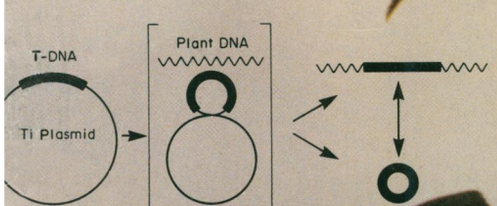
19 September 1980 • Vol. 209 • No. 4463 $1.50

SCIENCE

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



Recombinant DNA

For bioresearch in the 80's: Beckman offers you a choice of seven ultracentrifuges.

L8's–The Most Advanced

The results of six years of intensive research, the Model L8's are so remarkable, so advanced that they introduce a new era in preparative ultracentrifugation.

Discover features like the Ultra-8™ drive, a frequency-controlled induction motor that drives the rotor directly from *inside* the vacuum system. We warrant the complete Ultra-8 drive for 16 billion revolutions!

Microprocessor Control lets you select rotor speed, run time, and other parameters by a finger touch control panel—no knobs or switches.

The Memory-Pac™ Programmable Module is the ultimate in automation. You can program/reprogram it in seconds. For duplicate runs using the same rotor speed, temperature, etc., just insert it in the L8: you get error-free runs with no time spent in setups.

There's a Dry Cycle to remove moisture from the chamber, an $\omega^2 t$ Integrator with recall capability, built-in slow-start programs, and internal diagnostic systems for simple servicing.

Choose from three models up to 80,000 rpm—only available in the Beckman L8 series.

L5B's–Efficient, economical

The Model L5B's have a host of proven features for separating your samples rapidly and economically. They give you convenience in the Automatic mode, with flexibility in the Manual mode.

A Dry Cycle keeps moisture out of the rotor chamber keeping your ultracentrifuge always ready to run—the next hour or the next day.

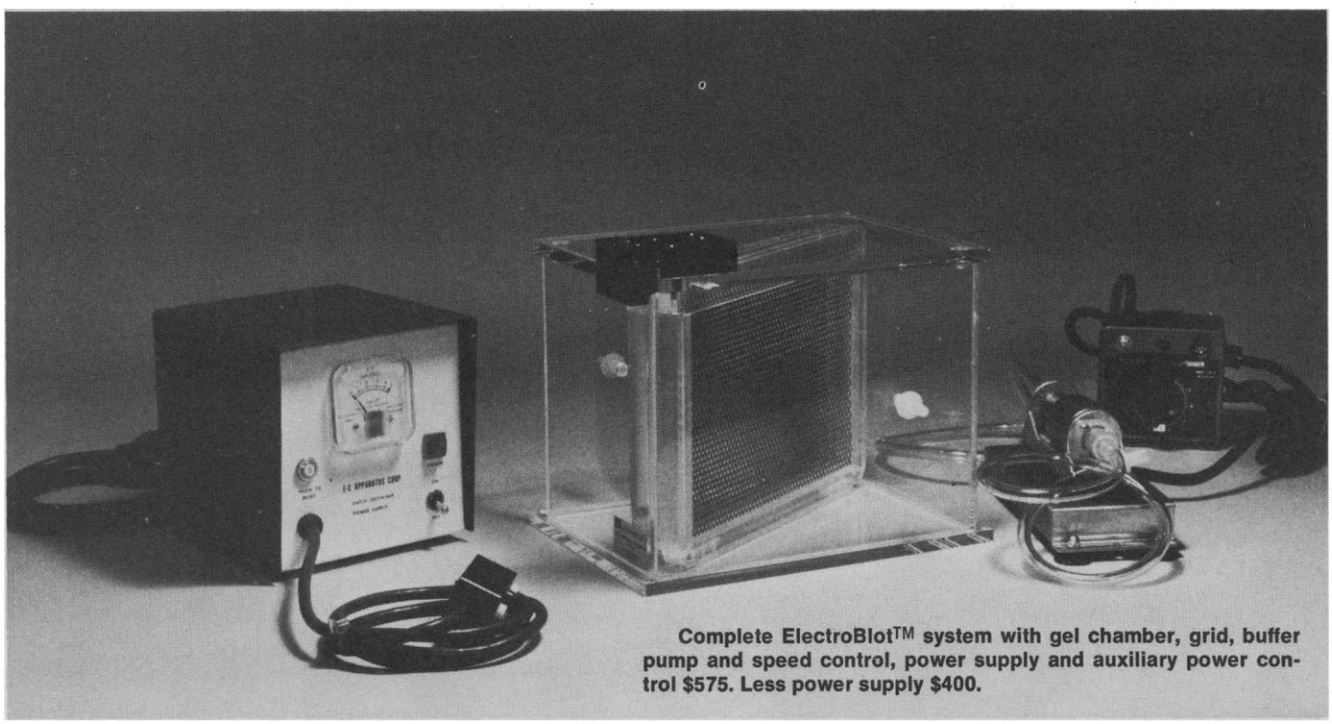
0 to 40°C operation lets you run physiological samples at body temperature, increasingly important in a variety of research. And the L-5B drive is powerful and efficient with its DC electric design.

Four models are available, from 50,000 rpm to 75,000 rpm.

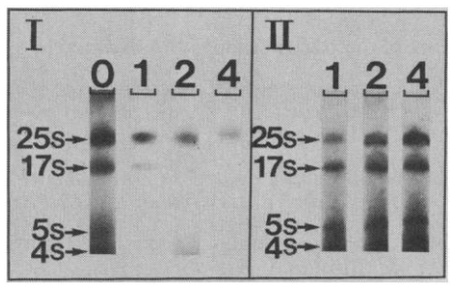
For information on the L8, write for Brochure SB-580; for the L-5B, write for Brochure SB-540—to Beckman Instruments, Inc., Spinco Division, 1117 California Avenue, Palo Alto, CA 94304.

BECKMAN

Circle No. 283 on Readers' Service Card



Complete ElectroBlot™ system with gel chamber, grid, buffer pump and speed control, power supply and auxiliary power control $575. Less power supply $400.



Autoradiogram comparison shows rapid rate of RNA transfer from original gel I to DBM paper II. Numbers above gel and paper indicate hours of transfer.

ElectroBlot™

Transfers DNA, RNA, Proteins Faster and Better

E-C's new ElectroBlot™ surpasses ordinary blot transfer by electrophoretically transferring DNA, RNA, and proteins onto DBM paper and proteins onto nitrocellulose sheets.

Consider these advantages:

- transfers all size molecules easily
- transfer completed rapidly
- transfer is direct, no loss of resolution
- transfer efficiency 80% or better
- transfer may be conducted under cold room conditions

With ElectroBlot™, there is no messy handling, no diffusion, no damage losses. System utilizes unique high current, variable low voltage power supply. Doubles as a destainer.

For more information call Technical Service collect at 813-344-1644 or write:

E-C Apparatus Corporation

3831 Tyrone Blvd. N.
St. Petersburg, Florida
33709

E-C

- Stellwag, E. J. and Dahlberg, A. E., *Nucleic Acids Res. 8:* 299, 1980
- Towbin et al., *Proc. Nat. Acad. Sci. (US) 76:* 4350, 1979

Circle No. 269 on Readers' Service Card

8E-0101

ISSN 0036-8075

19 September 1980

Volume 209, No. 4463

SCIENCE

Recombinant DNA

Edited by John Abelson and Eleanore Butz

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®**. Domestic individual membership and subscription (51 issues): $38. Domestic institutional subscription (51 issues): $76. Foreign postage extra: Canada $14, other (surface mail) $17, air-surface via Amsterdam $45. First class, airmail, school-year, and student rates on request. Single copies $1.50 ($2 by mail); back issues $2.50 ($3 by mail); classroom rates on request. **Change of address:** allow 6 weeks, giving old and new addresses and seven-digit account number. **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

Genes Whose Mission Is to Jump

Engineered Mutagenesis

Expression of Cloned Genes in New Environment

COVER

Transfer of DNA from bacteria to plant cells and regeneration of a whole plant from tumor tissue. A shoot from a cloned teratoma tumor of Havana 425 tobacco induced by the soil bacterium *Agrobacterium tumefaciens* was grafted onto a Turkish variety host. The flowering shoot and teratoma which developed at the graft union both contained genetic information derived from *Agrobacterium*. Also shown is a diagram of possible models for the transfer of tumor-inducing (Ti) plasmid DNA from *Agrobacterium* to plant DNA. See page 1385. [Andrew Binns, Rockefeller University, New York City]

MINC lets you spend less time gathering data and more time using it.

Set up a MINC computer in your lab. Connect your instruments. Run your experiments. Suddenly, you'll notice you've got extra time. Time you never had before.

Time to manage. Time to interpret. Time to conceptualize, theorize, extrapolate. Time to make good use of all that data you once spent so much time collecting.

That's the value of MINC: the Digital family of convenient, inexpensive laboratory computer systems.

MINC is designed specifically for scientific use. It interfaces easily with lab equipment. It has the versatility to perform a wide variety of research tasks. And it comes with graphics display, plug-in input/output modules, and easy-to-use, ready-to-run software routines. So even if you've never used a computer before, you can have MINC fully integrated into your lab with a minimum of training and start-up time.

Of course, with MINC, you get a lot more than just time. You get the service, resources, and reputation of Digital, the undisputed leader in laboratory computers. Now MINC is available with the powerful Digital PDP-11/23 microcomputer. Which means it's more than just reliable. It's compatible with most other Digital computers. As your lab grows, this extensive compatibility assures you that your investment in Digital equipment is always protected.

There are now three MINC computer systems to choose from, priced from $9,900 to $30,900.* A Digital Laboratory Data Products representative can tell you all about them. You'll see just how easy it is to bring a MINC into your lab. And just how valuable a tool it can be.

MINC. For the work it does. And for the time it spares you.

TO: Digital Equipment Corporation
Laboratory Data Products Group MR 2-4/M 16
One Iron Way, Marlboro, Mass. 01752
(617) 467-5869

European headquarters: 12 av. des Morgines, 1213 Petit-Lancy/Geneva.
In Canada: Digital Equipment of Canada, Ltd.

Yes, maybe we can be using our time more effectively. Tell me more about MINC.

Name_____

Title_____

Organization_____

Address_____

City_____

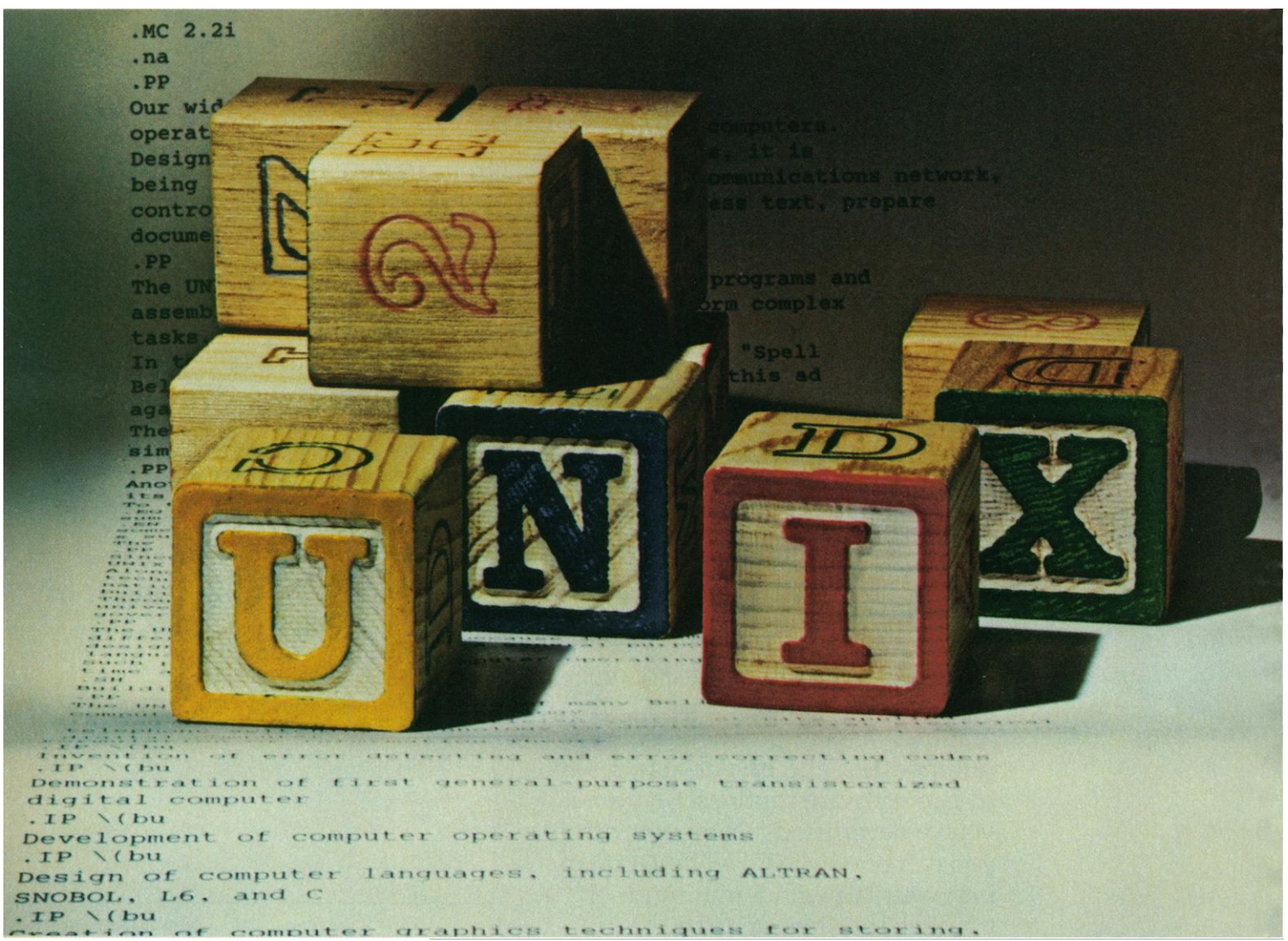
State_____ Zip_____ Phone_____

Sci 9/19/80 D-X397

*Prices apply in U.S.A. only. MINC (Modular INstrument Computer) is a trademark of Digital Equipment Corporation.

digital

An easier way to use computers... from a pioneer in computing technology.



The computer printout in the picture above contains the instructions and input needed for the *UNIX* system to format and produce the text on the opposite page.

Our widely accepted *UNIX*™ operating system is simplifying the use of computers. Designed to handle a variety of applications, it is being used to manage and maintain the telecommunications network, control experiments, develop software, process text, prepare documents, and teach computer science.

The *UNIX* system allows users to take small programs and assemble them like building blocks to perform complex tasks. In text processing, for example, the command "Spell Bell Labs Ad" tells a computer to proofread this ad against a dictionary filed in its memory. The program that performs the task was created by simply combining several smaller *UNIX* programs.

Another useful feature of our *UNIX* operating system is its ease in typesetting mathematical expressions. To typeset an equation like

$$\sum_{i=1}^{\infty} \frac{1}{x_i} = \pi$$

someone need only type: "Sum from i = 1 to infinity 1 over x sub i = pi." The computer does everything else.

Since 1969 the Bell System has installed more than 1100 *UNIX* systems. Along with other Bell Labs innovations in computing technology, these systems are enhancing the way the nation's telecommunications network is planned, designed, built, and operated. Through licensing agreements with Western Electric, universities have installed over 800 *UNIX* systems, and government and industrial facilities are using over 400.

The *UNIX* operating system can be used with computers of different manufacturers because it is small, cleanly designed, and written in a general-purpose programming language. Such portability in a computer operating system saves time and money.

Building on the past

The *UNIX* system is just one of many Bell Labs advances in computing science and technology over the years. Among our innovations:

- Application of telephone switching concepts and technology to early computers
- First demonstration of remote computer terminal and data link
- Conception of electronic analog computer
- First design of AND and OR gates for diode circuitry
- Formulation of Information Theory
- Invention of error-detecting and error-correcting codes
- Demonstration of first general-purpose transistorized digital computer
- Development of computer operating systems
- Design of computer languages, including ALTRAN, SNOBOL, L6, and C
- Creation of computer graphics techniques for storing, manipulating, and presenting information
- Development of Fast Fourier Transform
- Design of central processors for switching systems having virtually no downtime

Looking ahead

Computing technology is having a major impact on the telecommunications business. It's increasing the Bell System's ability to provide new services and handle existing ones more efficiently. Today, for example, the nationwide telecommunications network links thousands of software-controlled electronic systems, making it by far the world's largest distributed processing network. We and our partners—Western Electric and the telephone companies of the Bell System—are putting technology to work so that the network will continue to evolve and expand its information-handling capabilities. The object, of course, is to meet the fast-growing and changing needs of Bell System customers.

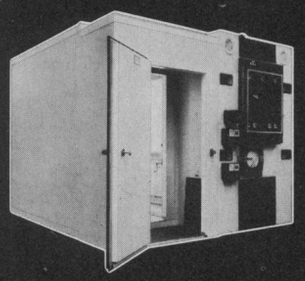
For information about employment, write:

Bell Laboratories, Room 3C-303, 600 Mountain Avenue, Murray Hill, N.J. 07974

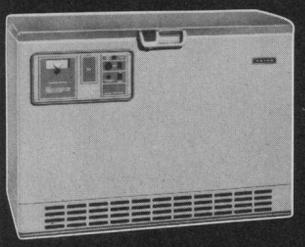
Please include a resume.

An equal opportunity employer.

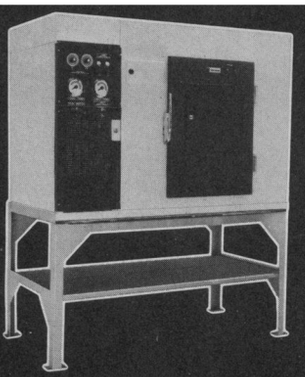
From Science: Service



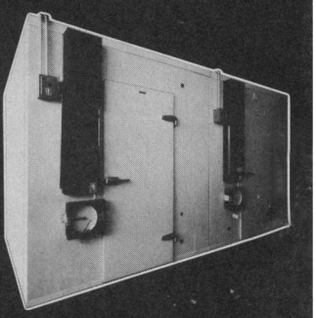
Sherer
CEC 511-38VHL



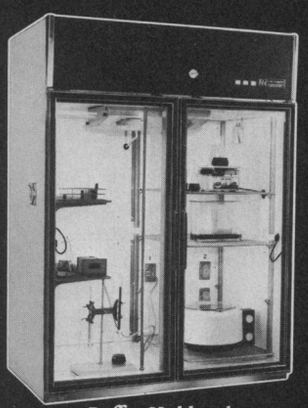
Revco
ULT 700 Series



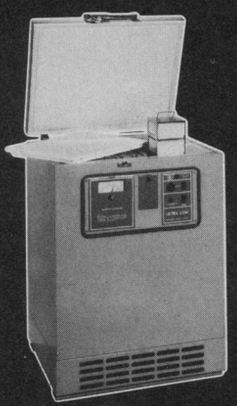
Sherer
CEC 255-6



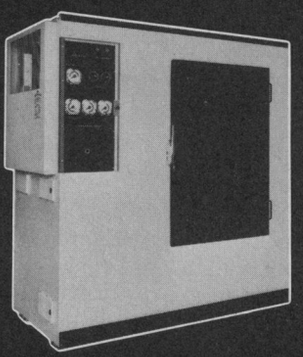
Sherer
Environmental Rooms



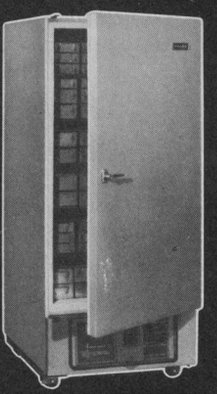
Puffer-Hubbard
Chromatography 50



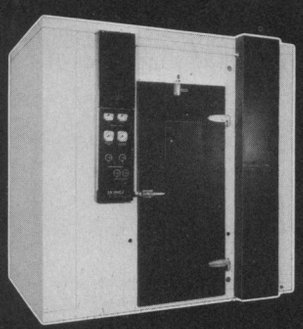
Revco
ULT 385



Sherer
CEC 36-10

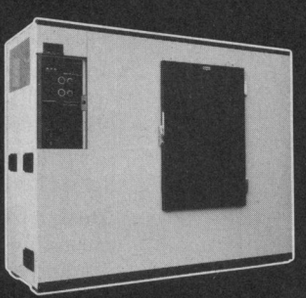


Revco
ULT 2235

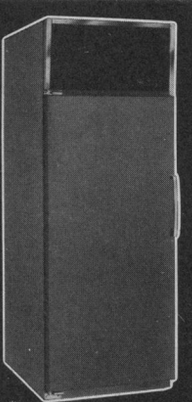


Sherer
CEC 69-34

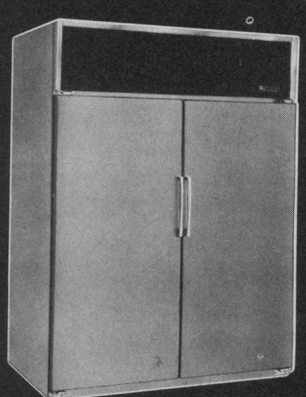
Puffer-Hubbard
Blood Bank Refrigerator 50



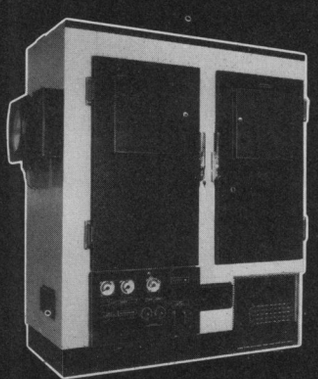
Sherer
CEC 38-15



Puffer-Hubbard
Explosion-Safe 23

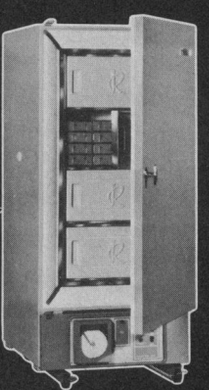


Puffer-Hubbard
LR 50/ LF 50

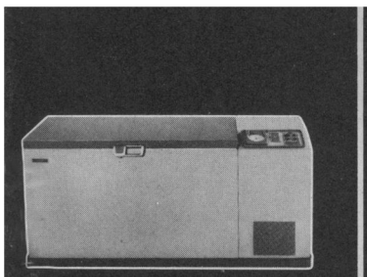


Sherer
CEC 4-4

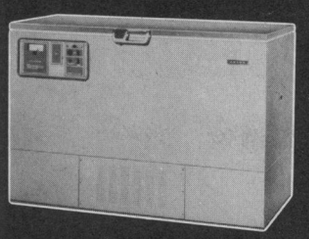
Puffer-Hubbard
Rx 50G



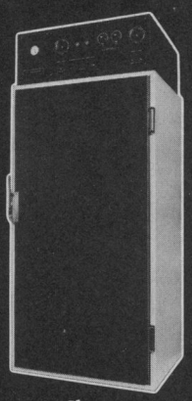
Revco
ULT 1185



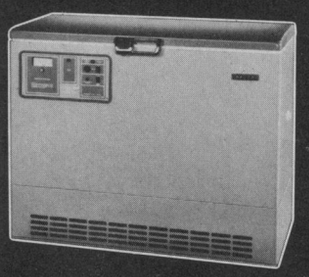
Revco
ULT 1985



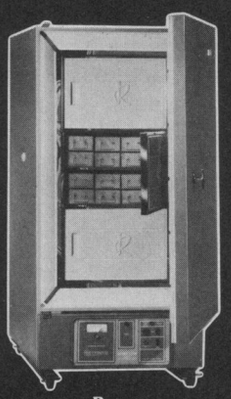
Revco
ULT 1785



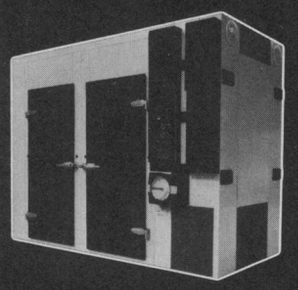
Sherer
CEC 25 Incubator



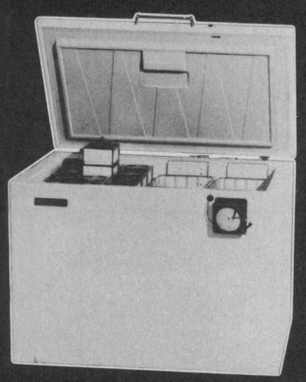
Revco
ULT 900 Series



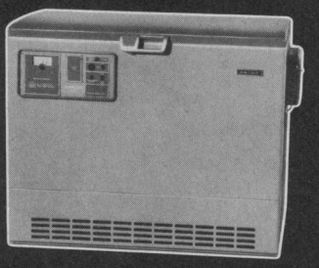
Revco
ULT 1685



Sherer
CEC 511-38



Revco
ULT 1535 Plasma Freezer



Revco
ULT 1200 Series

Three Great Names. One Great Company. Lots Of Great Products.

Three of the industry's best known product lines — Revco, Puffer-Hubbard and Sherer — are now together under one banner.

Which means you can now enjoy the benefits of doing business with one manufacturer whose specialty is refrigerated products for science, medicine, research and industry.

Revco, for over 40 years, has been the leading supplier of ULTra-Low® temperature equipment to medical centers, universities, hospitals, blood centers and industries throughout the world.

Puffer-Hubbard, founded in 1898, offers a complete line of laboratory refrigerators and freezers, chromatography and pharmaceutical refrigerators, explosion-safe refrigerators and freezers, and blood bank refrigerators.

Sherer incubators, plant growth chambers and controlled temperature and humidity rooms have proved themselves in thousands of installations. They are easily adapted to individual requirements and quickly installed because of their design and construction. Sherer — a name synonymous with innovative refrigeration since 1852.

All three product lines are covered by one of the industry's best developed warranties and maintained by a worldwide network of service centers.

The best of all possible worlds — Revco, Puffer-Hubbard and Sherer.

REVCO

Circle No. 351 on Readers' Service Card

puffer-hubbard

Circle No. 352 on Readers' Service Card

SHERER

Circle No. 353 on Readers' Service Card

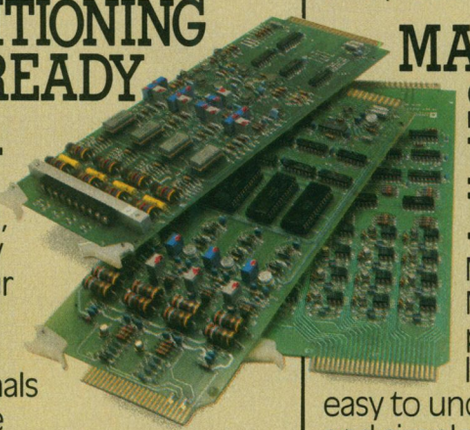
Rheem Manufacturing Company/ Refrigeration Products Division
A Subsidiary Of City Investing Company
1100 Memorial Drive West Columbia, S.C. 29169
Telephone 803-796-1700 TWX 810-666-2103

MACSYM 2 MAKES LABORATORY AUTOMATION EASY.

At last, there is a new, fast and easy way to automate laboratory instrumentation and experiments. It's MACSYM 2.

MACSYM 2 is a basic, stand alone, interactive measurement and control system. It boasts a powerful minicomputer with a fast 16-bit processor and up to 128 K bytes of memory. It's specifically designed for applications requiring signal conditioning, data collection, storage, computation and display, and a total MACSYM 2 system starts as low as $9,990.

YOUR SIGNAL CONDITIONING IS ALREADY DONE.



With MACSYM 2, you simply attach your field wiring to the terminals and you're ready to go. Our comprehensive library of I/O cards can interface to virtually any instrument or sensor, and changing signals is as easy as changing cards.

REAL POWER IN REAL TIME.

With its 16-bit processor and 12-bit data acquisition capability, MACSYM 2 can capture data at 4,000 samples per second. And it stores, reduces and presents data in real time.

MACSYM 2 SPEAKS A BASIC LANGUAGE.

MACSYM 2 speaks MACBASIC — a powerful computer language that uses easy to understand English and simple algebraic expressions. With MACBASIC you can run as many as 18 independent tasks at the same time. With MACBASIC you spend your time designing your real time application, not worrying about programming.

MACSYM 2 is the one stand alone measurement and control system that really makes sense. It is simple, cost effective, and it all comes in one compact, ready-to-go desktop package. Now what could be easier? For all the basics, call your local Analog Devices office listed below.

ANALOG DEVICES

WAY OUT IN FRONT.

Analog Devices, Inc., Measurement and Control Products Division, Box 280, Norwood, MA 02062; East Coast: (617) 329-4700 Ext. 303; Midwest: (312) 894-3300; West Coast: (714) 842-1717; Texas: (713) 664-6704; Belgium: 031/37 48 03; Denmark: (02) 845800; England: 01/94 10 46 6; France: 686-7760; Germany: 089/53 03 19; Japan: 03/26 36 826; Netherlands: 076/879 251; Switzerland: 022/319704; and representatives around the world.

Circle No. 324 on Readers' Service Card

Napco® announces the years-ahead incubator system that won't be matched.

The new Napco water jacketed 6000 series embodies more important benefits and features than any incubator ever marketed.

Here are some of over 15 advances in incubator design:

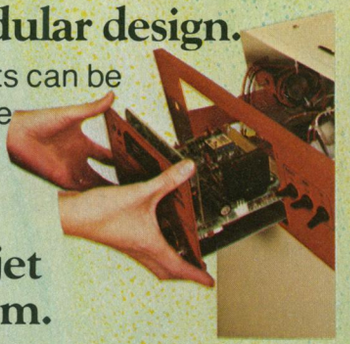
1. More accurate control of chamber temperature.

By positioning sensors not only in the water jacket, *but also in the chamber itself,* Napco permits more precise chamber monitoring than other water jacketed incubators.

2. New electronic controls, digital display.

New solid state control system reduces chamber variances, and scanning digital displays monitor chamber parameters.

3. The first modular design.

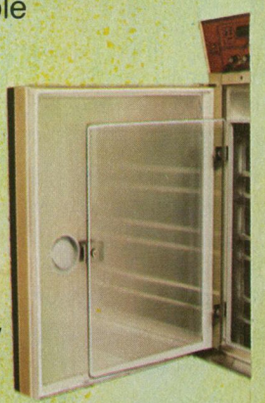


All control elements can be unplugged from the chamber module for quick service.

4. Unique wet-jet air flow system.

The exclusive wet-jet air flow system provides maximum chamber uniformity and assures the highest relative humidity available in any incubator.

5. More secure chamber uniformity.



Superior new Napco door closure systems ensure integrity of inner chamber.

6. The only water jacketed CO_2 incubator you can get really clean.

Shelf standards and plenums can be easily removed for cleaning in five minutes. This leaves an empty, perfectly smooth chamber that can be swabbed for easy management of spores and contaminating organisms.

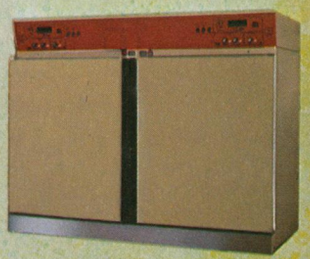
7. The best service in the industry.

If you should ever have an equipment breakdown, *a Heinicke-Napco Minute Man will be on his way to you in 48 hours.* You'll seldom need the Minute Man service because Heinicke and Napco instruments are built to work. But if you do, dial toll free 800-327-9783.

Introducing a new constant flow incubator- the 4000 series

The new modular Napco constant flow system embodies a unique principle that offers superior results in tissue culture and related disciplines. Each of the modular chambers has its own individual controls and separate metering system, to accommodate specific environments in each module.

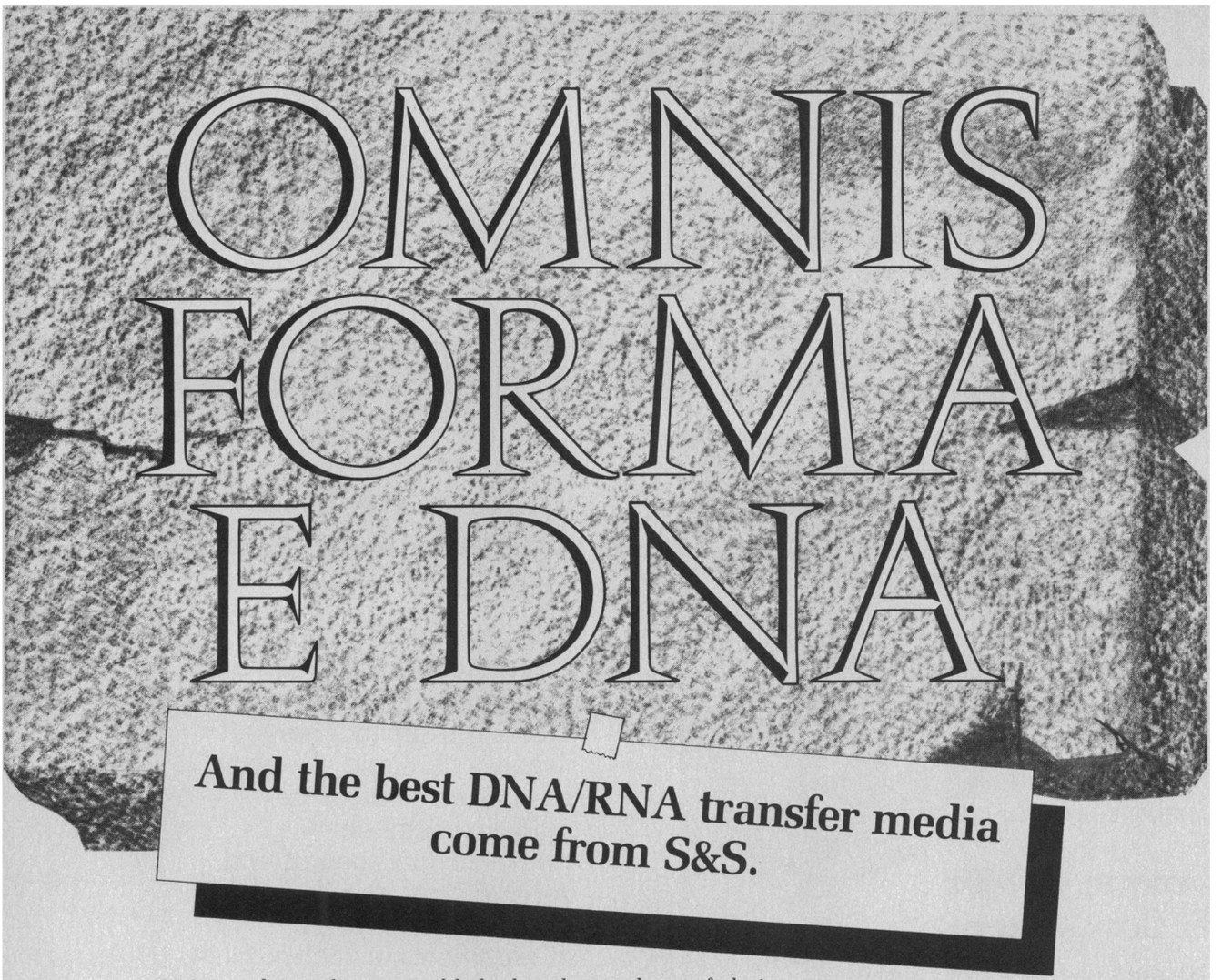
All Napco water-jacket incubators are available in three space saving models.



National® Appliance Company

A Heinicke Company
3000 Taft Street, Hollywood, Fl. 33021
800-327-9783 or (305) 987-6101
Telex: 512610

Available at the following dealers: Curtin-Matheson, Fisher Scientific Co., Preiser Sargent-Welch, S.G.A. Scientific, Scientific Products, Arthur H. Thomas Co. VWR. In Canada: Canlab, Fisher Scientific Co. Ltd., Sargent-Welch of Canada Ltd.



And the best DNA/RNA transfer media come from S&S.

S&S transfer media are established as the products of choice for "Southerns," "Northerns," "Westerns," "shotgunning," "plaque lifts" and "blitz-blotting"—because they do the job.

Pure nitrocellulose—the proven standard

Because S&S nitrocellulose is *pure* nitrocellulose, it effects a high degree of DNA transfer from gels, bacterial and plaque lawns. Maximum levels of hybridization can be achieved, resulting in more intense bands or spots. S&S nitrocellulose is available in whatever form you need: 12-0.025 μm pore size, gridded, in circles, squares, strips, rolls or full sheets.

Transa-Bind™—universally accepted medium for "Northern" transfers

Schleicher & Schuell Transa-Bind medium has found wide use in DNA, RNA and protein transfers because the fragments are covalently bound to the medium. Available in NBM (nitro) form and ABM (amino) form to suit your needs. Packaged in nitrogen-filled opaque bags to extend shelf life.

New S&S products in development for genetic researchers

S&S enjoys an earned reputation for working with researchers in developing new products to meet their specific needs. Be on the alert for new S&S transfer media soon to be introduced. Contact S&S for any information or technical help you might need.

Schleicher & Schuell

Schleicher & Schüll, Inc.
Keene, New Hampshire 03431

Schleicher & Schüll GmbH, D-3354.
Dassel, West Germany

Schleicher & Schuell AG, CH-8714
Feldbach ZH, Switzerland

Latin, "Omnis forma e DNA," — "All forms (of life) from DNA."

Circle No. 311 on Readers' Service Card

INSTRUMENTS OF SUCCESS

Like any scientific instrument, the CA SELECTS® series of current-awareness publications is designed to make you a better scientist.

Choose your topic from more than 100 now available, and CA SELECTS will bring you informative abstracts from the world's scientific literature relevant to your interest.

CA SELECTS Covers More Than Just the Best Journals

CA SELECTS publications are derived from the comprehensive CHEMICAL ABSTRACTS information base, the world's most complete source of abstracts and bibliographic references for chemistry-related journal articles, patents, dissertations, reviews, books, conference proceedings, and other published research.

Receive CA SELECTS every two weeks and you can stop worrying about what you've missed. We monitor more than 14,000 scientific journals to produce this outstanding series: not only the "cream of the crop," but all significant chemistry-related publications.

CA SELECTS Is For Chemists, Physicists, Biologists And Many Others

If your field bears any relation to chemistry, chances are there's a CA SELECTS topic for you.

Ask for your free CA SELECTS catalog today. Then join the thousands of scientific professionals who find timely, convenient current-awareness in their own CA SELECTS subscriptions.

Chemical Abstracts Service
A Division of the American Chemical Society

Circle No. 214 on Readers' Service Card

Mail This Form for Your FREE CA SELECTS Catalog

CA SELECTS

Please send me my free catalog of CA SELECTS topics. I understand there is no obligation to order a subscription.

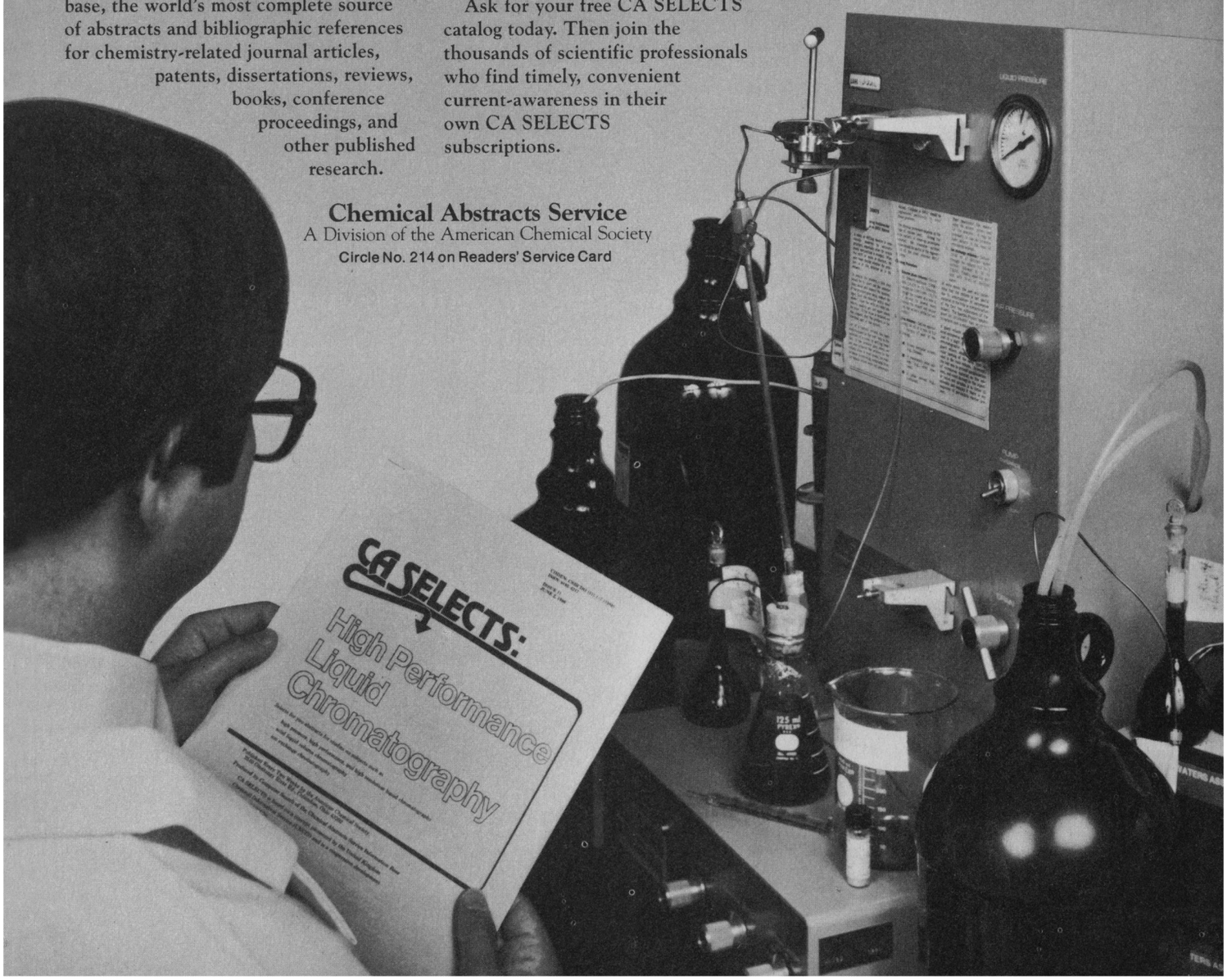
Name

Title

Organization

Address

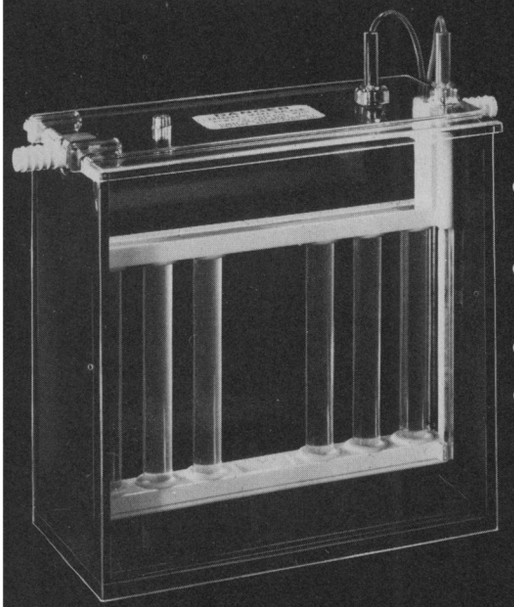
Mail to:
Chemical Abstracts Service
Marketing Dept. SMA
P.O. Box 3012
Columbus, Ohio 43210



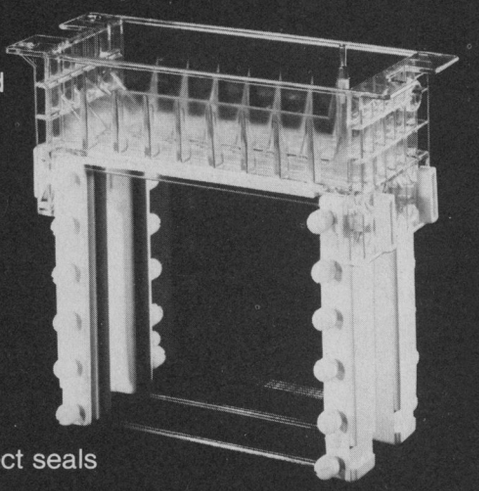
New from

HOEFER SCIENTIFIC INSTRUMENTS

SE 600
The Definitive Hoefer Design for Vertical Slab Gel Electrophoresis

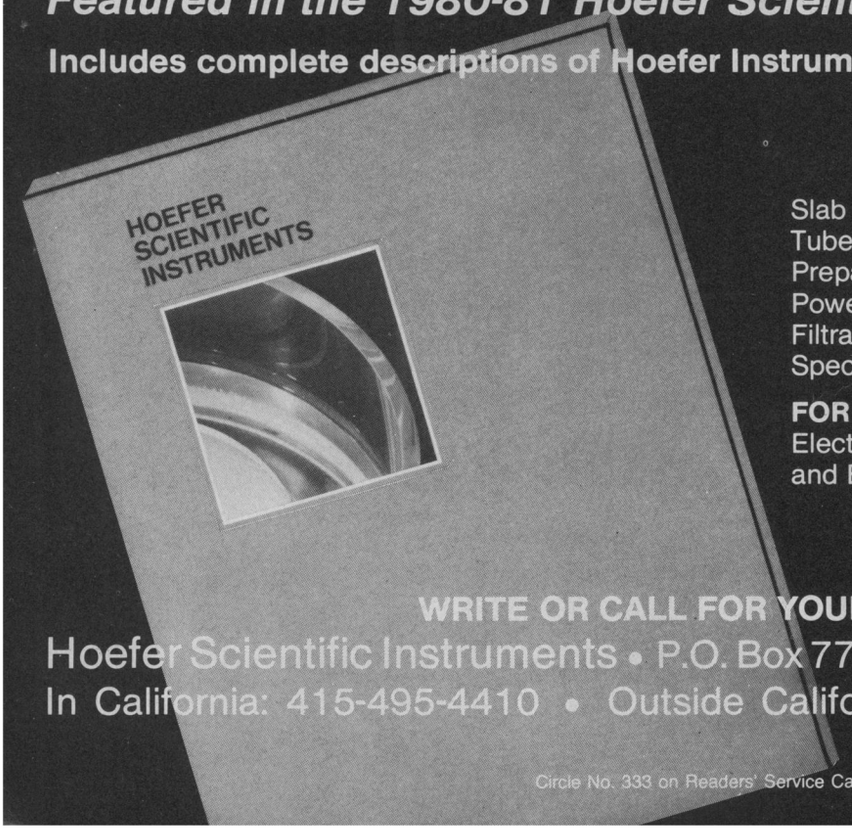


- Simple to Use. Can be Mastered in one trial run.
- Rectangular Glass Plates instead of fragile notched glass
- Improved Design for 2-D
- Excellent for Agarose
- Superb Cooling
- Made of Molded Polycarbonate. Virtually unbreakable.
- Easy-to-Use Clamps make perfect seals



One of the New Instruments Featured in the 1980-81 Hoefer Scientific Instruments Catalog

Includes complete descriptions of Hoefer Instruments and Accessories



Slab Gel Electrophoresis
Tube Gel Electrophoresis
Preparative Electrophoresis
Power Supplies for Electrophoresis
Filtration, Centrifugation, Dialysis
Special Prices for Complete Systems

FOR NEW USERS, an entire section on Electrophoretic Theory, Techniques, and Exercises

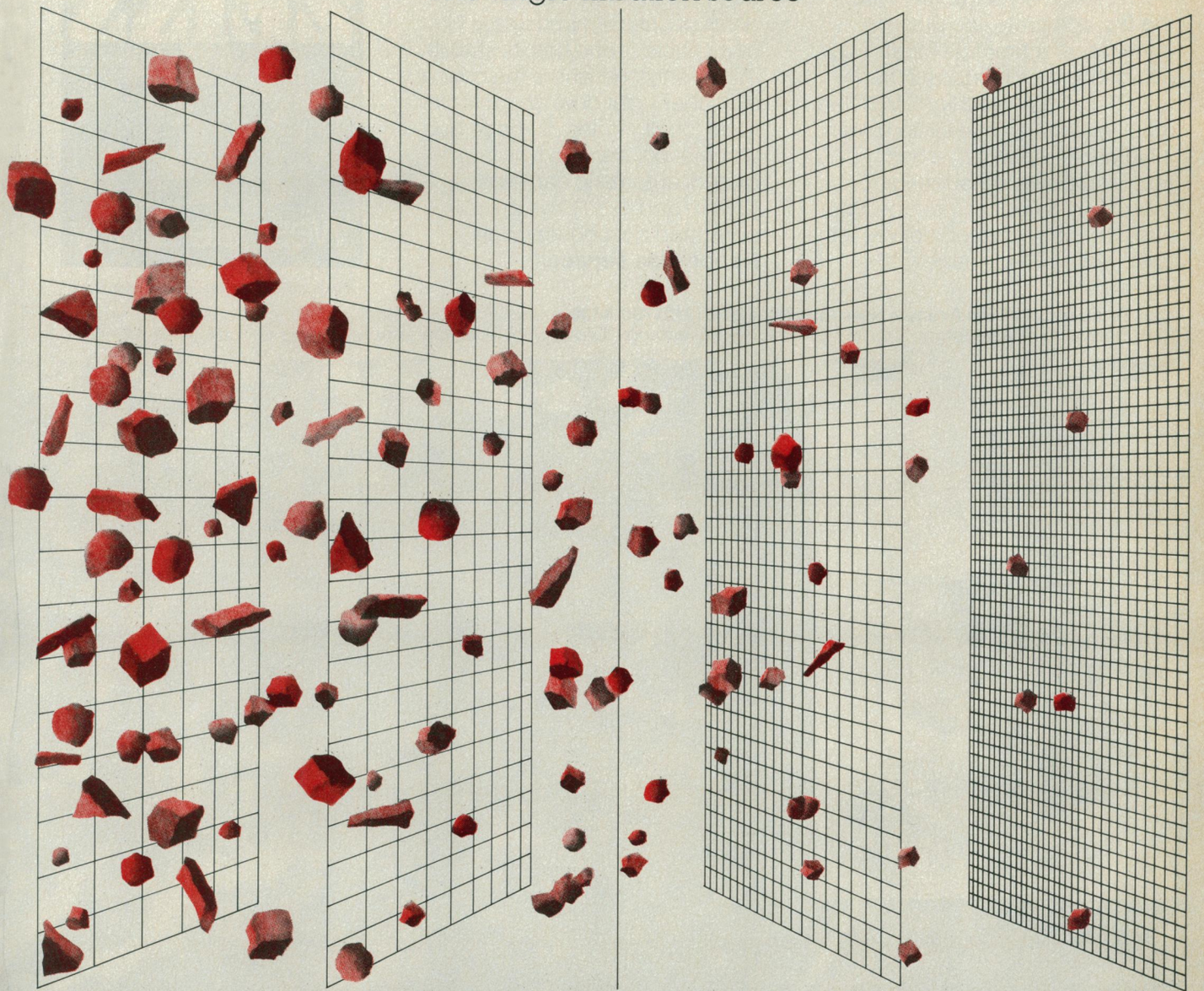
WRITE OR CALL FOR YOUR COPY:

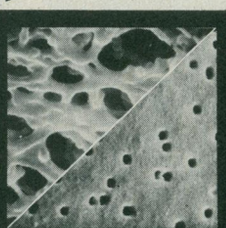
Hoefer Scientific Instruments • P.O. Box 77387 San Francisco CA 94107
In California: 415-495-4410 • Outside California toll free: 800-227-4750

Circle No. 333 on Readers' Service Card

NUCLEPORE IN THE '80s

One single filtration source



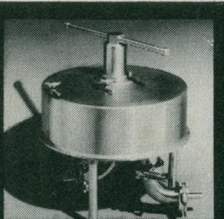


Microfiltration

4 membranes: Polycarbonate and polyester capillary pore; cellulose ester and PTFE tortuous pore.

21 holders including 142mm stainless suitable for EPA hazardous waste test.

Special purpose membranes.

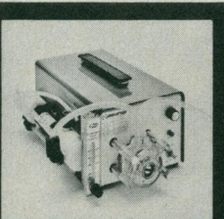


High Volume Filtration

Famous One-Fiver and One-Sevener membrane holders.

QR filter cartridges.

3, 7, 12-element cartridge housings.



Ultrafiltration/ Reverse Osmosis

Three UF membrane types including low-adsorption-type C.

Low/high pressure stirred cells.

Hollow fiber/beakers/ systems.

Water purifiers.

The Nuclepore Catalog

88 pages of helpful information including many useful selection, application and chemical compatibility guides. Circle the Reader Service Number for your free copy.

Nuclepore Corporation
7035 Commerce Circle
Pleasanton, CA 94566
(415) 462-2230. Telex 337-751

NUCLEPORE CORPORATION

You can't beat the best

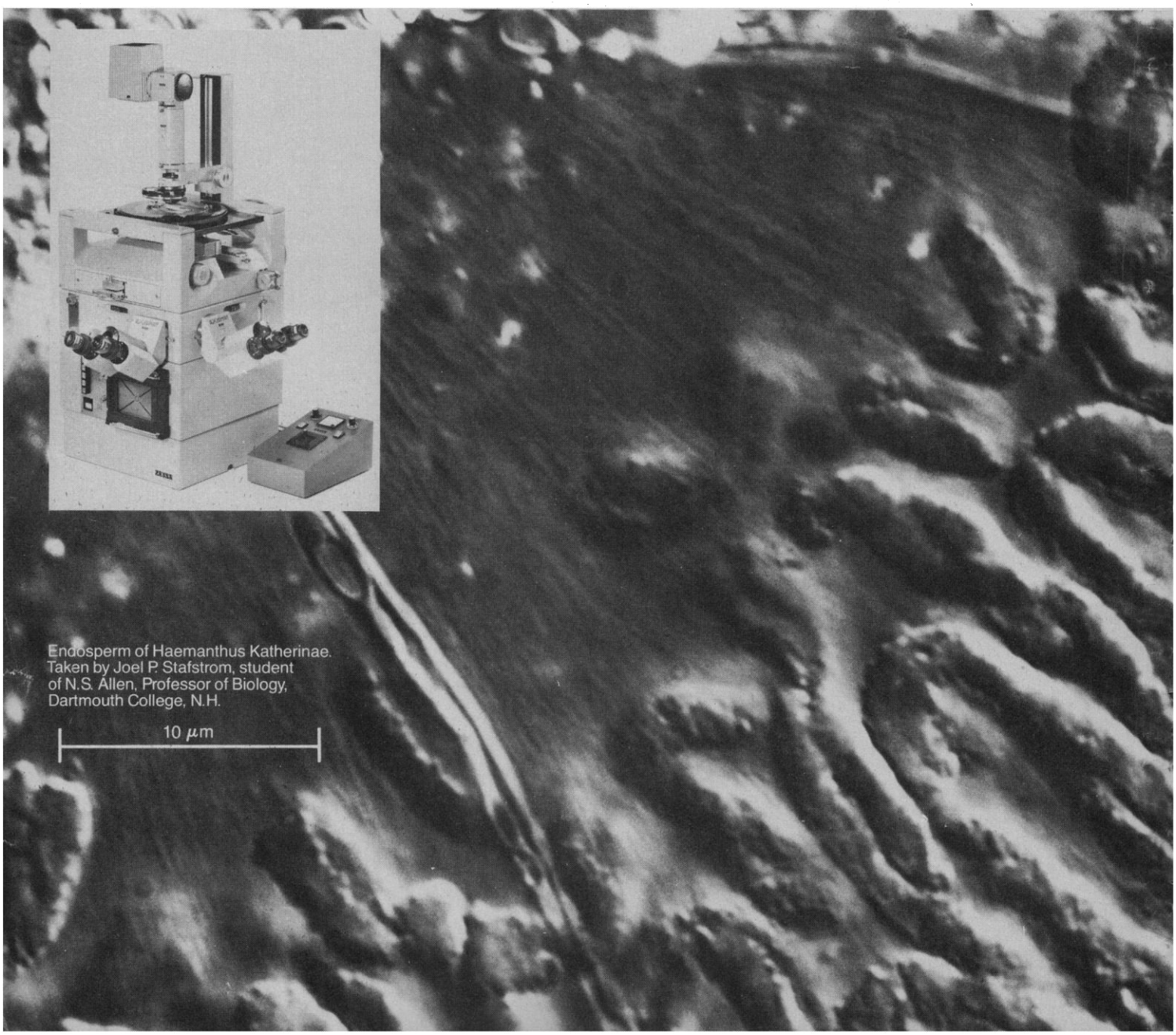
Aberration-free wide-field optics
It's the Axiomat, of course. With the first complete line of strain-free Planapochromats for all microscope techniques in transmitted and reflected light. With the most versatile phase system. With a Nomarski system that has resolving power far superior to that of any other microscope. With superbly corrected objectives for crisp, detail-filled images.

The most stable, most versatile
It's the ideal instrument for all fields of critical microscopy. No other microscope has its stability: it's the only one where the optical axis goes right down the middle. Ideal for all modes of image documentation, with two fully integrated, automatic cameras (35mm and 4x5"), two auxiliary ports, and dual observation.
Nationwide service.

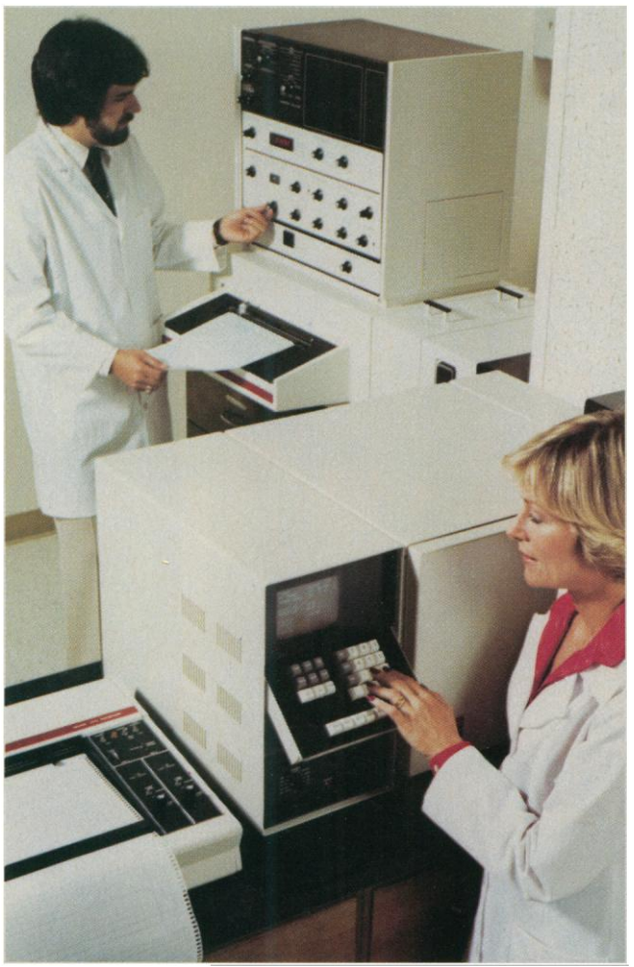
The great name in optics
ZEISS
West Germany

Circle No. 372 on Readers' Service Card

Carl Zeiss, Inc., 444 5th Avenue, New York, N.Y. 10018 (212) 730-4400. Branches: Atlanta, Boston, Chicago, Houston, Los Angeles, San Francisco, Washington, D.C. In Canada: 45 Valleybrook Drive, Don Mills, Ontario, M3B 2S6. Or call (416) 449-4660.



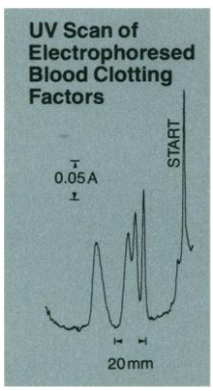
Faster and easier protein separation and analysis– Varian has the answer.

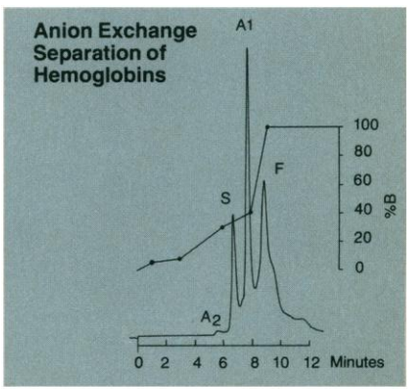


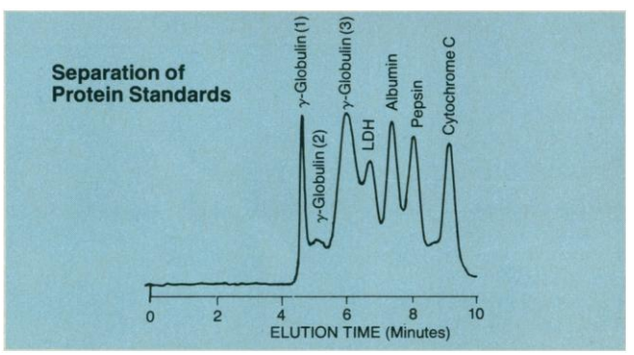
Meet the latest additions to Varian's growing family of instruments for the life sciences: the Model 5000 Liquid Chromatograph and the Varian Cary 210 UV-Vis Spectrophotometer. See how Varian life science researchers have used the analytical power of these instruments in new and better ways to study proteins.

High-speed protein separations by molecular size. The microprocessor-based Model 5000 LC, coupled with advanced column technology, completely revolutionizes gel permeation chromatography. Using the new high-resolution MicroPak TSK Type SW columns, you can separate proteins within an MW-range of 5,000 to over a million in minutes, with excellent recovery of protein mass and enzyme activity. Circle Reader Service Number 336 for more information.

Anion exchange chromatography of proteins. The Model 5000 LC also enables you to perform separations similar to those done on conventional DEAE gels, but in a matter of minutes rather than hours. The new Synchropak AX-300 column provides improved resolution and excellent sample recovery. Circle Reader Service Number 337 for further information.







Unstained gel scanning in the far-UV. You can locate protein peaks minutes after an electrophoresis run with the Varian Cary 210. There is no need for cumbersome staining and destaining. You can even scan unstained gels directly in their quartz tubes. To find out how, circle Reader Service Number 338.

Let us show you how. Researchers in the Varian laboratories are continually developing solutions to problems like those in your own lab. Ask for their reports on the above subjects—circle the appropriate Reader Service Number. If you would like a Varian representative to call, circle Number 339.

varian

For immediate assistance contact: 611 Hansen Way, Palo Alto, CA 94303 • Florham Park, NJ (201) 822-3700 • Park Ridge, IL (312) 825-7772
Houston, TX (713) 783-1800 • Los Altos, CA (415) 968-8141. In Europe: Steinhauserstrasse, CH-6300 Zug, Switzerland.

State-of-the-art cell sorting and analysis from Ortho

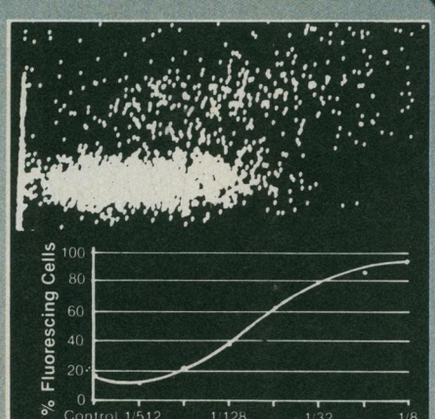
The Cytofluorograf® Systems 30/50 offer unequalled capabilities.

No other commercially available cell sorter and analyzer approaches the power, precision and versatility of the Ortho Systems 30/50. The instrument is offered in two basic configurations: System 30—a high resolution, 21 parameter analytical flow cytometer, and System 50—which adds cell sorting capabilities to the System 30 flow cytometer. Both feature dual lasers as standard equipment for increased analytical power.

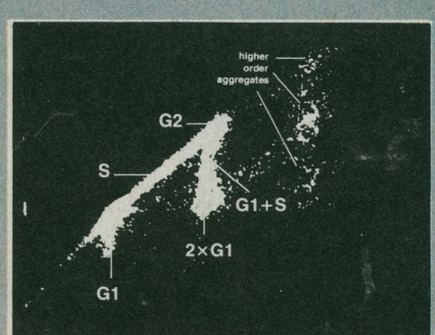
System Components

To appreciate the far reaching capabilities of these Ortho instruments, consider that the System 50 combines: two lasers—a .8 milliwatt helium-neon for ultra high precision scatter measurements and a 5 watt argon type for fluorescence measurements (optional argon-ion, and krypton-ion lasers with U.V. capability are available); four detectors—two of the photomultiplier type for right angle scatter, and fluorescent emission detection (S-20 response, 185 nm –850 nm), and two solid state sensors for axial light loss and narrow angle forward scatter: a sophisticated optical system incorporating fiber optics: a multiplexed multichannel analyzer, with C.R.T. display: the signal processor unit: and an advanced cell sorter module (System 50). Additionally, the Model 2150 computerized 8 parameter data handler/sorter controller is available as an option*. The 2150 System features simultaneous data acquisition, and realtime processing while sorting is in progress.

***Complete Model 2150 specifications available on request.**



1. Upper: Direct immunofluorescence test (cytogram). Lymphocytes from CLL patient incubated with FITC labelled anti-human IgG. Lower: Titration of V-25 Leukemia cells from C-57 black mice different dilutions of FITC conjugated rat radiation leukemia virus antibody.

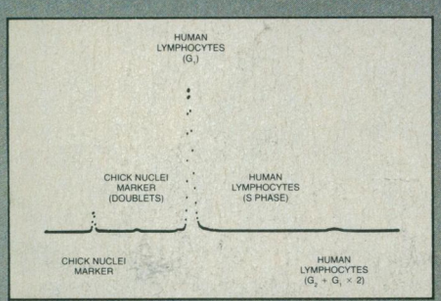


2. Cytogram of somewhat clumped Erlich ascites tumor cells, stained for DNA with ehtidium bromide. Correlation of pulse area measurement (X) with pulse area (Y) with pulse height (Y) permits distinguishing G2 cells from 2 x G1 aggregates.

System Capabilities

These modules allow the System 50 to provide and analyze morphological information and sort on this basis, a significant first for a flow cytometric instrument. With four detectors and the ability to display pulse height, pulse area or pulse width analysis for each—

System 50H with optional argon ion and krypton ion lasers installed.



3. Histogram of human lymphocytes utilizing a chick nuclei marker for standardization and stained for D.N.A. with Propidium Iodide. C.V. = 1.65% (Human Lymphocytes)

a total of 21 distinct measurement parameters can be studied.

The System 50 also features: two bi-dimensional regions of interest, dual histogram multi-channel analyzer with cytogram mode, super-sil quartz optics with which the cells are analyzed and easy sample entry.

Remarkable Results

The histograms and cytograms displayed were produced by the System 50. Evaluate them. And consider the difficulty of deriving this data by any other means. The capabilities of this unique Ortho instrument will speak for themselves.

In order to provide customers with complete support, Ortho maintains an Applications Laboratory that is available for confirmation and consultation services. Additionally, an international network of service technicians is ready to aid customers should calibration or repairs ever be required.

Ortho Cytofluorograf Systems precisely tailored to your needs

The modular, "building block" nature of Ortho instrumentation permits you to create exactly the instrument you need. There's no need to settle for less capability than you require or pay for more. Of course, it's also easy to upgrade the Cytofluorograf System as your requirements expand. Learn more about Ortho Systems 30/50 simply by calling or writing Ortho. Naturally, there's no obligation. But you owe it to yourself to evaluate an ultimate system.

Protocols No. 28

One step Ethidium Bromide; D.N.A./cell staining procedure

Protocols No. 29

D.N.A. analysis using D.A.P.I.

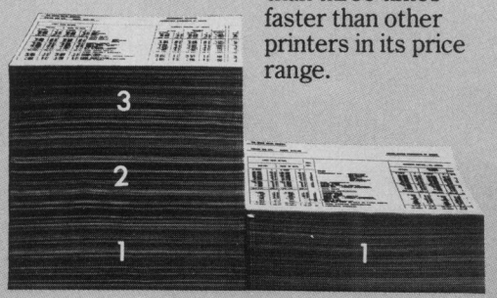
To receive your complimentary copy of Protocols, write or call, Ortho Instruments, Research Instruments Division, 410 University Ave, Westwood, Ma., 02090 617-329-6100.

ORTHO INSTRUMENTS
410 UNIVERSITY AVE., WESTWOOD, MA 02090

Output for Versatec's

A new generation of printer/plotters delivers more output for less money.

Faster printing. The new Versatec V-80 prints 1000 lines per minute, more than three times faster than other printers in its price range.

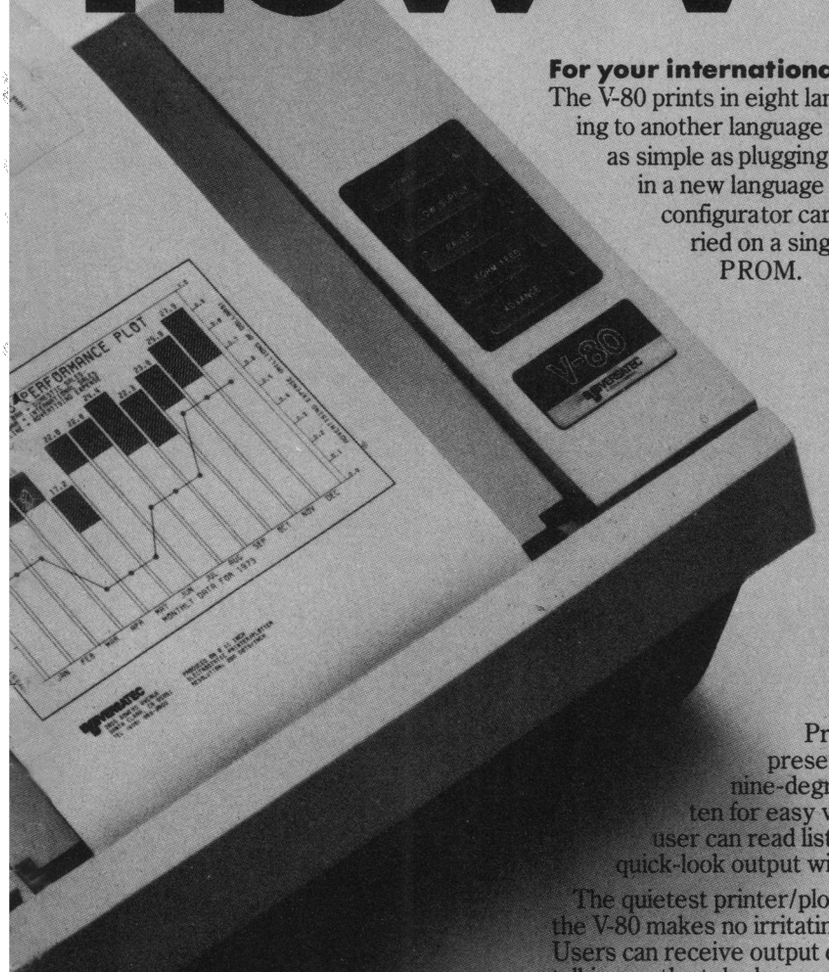


Graphics. The Versatec V-80 gives you better image quality than other printer/plotters. Get true high quality graphics with 200 dot per inch resolution. Plot an 11 by 8½-inch page in just seven seconds.

Hard copy from display. V-80, with an optional controller, makes quick, archival quality copies from storage tube displays or digital sources within twenty seconds.

Easy to integrate. Use V-80 with any popular computer. Styled to complement your computer-based system, the V-80 is suitable for any office or laboratory environment. The V-80 can be mounted directly into your system console, placed on a table, or be carried on its own optional utility stand. Weight is only 75 pounds.

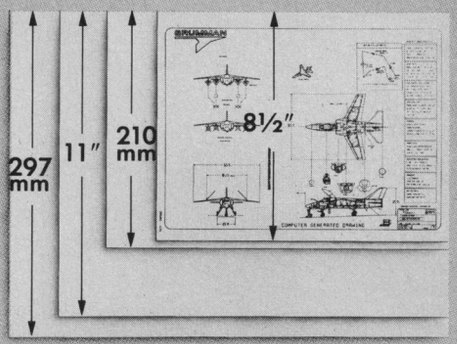
the 80's. new V-80.



For your international customers. The V-80 prints in eight languages. Changing to another language is as simple as plugging in a new language configurator carried on a single PROM.

The V-80 has been designed to meet both UL and VDE standards. Re-positioning one electrical plug adapts the printer/plotter to different voltage requirements.

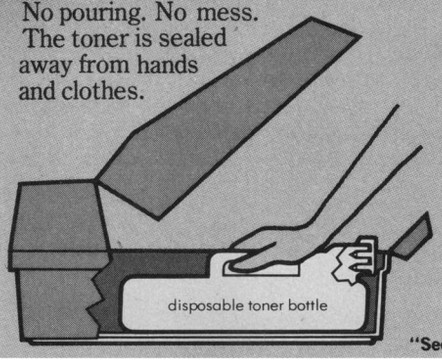
Paper widths of standard 8½ and 11-inch *and* international A4 (210 millimeter "Portrait" and 297 millimeter "Landscape").



Easy to use. Printed output is presented on a nine-degree sloped platen for easy viewing. The user can read listings and other quick-look output without standing.

The quietest printer/plotter ever built, the V-80 makes no irritating clatter. Users can receive output even when talking on the telephone.

Changing toner is easier, faster and cleaner than changing typewriter ribbon. The disposable toner bottle inserts directly into the printer. No pouring. No mess. The toner is sealed away from hands and clothes.



Easy to maintain. Electrostatic writing is simple, because it's electronic rather than mechanical. Versatec has reduced mechanical part count to just 135, and that includes screws. Improvements in electronic design include microprocessor control, new LSI technology, and low power Schottky TTL logic. Fewer mechanical and electronic parts reduce spares requirements.

For more information, circle our readers' service number for the free brochure—"Output for the Eighties." To arrange a demonstration, call your local Versatec representative.

VERSATEC
A XEROX COMPANY

2805 Bowers Avenue
Santa Clara, California 95051
Telephone: (408) 988-2800
TWX: 910-338-0243

Versatec European Headquarters
27/35 London Road
Newbury, Berkshire, England
Telephone: (0635) 42421
Telex: 847259

Circle No. 266 on Readers' Service Card

"See us at SEG (Houston, Texas) and CAD/CAM (Anaheim, California


Only from
NEN:
NEN
U.S. PAT.
reactions
Not for use in humans or clinical diagnosis

Five systems to make your DNA-RNA studies faster, surer, and more reproducible

5′ End Labeling

The world's first 5′ End Labeling System is an accurate, efficient, time-saving means of labeling nucleic acid. Adapted from procedures described by Maxam and Gilbert,[1] it includes ATP, [γ-^{32}P] with our own specially prepared polynucleotide kinase and a carefully balanced complement of buffers, enzymes, and other reagents necessary for labeling the 5′ termini of DNA fragments.

The components are sufficient for about 10 reactions:

- Adenosine 5′-triphosphate, [γ-^{32}P]-
- Alkaline Phosphatase
- Polynucleotide Kinase (purified to homogeneity)
- Phosphatase Buffer
- Direct Phosphorylation Buffer
- Exchange Phosphorylation Buffer
- *Hinf* I Digest of Plasmid DNA, pBR322 (control to check the system)
- Deionized Water

The system is tested the day before shipment using the same lots of components you will receive, including fresh tracer. The resulting autoradiogram is included with your system.

Order NEK-006

[1]Maxam, A.M. and Gilbert, W., *Methods Enzymol.*, **65,** 1980

Translation

NEN's *in vitro* protein translation systems have made cell-free translations of eukaryotic mRNAs exceptionally reliable and reproducible. These time-and trouble-saving systems are offered with either Methionine, L-[^{35}S] or Leucine L-[^{3}H] labeled tracers. Both utilize an extract of rabbit reticulocyte lysate that has been treated with micrococcal nuclease to inactivate endogenous mRNA. The lysate is prepared under strictly controlled conditions to ensure retention of high protein synthesis activity.

The components are sufficient for about 100 assays:

- Rabbit Reticulocyte Lysate
- Methionine, L-[^{35}S]-, or
- Leucine, L-[3, 4, 5-^{3}H]-
- Translation Cocktail
- Control mRNA
- Magnesium Acetate
- Potassium Acetate
- Deionized Water

Each lot of systems is biologically tested with the exogenous control mRNA. A graph demonstrating Methionine or Leucine incorporation is provided with your shipment. Special accommodation systems will be arranged.

Order NEK-001 (Met [^{35}S])
NEK-002 (Leu [^{3}H])

Nick Translation

We now offer two exclusive systems for making consistently high specific activity probes using nick translation: dCTP, [^{32}P] and dTTP, [^{3}H]. Both systems include *E. coli* DNA Polymerase I prepared in our laboratories to ensure extremely high reproducibility. The DNase I, dNTP mixtures, stop buffer, and sterile deionized water are optimized for compatibility and stability.

The components are sufficient for about 20 assays:

- Deoxycytidine 5′-triphosphate, [α-^{32}P]-, or
- Deoxythymidine 5′-triphosphate, [*methyl*, 1′, 2′, -^{3}H]-
- DNase I
- DNA Polymerase I
- Control Plasmid DNA (pBR322)
- Deoxynucleoside Triphosphate Mixture
- Nick Translation Buffer
- Nick Translation Stop Buffer
- Deionized Water

Each lot of systems is tested with the control supercoil pBR322 plasmid DNA to ensure efficient incorporation of dCTP or dTTP into DNA, and a copy of the curve is included with your system.

Order NEK-004 (dCTP [^{32}P])
NEK-005 (dTTP [^{3}H])

Circle No. 343 on Readers' Service Card

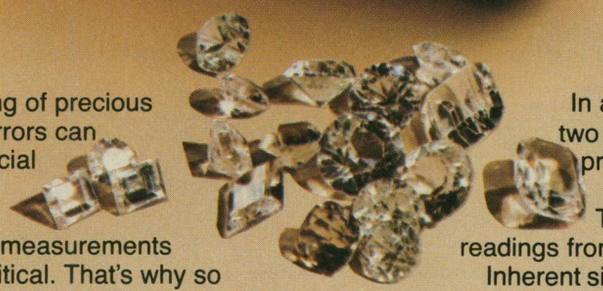
Call us toll free to request detailed descriptions of any of these systems or to discuss any questions you may have for our technical staff.

NEN® **New England Nuclear**

549 Albany Street, Boston, Massachusetts 02118
Call toll free: 800-225-1572 (In Massachusetts and International: 617-482-9595)

NEN Chemicals GmbH: D-6072 Dreieich, W. Germany, Postfach 401240, Tel. (06103) 85034, Telex 4-17993 NEN D
NEN Canada: 2453 46th Avenue, Lachine, Que. H8T 3C9, Tel. 514-636-4971, Telex 05-821808

When there's no room for error... make room for Fisher



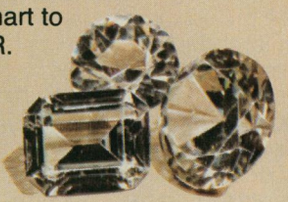
In the weighing of precious stones, tiny errors can become financial catastrophes. Industrial and research measurements are equally critical. That's why so many scientists turn to Fisher/Ainsworth.

Our M-300DR balance offers the kind of accuracy that's needed when errors are costly. Its microprocessor brain has the uncanny ability to sense weighing variables — changes in ambient temperatures, electrical fields — and apply corrections for extra-accurate results. And results are extra-stable because the M-300DR averages several readings over an optimum time interval.

In addition, this tiny toploader gives you two balances for the price of one. You do precision weighings from 0 to 30g (with ±0.001g accuracy) in the low range. Then you flip the range switch for readings from 0 to 300g (with ±0.01g accuracy).

Inherent simplicity makes the M-300DR easy to use. Hence, less chance of operator error. Offers full-range taring, fast response, bold LED readout and the superb reliability of microprocessor electronics.

So when you have no room for errors — or for their cost — you're smart to make room for the M-300DR.

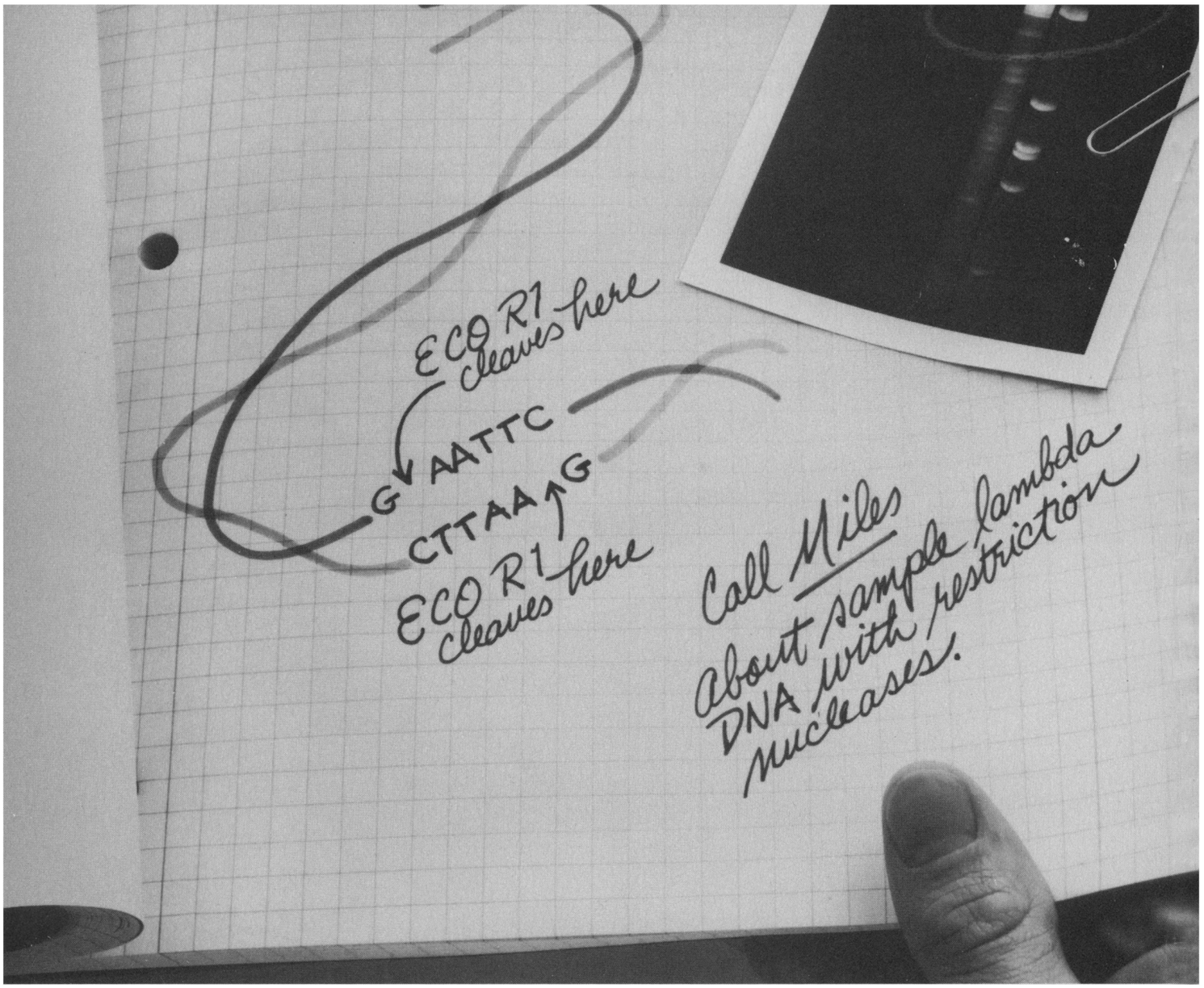


We know laboratories

Fisher Scientific Company

711 Forbes Avenue
Pittsburgh, Pennsylvania 15219
(412) 562-8543

Circle No. 270 on Readers' Service Card



Happy Endings.

Your DNA research should have a happy ending. That's why Miles has developed enzymes that cleave and splice DNA easily and accurately.

All of our restriction nucleases–such as *Eco* RI–specifically cleave DNA within certain well-defined base sequences. And to make sure you're happy with the cleaved ends, we include a sample of lambda DNA for verification of enzyme activity... so you never risk your research DNA. The results of our stringent specification tests are reported on the chemical credential that accompanies each order. No surprises, no mystery.

And, for recombinant DNA, we have terminal transferase to add dA and dT segments and DNA ligase to splice fragments together.

Restriction nucleases, terminal transferase, DNA ligase. Miles enzymes for happy endings... and beginnings.

Please supply more information about: Science 9/19/80

☐ Restriction nucleases ☐ DNA ligase ☐ Terminal transferase

☐ Please send a current Miles Biochemical Catalog.

Name _____
(please print)

Institution _____

Address _____

City _____ State _____ Zip _____

Research Products Division
Miles Laboratories, Inc.
P.O. Box 2000
Elkhart, IN 46515
Tel: 219-264-8804

Miles Laboratories, Ltd.
P.O. Box 37
Stoke Court, Stoke Poges
Slough SL2 4LY. England
Tel: Farnham Common 2151

Research Products Division MILES

Miles enzymes for the cleaving and splicing of DNA.

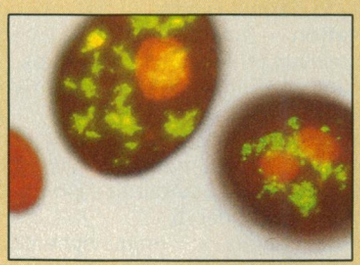
Circle No. 285 on Readers' Service Card

MRP-5028

Becton Dickinson FACS Systems

ADVANCES IN HEMATOLOGY

The Fluorescence Activated Cell Sorter (FACS) has become a powerful means of identifying and separating cells and cell constituents according to distinctive properties of FLUORESCENCE and SIZE. FACS makes possible multiparameter measurement of individual cells, providing the distribution of these measurements in a sample. Evaluation against operator-selected criteria, at rates to 5,000 cells per second, forms the basis for physical separation of viable subpopulations. FACS measurements have been documented for sensitivity to as few as 3,000 fluorescent molecules per cell. Light-scatter measurements are sensitive to particles as small as 0.3 micron in diameter, and can be used to detect viability, without staining, in homogenous populations such as lymphocytes. FACS Systems are accepted as the standard of comparison for quality, performance and reliability, and are in daily use in top laboratories worldwide. Following is a brief view of recent FACS advances:

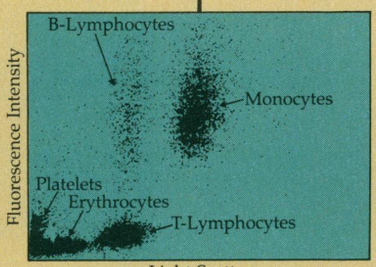


Platelet Subpopulations in Immune Disorders

Platelet immune destruction has been studied using FACS for quantitation of IgG and C3 on individual platelets. Analysis of samples with counts as low as 1000/mm^3, using as little as 1 ml of blood, are possible. Many subjects with evidence of immune platelet destruction show one subset of platelets reacting with both anti-IgG and C3, while a second subset is unreactive.

FACS Analysis of Leukemic Cells

Cell-surface-binding fluorescent ligands have been used by researchers to distinguish between leukemic cell types and between leukemic cells and their presumed normal counterparts. Binding sites for cholera toxin have been found to be normally expressed in chronic leukemias but greatly diminished or absent in acute leukemias irrespective of their morphological type. Antibodies specific for the common form of acute lymphoblastic leukemia (ALL) have been produced in rabbits and shown to define a cell surface antigen of non-T, non-B type ALL.



Stem Cell Analysis and Sorting Using Light Scatter

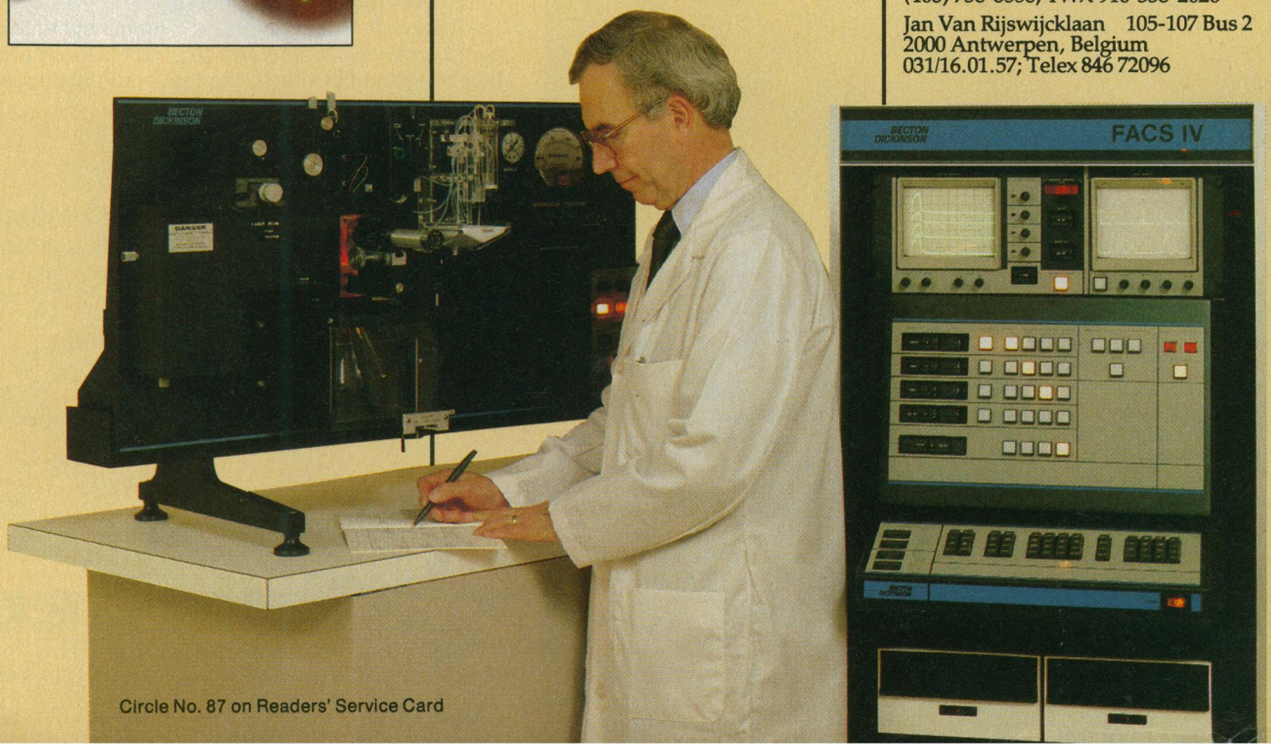
Morphological discrimination of the hematopoietic stem cell—the colony forming unit of spleen (CFU-s)—has been made using light scattering measurements, without fluorescence staining, in FACS. Light scatter is measured simultaneously from different directions. Correlated analyses of mouse bone marrow cells have then been used for sorting and microscopic identification. CFU-s are found among those cells classified by light scatter as large lymphocytes, or blast cells.

For additional information, including an extensive bibliography, call or write Becton Dickinson FACS Systems.

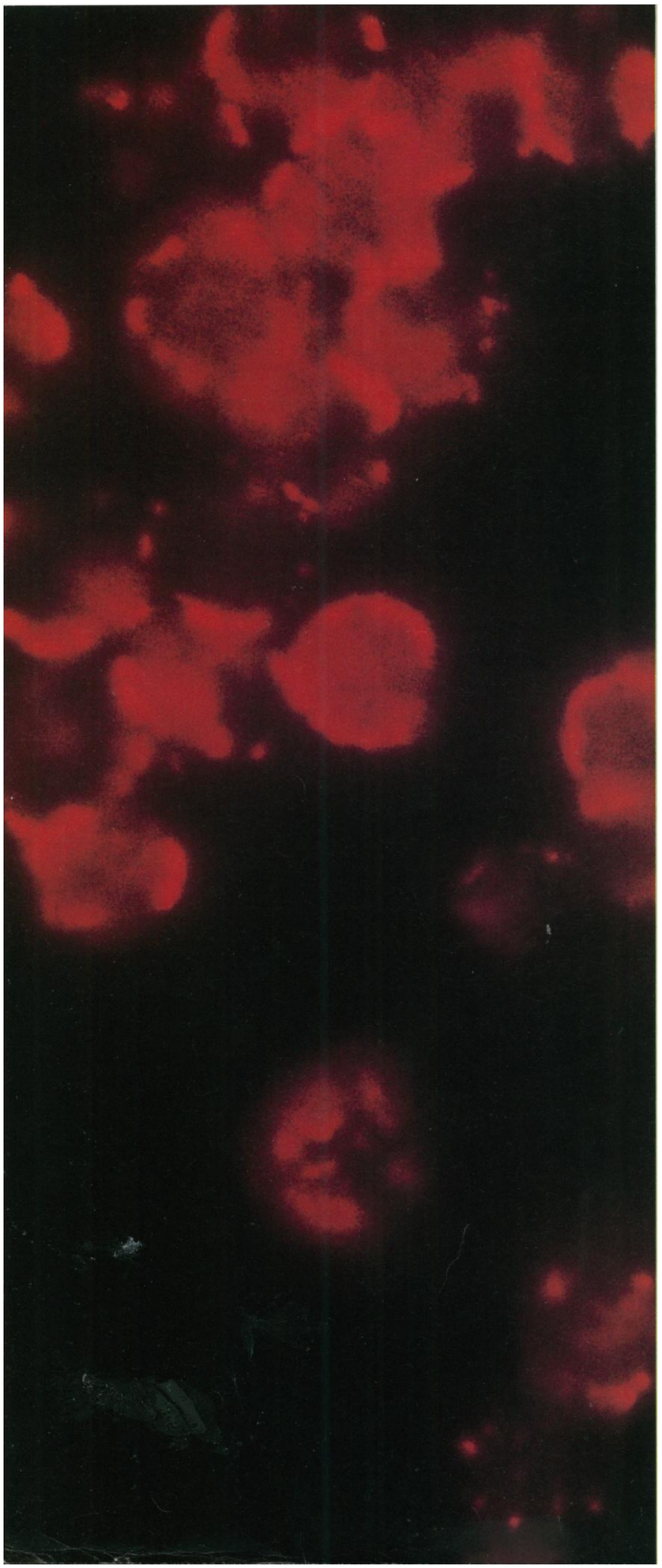
BECTON DICKINSON
FACS Systems

490-B Lakeside Drive
Sunnyvale, CA 94086
(408) 738-8558; TWX 910 338 2026

Jan Van Rijswijcklaan 105-107 Bus 2
2000 Antwerpen, Belgium
031/16.01.57; Telex 846 72096



Circle No. 87 on Readers' Service Card



Monoclonal antibody specific to Human T cell antigen is now available.

Immunochemical techniques for identifying and isolating lymphocyte subpopulations are generally preferred over other methods. Antibody mediated procedures offer more precise cell differentiation and greater procedural convenience.

Antibodies directed against B cell surface immunoglobulins are available as conventional antiserum, but prior to the development of monoclonal antibodies, no equivalent immunochemical markers for T cells have been commercially available. Now Hybritech — the leading company in hybridoma technology — announces the immediate availability of a monoclonal antibody specific for a surface antigen on all human T cells.*

Monoclonal antibody to human T cells creates new research opportunities.

Hybritech's new monoclonal antibody will greatly enhance research applications requiring precise differentiation of Human T cell populations.

Identification of T cell Leukemia and lymphoma
Assay of peripheral lymphocyte subpopulations
Separation of T cells using immunoadsorbents
Investigation of T cell function

Hybritech antibody to human T cells offers superior performance.

For research programs requiring identification or isolation of T cells, Hybritech's antibody satisfies the most important criteria.

Specificity — Identification, localization and isolation of all human T cells with no cross-reactivity to normal B cells
Quantitation — Inclusion of T cells that generally are missed by rosetting techniques.
Cytotoxicity — Elimination of T cells in lymphocyte preparations
Diagnosis — Detection of acute and chronic leukemias and lymphomas of thymic origin
Reproducibility — Standardization of results with monoclonal antibody

Learn more about this new immunochemical reagent and how it can enhance your research program by contacting Hybritech, the leaders in hybridoma technology.

◁ Immunofluorescence of Human T cells following incubation with Hybritech's T cell specific antibody and rhodamine conjugated horse anti-mouse antibody.

Circle No. 251 on Readers' Service Card

Hybritech
INCORPORATED
2945 Science Park Road, La Jolla, CA 92037 (714) 455-6700

At the present time, Hybritech antibodies are not designed or intended for either diagnostic or therapeutic use. The products are therefore labeled and made

19 September 1980, Volume 209, Number 4463 **SCIENCE**

Recombinant DNA Revisited

Thoughtful people might well begin to wonder at yet another celebration marking a new generation of major discoveries in molecular genetics. But it is true that since 1953, when the Watson-Crick model for DNA structure was proposed, there has been a dizzying succession of advances, each deepening our understanding of biology at the molecular level. It has been a 30-year high for those who participated, although for the most part we did poorly in imparting to others the reasons for our excitement.

In this regard, the recombinant DNA debate had a happy effect. The daily papers and television now report frequently on the activities of biologists. Lately, these reports have been upbeat, as the production of rare and medically significant materials nears reality. This is a marked change from the hair-raising headlines of a few years ago. Most people now understand that the extreme views heard at the height of the debate were groundless. No novel hazards have emerged from the research, and the cautious approach instituted at Asilomar in 1975, and continued by national guidelines in many countries, has not seriously hampered the progress of research.

Dramatic differences exist between the reports appearing in the mass media and those in this issue of *Science*. The manufacture of important biological agents like insulin and interferon by recombinant DNA procedures is the fruit of the basic research of the past. Here are reported the foundations for the future. It would be foolhardy to try to predict specific outcomes. We can be certain only that they will be unexpected and astonishing. And we ought not fear these unknowns. Rather we should work to ensure that the singular intellectual bounties of our era are exploited for the good of all.

The present articles, regardless of any future impact, stand on their own for their originality and remarkable insights into how the genes of all organisms, including man, are arranged, expressed, and regulated. Once we thought the DNA of complex organisms was inscrutable. Now we cope with it readily. We thought of DNA as immovable, a fixed component of cells. Now we know that some modules of DNA are peripatetic; their function depends on their ability to move about in a genome. There are already sufficient examples of peripatetic DNA for us to be certain that it is a universal element in differentiation and development. We thought genes were continuous stretches of DNA. Now we know coding regions may be interrupted dozens of times, and spliced together in the form of messenger RNA when needed. We have learned that genes are fungible; animal genes function perfectly well within bacteria and bacterial genes within animal cells, confirming the unity of nature. We need no longer depend on chance events to generate the mutations essential for unraveling intricate genetic phenomena. Specific mutations can be constructed at will, and millions of mutant genomes readily produced for study. We already see that some standard questions about evolution must be rephrased to account for new information.

Recombinant DNA techniques alone did not accomplish all this. Coincident improvements in methods for the chemical and enzymatic manipulation of DNA were equally important. First, the discovery and exploitation of restriction endonucleases allow us to cut up large genomes into reproducible small segments. The segments are ready-made for insertion into a recombinant DNA vector because of the special termini generated by the endonuclease cleavage. Next, it is feasible and indeed common to determine with precision the sequence of thousands of base pairs on a DNA segment. Finally, there is the matter of scale; nanogram, even picogram amounts of DNA can be characterized with precision because of the availability of highly radioactive phosphorus-32 and simple electrophoretic techniques carried out on semisolid gel supports. Together, these methods have opened opportunities unimaginable even 5 years ago. And molecular biologists alone did not accomplish all this. They had unprecedented support from enlightened societies and governments. It has been a joint venture, and we should celebrate together.—MAXINE SINGER, *Chief, Laboratory of Biochemistry, National Cancer Institute, Bethesda, Maryland 20205*

Ask us anything about titrators and get the answer fast.

Dial 800/645-3050.*

Metrohm. We're the titrator people.

Titration procedures can prove problematic. So can instruments. So please... ask us your questions.

You'll get an immediate, authoritative response on the most accurate, the most convenient and the most economical way to resolve your problems.

Ask us, and we'll also tell you which Metrohm Titrators and accessories might be best suited to your needs. They range from simple digital automatic burets costing as little as $1,300 to fully automated titrators costing $13,500 that record curves and calculations simultaneously by inserting a program card.

Ask us; call toll-free 800/645-3050.

*In New York State, call 516/334-7500. In Canada, 416/675-7911.

Metrohm Division, Brinkmann Instruments, Inc., Subsidiary of Sybron Corporation, Cantiague Road, Westbury, NY 11590. In Canada, Brinkmann Instruments (Canada), Ltd.

SYBRON | Brinkmann

Circle No. 239 on Readers' Service Card