

14 June 1985 • Vol. 228 • 4705

\$2.50

SCIENCE

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



Just Captured: The World of Ultracentrifugation With the SpinPro™ Expert System

Beckman proudly presents SpinPro—the first Expert System on Ultracentrifugation for the Personal Computer. Not a simulation, this truly advanced software program can shorten run times, improve the quality of separations, make more efficient use of your ultracentrifuge.

Designed for use with the IBM-PC-XT, SpinPro uses three state-of-the-art conveniences—the Mouse Cursor, Pop-Up Menus, and a Browser—to move you through the program with no keyboarding.

Consults, Informs, Calculates

Consultation: Designs detailed run plans through a question-and-answer dialogue. Produces an Optimal Plan—the

best possible procedure with no limits on equipment—and a Lab Plan based on the rotors and centrifuges you have. Increases efficiency. Maximizes productivity!

Information: Gives access to the most complete compendium of ultracentrifugation data ever compiled including sample materials, separation methods, density gradients. Contains hundreds of references. A Glossary too! Simplifies data retrieval. Updates lab procedures.

Calculation: Performs a variety of calculations—rotor speed reductions, pelleting times, *k* factors, and more. Saves time. Eliminates errors!

Now you can have a knowledgeable advisor at your command in your own lab—the SpinPro Expert System!

For SpinPro Brochure SB-664, write Beckman Instruments, Inc., Spinco Division, 1050 Page Mill Road, Palo Alto, CA 94304, or call (800) 362-2248. Offices in major cities worldwide.



BECKMAN

Circle No. 324 on Readers' Service Card

The one enhancer for all your gels



Our improved EN³HANCE™ Autoradiography Enhancer
is the only one you really need on your shelf.

It's effective with all common types of gels—agarose, polyacrylamide, or mixed,
thick or thin—and with all of them you get outstanding resolution and sensitivity.

For more details, contact your Du Pont NEN Research Products
representative today. Or get our technical brochure, plus a free Guide to
Fluorography Enhancement, by calling toll free: 800-225-1572.
(In Mass. and international: 617-482-9595.)

Circle No. 330 on Readers' Service Card

NEN Research Products



This Week in *Science* 1246

LETTERS NIH Budget Growth: *J. D. Ebert* and *M. A. Stoto*; *B. J. Culliton*; Cost of Superconducting Super Collider: *R. I. Louttit*; *M. Crawford* 1260

EDITORIAL World Supplies of Natural Gas 1263

ARTICLES Tunable Coherent X-rays: *D. Attwood*, *K. Halbach*, *K.-J. Kim* 1265
Structure, Dynamics, and Reactivity in Hemoglobin: *J. M. Friedman* 1273
The Mechanism of Irreversible Enzyme Inactivation at 100°C: *T. J. Ahern* and *A. M. Klibanov* 1280
Biochemical Modeling of an Autonomously Oscillatory Circadian Clock in *Euglena*: *K. Goto*, *D. L. Laval-Martin*, *L. N. Edmunds, Jr.* 1284

NEWS AND COMMENT Tax Plan Would Have Impact on R&D 1289
Chemical Giants Push for Patents on Plants 1290
DOD Program Proves Attractive 1291
AAAS Meeting: Scientific Fraud Probed at AAAS Meeting; Scientific Secrecy; Nuclear Proliferation; TV Scientists; Biotechnology; High Energy Physics; Future AAAS Meetings 1292
Biotech Policy Draws Flood of Comments 1296

RESEARCH NEWS Solving Linear Systems Faster 1297
Something Strange from Cygnus X-3 1298
Why Are Male Hawks So Small? 1299

AAAS NEWS AAAS Annual Elections: Preliminary Announcement; Reception and Prize Honor Abelson; Western Scientists Meet in Montana; AAAS Travelers 1301

BOARD OF DIRECTORS

DAVID A. HAMBURG
Retiring President, Chairman

GERARD PIEL
President

LAWRENCE BOGORAD
President-Elect

ROBERT W. BERLINER
MILDRED DRESSLEHAUS

DONALD N. LANGENB
DOROTHY NELKIN

CHAIRMEN AND SECRETARIES OF AAAS SECTIONS

MATHEMATICS (A)
Daniel Zelinsky
Lynn Arthur Steen

PHYSICS (B)
Ralph O. Simmons
Rolf M. Sinclair

CHEMISTRY (C)
Rustum Roy
Jean'ne M. Shreeve

ASTRONOMY (D)
David Morrison
John E. Gaustad

PSYCHOLOGY (J)
John I. Lacey
William N. Dember

SOCIAL, ECONOMIC, AND POLITICAL SCIENCES (K)
David Mechanic
David L. Sills

HISTORY AND PHILOSOPHY OF SCIENCE (L)
Edward Grant
Arthur L. Norberg

ENGINEERING (M)
Henry McGee
W. Edward Lear

EDUCATION (Q)
John F. Schaff
Joseph D. Novak

DENTISTRY (R)
Gordon H. Rovelstad
Harold M. Fullmer

PHARMACEUTICAL SCIENCES (S)
Edward G. Rippie
Betty-ann Hoener

INFORMATION, COMPUTING, AND COMMUNICATIONS (T)
Karen B. Levitan
Elliot R. Siegel

DIVISIONS

ARCTIC DIVISION

Robert White
President

Gunter E. Weller
Executive Secretary

CARIBBEAN DIVISION

Juan A. Bonnet, Jr.
President

Lucy Gaspar
Secretary-Treasurer

PACIFIC DIVISION

Walter Gardner
President

Alan E. Levit
Executive Director

SCIENCE is published weekly on Friday, except the last week in December, by the American Association for the Advancement of Science, 1515 Massachusetts Avenue, NW, Washington, D.C. 20005. Second-class postage (publication No. 484460) paid at Washington, D.C., and at an additional entry. Now combined with *The Scientific Monthly*® Copyright © 1985 by the American Association for the Advancement of Science. Domestic individual membership and subscription (51 issues): \$60. Domestic institutional subscription (51 issues): \$98. Foreign postage extra: Canada \$24, other (surface mail) \$27, air-surface via Amsterdam \$65. First class, airmail, school-year, and student rates on request. Single copies \$2.50 (\$3 by mail); back issues \$3 (\$3.50 by mail); Biotechnology issue, \$5 (\$5.50 by mail); classroom rates on request. **Change of address:** allow 6 weeks, giving old and new addresses and seven-digit account number. Authorization to photocopy material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act is granted by AAAS to libraries and other users registered with the Copyright Clearance Center (CCC) Transactional Reporting Service, provided that the base fee of \$1 per copy plus \$0.10 per page is paid directly to CCC, 21 Congress Street, Salem, Massachusetts 01970. The identification code for *Science* is 0036-8075/85 \$1 + .10. **Postmaster:** Send Form 3579 to *Science*, 1515 Massachusetts Avenue, NW, Washington, D.C. 20005. *Science* is indexed in the *Reader's Guide to Periodical Literature* and in several specialized indexes.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

BOOK REVIEWS	The Education of a College President, reviewed by L. Galambos; Beyond Velikovsky, J. W. Patterson; Genetic Variability in Responses to Chemical Exposure, G. J. Brewer; Late Quaternary Environments of the Soviet Union, G. H. Miller; Books Received	1304
---------------------	--	------

REPORTS	Free Radicals in the Stratosphere: A New Observational Technique: J. G. Anderson et al.	1309
	The Fajada Butte Solar Marker: A Reevaluation: M. Zeilik	1311
	Microinjected c-myc as a Competence Factor: L. Kaczmarek et al.	1313
	Filamentous Fusion Phage: Novel Expression Vectors That Display Cloned Antigens on the Virion Surface: G. P. Smith	1315
	Phosphate Release and Force Generation in Skeletal Muscle Fibers: M. G. Hibberd et al.	1317
	Defect in Vitamin B ₁₂ Release from Lysosomes: Newly Described Inborn Error of Vitamin B ₁₂ Metabolism: D. S. Rosenblatt et al.	1319
	Correlated Measurements of DNA, RNA, and Protein in Individual Cells by Flow Cytometry: H. A. Crissman et al.	1321
	Angiogenesis Induced by Degradation Products of Hyaluronic Acid: D. C. West et al.	1324
	Dragonfly Flight: Novel Uses of Unsteady Separated Flows: C. Somps and M. Luttges	1326
	Monitoring the Time Course of Cerebral Deoxyglucose Metabolism by ³¹ P Nuclear Magnetic Resonance Spectroscopy: R. K. Deuel et al.	1329
	Sonar Tracking of Horizontally Moving Targets by the Big Brown Bat <i>Eptesicus fuscus</i> : W. M. Masters, A. J. M. Moffat, J. A. Simmons	1331
	Coral Community Reproductive Patterns: Red Sea Versus the Great Barrier Reef: Y. Shlesinger and Y. Loya	1333

PRODUCTS AND MATERIALS	Exonuclease; Microbiology Computer System; Automated Sample Processing; Laboratory Ovens; Benchtop Fermentor; Replaceable Junction pH Electrodes; Liquid Scintillation Analyzer; Heatable Plastic Beakers; Fluorescence Microscope; Peptide Synthesizer; Cloning and Expression System; Centrifuges; DNA Synthesizer; Gas Chromatograph; Literature	1336
-------------------------------	---	------

E. SAWYER
A E. WIDNALL

LINDA S. WILSON

WILLIAM T. GOLDEN
Treasurer

WILLIAM D. CAREY
Executive Officer

OGY AND GEOGRAPHY (E)
H. Matthews III
M. McCammon

BIOLOGICAL SCIENCES (G)
Betty M. Twarog
Judith P. Grassle

ANTHROPOLOGY (H)
Albert C. Spaulding
Priscilla Reining

AL SCIENCES (N)
P. Fishman
ian E. Rhoads

AGRICULTURE (O)
Roy G. Creech
Ralph J. McCracken

INDUSTRIAL SCIENCE (P)
Robert H. Pry
Robert L. Stern

STICS (U)
art Hunter
d J. Wegman

ATMOSPHERIC AND HYDROSPHERIC (W)
F. Kenneth Hare
Bernice Ackerman

GENERAL (X)
Harold P. Green
Rodney W. Nichols

THWESTERN AND ROCKY MOUNTAIN DIVISION

Donald J. Nash
President

M. Michelle Balcomb
Executive Director

American Association for the Advancement of Science was founded in 1848 and incorporated in 1874. Its objects further the work of scientists, to facilitate cooperation among them, to foster scientific freedom and responsibility, prove the effectiveness of science in the promotion of human welfare, and to increase public understanding and station of the importance and promise of the methods of science in human progress.

COVER

Shadowgraph of a dragonfly, *Aeschna palmata*. The slender body and intricate wing venation of the dragonfly reflect millions of years of evolutionary pressures. Such structures support remarkable aerodynamic agility. Unsteady, separated fluid mechanisms appear to produce the high lift needed for this agility. See page 1326. [Wolfgang Bank, University of Colorado, Boulder 80309]

Sampling the stratosphere

A “reel-down” device invented by Anderson *et al.* has been used to measure the concentration of atomic oxygen high in the stratosphere (page 1309). The device, tethered to a helium balloon, rose 40 kilometers above Earth. The monitor was then lowered 12 kilometers on a filament 1.5 millimeters in diameter, and a stratospheric sample flowed through the detector. In the stratosphere, ultraviolet radiation from the sun and oxygen react to form ozone. The ozone layer at the top of the stratosphere prevents damaging ultraviolet radiation from reaching Earth’s surface; close to Earth, ozone is a pollutant. A complex series of chemical reactions maintains the balance between oxygen and ozone in the stratosphere. Atomic oxygen was the first component measured with this device because it is an important reactant in most of these catalytic chemical cycles. On future balloon flights other free radicals of chlorine, nitrogen, and hydrogen will be measured in part-per-trillion amounts.

Vitamin B₁₂

A step in the processing of vitamin B₁₂ has been inferred from studies of cells obtained from an infant with an unusual metabolic deficiency disease (page 1319). Vitamin B₁₂ is not made by humans or other animals and must be absorbed from food. In the body it forms a complex with a carrier protein. The complex interacts with a receptor at cell surfaces, moves into the cell, and is taken into lysosomes filled with digestive enzymes which release the vitamin from its carrier. Subsequently, the vitamin appears in the cytoplasm of the cell. Rosenblatt *et al.*, in studies of cells from a child with delayed development and laboratory signs of vitamin B₁₂ deficiency, found that the free vitamin accumulated in the lysosomes and did not enter the cytoplasm. They propose that healthy cells have a transport system for exporting vitamin B₁₂ from lysosomes and that the transport system is defective in the child.

Angiogenesis factors

Sugar compounds can induce angiogenesis, or new blood vessel formation. Capillaries form in the body during normal development, during the repair of tissues damaged by wounds, disease, inflammation, and immune responses, and during tumor growth. West *et al.* show that one inhibitor of this process is hyaluronic acid, the gel-like substance that is an integral part of connective tissue and skin (page 1324). When hyaluronic acid is partially degraded, many smaller sugar fragments are produced that have strong angiogenic effects in a test system. Intact hyaluronic acid and its breakdown products may be crucial controlling factors in capillary formation and maintenance in normal and pathologic circumstances.

NMR for studying brain metabolism

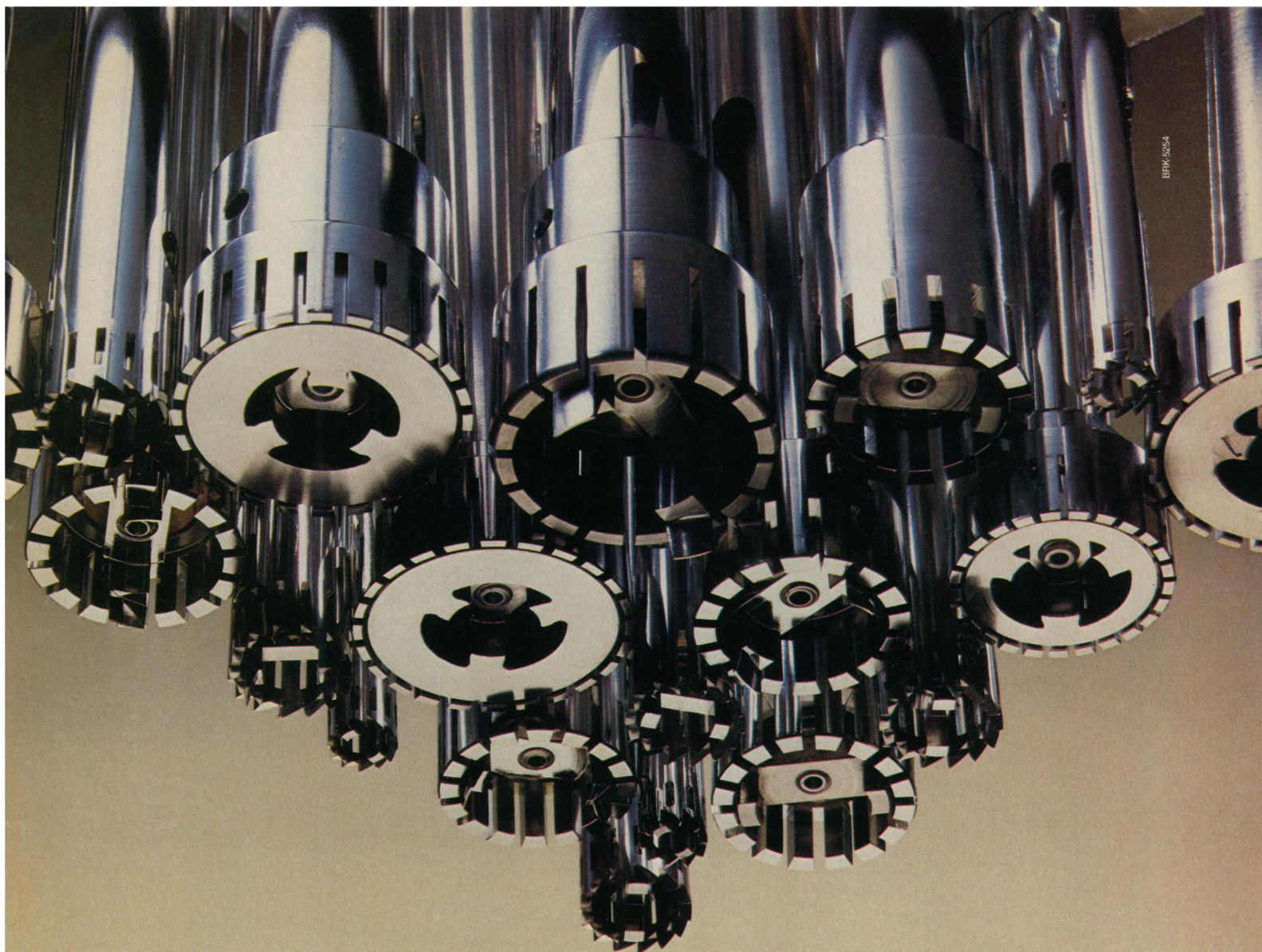
A metabolic process making energy available for use in the brain can be measured through time in conscious animals by a noninvasive technique, nuclear magnetic resonance (NMR). Deuel *et al.* measured the metabolism of a sugar molecule traditionally used as an indicator of brain metabolism (page 1329). The first step in the metabolism of this molecule is phosphorylation, the incorporation of a phosphorus component into its structure. The phosphorylated sugar is detected by the NMR receiver because its atomic nucleus can absorb energy at the characteristic radio frequency for phosphorus. Rats received an injection of the unphosphorylated sugar, and a monitor over their heads measured phosphorylation and subsequent dephosphorylation at a later stage of metabolism. NMR will make possible studies of metabolic changes that occur in the active brain under normal and pathologic conditions.

Bats

The bat, an echo-locator, emits ultrasonic sounds and continually receives updates on the whereabouts of moving prey from returning echoes. Masters *et al.* trained two bats to sit on a platform and track a small ball moving in front of them (page 1331). Measurements of the head movements of the bats in relation to the positions of the targets suggested that the bats use a “nonpredictive” strategy for locating objects in the experimental setting. About 20 times per second a broad beam of sound was emitted and a bat aimed its head toward the target’s last known position. There was no indication that the bat used information on past positions, velocities, or accelerations to predict the target’s path.

Reproduction in coral reefs

Coral communities in two tropical seas are replenished through different reproductive strategies. Shlesinger and Loya found that in the Red Sea at Israel the corals reproduce at different times but in a regular sequence (page 1333). At the Great Barrier Reef off Australia, the corals reproduce simultaneously, with most species spawning essentially on a single night. Following a free-swimming stage, larvae of most species settle on the reef, where they remain fixed. The reproduction pattern at the Red Sea may minimize competition for space on the reef among coral species as well as between coral and algae (the major noncoral competitors on the reef) since most of the corals are settling when the algae are at an annual low. At the Great Barrier Reef, the simultaneous reproduction of the corals may actually minimize overall losses of larvae by satiating predators. Local differences such as the length of the warm season may also have contributed to the development of these distinct reproductive patterns.



Only the sample breaks down.

Brinkmann homogenizers make the difference
—in 30 seconds.

Rapid action preserves biological integrity.

Brinkmann homogenizers take advantage of mechanical shearing and cavitation to assure you of uniform sample breakdown in only 30 to 60 seconds. This rapid action protects your samples from inactivation by heat generated during prolonged homogenization.



Powerful, durable motors work harder...longer.

Brinkmann homogenizers use heavy-duty, high-speed 700 W and 1600 W motors for high torque and long life. They reach speeds of up to 27,000 rpm to disintegrate samples efficiently and effortlessly.

One system meets all your homogenization needs.

Brinkmann homogenizers handle samples from 0.5 mL to 25 L with 21 generators, two motors, and a complete range of accessories.

For complete information or a demonstration, call or write:

Brinkmann Instruments Co., Division of Sybron Corporation, Cantiague Road, Westbury, NY 11590, Tel: 800-645-3050; in New York: 516-334-7500. In Canada: 50 Galaxy Blvd., Rexdale, Ontario M9W 4Y5, Tel: 416-675-7911.



Homogenizers

For literature circle reader service number 265
For a demonstration circle reader service number 266

Brinkmann
DIVISION OF
SYBRON

The CRB...

ATTENTION!

**We interrupt this ad
to announce a
breakthrough in
supercomputing
services.**

X-MPower from Boeing.

We've combined a Cray X-MP Supercomputer with a Solid-State Storage Device (SSD) that packs a whopping 128 million words.

And it's available now via our international teleprocessing network.

This isn't just a better mousetrap. It's a total revolution in computing power.

Not only are we solving current research and design problems at amazing speeds, we're changing the way scientists and engineers think about solving problems. Here's why.

LIGHTNING FAST JOB TURN-AROUNDS. The X-MP is 30 percent faster on scalar jobs than the Cray 1S, the old efficiency champ. For vectorized jobs, it runs from 2 to 3 up to 10 times faster. Best of all, the SSD is 100 to 250 times faster than disks. The result? I/O problems become a thing of the past. And CPU time will almost equal turnaround time.

Recently, one group of researchers took only 3.6 hours to solve a seismic, 3-D migration problem that would have taken 23.8 hours! And for the structural analysis of an offshore platform, the X-MP turned a 28-hour CYBER 760 job into a 26-minute snap.

ACCELERATES RESEARCH AND DESIGN. The X-MP lets you do more computer runs in the time you've got for the same price or less. That squeezes more results out of your R&D dollar. And brings them in on time.

OPENS UP NEW WAYS TO SOLVE PROBLEMS. Because you have so much more calculating power, you can not only run current problems faster, but you can develop totally new algorithms as well. Totally new approaches to old problems!

These are big claims.

That's why we want a chance to tell you more. We've got more data than we can cram into one ad. Such as the X-MP's incredible versatility. In manufacturing. Oil and gas extractions. Telecommunications. Pharmaceuticals. Nuclear power. And more. Plus, you'll have full access to our MAINSTREAM® time-sharing services and our engineering and scientific software library.

To get the whole story, call Bob Nicholson today at (206) 763-5097. Or write Boeing Computer Services, P.O. Box 24346, M/S 7A-33, Seattle, WA 98124.

Scholar/...
For four...
can't touch...
mainframe...
unsurpassed

1. The ease...
available. It...
learn... even...
puter background

2. The most...
analysis capabilities

3. Mainframe...
trative capabilities...
other CBT systems

4. With more...
ibility, Scholar...
est cost CBT system...
or compatible network

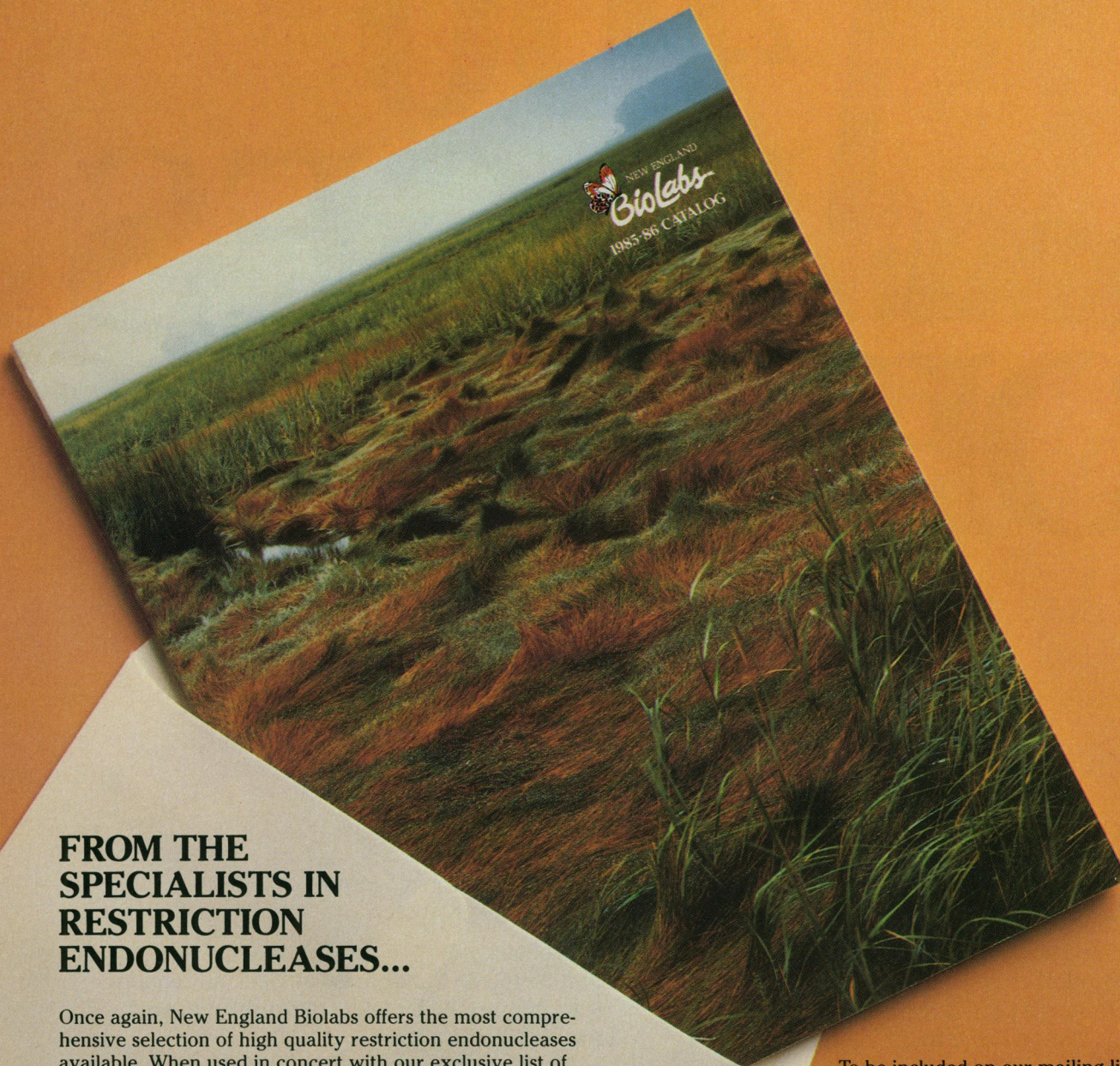
Now it's even better...
reasons the computer...
not think about.

...would rather...

...given Scholar/Teach both...
We've kept it simple. But it's flexible...
enough to grow with you as your

BOEING

NEW...1985-86 CATALOG

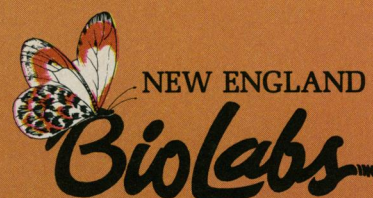


FROM THE SPECIALISTS IN RESTRICTION ENDONUCLEASES...

Once again, New England Biolabs offers the most comprehensive selection of high quality restriction endonucleases available. When used in concert with our exclusive list of methylases, an expanded selection of over 130 unique DNA cleavage specificities is now at your fingertips. Detailed information describing these and over 150 additional products for molecular biology are featured in our latest catalog.

- 90 Restriction Endonucleases (13 new listings)
- 12 Methylases (7 new listings) provide access to over 40 additional DNA cleavage specificities
- A wide selection of RNA and DNA metabolizing enzymes including SP6 RNA Polymerase and Mung Bean Nuclease
- DNA products including new molecular weight markers and a new M13 cloning and sequencing system
- New linkers and primers from our Organic Synthesis Division
- Comprehensive Appendix and Technical Information Sections

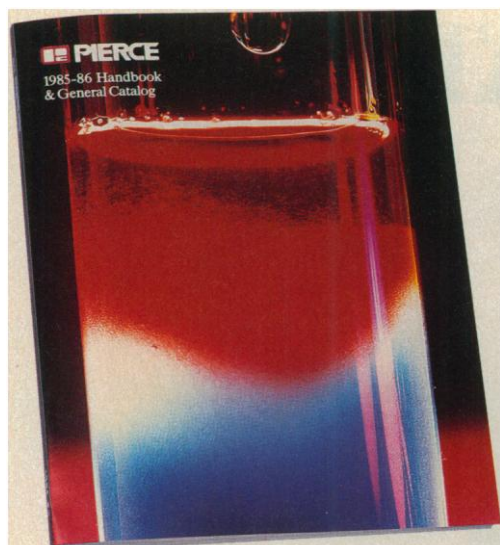
To be included on our mailing list,
please contact us at...



32 Tozer Road, Beverly, MA 01915/U.S.A.
TEL. (617) 927-5054 TELEX 6817316

New England Biolabs GmbH
Postfach 2750
6231 Schwalbach/Taunus
Federal Republic of Germany
TEL. (06196) 3031 TELEX 410989 NEB

Circle No. 318 on Readers' Service Card



400 PAGES OF FREE INFO

The 1985-86 Pierce Handbook and General Catalog contains over 400 pages of distinctive products and helpful information. Major sections include products for:

- affinity chromatography
- amino acid analysis
- chemical cross-linking
- DNA and peptide synthesis
- gas chromatography
- HPLC

- protein modification
- protein sequencing
- specialty labware
- thin layer chromatography
- clinical diagnostics

To obtain your free copy of the 1985-86 Pierce Handbook and General Catalog please contact the literature department of your local Pierce office.

PIERCE

Pierce Chemical Company

P.O. Box 117
Rockford, IL U.S.A. 61105
Tel. 800-435-2960 or
800-8-PIERCE
Telefax: 815-968-7316
TWX: 910-631-3419
Cable PIERCHEM

Pierce Eurochemie bv

P.O. Box 1512
3260 BA oud-Beijerland
Holland
Tel. 31 1860 19277
Telex 21676
Telefax: 31 1860 19179

Pierce GmbH

Daimlerstr. 15-17
6054 Rodgau 6
Weiskirchen
Tel. (0 61 06) 1 32 86
Telefax (0 61 06) 1 33 19
Telex 416224 tecat d

Pierce UK, Ltd

36 Clifton Road
Cambridge CB 14 ZR
England
Tel. (0223) 214525
Telex 817969 PIERCE

Hicol bv

Postbus 1525
3260 BA oud-Beijerland
Holland
Tel. 31 1860 14822
Telex 21676

Circle No. 309 on Readers' Service Card

Isco's smartpumps are dispensers and diluters, too.

An Isco WIZ is more than an ordinary lab pump. Spend two minutes calibrating it when you first set it up — from then on, just key in any flow rate you want, directly in ml/min or any other desired unit. The output will be within 1% of your selected value.

You'll get quick system set-up because you know immedi-

ately what the flow rate will be without re-measuring effluent or performing any calculations. And when you use WIZ with an Isco fraction collector, you can even set the fraction volume directly in ml on the collector controller.

WIZ is also a dispenser. Just key in any volume — that's what you'll get every time you press the button. Or use it for a diluter: push a button to take up any desired volume of sample; push it again to dispense the sample followed by any volume of diluent.

WIZ is available in two versions. You can have a peristaltic WIZ pump with four removeable tubing cassettes, or a reciprocating piston WIZ pump that's inert and operates at 100 psi. Both have design

and construction quality features not found in most other pumps: microprocessor control, ball bearings, and all-metal frames and cabinets. That means they're rugged, reliable, and long lived.

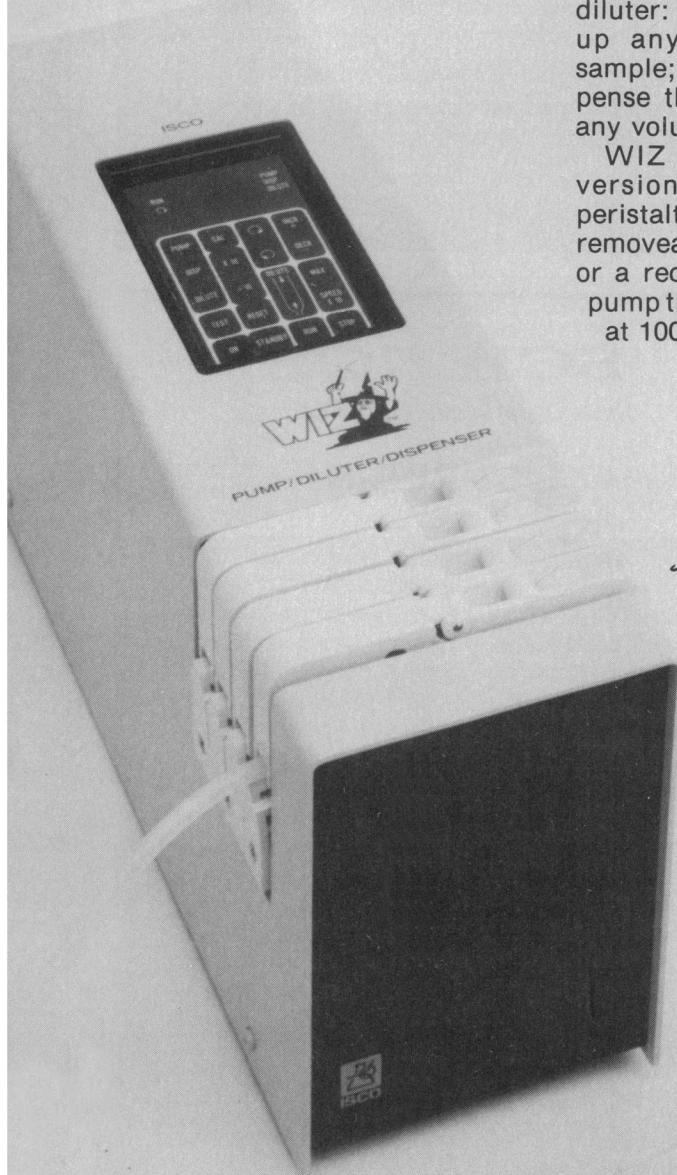
WIZ can also be an important part of your custom automation design: use it with your computer, or with an Isco ISIS Autosampler to automate reagent addition and other lab processes.

Send now for literature or phone toll free [800]228-4250.

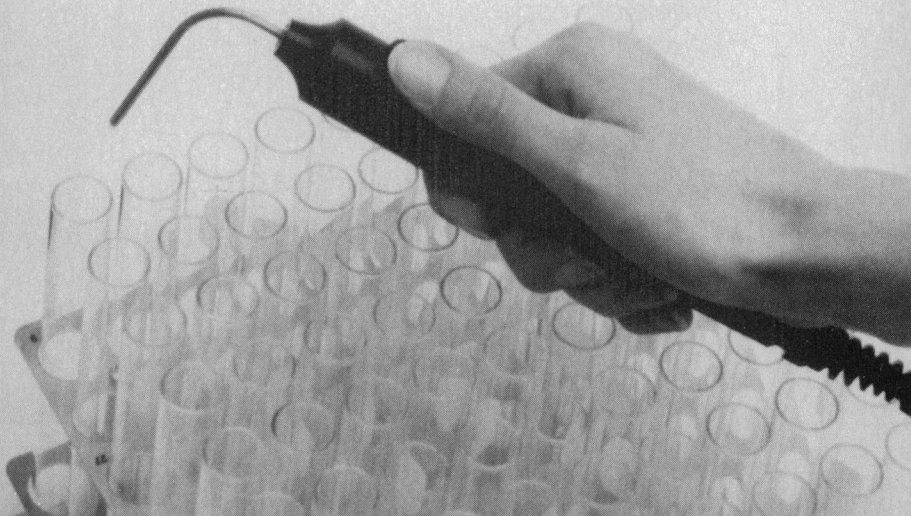
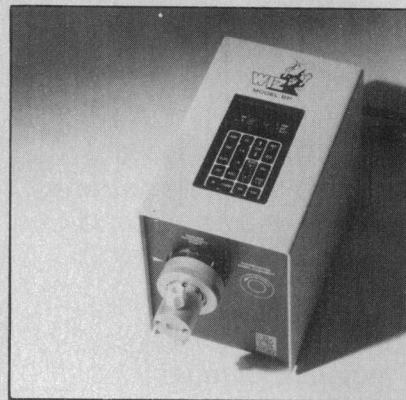
Isco, Inc.
P.O. Box 5347
Lincoln, NE
68505



Circle No. 298 on Readers' Service Card



*either model
only \$1150!*



Treff Lab

Our customers tell us
our Microtips &
Centrifuge tubes are the
best they've ever used...
Call us toll free for
Free Samples and
verify their evaluation.
800-543-4461
Tekmar®

**High quality
precision
Micro-centrifuge
Tubes and
Microtips**

Tekmar®

Micro-centrifuge Tubes:

- Easy open, seals securely
- Unique writing surface
- Color coded (5 colors)
- Graduated marks
- Low cost

Precision Microtips:

- Packaged in an autoclavable box
- Universal tips fit most micropipettes
- Precision made
- Low cost

Call for Free Samples Today!

Call toll free **800-543-4461**
In Ohio, Canada call collect **513-761-0633**
Telex No. 21-4221

Tekmar Company, P.O. Box 371856
Cincinnati, OH 45222-1856

Circle No. 299 on Readers' Service Card

SCIENCE

News Department Reprint Series

**European Missile
Deployment**

No defense decision has so strained the Western alliance and awakened the average citizen to the risks of nuclear destruction as the decision made by NATO in 1979 to install new nuclear missiles in Western Europe. Although the initial phase of the deployment has been successfully carried out, it has left in its wake an unforeseen series of painful and potentially lasting military and political consequences.

In a compelling 4-part series in *Science*, R. Jeffrey Smith describes the genesis of the deployment decision, the course of arms negotiations that followed, and the choices that lie ahead for NATO—choices that may influence the direction of future U.S. military expenditures as well as the potential risk of a superpower conflict. This reprint collection is available now.

Single copies \$3.00; twenty or more \$1.50 each.
Orders must be prepaid.

Write to AAAS, Dept. EMD, 1515 Massachusetts Ave., N.W., Washington, D.C. 20005.

SCIENCE

News Department Reprint Series

Catalysis

"There is no area in chemistry today more exciting than catalysis." [George Pimentel, chairman of the National Academy of Sciences/National Research Council Committee to Survey Opportunities in the Chemical Sciences]

This survey of the most active areas of catalysis conveys that excitement while explaining some of the unusual forces that have combined to drive studies of catalysis forward. Among the topics covered: Heterogeneous catalysis, cluster chemistry, activation of carbon-hydrogen bonds, asymmetric synthesis, photocatalytic production of fuels and electricity, modification of enzymes, and immobilization of enzymes.

This collection of recent articles from *Science* by Thomas Maugh II is now available for use by professionals, teachers, researchers, and anyone interested in this field.

Single copies \$3.00; twenty or more \$1.50 each.
Orders under \$10.00 must be prepaid.

Write to AAAS, Dept. CAT, 1515 Massachusetts Ave., N.W., Washington, D.C. 20005.



THE PLATE'S ON YOU. THE MUG'S ON US.

Buy a Corning® PC-351 or PC-101 Hot Plate/Stirrer and get a free Pyrex® beaker shuttle mug. It's our way of celebrating 70 years of Corning vision, from our low-expansion borosilicate beakers in 1915 to space shuttle windows and heat-resistant shielding.

Our vision of the perfect glass-ceramic hot plate surface is a Corning original—chemically durable Pyroceram® top.

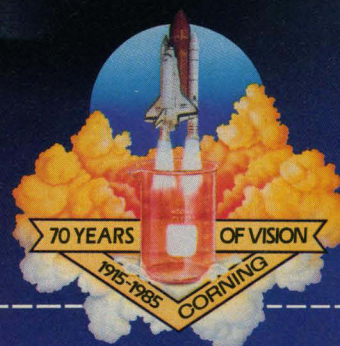
- Heats and cools evenly.
- Cleans easily.
- Resists chemical corrosion.
- Overhang protects against spills.
- Reliable, built to last.

Our vision saves yours with easy-to-read control dials and operation indicator lights. And more...

- Built-in automatic stirrer.
- 35 or 100 sq. in. surface.

See for yourself why Corning hot plates and hot plate/stirrers have become the accepted laboratory standard.

Circle No. 292 on Readers' Service Card



SE-06-85-VH

FREE SHUTTLE MUG



when you buy a Corning® PC-351 or PC-101 Hot Plate/Stirrer. Clip this coupon and Proof of Purchase to your letterhead with name, title and shipping

address. Send to Corning Glass Works, Science Products, P.O. Box 1150, Elmira, New York 14902-9944. Offer ends November 29, 1985. (Proof of Purchase is the specification label from the side panel of a Corning Hotplate or Stirrer box, PC-351 or 101.)

The Most Trusted Tools Of Science

CORNING

SCIENCE / SCOPE

A new radar can map military targets with high resolution equal to that of infrared devices, even in rain and other bad weather. The Advanced Synthetic Aperture Radar System (ASARS-2), designed to complement electro-optic sensors, is flown on a U.S. Air Force TR-1 reconnaissance aircraft and provides real-time radar imagery to a ground station. ASARS-2 operates in all weather at ranges far exceeding the capabilities of infrared and other electro-optic devices, thanks to new state-of-the-art signal processing and other advances. The Air Force gave the system an excellent rating after it underwent strict operational performance tests as part of a "fly-before-buy" program. Hughes Aircraft Company is producing the system under a development and production contract. Eventually ASARS-2 is expected to be adapted for tactical aircraft and mobile tactical stations.

Jam-resistant communications have been introduced into NATO by a new terminal for AWACS early-warning aircraft. The Joint Tactical Information Distribution System (JTIDS) Class 1 terminal is designed to combat the formidable and growing electronic countermeasures threat to tactical communications. JTIDS uses principles of time division multiple access to provide secure, high-capacity communications for AWACS radar planes and ground stations. The system relays a wide variety of information, such as command and control, surveillance, intelligence, force status, target assignments, warnings and alerts, weather, and logistics. Software filtering lets each participant select data pertinent to his own needs. Hughes is producing the JTIDS terminal for use with NATO's Airborne Early Warning/Ground Environment Integration Segment (AEGIS).

Lasers soon will be inspecting solder joints of fighter aircraft radars, thanks to new manufacturing technology being set in place at Hughes. Solder joints will be examined by a computerized technique using lasers and fiber optics, the glass threads that carry laser light transmissions. The process will free manufacturing personnel from tedious and time-consuming inspections of more than 36 million solder joints created in a single year's production. The project is part of an Industrial Modernization Incentive Program (IMIP) awarded by the U.S. Navy and Air Force. IMIP is a share-the-savings concept that will reduce costs of the F-14, F-15, and F/A-18 radar programs by more than \$10 million, while improving the quality and reliability of the systems.

Two high-power direct-broadcast satellites will carry family-oriented and religious programming for Dominion Video Satellite, Inc. The Hughes satellites will incorporate a novel design, combining existing technologies of spin-stabilized satellites and body-stabilized satellites. Each will carry large, winglike solar arrays similar to those on body-stabilized satellites. The wings will extend 110 feet, generating 5,000 watts of electrical power for eight channels of communications. A central spinning section will provide gyroscopic stability and additional electrical power for basic housekeeping functions. The satellites will be equipped with batteries to provide full power when the spacecraft pass through Earth's shadow and the sun is blocked from the solar cells.

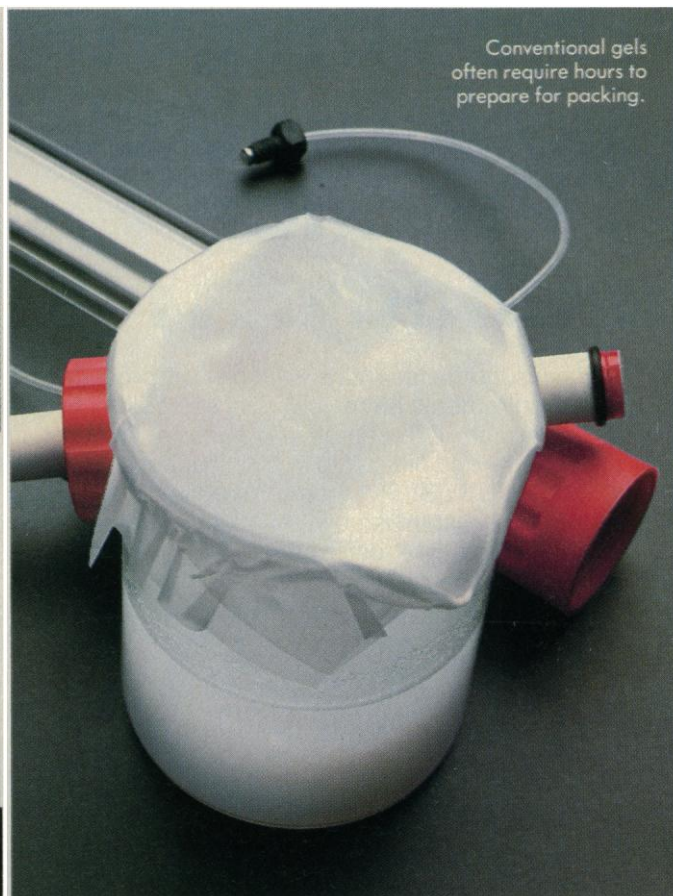
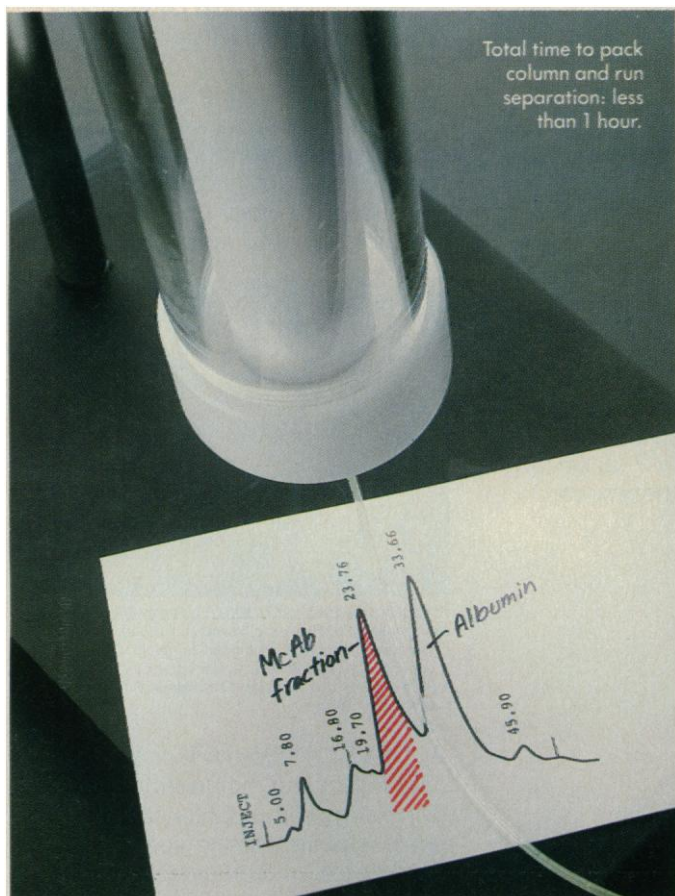
Hughes' Santa Barbara Research Center is seeking experienced engineers and scientists to further develop advanced IR focal plane technologies. We need custom integrated circuit designers, nuclear effects engineers, material scientists, semiconductor device scientists and process engineers, and IR system analysts. To learn how to become involved in this innovative technology, contact the Santa Barbara Research Center, Professional Employment, Dept. S2, 75 Coromar Drive, Goleta, CA 93117. Equal opportunity employer. U.S. citizenship required.

For more information write to: P.O. Box 11205, Dept. 70-12, Marina del Rey, CA 90295



Waters ACCELL™ media. Protein isolation complete.

Conventional gel. Still on the shelf.



© Millipore 1985

Now get LC isolation of your protein in minutes—not hours. With Waters ACCELL ion exchange media.

ACCELL packs quicker, easier and allows faster flow rates—to minimize time spent on protein separations. A patented copolymerization process exploits the properties of a rigid separation media while giving excellent recovery of biological activity. Because it's not subject to the shrinking and swelling typical of gels, ACCELL provides better reproducibility and resolution previously unattainable by con-

ventional techniques. Its rigid structure permits linear scale-up at all flow rates and pressures—from analytical to prep to process—using the same methods and the same chemistry.

Try Waters ACCELL media in your lab at no cost. Simply fill out and mail the attached coupon, and we'll send you a free trial kit which includes all the technical specifications, protocols, and materials you need to evaluate ACCELL on your protein. Or write to Millipore, Waters Chromatography Division, Dept. PM, 34 Maple Street, Milford, MA 01757.

FREE trial offer.

Mail to: Millipore
Waters Chromatography
Division
Department PM
34 Maple Street
Milford, MA 01757



WA 755

Name _____

Title _____

Company _____

Address _____

Phone _____

MILLIPORE

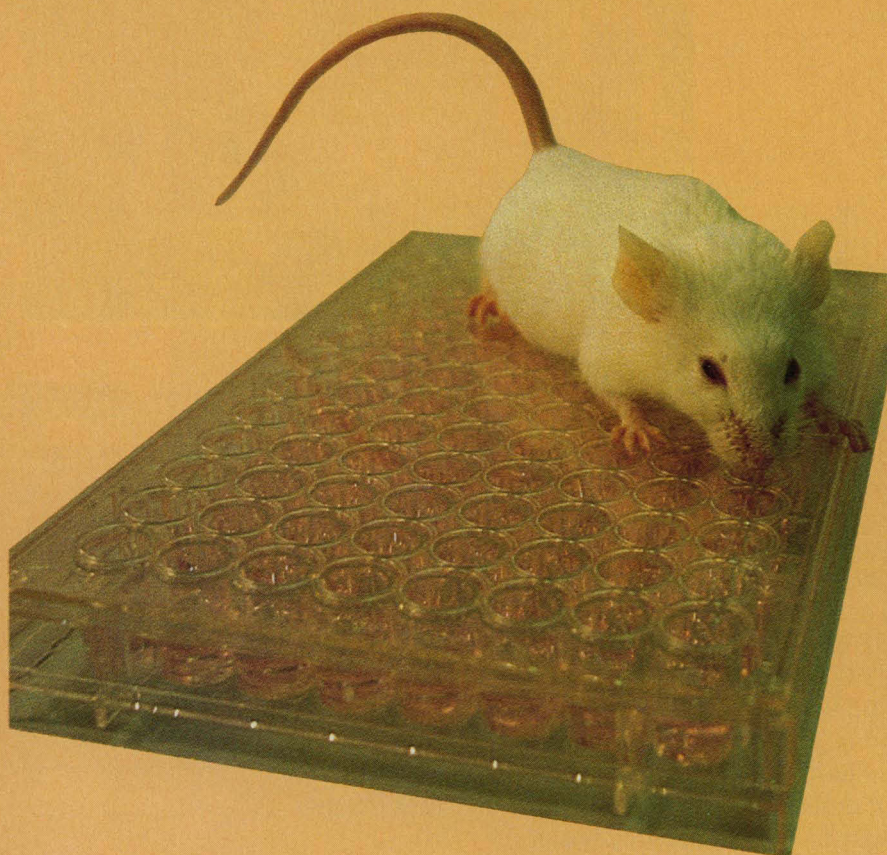
Waters Chromatography Division

Circle No. 151 on Readers' Service Card

In Its Time, It Was A Reliable Way To Produce Antibody....

Now economics, purity, quantity, and quality requirements have rendered this system – “research grade”, expensive and difficult to scale-up. The ACUSYST-P™ mammalian cell culture system is now available. This automated technol-

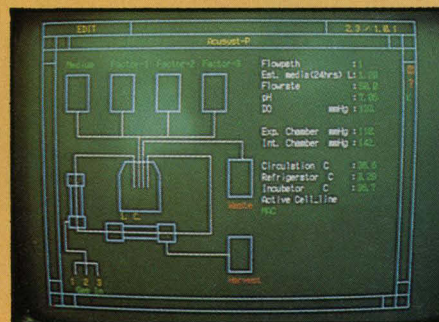
ogy will produce grams to kilograms of secreted substance with high purity, at low-cost, in your facility or in our new licensed GMP facility for diagnostic as well as therapeutic substances.



Scale-up production process – in your facility or ours, the decision, and flexibility to change that decision, is yours.

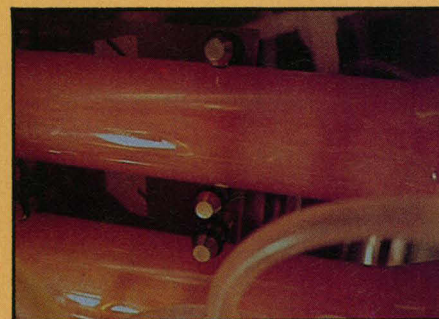
Efficient Production Of Biologicals – Grams To Kilograms

Secreted cell product such as monoclonal antibodies as well as interferons, growth hormones, tissue plasminogen activator, and other low molecular weight proteins can be efficiently produced. The



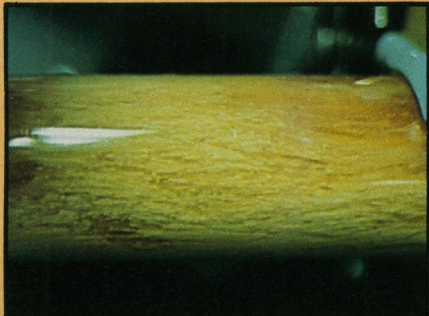
The optional research ACUSOFT™ software package is the users interface to the media flowrates, fluid/gas pressures, pH, etc., for bioprocess control development. Different process control algorithms and strategies can be programmed to optimize the secretion parameters of different mammalian cell lines.

ACUSYST-P system incorporates patent-pending, hollow fiber culture technology with sophisticated process control strategies to produce secreted biological substances – economically.



Bioreactor just after inoculation of cells.

ACUSYST-P™ production system for secreted mammalian cell products



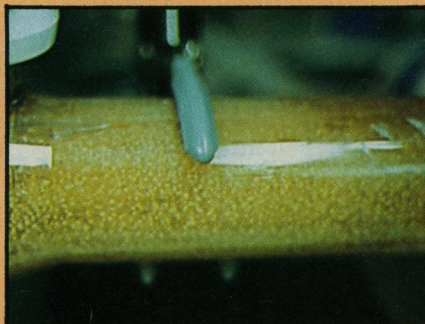
This cell line has been producing for 90 days with McCoy's 5A medium. No serum has been added for 9 weeks. Unlike ascites methods, suspension culture, encapsulation technologies, support matrices, or stand alone hollow fiber cartridges, the ACUSYST-P system incorporates patent-pending technology to provide a high purity product. Glucose uptake, lactic acid production, and oxygen uptake show strong signs for all vital parameters.

Endotronics Offers The "Flexible Alternative" When Choosing A Method For Production

The pharmaceutical and biotechnology industry is at a crossroads. A production process for secreted substances from mammalian cells must be put in place in order to compete in the marketplace. Economics, flexibility, and the ability to deliver are key factors in choosing the process.

Economics – cost per gram in the ACUSYST-P production system is lower than any other production system. Our low-cost Cell Line Characterization Program will prove to you and your management that this system is the most economical way to produce your secreted substance. When the program is completed you will receive a Research Report, Cost Analysis and harvested product on your particular cell line.

Flexibility – Endotronics offers Contract Production Services in our new FDA approved GMP production facility, or you can place the ACUSYST-P systems in your facility for research and production purposes.



Anchorage — dependent cell lines do very well in the ACUSYST-P production system.

Sophisticated process development software allows further optimization of production processes for further reductions in cost per gram. Endotronics offers maximum flexibility for your production needs. Produce your product on contract with us in our licensed manufacturing facility for clinical trials or first production runs with the flexibility to transfer the production technology to your facility at any time. No other company can offer the flexibility of ACUSYST-P instrumentation as well as contract production services.

Delivery – ACUSYST-P systems are now in place in the U.S., Canada, and Japan. More systems are producing substance in our GMP Contract Production Facility and Cell Line Characterization Laboratory. Response to our "flexible alternative" has been gratifying as we are forming mutually beneficial business relationships that can help solve production problems in biotechnology.



The ACUSYST-P™ production system for secreted mammalian cell products can be utilized for anchorage-dependent or independent cell lines.

Share With Us Your Needs

Your needs in cell culture are seen as opportunities by Endotronics. We would like to discuss with you, your cell culture research and production questions, and offer some answers, and share with you our technological advances over other production methods.



Get more information.

Circle No. 316 on Readers' Service Card

TM

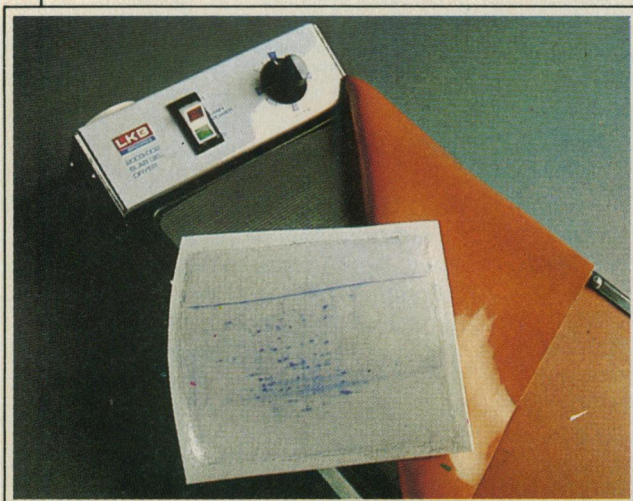
8500 Evergreen Blvd. N.W.
Coon Rapids, MN 55433
612-786-0302

LKB offers you a choice of two

This one combines fi

If it's genuine versatility you're looking for, then you need look no further than the LKB Vertical Electrophoresis System. With a dual gel capacity that allows you to run up to 40 samples at a time, its design ensures that all gels are always run under uniform conditions, thereby guaranteeing superior reproducibility. And now we have further enhanced the already impressive versatility of this system by adding a 30 cm gel capability for even higher resolution, a tube gel kit for greater 2-D flexibility, and the new LKB Transphor Electroblotting Unit for improved visualization.

This fine 2-D gel shows the use of the LKB Gel Dryer in preparing gels for storage, scanning or autoradiography ▼



No grease, no leaks, no mess

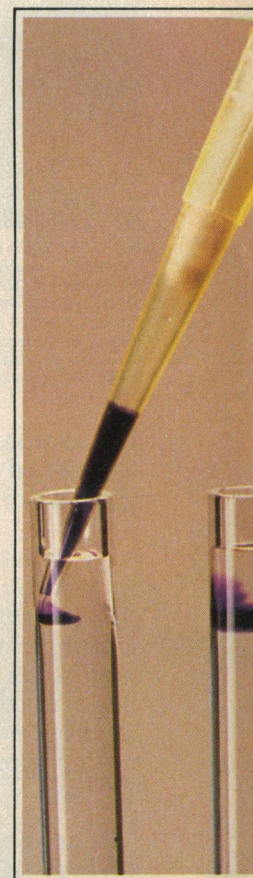
One clear benefit of using the LKB Vertical Electrophoresis System is the simplicity it brings to the job of gel casting. The basic system includes everything you need to cast and run perfect gels first time, every time. The gels are cast between glass plates, avoiding both the use of grease and the probability of leaks and turning gel casting into a clean and pleasant activity.

The Tube Gel Kit allows the LKB system to perform both the first and second dimensions in 2-D applications ►

PAGE and gradient PAGE techniques

Conventional PAGE and SDS/PAGE techniques, using either continuous or discontinuous buffers, are fully catered for by the basic LKB system. The addition of our Gradient Gel Kit provides a quick and convenient method of casting both linear and exponential gradient polyacrylamide gels. Due to their relatively small pore size, these gels effectively limit diffusion. Linear gradients counteract band broadening effects, while exponential gradients are useful for resolving components with widely differing molecular weights.

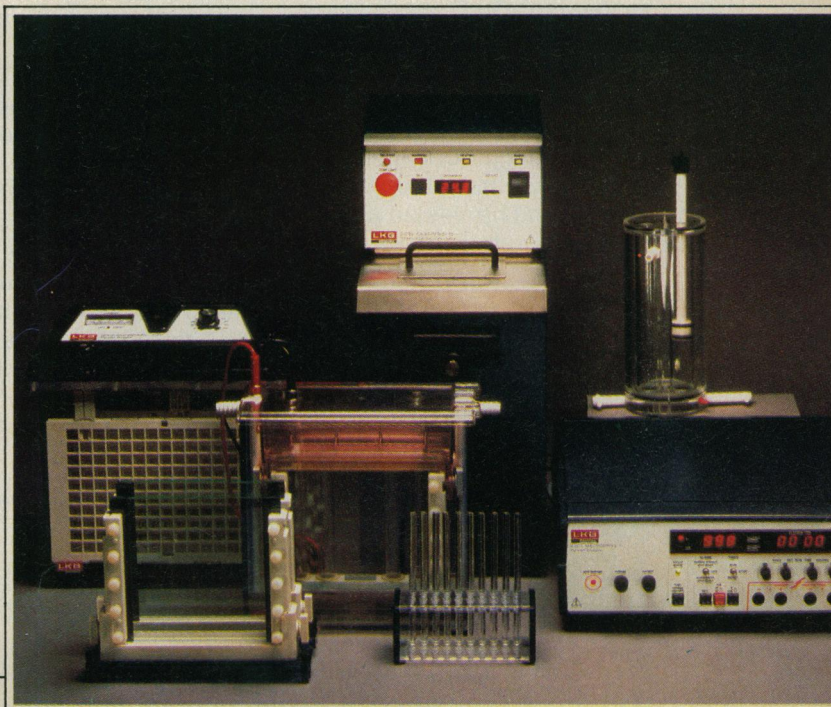
The Vertical Electrophoresis System, based on the LKB 2001 Electrophoresis Unit, also includes a power supply, thermostatic circulator and all the necessary accessories, kits and quality chemicals ▼



THE LKB SYSTEMS APPROACH

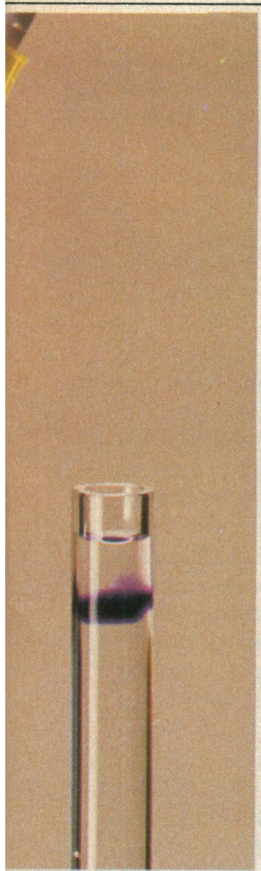
At LKB we believe that we should be able to give you professional training, advice and support in the use and application of our products. And we should certainly be able to supply you with everything you need to perform your experiments, so you never have to worry about where each item comes from, how good it is, whether it will work properly with all the other pieces of apparatus, and who to turn to when you have problems. That is why we offer complete integrated systems, not merely a range of individual units. LKB systems contain all the instruments, kits, chemicals, accessories and supplies you will need in your laboratory. Every component of the system is designed to work together with and enhance the high performance of all the other components. Every item carries our name, and we take full responsibility for it.

LKB - the electrophoresis experts



Vertical Electrophoresis Systems

ve different techniques



Agarose gel techniques

For researchers who sometimes want to use agarose, there is a special kit to help you cast and run the 3 mm agarose gels on the LKB Vertical Electrophoresis System. The kit includes frosted glass plates to provide essential support for the gel.

Two-dimensional techniques

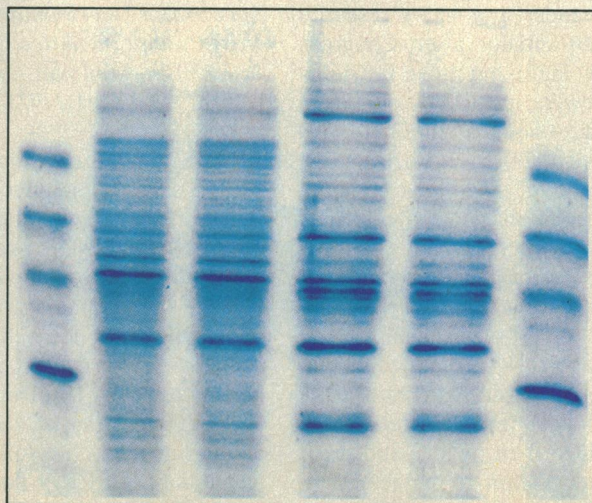
This is the only complete vertical electrophoresis system that can carry out both the first and second phases of 2-D electrophoresis in a single unit, and can offer the user a choice of either tube or slab gels for the first dimension. Our 2-D Kit includes a special cleaver for preparing slab gels, while tube gels are easily applied to the top of a standard slab gel by means of the trough built into the upper buffer chamber.

LKB's new Transphor Electroblotting Unit improves the sensitivity and resolution of detection procedures ►

Autoradiography techniques

Another kit, containing all the accessories you need to cast accurate gels only 0.75 mm thick, makes it easy for you to use the LKB Vertical Electrophoresis System for high resolution autoradiography using thin gels. The LKB Slab Gel Dryer, which combines dry heat and reduced pressure to rapidly dry and affix the gel onto paper or film for later analysis and storage, is ideal for drying down thin gels onto disposable plastic sheets prior to detection.

*The result of gradient gel electrophoresis of two crude extracts from *Beneckea harveyi* on the LKB system ▼*

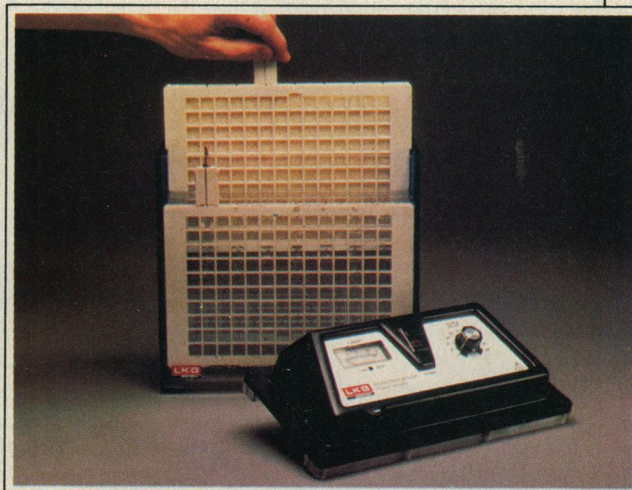


Electroblotting techniques

The new LKB Transphor uses the principles of electrophoresis to transfer proteins or nucleic acids from polyacrylamide or agarose gels onto nitrocellulose or other immobilizing matrices. In this way the electrophoresis bands are made easily accessible for faster and more sensitive visualization than on the original gel. The resulting patterns can be stored for months without deteriorating and multiple analyses can be performed using just the one pattern.

Want proof?

These may sound like extravagant claims, but just call us and we'll be happy to come and demonstrate the versatility of the LKB Vertical Electrophoresis System for you and your colleagues. At your convenience.



LKB
BROMMA

344

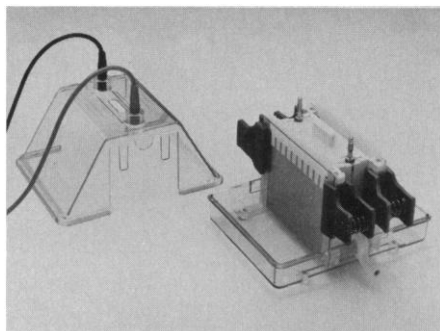
LKB-Produkter AB,
Box 305, S-161 26 Bromma, Sweden
Tel. +46 (8) 98 00 40, Telex 10492

Antwerp (03) 218 93 35
Athens-Middle East +30 (1) 894 73 96
Copenhagen (01) 29 50 44 · London (01) 657 88 22
Lucerne (041) 55 44 57 · Madras (044) 45 28 74
Moscow (095) 256-9002 · Munich (089) 85 830
Paris (06) 92 86 507 · Rome (06) 39 90 33
Stockholm (08) 98 00 40 · Tokyo (03) 293-5141
Turku (021) 678 111 · Vienna +43 (222) 92 16 07
Washington (301) 963 3200
Zoetermeer (079) 31 92 01
Over 60 qualified representatives throughout the world

Hoefer has expanded the Mighty Small line

Hoefer's Mighty Small I has become the laboratory standard for doing electrophoresis in the small gel format. Now Hoefer is introducing Mighty Small II, and to complete the system, Mighty Small Transphor, Casting Stand, and Power Supplies.

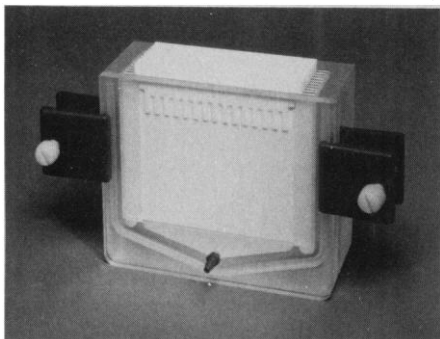
- **Mighty Small II** is Cool and Fast: It can run two mini-gels, 8 x 10 cm, in 45 minutes. Two mini-gels are produced in two gel sandwiches, held back to back, in a



double-sided pod. The pod consists of two discretely separate upper buffer chambers and a serpentine coolant chamber between. *Cooling is the key feature of the Mighty Small design.* The back plate of each gel sandwich is in contact with the upper buffer and is made of sturdy alumina. Alumina is an excellent heat conductor, 40 times faster than a comparable thickness of glass. It rapidly conducts joule heat away from the gel sandwich into the buffer. A serpentine coolant chamber, permanently sealed between the two buffer chambers, assures further heat dissipation. This excellent cooling system means you can get flat, side by side sample lanes with no smile in 45 minutes.

Reader service card no. 334

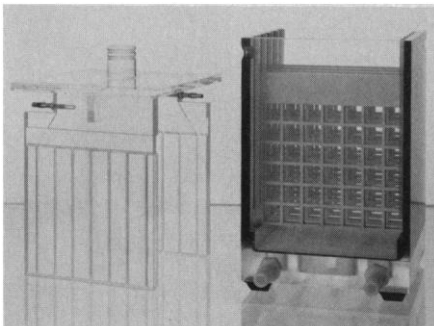
- **The Mighty Small Multiple Gel Caster** enables you to cast 10 gels at a time, 8 x 10 cm, gradient or native. You can pour batches of gels ahead of time,



probably a week's supply.

Reader service card no. 335

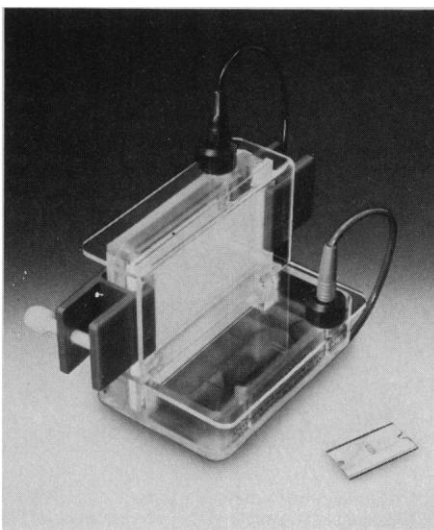
- **The Mighty Small Transphor** can transfer proteins from four small gels (up to 9 x 10 cm) at once, to either nylon membranes or nitrocellulose, in as little as 30 minutes. It comes complete with four



glass-filled polycarbonate cassettes. A serpentine cooling channel milled into the base and covered with alumina assures *excellent cooling.* Under standard transfer conditions the temperature variation will be less than 5°C. Platinum wire, 155 cm of it, strung in 14 opposing strands 1½ cm apart establishes a *uniform electrical field.* Because of its small size, it is possible to use a standard electrophoresis power supply — we recommend the Hoefer PS 500X. Mighty Small Transphor requires only a small amount of buffer, about one liter, another important cost-saving factor.

Reader service card no. 336

- If you want to run small gels, 100 mm wide x 80 mm high, the **Mighty Small I** does the job fast and right. You can run a 10% gel at 200 constant volts in only 42 minutes. The gel sandwich is the core of the design. Its alumina back interfaces with the buffer pod to insure even heat distribution across the gel surface. The result: flat,



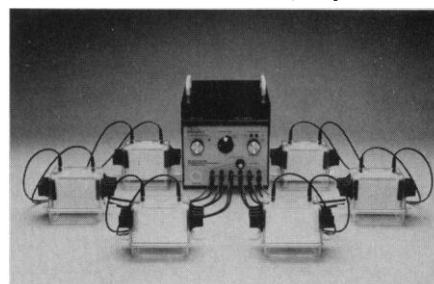
side-by-side bands.

Reader service card no. 337

- Hoefer introduces a **new line of transfer membranes** for all blotting techniques: a pure grade of nitrocellulose to insure faithful replicas and minimal background staining, and high binding capacity Nylon 66 membranes. You have a wide choice of shapes and pore sizes.

Reader service card no. 338

- **The PS 250 power supply** is a workhorse for the electrophoresis lab. It can produce 0-250V; 0-2.5A, adjustable in



both voltage and current. It has two digital panel meters and a 7 hour timer. You can run six Mighty Small II units at one time and monitor each separately. For transfer work the PS 250 provides ample current for several small or large transfer units. *We recommend running transfers in constant current to eliminate overheating.*

Reader service card no. 339

- **The PS 500X**

is the standard power supply for small gel electrophoresis. It can produce 0-500V, 0-400mA; adjustable in voltage and current; automatic crossover from current to voltage. You can run two Mighty Small II units at one time or two Mighty Small Transphor units.



The PS 500X is portable (only 8 lbs.) and compact (4" x 8" x 12").

Reader service card no. 340

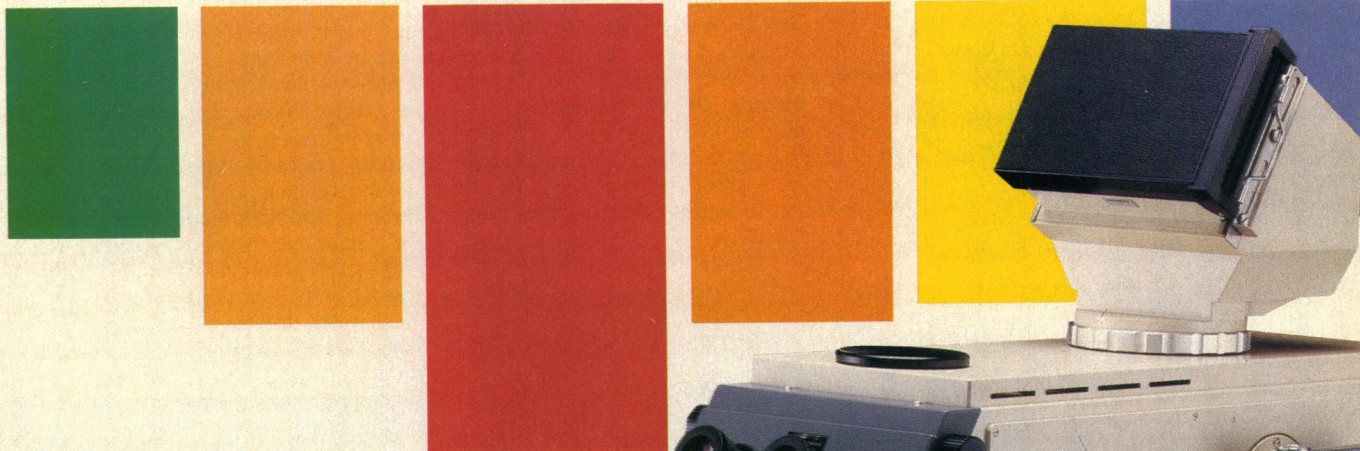
- **Hoefer Scientific Instruments**, P.O. Box 77387, San Francisco, CA 94107 USA. In California: 415-282-2307. Outside California: 800-227-4750. Outside USA: Telex 470778.

For demonstration of the Mighty Small line, Reader service card no. 341

For complete catalog, Reader service card no. 342

OLYMPUS®

The Image of Quality



Introducing the New VANOX. A breakthrough in research capability.

The quality of any research microscope relies on the interrelationship of optical performance, computer intelligence and mechanical capability. For more than six decades, Olympus has dedicated itself to development of a unique fusion of these distinct disciplines.

Nowhere is this achievement better exemplified than in the all-new Vanox Research Microscope System. An innovative concept that *builds into* the System's models a broad range of skills and versatility traditionally requiring attachments, accessories and add-ons to limited-capability microscopes...all make the new Vanox the most significant contribution to research microscopes in over a decade.

Some of the *built-in* innovations include three photographic ports for cine, 35mm or large format cameras, auto-exposure with spot or integrated measurements, light balancing filters, choice of condensers and illuminators, including Koehler, and so much more that only a hands-on experience can attempt to show the breakthrough quality of the new Vanox models.

Arrange a demonstration now by contacting Olympus Corporation, Precision Instrument Division, 4 Nevada Drive, Lake Success, NY 11042-1179. Or phone: East—(609) 482-1010; West—(415) 342-3384; Midwest—(913) 648-8323. In Canada: W. Carsen Co., Ltd., Ontario

OLYMPUS®



For literature circle reader service number 171
For a demonstration circle reader service number 172



FREE! \$15995 POLAROID® SLIDE KIT
Color photomicrographic slides in minutes with this complete Polaroid outfit. Contains AutoProcessor, Slide Mounter and Mounts 2 rolls of Polachrome 35mm instant slide film. All free from Olympus with purchase of any PM-10 35mm camera or AH-2 Series microscope. Limited offer from your Olympus Microscope Dealer.

Polaroid® is a registered trademark of Polaroid Corporation.

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: WILLIAM D. CAREY

Editor: DANIEL E. KOSHLAND, JR.

Deputy Editors

PHILIP H. ABELSON (*Engineering and Applied Sciences*), JOHN I. BRAUMAN (*Physical Sciences*), GARDNER LINDZEY (*Social Sciences*)

Editorial Board

PHILIP W. ANDERSON, DAVID BALTIMORE, ANSLEY J. COALE, JOSEPH L. GOLDSTEIN, LEON KNOPOFF, SEYMOUR LIPSET, WALTER MASSEY, OLIVER E. NELSON, ALLEN NEWELL, RUTH PATRICK, VERA C. RUBIN, HOWARD E. SIMMONS, SOLOMON H. SNYDER, ROBERT M. SOLOW

Board of Reviewing Editors

JAMES P. ALLISON, LUIS W. ALVAREZ, DON L. ANDERSON, KENNETH J. ARROW, C. PAUL BIANCHI, ELIZABETH H. BLACKBURN, FLOYD E. BLOOM, MICHAEL S. BROWN, NINA V. FEDEROFF, GARY FELSENFELD, DOUGLAS J. FUTUYMA, THEODORE H. GEBALLE, STEPHEN P. GOFF, PATRICIA S. GOLDMAN-RAKIC, RICHARD M. HELD, GLORIA HEPPNER, ERIC F. JOHNSON, KONRAD B. KRAUSKOPF, PAUL E. LACY, JOSEPH B. MARTIN, JOHN C. MCGIFF, MORTIMER MISHKIN, JOHN S. PEARSE, YESHAYAU POCKER, FREDERIC M. RICHARDS, JAMES E. ROTHMAN, RONALD H. SCHWARTZ, OTTO T. SOLBRIG, ROBERT T. N. TJIAN, VIRGINIA TRIMBLE, GEERAT J. VERMEIJ, MARTIN G. WEIGERT, GEORGE M. WHITESIDES, WILLIAM B. WOOD, HARRIET ZUCKERMAN

Editorial Staff

Managing Editor: PATRICIA A. MORGAN
Assistant Managing Editors: NANCY J. HARTNAGEL, JOHN E. RINGLE
Production Editor: ELLEN E. MURPHY
News Editor: BARBARA J. CULLITON
News and Comment: COLIN NORMAN (deputy editor), MARK H. CRAWFORD, CONSTANCE HOLDEN, ELIOT MARSHALL, R. JEFFREY SMITH, MARJORIE SUN, JOHN WALSH
European Correspondent: DAVID DICKSON
Research News: ROGER LEWIN (deputy editor), RICHARD A. KERR, GINA KOLATA, JEAN L. MARK, THOMAS H. MAUGH II, ARTHUR L. ROBINSON, M. MITCHELL WALDROP
Administrative Assistant, News: SCHERRAINE MACK; **Editorial Assistant, News:** FANNIE GROOM
Senior Editors: ELEANORE BUTZ, RUTH KULSTAD
Associate Editors: MARTHA COLLINS, SYLVIA EBERHART, CAITILIN GORDON, WILLIAM GREAVES, BARBARA JASNY, STEPHEN KEPPEL, EDITH MEYERS, LOIS SCHMITT
Assistant Editor: LISA MCCULLOUGH
Book Reviews: KATHERINE LIVINGSTON, **Editor:** LINDA HEISERMAN, JANET KEGG
Letters Editor: CHRISTINE GILBERT
Contributing Editor: RUTH L. GUYER
Production: JOHN BAKER, HOLLY BISHOP, KATHLEEN COSIMANO, ELEANOR WARNER, ISABELLA BOULDIN, SHARON RYAN, BEVERLY SHIELDS
Covers, Reprints, and Permissions: GRACEY FINGER, **Editor:** GERALDINE CRUMP, CORRIE HARRIS
Guide to Scientific Instruments: RICHARD G. SOMMER
Manuscript System Analyst: WILLIAM CARTER
EDITORIAL CORRESPONDENCE: 1515 Massachusetts Avenue, NW, Washington, D.C. 20005. Telephone: 202-467-4400. For "Information for Contributors" see page xi, *Science*, 29 March 1985.

Business Staff

Chief Business Officer: WILLIAM M. MILLER III
Business Manager: HANS NUSSBAUM
Assistant to Chief Business Officer: ROSE LOWERY
Business Staff Supervisor: DEBORAH JEAN RIVERA
Membership Recruitment: GWENDOLYN HUDDLE
Member and Subscription Records: ANN RAGLAND

Advertising Representatives

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

World Supplies of Natural Gas

Once regarded as a nuisance, natural gas is emerging as an important substitute for oil. During the past 10 years, proved reserves of natural gas have doubled, whereas those of petroleum have not grown. Worldwide, natural gas with a total energy content approaching that of oil has been found in about 50 countries, and as the search continues, world reserves of gas will probably surpass those of petroleum. Already some less-developed countries (LDC's) such as Thailand, once totally dependent on imported hydrocarbons, are using local natural gas. The pace at which petroleum will be displaced in developing countries will depend on arrangements for technical, financial, and managerial assistance. Such arrangements are not easy to achieve. Most LDC's are overburdened with debt, and their currencies are usually not freely convertible.

There are three major reasons for speculating that much more natural gas will be found. First, some petroleum companies that for decades were interested only in discovering oil are now more willing to look for gas. Second, geophysical prospecting methods continue to improve. The third reason relates to geochemistry. Natural gas is created and can survive in circumstances where oil either cannot be formed or is unstable. For example, source rocks for petroleum must contain what was originally lipid-rich organic matter. Natural gas can be derived from all kinds of organic matter, including cellulose. It can be formed through a broader range of temperatures than those required for petroleum and is stable at temperatures at which other hydrocarbons are destroyed.

In most instances the proven reserves of natural gas are in countries where it was found in association with oil. In 1984, of a world total of about 100 trillion cubic meters, reserves, in these units, were Soviet Union, 39.6; Iran, 13.6; United States, 5.6; Qatar, 4.2; Algeria, 3.6; Saudi Arabia, 3.4; and Nigeria, 3.1. Natural gas has also been found in about 30 countries in which no petroleum has been discovered.

The proven reserves in the Soviet Union have nearly doubled in the last 10 years. The energy content of Soviet gas reserves is now substantially larger than that of the oil reserves of Saudi Arabia. In recent years, exports to Western Europe have increased. A new development is an agreement by Turkey to import gas from the Soviet Union.

In an era of cheap oil, many of the developing countries became dependent on it. Sooner or later, they must reduce this dependency by utilizing alternate lower cost and preferably domestic sources of energy. A World Bank study in ten LDC's has shown that they could save foreign exchange and obtain energy more cheaply by developing local resources of natural gas. Costs for them of clean, nonpolluting natural gas delivered at the city gate are estimated to be between \$0.61 to \$1.79 per million Btu's. Comparable costs for unrefined petroleum are about \$5.

A few of the LDC's will export some of their gas, but the major use will be internal. To explore for, develop, and create even a limited distribution system for it, a minimum of 5 years is usually required. In addition, front-end costs are large, though later expenditures are small. Thus foreign investors must have great confidence in the stability of agreements and on the chances of being repaid in hard currencies if they are to risk their capital. In this situation, the World Bank is playing an important role. It has increased its involvement in energy matters and has assembled a group expert in exploration and development of natural gas. Thus far it has assisted in efforts in about 20 countries, furnishing funds for feasibility studies, bringing the necessary parties to an investment together, and helping arrange terms that are fair to all concerned. As such efforts continue, the substitution of natural gas for petroleum will expand.

—PHILIP H. ABELSON

When you say "why FPLC" you are half way there...

... because Superose™ from Pharmacia is the peak of evolution in high performance gel filtration for the separation of labile biomolecules.

Over the past 25 years, Pharmacia has developed a broad range of chromatography media, including Sephadex®, Sepharose®, Sephacryl®, MonoBeads™, ProRPC™, and PepRPC™, together with the FPLC System, to meet the ever-growing requirements of experienced, innovative and demanding groups of researchers throughout the world.

Now, the FPLC System and Superose from Pharmacia allow you to use high performance gel filtration without the limitations imposed by silica and stainless steel.



With the introduction of Superose, the Pharmacia range of high performance chromatography media, including MonoBeads, ProRPC and PepRPC, has been extended to provide you with gel filtration media for fast, high resolution separations of biomolecules, from small peptides to large proteins and DNA-fragments.

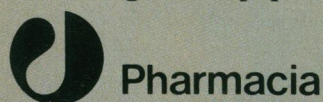
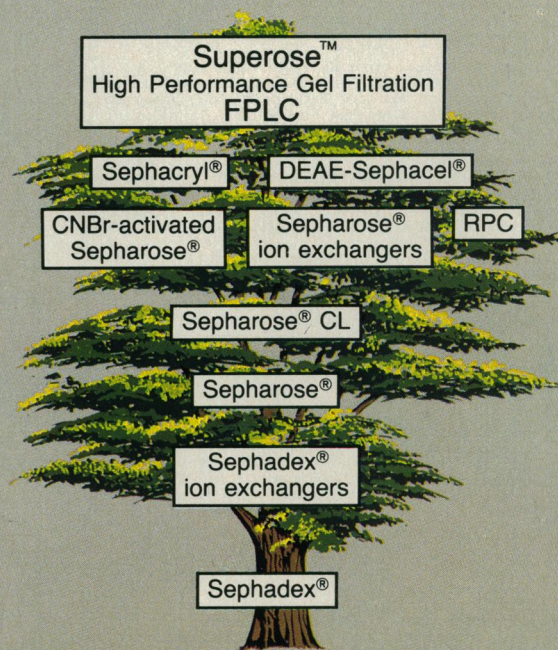
- High performance prepacked glass columns
- Reproducible results
- High recovery of biological activity
- pH stability (1–14)
- Extended column life
- Pharmacia know-how

... so go all the way

Superose pre-packed glass columns with high chemical and pH stability, up to pH 14, provide you with unequalled flexibility in your choice of eluents and greatly simplify your column cleaning routines.

Superose allows you to perform rapid separations (20–60 min) while obtaining high resolution and high recovery, facilitating and improving your work in research, quality control or process development.

Superose has been especially developed for bioscientists and is optimized for high performance separation of proteins, DNA-fragments, peptides and other biomolecules.



Pharmacia

Laboratory Separation Division
Piscataway, New Jersey 08854
Information: (800) 526-3618
In NJ: (201) 457-8000

The natural selection ...
... for the separation of biomolecules.

Circle No. 326 on Readers' Service Card