(In Massachusetts: 617-577-1017)

**MathCAD**

MathSoft, Inc., 1 Kendall Sq., Cambridge, MA 02139

Requires IBM PC® or compatible, 512KB RAM, graphics card.  
IBM PC® International Business Machines Corporation.  
MathCAD™ MathSoft, Inc.



### LIMITED TIME OFFER

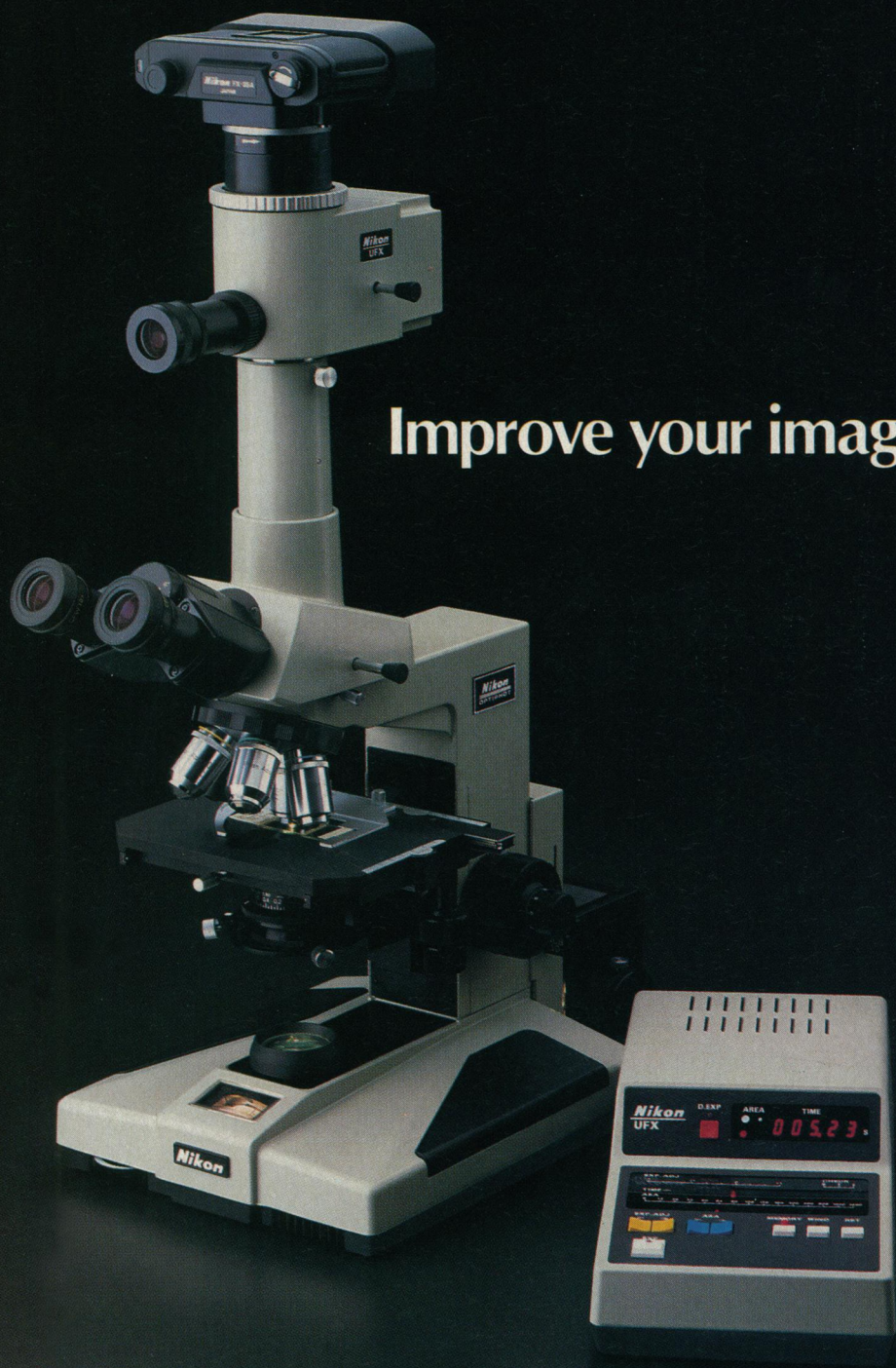
Buy MathCAD 1.1 before August 31, 1987 at just \$249 and receive a FREE upgrade to MathCAD 2.0, to be released in September at \$349 list. You save \$100 if you buy now.

Coming Soon. MathCAD 2.0 Featuring:

- Matrices
- Equation Solving
- Twice the Speed
- More Printer/Plotter Support
- Enhanced Word Processing
- And more

Circle No. 64 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.

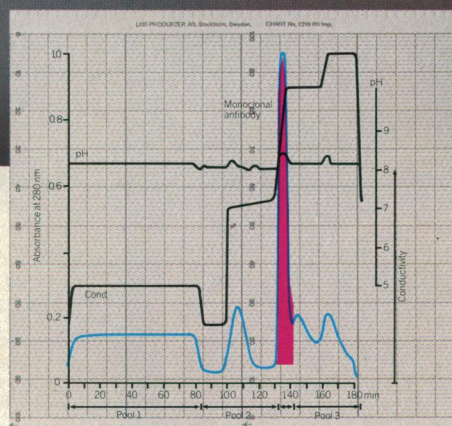
If you'd like to improve the image you're seeing now, ask to look into the Nikon Optiphot. For information, contact: Nikon Inc., Instrument Group, 623 Stewart Avenue, Garden City, NY 11530. (516) 222-0200.

For information circle reader service number 61. For a demonstration circle reader service number 62.

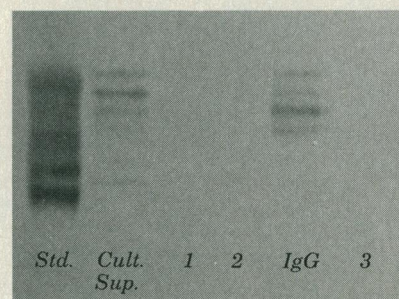
# NIKON OPTIPHOT

**Nikon**  
Extending Man's Vision





Scale-up purification of IgG antihuman urokinase using a QAE ZetaPrep 800 cartridge. Yield: 1300 mg IgG. Flow rate: 160 ml/min. Sample volume: 10,000 ml cell culture supernatant.



Purity check by western blotting.



# MAb trapping

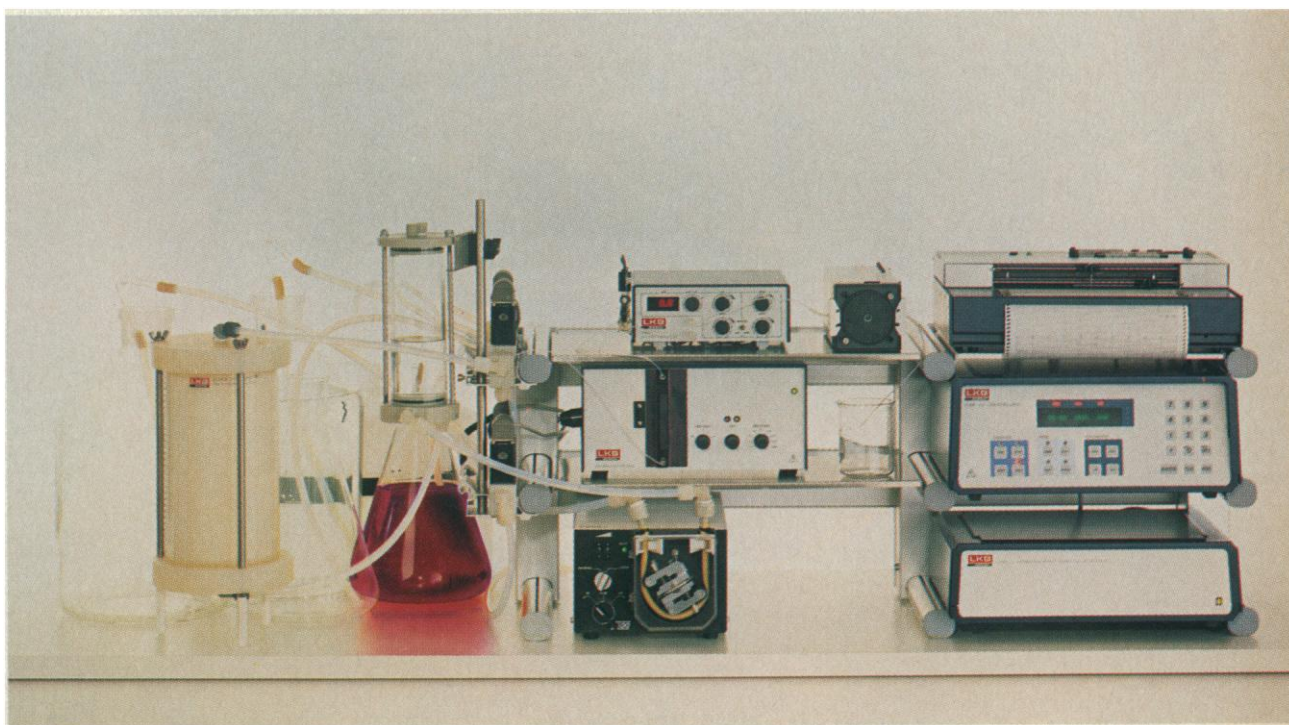
When your business is to purify MAbs efficiently, it pays to use the best trap.

Pioneering new frontiers in biopurification demands new strategies. One key approach involves a preparative system designed to enable rapid methods development and scale-up of MAb purification. Based on LKB's Pilot Chromatography System, it exploits the advantages of mass ion exchange inherent in ZetaPrep discs and cartridges. A universal concentrating technique, mass ion exchange effectively achieves 50% to 90% purity of most monoclonals.

ZetaPrep discs can be used to determine optimal separation conditions quickly and accurately. Replace the disc with the appropriate ZetaPrep cartridge and you're ready for full-scale operation. Need higher purity? The Pilot Chromatography System is easily extended to the GTi Bioseparation System for high resolution HPLC and FPLC.

Don't become trapped in a strategic maze. Linear scale-up is just around the corner. Your local LKB representative can elaborate.

\* ZetaPrep® is the Trademark of Cuno, Inc.



*Pilot Chromatography System.*

# LKB

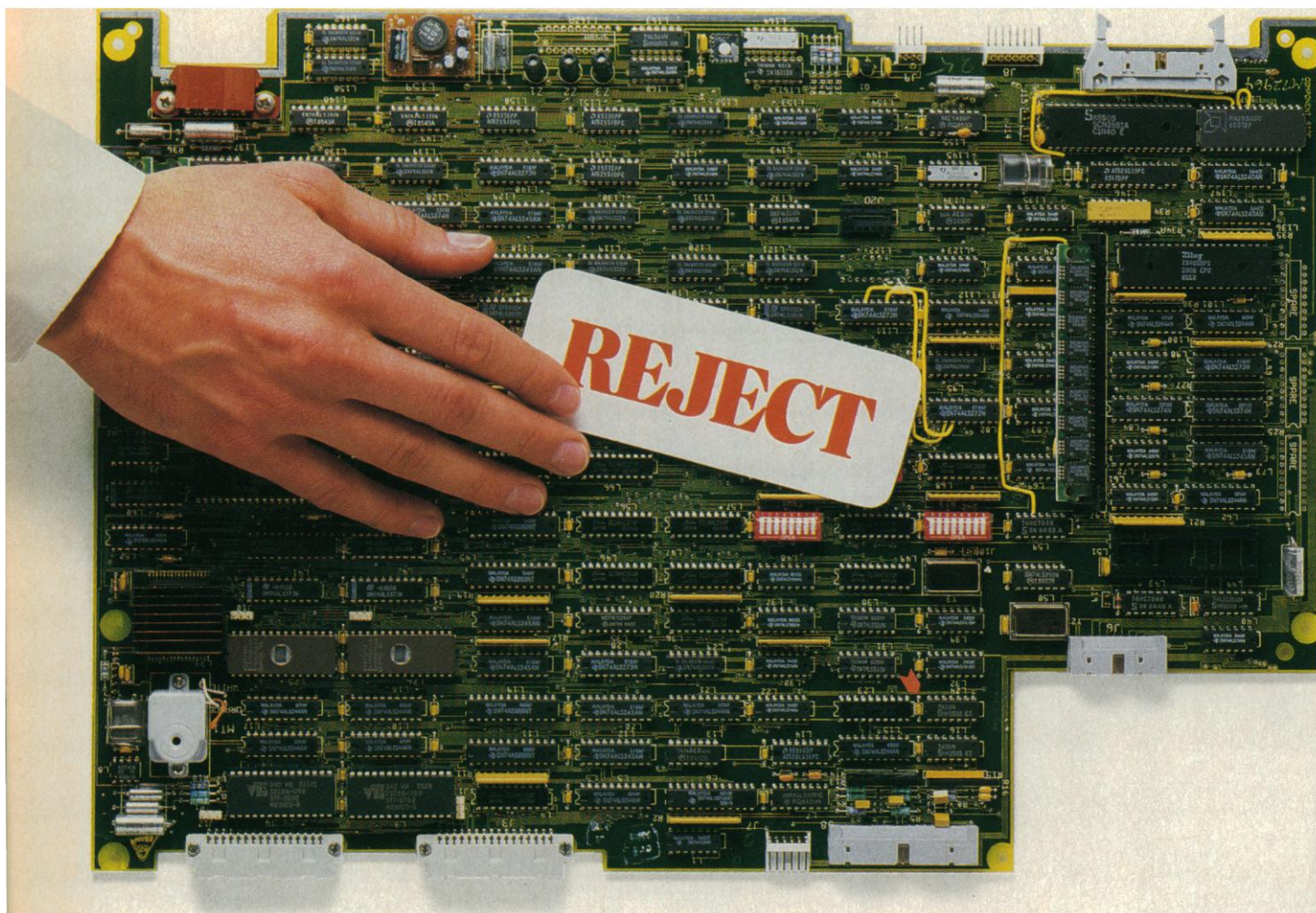
Chromatography Division

LKB-Produkter AB, Box 305, S-16126 Bromma, Sweden. Tel. 08-7998000, telex 10492

Antwerp (03) 218 93 35 • Athens-Middle East + 30 (1) 894 73 96 • Beijing 89 06 21 • Copenhagen (01) 29 50 44 • HongKong (852) 5-814 84 21  
London (01) 657 88 22 • Lucerne (041) 57 44 57 • Madras (044) 45 28 74 • Moscow (095) 255-6984 • Munich (089) 85 830 • Paris (01) 64 46 36 36  
Rome (06) 39 90 33 • Sao Paulo (011) 578 41 38 • Stockholm (08) 764 75 50 • Tokyo (03) 293-5141 • Turku (021) 678 111 • Vienna + 43 (222) 92 16 07  
Washington (301) 963 3200 • Zoetermeer (079) 3192 01 Over 60 qualified representatives throughout the world.

Circle No. 50 on Readers' Service Card





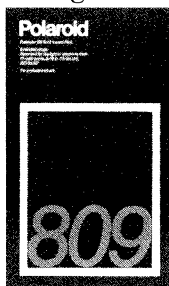
# Recall.

**Get the results you want instantly with Polaroid instant films and imaging systems.**

If you ever have to capture a breakdown in quality, the last thing you'll want is photography that fails.

With Polaroid instant imaging you never have to worry. Because our full line of over 40 different instant professional films, from 35mm to 8 x 10", will deliver the results you

want, when you want them. You can document, review, or present your findings instantly.



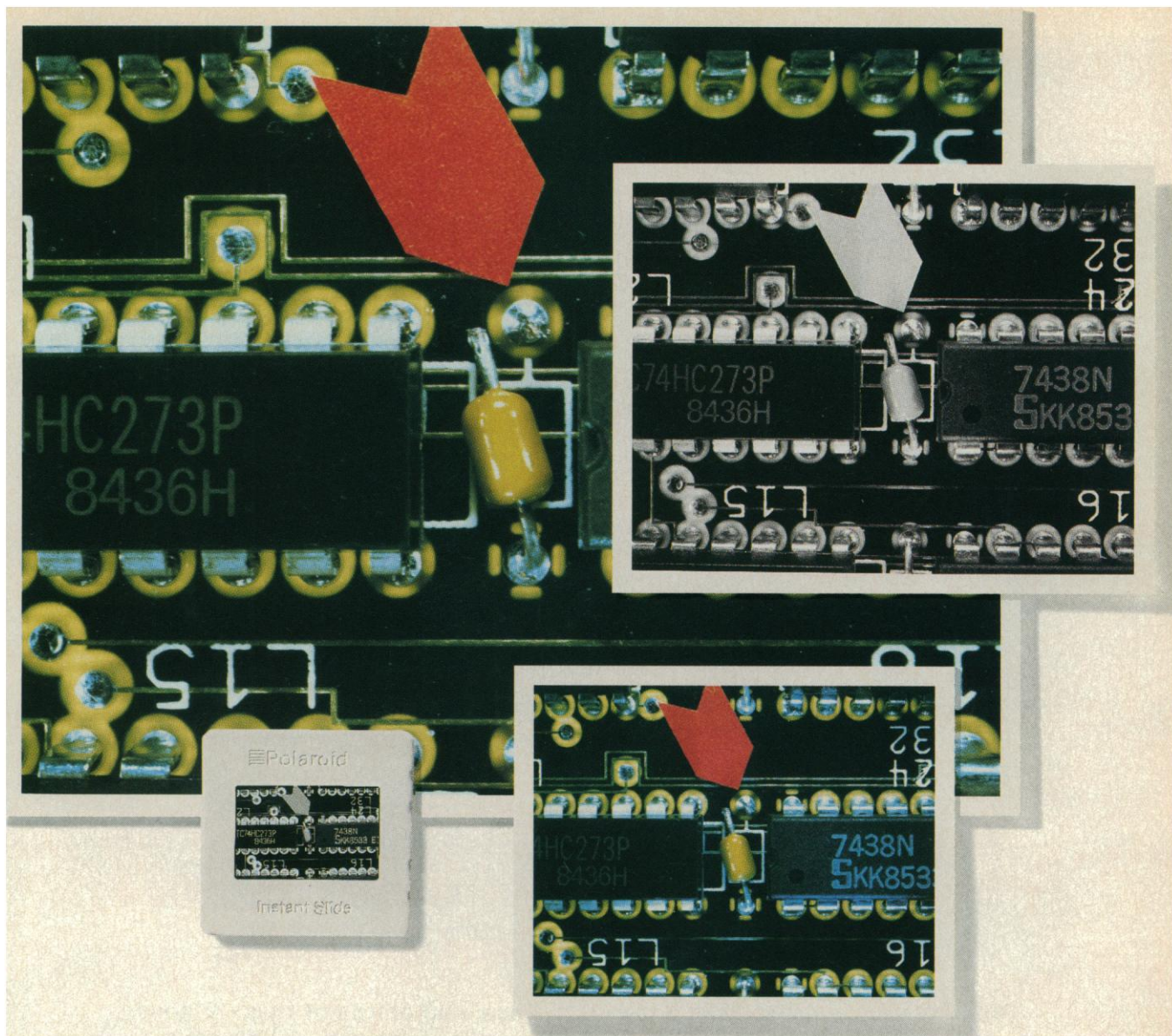
You can choose from a complete range of color or black and white emulsions that meet the requirements of virtually any QC need. In the formats and film types you

really want.

What's more, we offer you a comprehensive range of instant imaging systems. Cameras for photography of laboratory set-ups and for recording off screen from instruments. Copy stands for recording flat art or very small objects. Plus electronic imaging systems for







# Instant Recall.

recording from most types of computers – PC's to mainframes – and from VCR's as well.

Everything, in short, to get you off the spot, on the spot.

Better still, you can do it all yourself. In house, in complete confidentiality. Without the delays that outside services create.

Quality control is

a lot easier when you have a photographic memory. Especially an instant one.

For the Polaroid Professional Film Center or Professional Products Dealer nearest you, call toll-free 800-343-5000, 8:00 a.m. to 8:00 p.m. Eastern Time.

 **Polaroid**

© 1987 Polaroid Corporation "Polaroid"®

Circle No. 27 on Readers' Service Card

For more information, mail this coupon to Polaroid Corporation, Dept. 658, P.O. Box 5011, Clifton, N.J. 07015.

Please send me information about:

☐ Polaroid Professional Films for Scientific Imaging

☐ Polaroid Instant Imaging Hardware SC7/10

Name \_\_\_\_\_

Company \_\_\_\_\_

Address \_\_\_\_\_

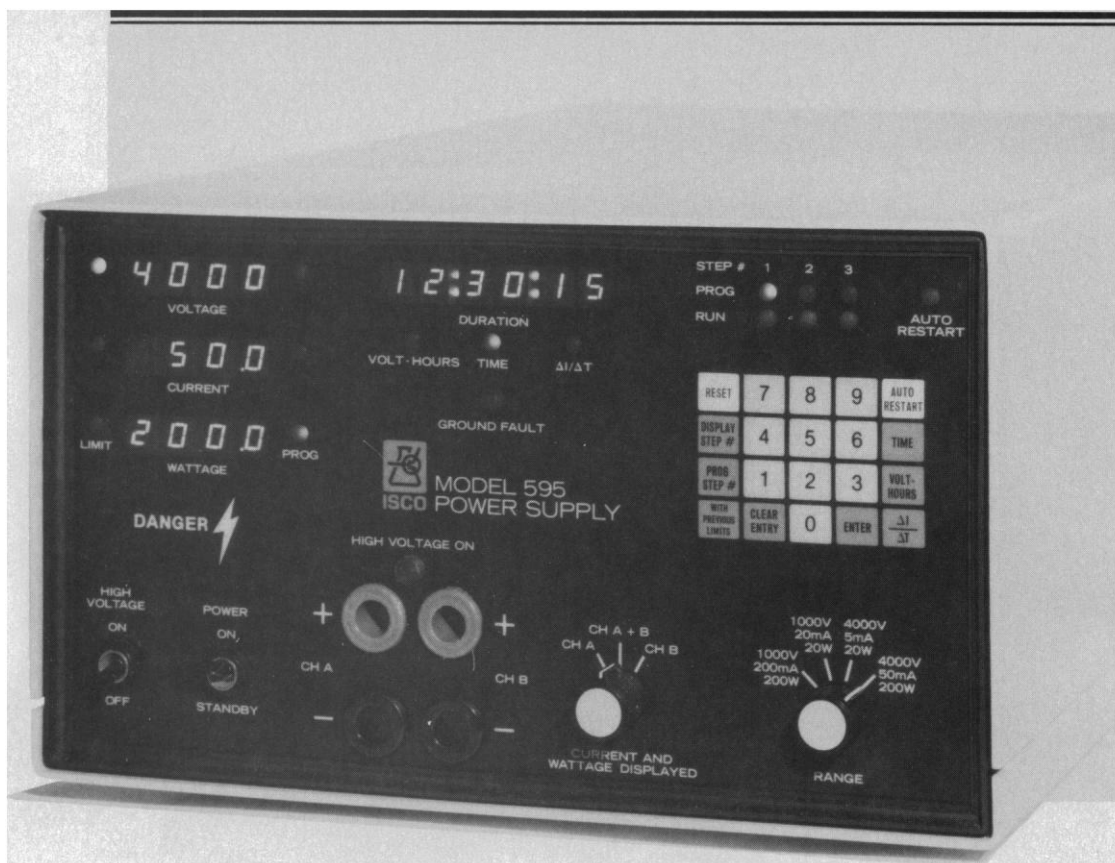
City \_\_\_\_\_

State \_\_\_\_\_ Zip \_\_\_\_\_

Telephone \_\_\_\_\_







## Smart power for electrophoresis.

New programmable power supply produces 4000 V,  
has volt-hour and  $\Delta I/\Delta T$  monitoring.

Exclusive programming features make an Isco Model 595 the most useful power supply for any exacting experiment — from nucleic acid sequencing to electrofocusing and more common techniques. Just set power, current, and voltage limits and get automatic crossover from one parameter to the other as conditions change in the gel. You can store three consecutive, completely different sets of parameter limits, automatically switching from one set to the next according to time, migration distance determined by volt-hours, or the rate of change of output current indicating the electrophoretic endpoint. For example, use the first set of limits when desired to condition the gel and sample for a certain time or volt-hour period; the second for running until the  $\Delta I/\Delta T$  indicates optimal separation has been achieved; and the third for shutdown or a reduced power maintenance level to preserve resolution.

There's no other way to get as good reproducibility with as little effort.

Experimental conditions are entered easily on a self-prompting, color-coded keyboard. LED displays indicate voltage, current, wattage, and duration expressed in volt-hours, minutes, or  $\Delta I/\Delta T$ . The Model 595 features Isco's unique ground fault detector that warns of dangerous conditions even at zero output voltage, so you can check for a defect before you turn on the power.

Send now for new literature. Call (800)228-4250, or write Isco, Inc., Box 5347, Lincoln, NE 68505.





# You talked. We listened.

## And responded with New Design Nalgene Disposable Filterware.

You talked about improving your favorite disposable filterware. Nalge listened.

And responded with a technically-advanced line of disposable filterware designed to make your work faster and more efficient than ever before.

## You asked for convenience. We listened.

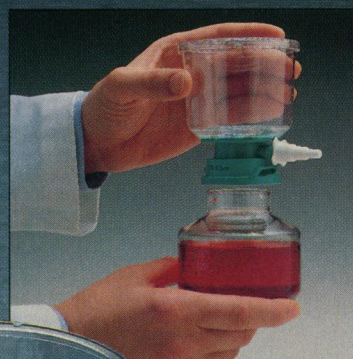
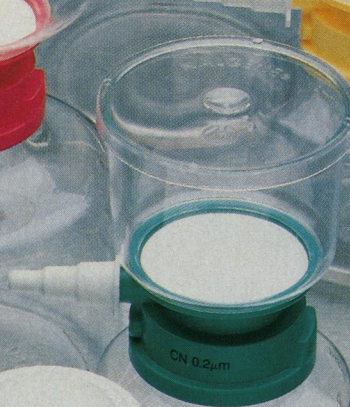
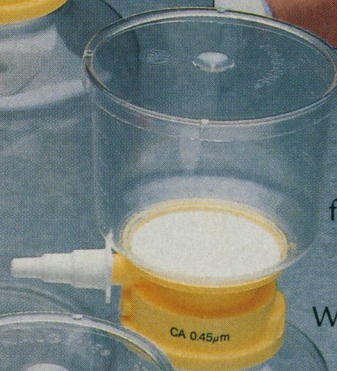
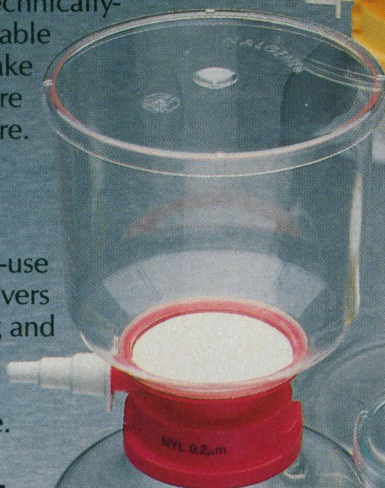
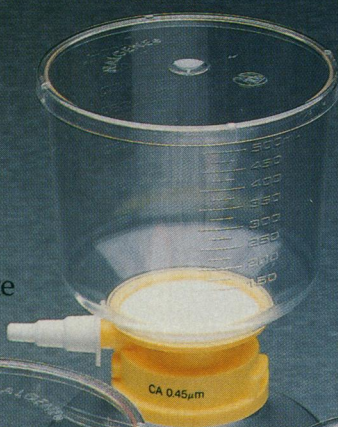
And gave you new easy-to-use two-piece units. Plus receivers designed for dispensing and storage with leakproof closures that are easy to put on and remove.

## You asked for versatility. We listened.

And offered you extra capacity with 150-, 250-, 500-, and 1000-mL sizes. Plus graduations on receivers and uppers for easy measurement, because you asked for it.

## You asked for easy identification. We listened.

So now, Nalgene Filter Units are color-coded by membrane material—and the pore size and membrane material are marked right on the collars.



## You asked for speed. We listened.

And increased the effective filtration area by more than 25% for faster flow rates.

## But we didn't change what we couldn't improve.

We didn't change the membranes or plastics you've always depended on. You get the same uncompromising standards you expect from Nalge, because all materials are carefully tested for cytotoxicity, and all units are guaranteed sterile. So you won't introduce any variables whatsoever into your work.

Nalgene Filterware . . . the name you've trusted for 20 years.

## Your ideas are built right in.

Available from Authorized Nalgene Labware dealers worldwide. Or write or call: Nalgene Labware Dept., Nalge Company, Subsidiary of Sybron Corp., Box 20365, Rochester, NY 14602-0365  
Telephone (716) 586-8800 Telex 97-8242.

## Nalge Company

Nalgene® Brand Products

The ability to listen. The technology to respond.



# Pro/WASH™ — The way ELISA was meant to be

Pro/WASH, a specially designed wash module, is the latest advance in the Pro/Pette® automated pipetting system. Now Pro/Pette automates all of your liquid handling—from dilutions and transfers to wash steps in ELISA, FIA and other heterogeneous immunoassays. With Pro/WASH you get more scientific control of the wash procedure:

- Set the wash volume from 1-3500  $\mu$ l
- Choose the soak cycle time
- Select the number of washes
- Choose the rows to be washed

Hooked to the CETUS™ Pro/Pette system, Pro/WASH lets you walk away from the drudgery of assays that have repetitive wash steps. Now you can automatically:

- Deliver samples to your assay plate
- Aspirate and wash
- Deliver the next reagent
- Incubate (at room temperature) and repeat—all under the control of the Pro/Pette system.

For more information call your Perkin-Elmer Technical Representative. Or, for literature in the U.S., call 1-800-762-4000.

Perkin-Elmer Corp.  
761 Main Avenue  
Norwalk, CT 06859-0012

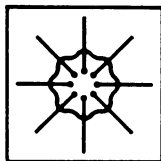
PERKIN-ELMER CETUS

Pro/WASH—the last step  
in total ELISA automation.

Circle No. 116 on Readers' Service Card



FIRST ANNOUNCEMENT



CALL FOR PAPERS  
ENZON'S 2ND CONFERENCE IN A SERIES

"Innovations in Protein Therapeutics:  
From Research to the Clinic"

Planned for December 9-11, 1987  
Walt Disney World Resort  
Lake Buena Vista, Florida

The field of peptide and protein therapy has expanded tremendously over the past few years. Both heterologous and homologous proteins are presently being considered for treatment for a variety of diseases. This conference is intended to address improvements in the pharmacodynamics, pharmacokinetics and immunology of proteins through various methodologies such as polyethylene glycol (PEG), albumin and dextran modification; liposomes and slow release techniques etc. Basic research through advanced clinical studies will be discussed.

You are invited to submit a proposal for presentation at the conference. A brief abstract of no more than 500 words should be sent to M.L. Nucci, ENZON Inc., 300 C Corporate Court, South Plainfield, NJ, 07080, postmarked no later than July 30. ENZON will notify you of acceptance no later than August 30.

Circle No. 57 on Readers' Service Card

# DRUGS OF THE FUTURE

Yours may be?  
You are an independent  
investigator.

You have discovered a new  
biological or chemical compound.

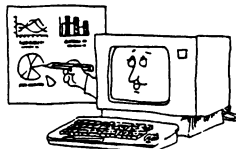
We are a Swiss financial  
institution and have the know-how  
and the means to develop your  
compound into a new drug.

Please send preliminary  
information to:

**DEBIOPHARM S.A.**  
**Rue du Petit-Chêne 38**  
**1003 LAUSANNE, SWITZERLAND**

Circle No. 3 on Readers' Service Card

## PlotIT®



### Interactive Graphics & Statistics

Create graphs the way you want  
them. 35 graph types can be used  
to create numerous renditions.  
Make posters and flow charts—  
with full screen editing of text.

- Vary character font, size,  
position, color
- Stack and overlay graphs
- 3-Dimensional graphs: fishnet  
& contour
- Linear & Non-Linear Regression
- Stochastic Distribution
- Independence Testing
- Descriptive Statistics

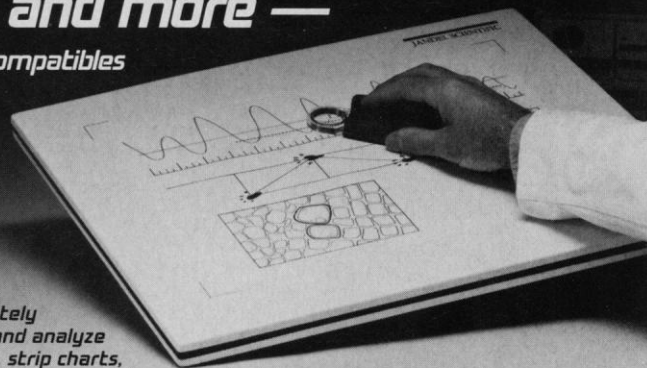
Contact: Scientific Programming  
Enterprises, P.O. Box 669, Haslett,  
MI 48840 (517) 339-9859

Circle No. 77 on Readers' Service Card

## SigmaScan™

measures areas, lengths  
coordinates, angles,  
slopes, and more —  
IBM PC and Compatibles

NEW  
VERSION 3.0



Quickly and accurately  
digitize, measure and analyze  
photomicrographs, strip charts,  
X-rays, maps, and more — using  
your own PC.

- Areas, lengths, angles, and slopes
- X,Y digitizing
- User-defined units
- Standard ASCII data output  
(use in Lotus, dBase, etc.)
- Keyboard macros
- User-defined data transforms

Save hundreds of hours annually over  
manual measurement techniques.  
Automate complex analyses. Comes  
complete with software, choice of  
digitizing tablet, money-back guarantee  
and full year hardware warranty.

Sigma-Scan™ software is also  
available separately.

Free brochure 800-874-1888  
In CA 415-331-3022  
FAX: 415-331-7838 / Telex: 4931977  
In Europe: R.J.A. Honders, Germany  
Ph# 02101/666268

**Jandel**  
SCIENTIFIC

"Microcomputer Tools for the Scientist"

2656 Bridgeway ■ Sausalito, CA 94965

Circle No. 97 on Readers' Service Card



---

---

---

---

---

---

## A MUST for your science collection

### *Books from Science*

**AIDS;** *R. Kulstad, ed.* Research papers and reports on acquired immune deficiency syndrome (AIDS) published between August 1982 and September 1985 show how far AIDS research has come and provide an indication of the directions in which it might go.

1986; case \$32.95; paper \$19.95; 653pp

**Astronomy & Astrophysics;** *M.S. Roberts, ed.* From the solar system to the pulsars at the very edge of the observable universe, this volume reveals a broad, coherent, and contemporary picture of our astronomical universe.

1985; case \$29.95; paper \$17.95; 383pp

**Neuroscience;** *P.H. Abelson, E. Butz, S.H. Snyder, eds.* Neuroscience research ranging from genetic engineering to clinical therapy is presented. Provides an integrative treatment of brain anatomy, physiology, and chemistry and addresses fundamental questions concerning nervous system functioning.

1985; case \$29.95; paper \$14.95; 453 pp

**Biotechnology & Biological Frontiers;** *P.H. Abelson, ed.* Covers the most important topics at the forefront of biological R&D and deals with both fundamental research techniques and practical applications. For researchers and students in all fields of biology, agriculture, and the health sciences.

1984; case \$29.95; paper \$14.95; 550pp

**Biotechnology: The Renewable Frontier** *D.E. Koshland, Jr., ed.* Like its predecessor, this new volume covers the latest and most important topics in biological R&D.

1986; case \$29.95; paper \$17.95; 384 pp

**Frontiers in the Chemical Sciences;** *W. Spindel, R.M. Simon, eds.* Details progress in all areas of chemistry, including new work in ultrafast reactions, catalysis, conduction organics, enzyme mechanisms, and materials and analysis.

1986; case \$29.95; paper \$17.95; 624pp

Order from AAAS Sales Dept C, 1333 H St. NW, Washington, DC 20005. Add \$1.50 postage & handling per order; allow 4-6 weeks for delivery.

American Association for  
the Advancement of Science

---

---

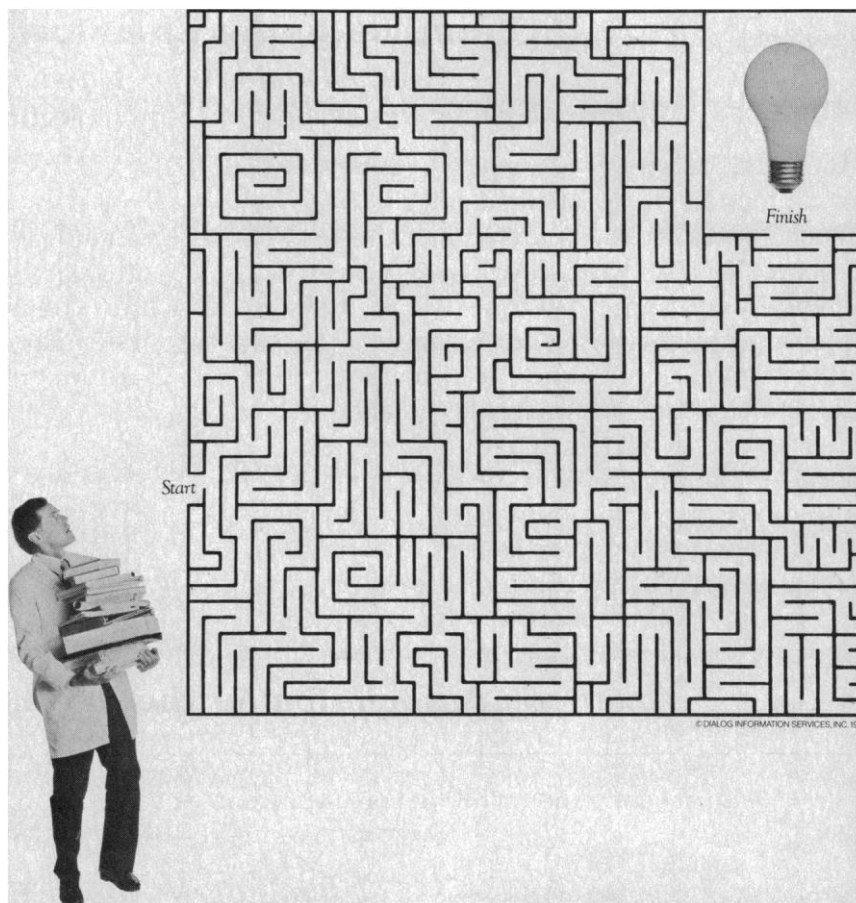
---

---

---

---

# When it comes to biotechnology research don't fight your way through the information maze.



If finding the right information on the latest patents, products and markets in biotechnology seems confusing, or if it takes too much valuable time, then you should know about DIALOG.<sup>®</sup>

Now you can quickly find the right information in databases such as CA SEARCH, with instant access to millions of articles indexed by Chemical Abstracts Service.

Or in SCISEARCH, offering a multidisciplinary index to the literature of science and technology. Or in BIOSIS PREVIEWS, providing worldwide coverage of research in life sciences.

And in EXCERPTA MEDICA, a leading resource for biomedical research. In fact, DIALOG saves valuable

research time by giving you instant access to over 275 databases with information on literally millions of products and much more. So you'll spend less time in the library and more time doing what you do best.

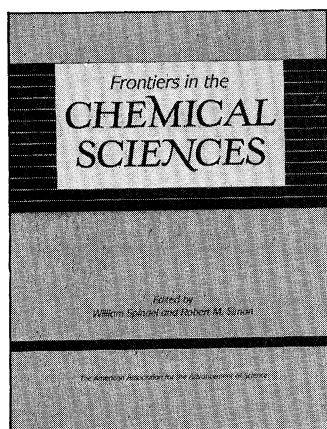
Your company may already be using DIALOG. Check to see. To get acquainted, DIALOG offers \$100 worth of free time to first time users. Just call 800-3-DIALOG. Or write DIALOG, 3460 Hillview Avenue, Palo Alto, CA 94304.

**DIALOG<sup>®</sup>** INFORMATION SERVICES, INC.  
A SUBSIDIARY OF LOCKHEED CORP

The world's largest online knowledgebank.

**800-3-DIALOG**





# Explore New Directions in Chemical Research

## Frontiers in the Chemical Sciences

*Selected and with an introduction by  
William Spindel and Robert M. Simon, National Research Council*

This collection of 38 articles from the pages of *Science* shows chemists unraveling the mysteries of molecular reactivity, developing powerful analytical and theoretical tools, exploring and exploiting new pathways for catalysis and synthesis, and contributing to disciplines as diverse as biology and materials science. Focusing on such themes as fundamental chemical change and extreme molecular complexity, this volume takes the reader on a tour of the contemporary research frontiers in chemistry. Articles by some of the leading scientists in their respective fields cover new

work in seven key areas: understanding chemical reactivity, chemical analysis, theoretical chemistry, chemical catalysis, organic synthesis, the chemistry of life processes, and the chemistry of new materials. Two Nobel lectures are included.

*592 pp.; fully indexed and illustrated*  
Hardcover \$29.95 (\$23.95 for AAAS members)  
Softcover \$17.95 (\$14.35 for AAAS members)

**Order from:** AAAS Marketing, Dept. C, 1333 H St., NW, Washington, DC 20005. Add \$1.50 postage and handling per order. Allow 4–6 weeks for delivery.

## American Association for the Advancement of Science

**Yes!** Please send me the following copies of *Frontiers in the Chemical Sciences*

\_\_\_\_\_ hardcover \$29.95 (AAAS member price \$23.95)      \$ \_\_\_\_\_

\_\_\_\_\_ softcover \$17.95 (AAAS member price \$14.35)      \$ \_\_\_\_\_

Postage and handling      \$      1.50

**TOTAL \$** \_\_\_\_\_

☐ Check    ☐ VISA    ☐ MasterCard

\_\_\_\_\_ credit card number

\_\_\_\_\_ expiration date

\_\_\_\_\_ signature

Name \_\_\_\_\_

Street Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

AAAS member number (from *Science* mailing label) \_\_\_\_\_

Thank you for your order. Please send it to: AAAS Marketing, Dept. C, 1333 H Street, NW Washington, DC 20005. Please allow 4–6 weeks for delivery.