13 November 1981 • Vol. 214 • No. 4522 $2.00

SCIENCE

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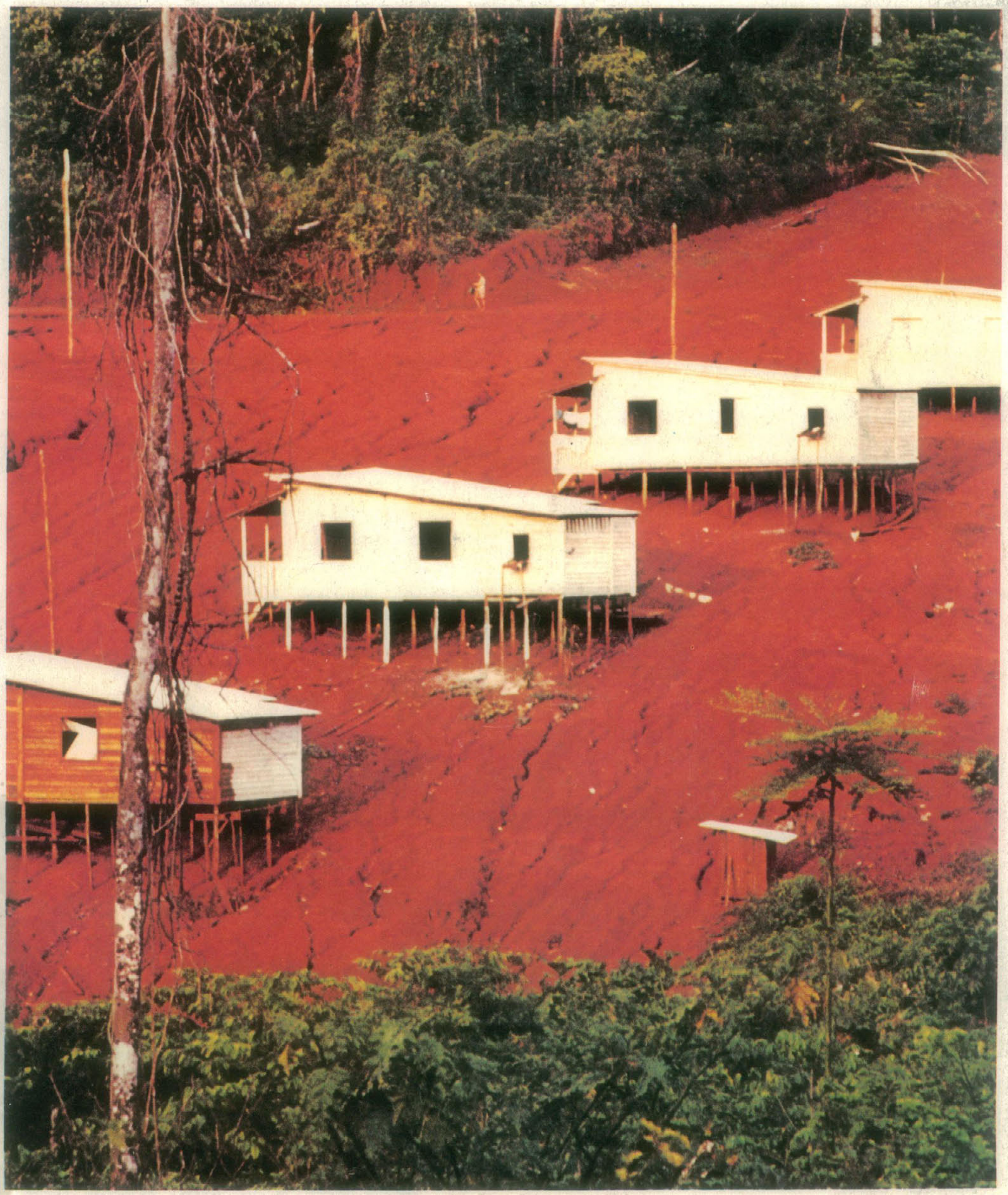

How do you make the best large-capacity centrifuge better? Add microprocessor control and a new drive.

There never has been a 6000-rpm large-capacity centrifuge like the new J-6M. It's microprocessor-controlled and has an induction drive based on technology developed for Beckman ultracentrifuges.

The microprocessor makes centrifugation virtually automatic. Just program into the memory the operating conditions of the runs you do most often. You can repeat a program at will by pressing just two controls. Or you can use the touch/tone keyboard to manually select run conditions.

With the J-6M Ultra-Smooth drive, you can take advantage of maximum acceleration/deceleration rates to save time or select other rates for special separations. And you'll never have to change brushes because there are none.

The J-6M also provides a new degree of temperature control with automatic temperature compensation for each rotor and automatic over-temperature protection. The rotor speed control systems are miles ahead too with automatic overspeed protection and microprocessor control to within 20 rpm of set speed.

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To find out more about how the J-6M is better, contract Beckman Instruments, Inc., Spinco Division, 1117 California Ave., Palo Alto, CA 94304.

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SCIENCE

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COVER

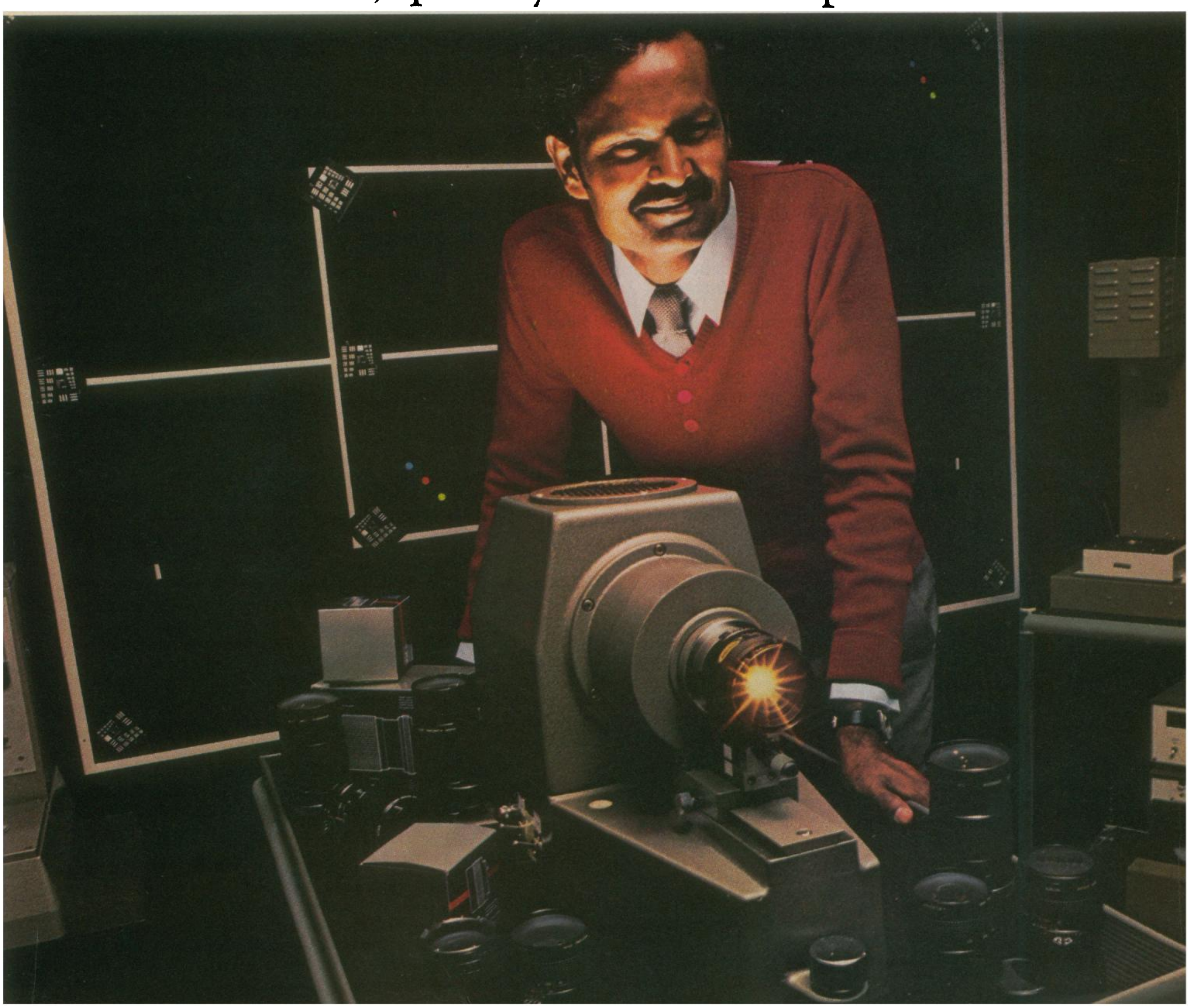
Severe soil erosion in a community along Brazil's Transamazon Highway. Because of the broken terrain and torrential rainfall, soil erosion is a major constraint on the agricultural development of the colonization scheme. Note the bright red earth which is derived from weathered basalt. See page 755. [Nigel J. H. Smith, University of Florida, Gainesville 32611]

Reddy Chirra improves his vision with an Apple.

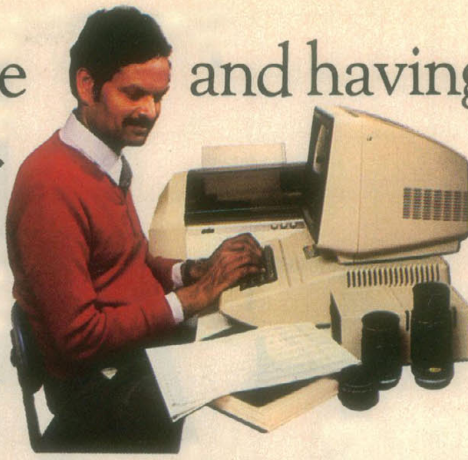
Reddy is an optical engineer who's used to working for big companies and using big mainframes.

But when he started his own consulting business, he soon learned how costly mainframe time can be. So he bought himself a 48K Apple II Personal Computer.

And, like thousands of other engineers and scientists, quickly learned the pleasures of



cutting down on shared time and having his own tamper-proof data base.



His Apple can handle formulas with up to 80 variables and test parameters on 250 different optical glasses.

He can even use BASIC, FORTRAN, Pascal and Assembly languages.

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Reddy looked at other microcomputers, but chose Apple for its in-depth documentation, reliability and expandability.

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THE LEADING EDGE

#1 in a series of reports on new technology from Xerox

About a year ago, Xerox introduced the Ethernet network—a pioneering new development that makes it possible to link different office machines into a single network that's reliable, flexible and easily expandable.

The following are some notes explaining the technological underpinnings of this development. They are contributed by Xerox research scientist David Boggs.

The Ethernet system was designed to meet several rather ambitious objectives.

First, it had to allow many users within a given organization to access the same data. Next, it had to allow the organization the economies that come from resource sharing; that is, if several people could share the same information processing equipment, it would cut down on the amount and expense of hardware needed. In addition, the resulting network had to be flexible; users had to be able to change components easily so the network could grow smoothly as new capability was needed. Finally, it had to have maximum reliability—a system based on the notion of shared information would look pretty silly if users couldn't get at the information because the network was broken.

Collision Detection

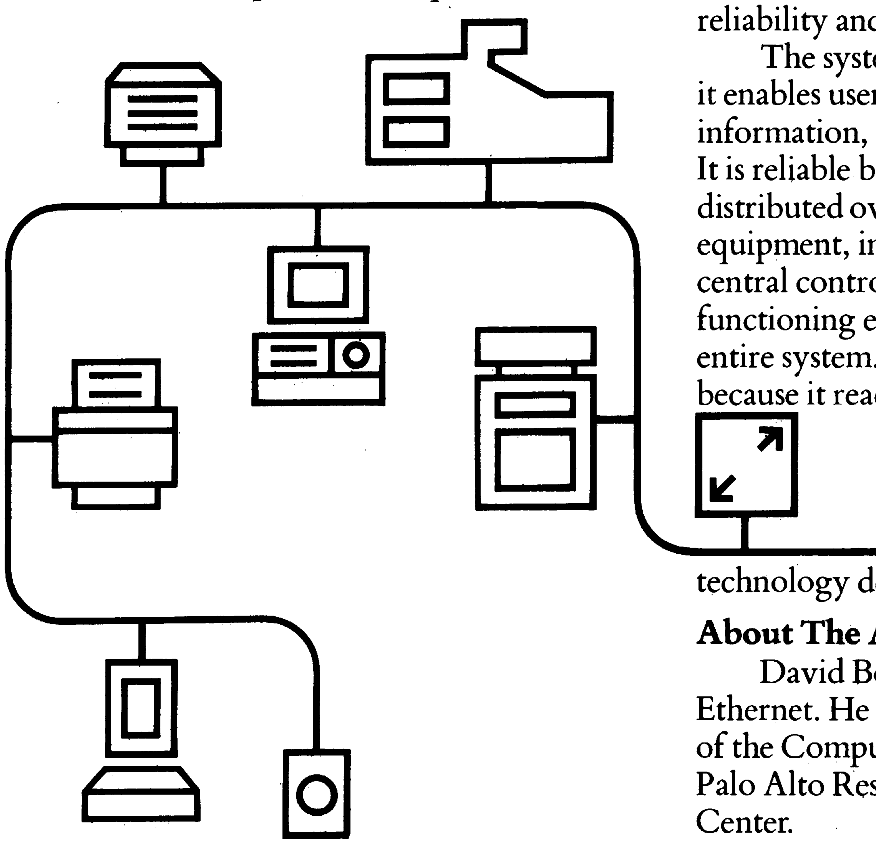
The Ethernet network uses a coaxial cable to connect various pieces of information equipment. Information travels over the cable in packets which are sent from one machine to another.

A key problem in any system of this type is how to control access to the cable: what are the rules determining when a piece of equipment can talk? Ethernet's method resembles the unwritten rules used by people at a party to decide who gets to tell the next story.

While someone is speaking, everyone else waits. When the current speaker stops, those who want to say something pause, and then launch into their speeches. If they *collide* with each other (hear someone else talking, too), they all stop and wait to start up again. Eventually one pauses the shortest time and starts talking so soon that everyone else hears him and waits.

When a piece of equipment wants to use the Ethernet cable, it listens first to hear if any other station is talking. When it hears silence on the cable, the station starts talking, but it also listens. If it hears other stations sending too, it stops, as do the other stations. Then it waits a random amount of time, on the order of microseconds, and tries again. The more times a station collides, the longer, on the average, it waits before trying again.

In the technical literature, this technique is called carrier-sense multiple-access with collision detection. It is a modification of a method developed by researchers at the University of Hawaii and further refined by my colleague Dr. Robert Metcalfe. As long as the interval during which stations elbow each other for control of the cable is short relative to the interval during which the winner uses the cable, it is very efficient. Just as important, it requires no central control—there is no distinguished station to break or become overloaded.



The System

With the foregoing problems solved, Ethernet was ready for introduction. It consists of a few relatively simple components:

Ether. This is the cable referred to earlier. Since it consists of just copper and plastic, its reliability is high and its cost is low.

Transceivers. These are small boxes that insert and extract bits of information as they pass by on the cable.

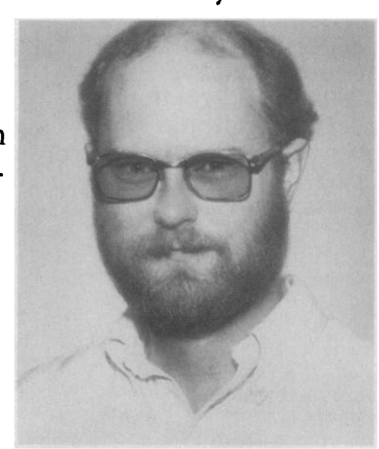
Controllers. These are large scale integrated circuit chips which enable all sorts of equipment, from communicating typewriters to mainframe computers, regardless of the manufacturer, to connect to the Ethernet.

The resulting system is not only fast (transmitting millions of bits of information per second), it's essentially modular in design. It's largely because of this modularity that Ethernet succeeds in meeting its objectives of economy, reliability and expandability.

The system is economical simply because it enables users to share both equipment and information, cutting down on hardware costs. It is reliable because control of the system is distributed over many pieces of communicating equipment, instead of being vested in a single central controller where a single piece of malfunctioning equipment can immobilize an entire system. And Ethernet is expandable because it readily accepts new pieces of information processing equipment. This enables an organization to plug in new machines gradually, as its needs dictate, or as technology develops new and better ones.

About The Author

David Boggs is one of the inventors of Ethernet. He is a member of the research staff of the Computer Science Laboratory at Xerox's Palo Alto Research Center.



He holds a Bachelor's degree in Electrical Engineering from Princeton University and a Master's degree from Stanford University, where he is currently pursuing a Ph.D.

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Systems sufficient for either 20 or 10 reactions contain the following:

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- 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 dCMP or dTMP into DNA, and a copy of the curve is included with your system.

Ordering information:

- NEK-004 (dCTP, $[\alpha\text{-}^{32}P]$) (20 reactions, tracer in ethanol)
- NEK-004A (10 reactions, tracer in ethanol)
- NEK-004B (20 reactions, tracer concentrated in aqueous solution)
- NEK-004C (10 reactions, tracer concentrated in aqueous solution)
- NEK-005 (dTTP, $[^{3}H]$) (20-reaction system)

3′ End Labeling

The system labels protruding (*Hae* II), flush (*Alu* I), and recessed (*Hin*f I) 3′ termini generated from pBR322 with 3′-dATP, $[\alpha\text{-}^{32}P]$- (cordycepin 5′-triphosphate) in a simplified protocol similar to the procedures of Tu and Cohen.[1] The system utilizes terminal transferase to add a single 3′-dAMP, $[\alpha\text{-}^{32}P]$-molecule to the 3′ end of a DNA chain. The resulting labeled DNA is suitable for sequencing by the Maxam and Gilbert[2] technique used in our new DNA Sequencing System (see next page).

The components include:

- 3′-dATP, $[\alpha\text{-}^{32}P]$- (cordycepin 5′-triphosphate)
- Terminal Deoxynucleotidyl Transferase
- Terminal Transferase Reaction Buffer
- Cobalt Chloride
- Control Plasmid DNA Fragments
- Deionized Water

Prior to shipment, all system components are subjected to a complete 3′ end labeling procedure. The polyacrylamide gel used to separate the fragments is autoradiographed to assess labeling efficiency, and a copy of the autoradiogram is included with your system.

Ordering information:

- NEK-009 (10-reaction system)
- NEK-009A (5-reaction system)

[1] Tu, C.-P.D. and Cohen, S.N., *Gene*, **10:** 177, 1980

5′ End Labeling

Adapted from procedures described by Maxam and Gilbert,[2] an efficient, time-saving means of labeling nucleic acid fragments preparatory to DNA sequencing (see next column). The system includes ATP, $[\gamma\text{-}^{32}P]$- with polynucleotide kinase prepared in our own laboratories, and a carefully balanced complement of buffers, enzymes, and other reagents necessary for labeling the 5′ termini of DNA fragments.

Systems sufficient for either 10 or 5 reactions contain the following:

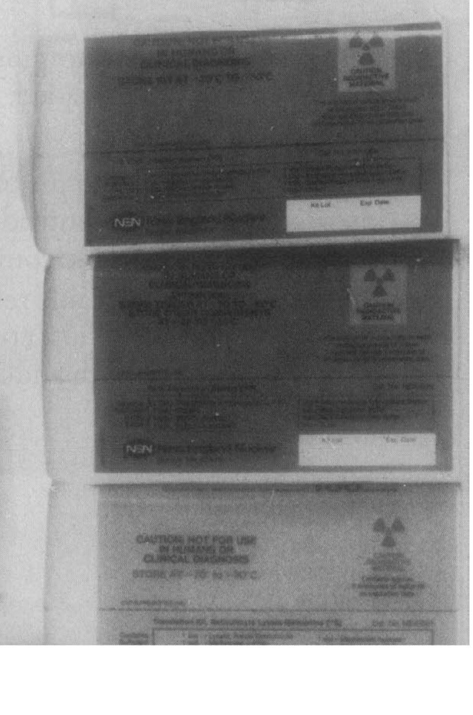
- ATP, $[\gamma\text{-}^{32}P]$-
- Alkaline Phosphatase
- Polynucleotide Kinase (purified to homogeneity)
- Phosphatase Buffer
- Direct Phosphorylation Buffer
- Exchange Phosphorylation Buffer
- *Hin*f I Digest of Plasmid DNA, pBR322 (control to check system)
- Deionized Water

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.

Ordering information:

- NEK-006 (10-reaction system)
- NEK-006A (5 reaction system)

Not for use in humans or clinical diagnosis.



NEW
DNA Sequencing

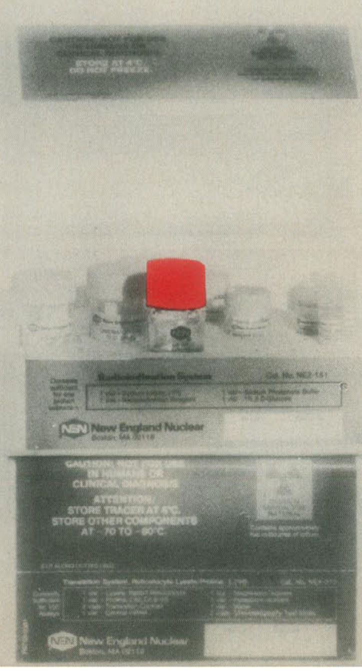
This system follows the Maxam-Gilbert procedure as published in *Methods in Enzymology* and includes the entire text of the article.[2] It is suitable for sequencing DNA labeled with our 3′ or 5′ End Labeling Systems and includes all reagents necessary for the four base specific cleavage reactions. Sufficient material is provided for at least fifty of each reaction.

The following components are included:
- Dimethyl Sulfate
- Hydrazine
- Piperidine
- Piperidine Formate
- Ferric Chloride
- Sodium Hydroxide
- Maxam-Gilbert Procedure Manual

Each new lot of components is tested before shipment in a sequence analysis of a DNA fragment. The purity of each component is monitored using chromatographic analysis and documented for inclusion with the system.

Ordering information:
NEK-010

[2] Maxam, A.M. and Gilbert, W., *Methods in Enzymology,* **65** (1980)



NEW
Transcription

This system provides all the components necessary to perform eukaryotic cell-free transcription. It contains a cell-free extract derived from HeLa cells which catalyzes the synthesis of mRNA precursors when provided with an exogenous DNA containing a promoter for recognition by the polymerase. This RNA polymerase II dependent reaction is highly sensitive to the presence of α-amanitin. The whole cell extract is prepared as described by Manley and coworkers.[3]

The system also includes UTP, [α-^{32}P]- for labeling specific mRNA precursors. A control DNA template, the cloned *Bal* I-E restriction fragment of Adenovirus-2, has been used to optimize the system and is included with it. This control should be used by the investigator to determine proper functioning of the system.

Components sufficient for performing 50 assays (25μl reaction volume) are listed below:
- UTP, [α-^{32}P]-
- HeLa Cell Extract
- Control DNA Template
- Transcription Cocktail
- Deionized Water

Ordering information:
NEK-014 (50-reaction system)

[3] Manley, J.L., Fire, A., Cano, A., Sharp, P.A., and Gefter, M.L., *PNAS* (U.S.A.), **77:** 3855 (1980)

Translation

Now Proline [^{3}***H***]

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

The components include:
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- Methionine, L-[^{35}S]-, or
- Leucine, L-[3,4,5-^{3}H]-, or
- Proline, L-[2,3,4,5-^{3}H]-
- Translation Cocktail
- Control mRNA
- Magnesium Acetate
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- Deionized Water

Each lot of systems is biologically tested with the control mRNA. A graph demonstrating Methionine, Leucine, or Proline incorporation is provided with your shipment.

Ordering information:

NEK-001 (Met [^{35}S]) (100 reactions)
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NEK-002 (Leu [^{3}H]) (100 reactions)
NEK-002A (incl. extra ml lysate)

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For literature, write: Eppendorf Division, Brinkmann Instruments, Inc., Subsidiary of Sybron Corporation, Cantiague Road, Westbury, NY 11590; or call 516/334-7500. In Canada: Brinkmann Instruments (Canada), Ltd.

To spin for minutes, set the timer.

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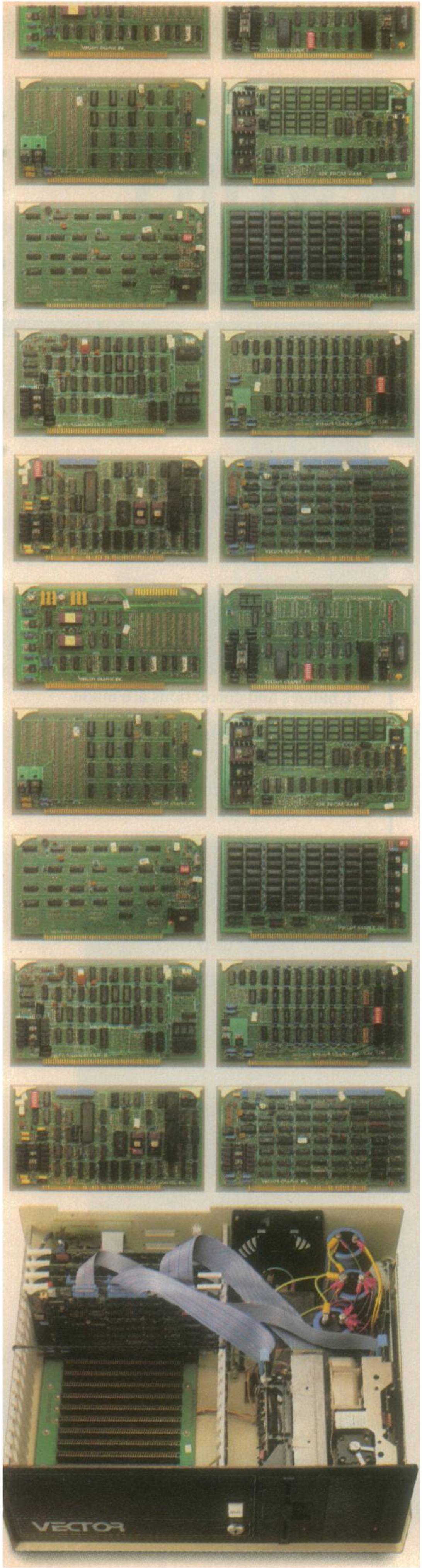
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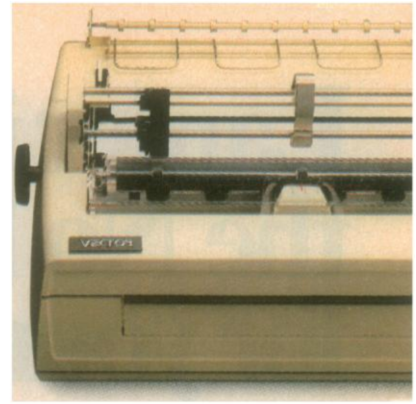

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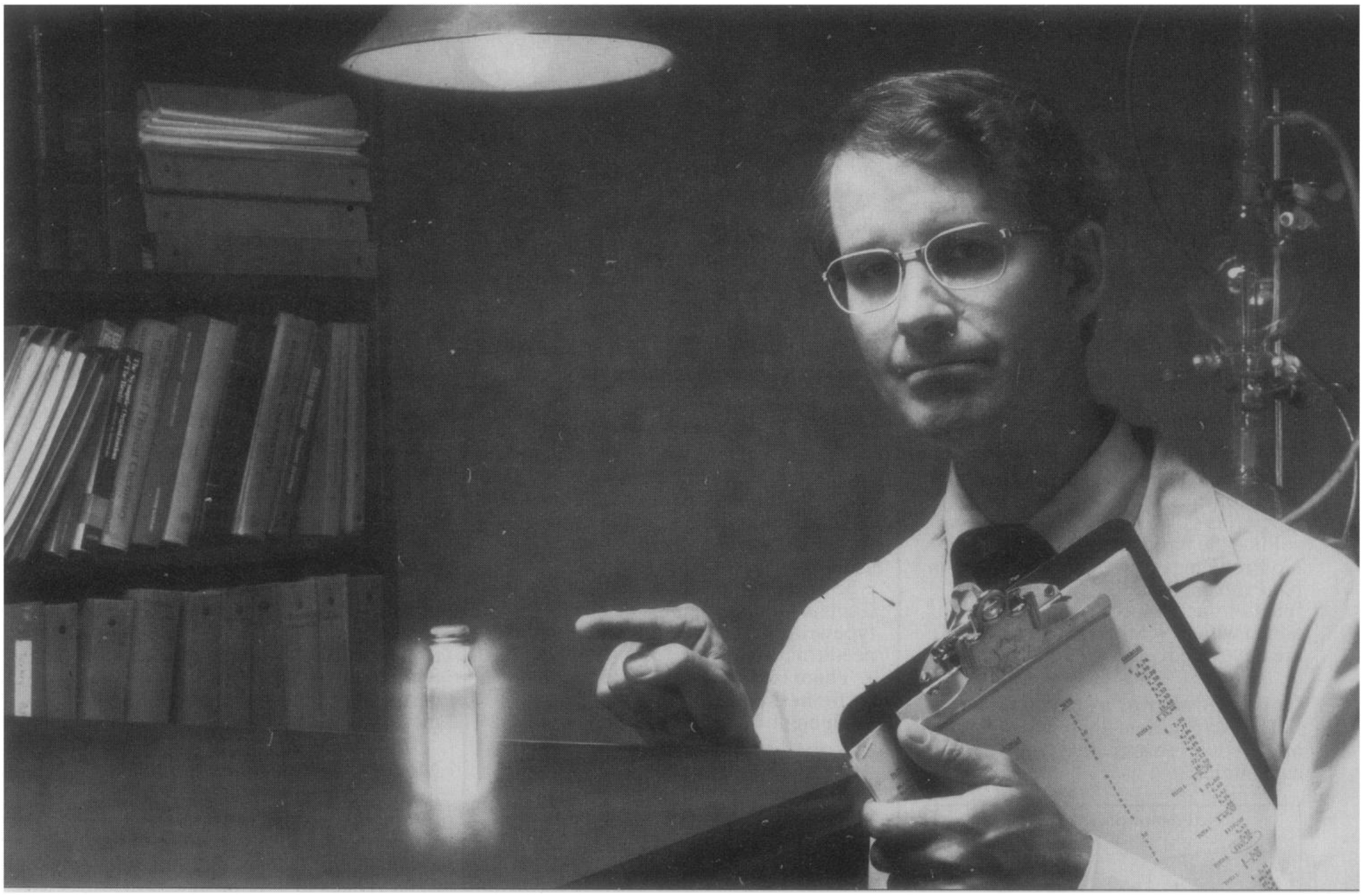

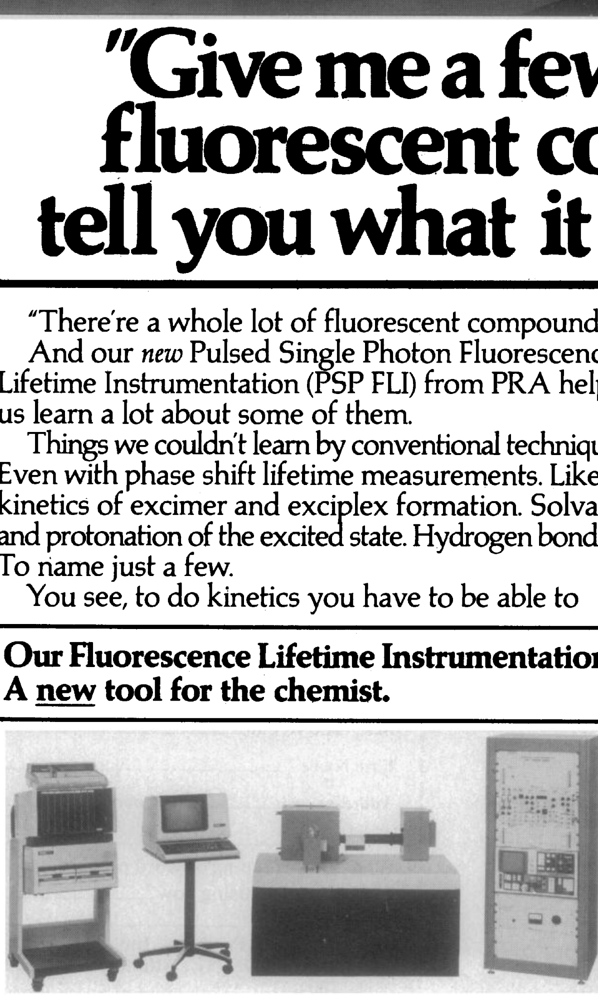

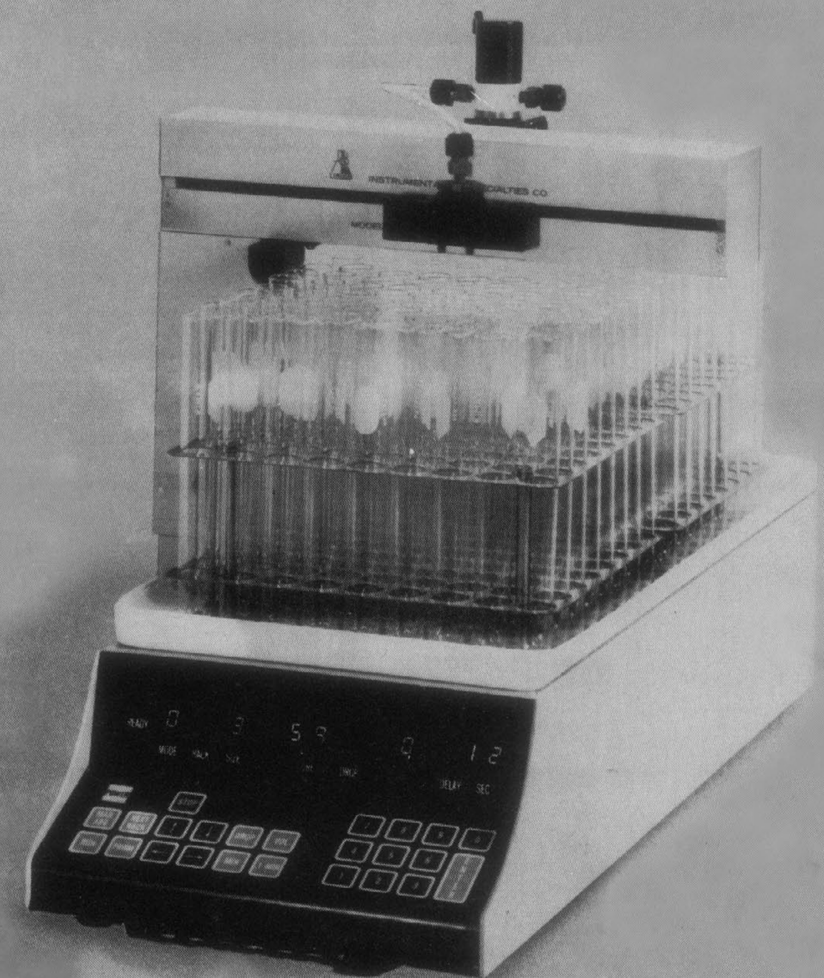

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Life scientists have trusted Varian instruments for decades—and for good reasons.

First, Varian offers the widest range of research and analytical instrumentation available today; so you can select state-of-the-art performance to suit the needs of your laboratory. Second, Varian puts the operator first by making ease and speed of operation a design commitment; you benefit from the increased productivity. Most important of all, you can rely on the accuracy of your results; they carry the authority of long-standing leadership in scientific instrumentation.

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The results you see here are examples of answers found to problems in the biosciences—from instruments designed to make them all seem routine.

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The separation of nucleotides, nucleosides, and bases shown was achieved in a single run in less than 90 minutes. The three-solvent capability of the *Model 5000 Liquid Chromatograph* was used to sequentially program two gradients. Flow programming was used to separate bases and nucleosides at a reduced flow during initial solvent gradient.

The Model 5000 is fully compatible with the new *VISTA 401 Chromatography Data System*.
Circle No. **63**.

❷ LC: Identify and purify peptides
With the *Model 5000*, peptide species differing in only a single amino acid *are sharply separated* by reverse-phase chromatography. Circle No. **64**.

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The new Varian *HPLC System* for protein and peptide chromatography gives you complete molecular-size exclusion, anion exchange, and reverse-phase capabilities. For example, you can separate proteins with a wide MW-range in minutes, with excellent recovery of protein mass and enzyme activity. Circle No. **65**.

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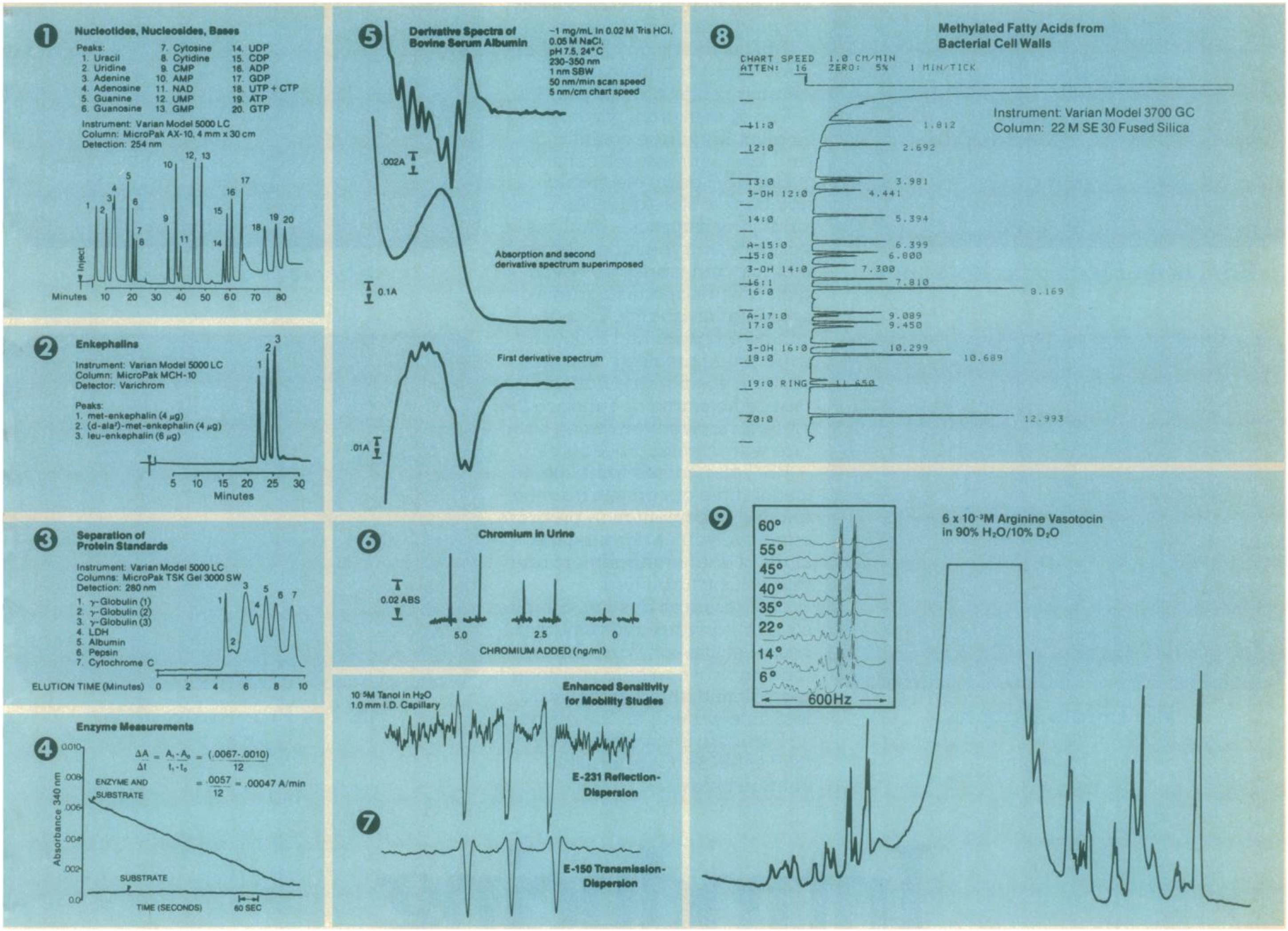
❻ AA: Measure electrolytes in tissue, cells, and fluids
With the new Varian *AA-875 Atomic Absorption Spectrophotometer*, you can study toxicity, nutrient and metabolic activities, and the therapeutic effects of some 67 elements. This AA spectrum shows a typical determination of chromium in urine, using the Carbon Rod Atomizer accessory. Sample volume is 20 μl. Sensitivity: 6 pg Cr in the urine matrix; precision: 10–20% RSD at 1 μg/24 hr sample level. Circle No. **68**.

you'll find Varian instruments



❼ EPR: Study RBC internal viscosity
In spin label studies of slow molecular motion, like investigations of red-blood-cell internal viscosity and the effects of chemotherapy on membrane fluidity, the saturation-transfer EPR (ST-EPR) experiment has been proven extremely useful.

The Varian *E-150 Induction EPR Accessory* now brings high sensitivity to dispersion ST-EPR, which makes it possible to use 90°-out-of-phase first-harmonic (μ') detection. This technique offers easier interpretation and simulation and makes spectrometer adjustment less critical.

Using the E-150 accessory, the full range of reflection and induction EPR experiments become available at the flick of a switch, allowing the scientist to select those parameters that optimize spectral sensitivity to slow molecular motions (10^{-3} sec $> \tau_c >$ 10^{-8} sec). Circle No. **69**.

❽ GC: Identify bacteria by methylated fatty acids
Superb resolution achieved with the fused-silica capillary column on the *Model 3700 Capillary Gas Chromatograph* and the data presentation capabilities of the *VISTA 401 Chromatography Data System* make bacteria fingerprinting a routine procedure.

The easy-to-read printout includes peak names, run conditions, and quantitative chromatographic data. All can be stored on a floppy disk for instant retrieval and precise reproduction of the analysis. Circle No. **70**.

❾ NMR: Elucidate peptide structure
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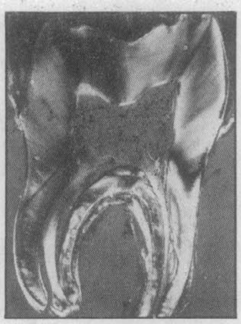

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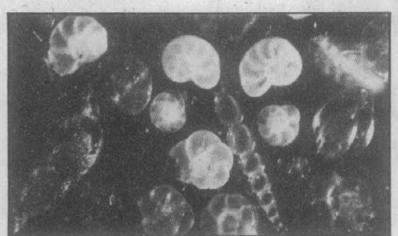

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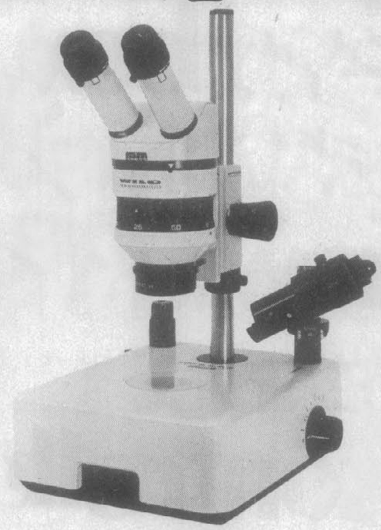

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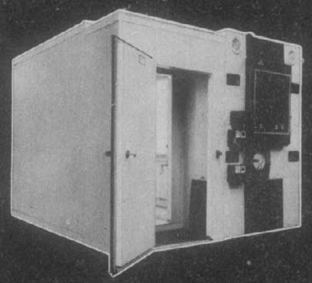

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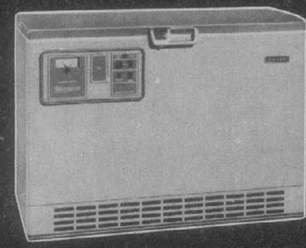

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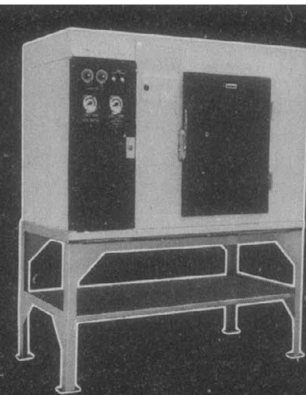

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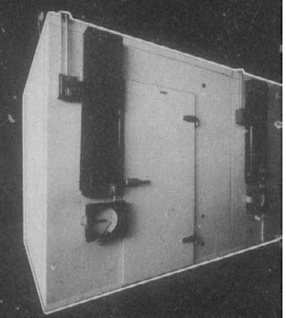

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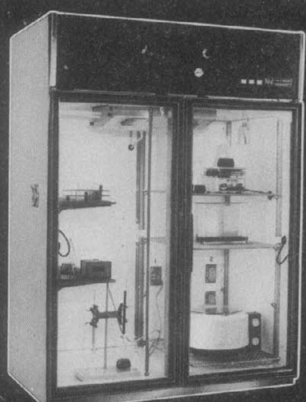

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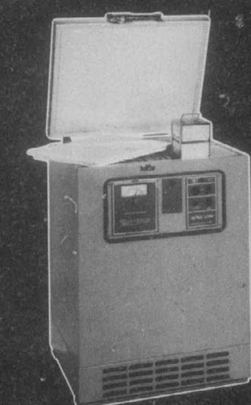

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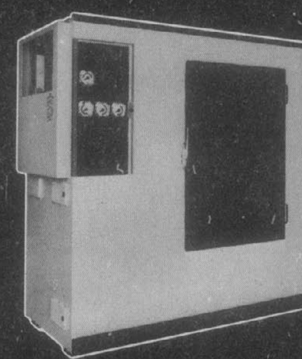

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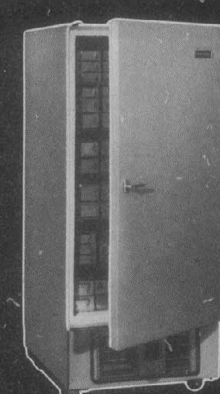

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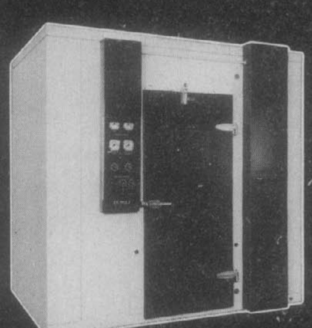

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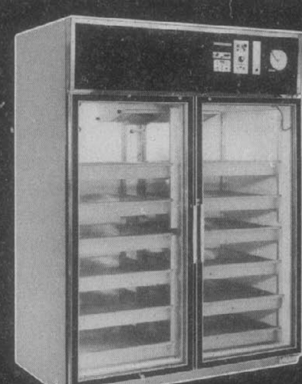

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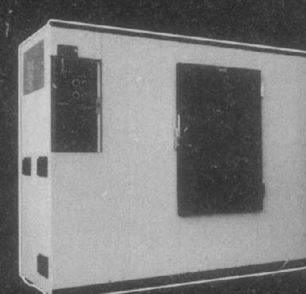

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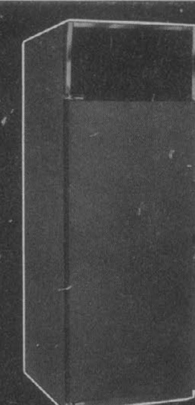

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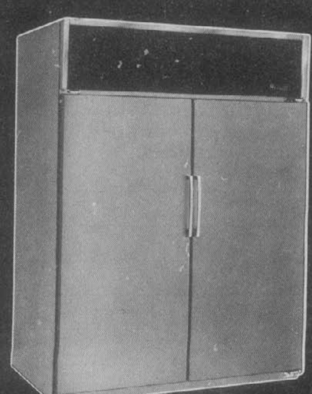

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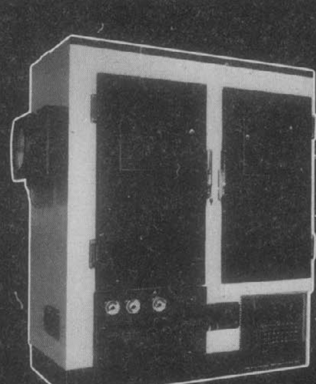

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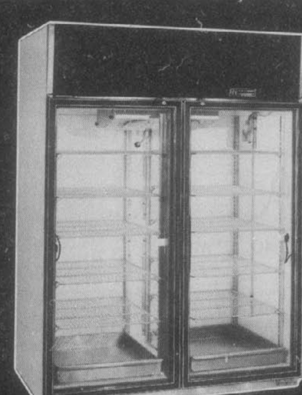

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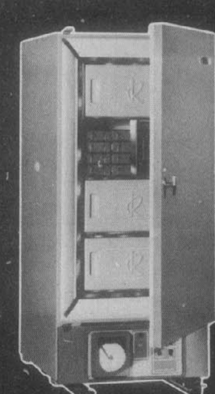

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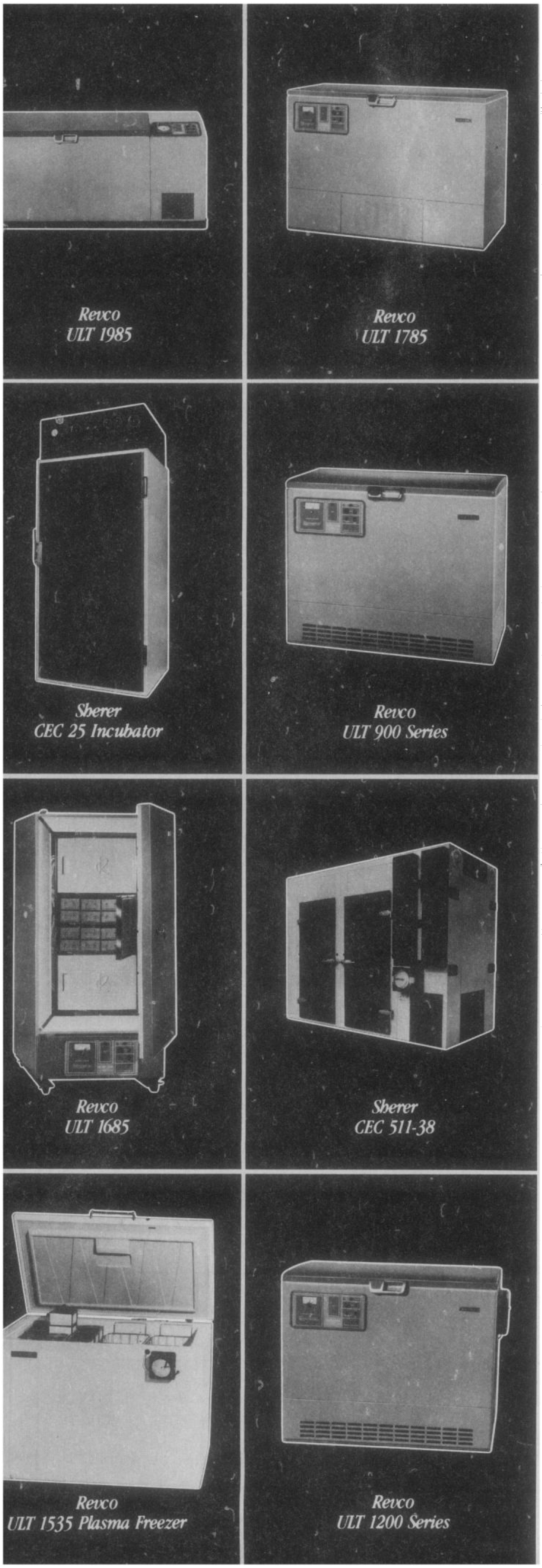

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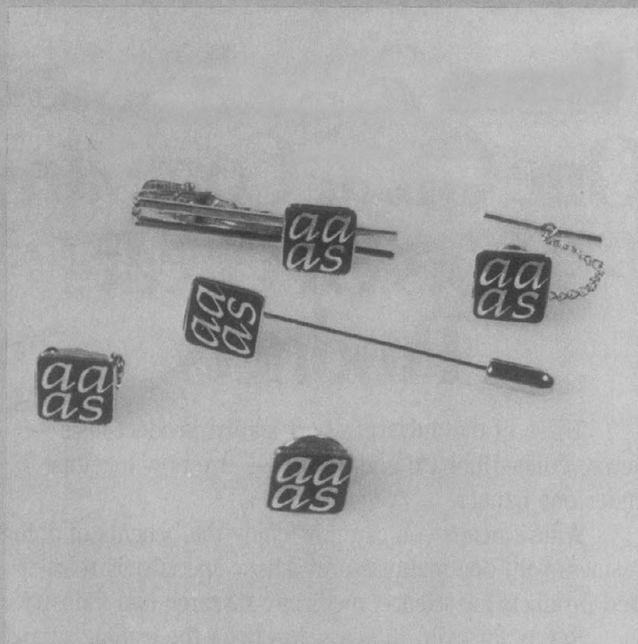


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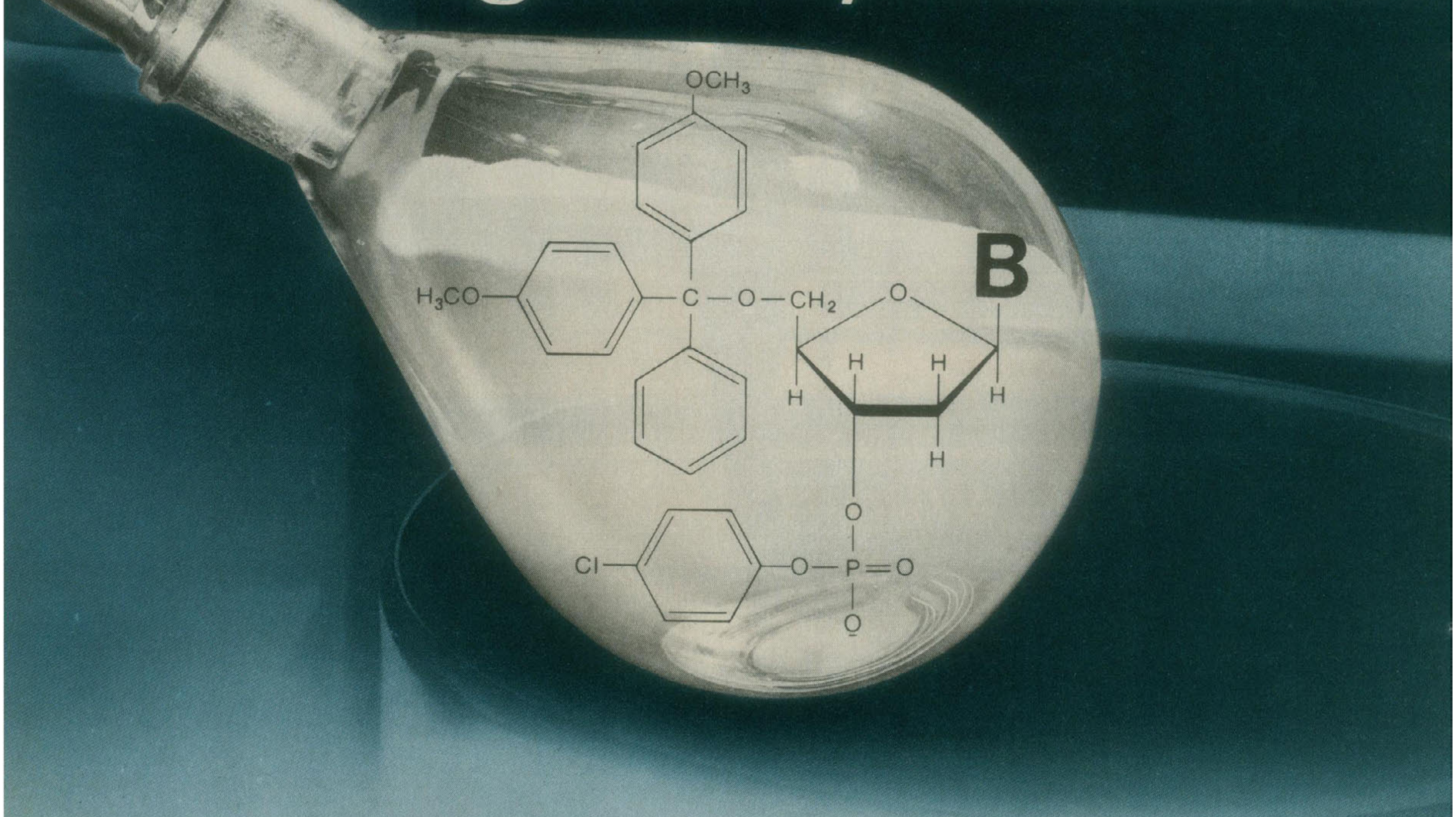

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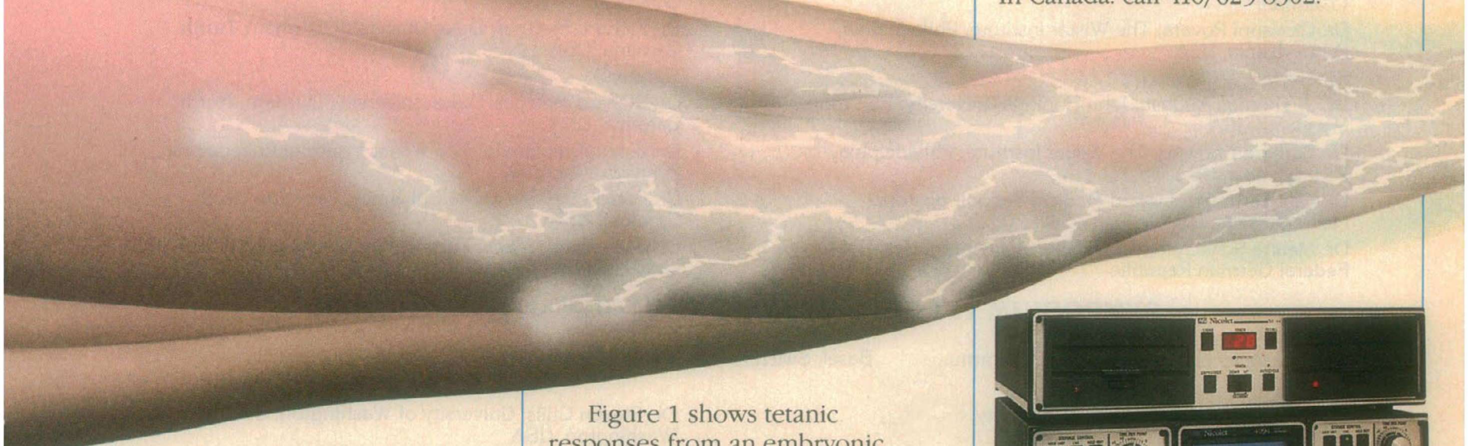

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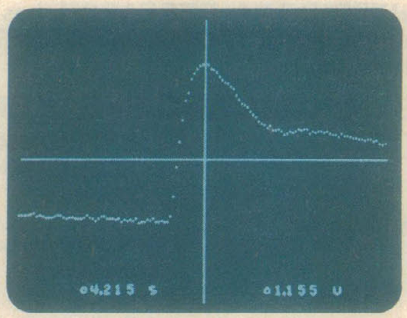

Fig. 2—Expansion of selected area for detailed analysis (up to X 256)

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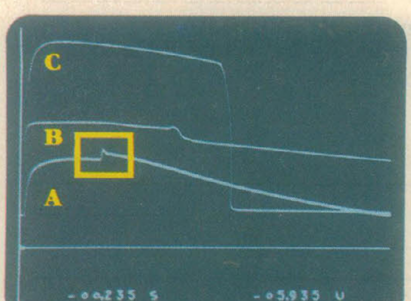

Fig. 1—Tetanic response in avian embryonic muscle after 15 days (A), 17 days (B), and 19 days (C) in ovo.

Figure 1 shows tetanic responses from an embryonic chicken muscle after 15, 17 and 19 days in ovo. These responses were captured and stored on a Nicolet digital oscilloscope then recombined on the screen for comparison. The high resolution and expansion capabilities allow detailed examination of small changes as shown in Figure 2. Cursor-interactive coordinate display eliminates the need to estimate amplitude or latency values of a waveform feature. Stored waveforms can be displayed or plotted in XY or YT format, transferred to internal disk memory for permanent storage or output to other computing devices via industry standard interfaces.

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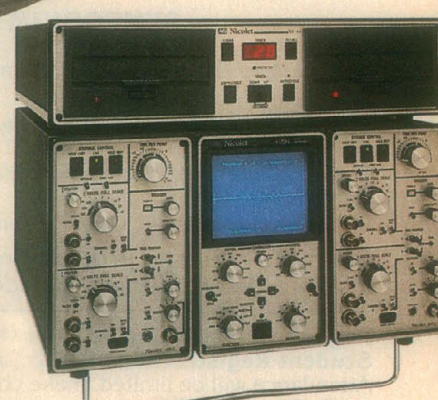

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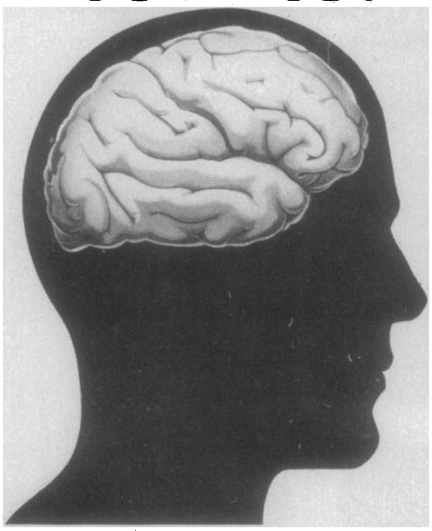

Newton and Mercury Poisoning

Tongue-in-cheek articles such as "Sir Isaac Newton: Mad as a hatter" (News and Comment, 18 Sept., p. 1341) are fun to write and fun to read. But *caveat lector*. Such articles are not to be taken seriously. Granted Newton carelessly exposed himself to a variety of potentially harmful chemicals, including mercury. Granted that at one time hatters suffered from occupational mercurialism in which erethism was a frequent manifestation. (I have seen many such.) But the most common sign of chronic poisoning from inorganic mercury is an intention tremor. In fact, this tremor is a sine qua non in diagnosing chronic poisoning. Jerky handwriting is routinely used as a means for eliciting this finding. I suggest that an examination of samples of Newton's handwriting before, during, and after his "episode" would provide more reliable evidence for or against mercury poisoning than does analysis of a hair. No mention of tremor is made in William J. Broad's article, although other symptoms are listed.

More distressing is the reappearance of the notion that the Mad Hatter was a victim of mercury poisoning. Alice's Mad Hatter has been identified as one Theophilus Carter, an eccentric and erratic furniture dealer in Oxford who earned his sobriquet from never appearing in public without wearing an outlandish top hat (*1*). The expression "mad as a hatter" is most likely a cockney corruption of "mad as an adder," common in the mid-19th century.

Broad, in his article, mentions "Newton folklore." I see nothing wrong with folklore as long as it is recognized for what it is and it does not masquerade as fact or science.

LEONARD J. GOLDWATER
Department of Community and Family Medicine, Duke University Medical Center, Durham, North Carolina 27710

References

1. L. J. Goldwater, *Mercury: A History of Quicksilver* (York, Baltimore, Md., 1972), pp. 267, 273–274.

Cost of Research

The "prospects for research libraries" (Editorial, 14 Aug., p. 715) are indeed grim. However, the answer does not seem to be in interlibrary loans and computer technology. What we lack is aggressive management of information by both librarians and researchers.

Librarians must be aggressive in writing treaties of cooperation. Without a national library for direction the heads of our libraries should fill the vacuum. We need more agreements on who is going to collect which subject areas; the treaties must include arrangements for efficient delivery. Perhaps some innovative agreements with area business libraries would help the funding.

Researchers, who benefit from the information, also must be aggressive. We need strong critiques of the new (and old) journals coming out. Which editorial boards are doing their work (or, at least, which are capable of doing their work)? As it is now, anything published must be bought. Yet, everything cannot be good. Professional societies could help in this analysis of quality, and editors themselves could give us direction.

Computer technology will help in the management of information, but only if we actively decide what needs to be done.

JULIAN W. GREEN
Geological Sciences Library, Harvard University, Cambridge, Massachusetts 02138

George Black's editorial accurately describes the problems research libraries face—maintaining subscriptions to an adequate number of journals, purchasing new books, and maintaining their present inventories in a time of rising costs and shrinking budgets. His proposed solutions, increasing interlibrary loans and cooperative stocking, are clearly necessary for the continued operation of our library system. . . . While I do not suggest that inadequate libraries are the cause of all our ills, I feel they may be a place to do something about our decline. Printing technology is inadequate for the huge amount of information necessary in today's technological society and is rapidly becoming too expensive. Something better is needed and fortunately is available in computer and telecommunications technology.

Implementing a nationwide electronic library system is a very large challenge for a variety of reasons, notably the lack of standards and direction; but most of the hardware is available. The software required would probably take several man-centuries to write, to say nothing of its cost. (New and current material can easily be entered, but I shudder when I think of the job of getting all previously published material on the system.) It is in everyone's best interest to start planning now for such an electronic library.

VICTOR A. LUPIDI
Control Data Corporation, Philadelphia, Pennsylvania 19103

. . . Black, in his reporting of statistics from the Association of Research Libraries (ARL), compares median figures for volumes added and expenditures for 1969–1970 to figures for 1979–1980. In 1969–1970 there were 76 university library members in ARL; by 1979–1980, 33 more university libraries had been added to the membership. Because the largest university libraries were already members in 1970, the 33 new members tended to be smaller, "developing" research collections. This had an effect on the median figures for the overall membership.

A 10-year analysis (*1*) of only those libraries that were members of ARL in both 1969–1970 and 1979–1980 indicates that expenditures for materials increased by 91 percent, while the number of volumes added decreased by 22.5 percent. Although the precise figures differ from Black's, the general trend is as he describes.

CAROL A. MANDEL
Association of Research Libraries, 1527 New Hampshire Avenue, NW, Washington, D.C. 20036

References

1. C. A. Mandel, *ARL Statistics* (Association of Research Libraries, Washington, D.C., 1980).

Future Planetary Missions

The Research News article "To the planets, cheaply" by M. Mitchell Waldrop (18 Sept., p. 1350) gives a misleading impression of finality to the reader and to the planetology community in particular. The six recommendations presented to the administrator of the National Aeronautics and Space Administration (NASA) by the Solar System Exploration Committee (SSEC) were strictly stopgap, addressing only immediate issues. These included emphasizing the high scientific priority of the Galileo mission to Jupiter and of the Venus Orbiting Imaging Radar mission; endorsing the Halley Intercept Mission as a budget add-on, not at the expense of an approved program; expressing concern over the cancellation of the U.S. Solar Polar spacecraft; examining the immediate and ongoing dependence of the planetary exploration program on the availability of a high-energy upper stage for the space shuttle (for example, Centaur); maintaining the readiness of low-thrust (for example, solar electric) propulsion technology; and strengthening international cooperation and commitments in general, with special attention to those with the Soviet Union.

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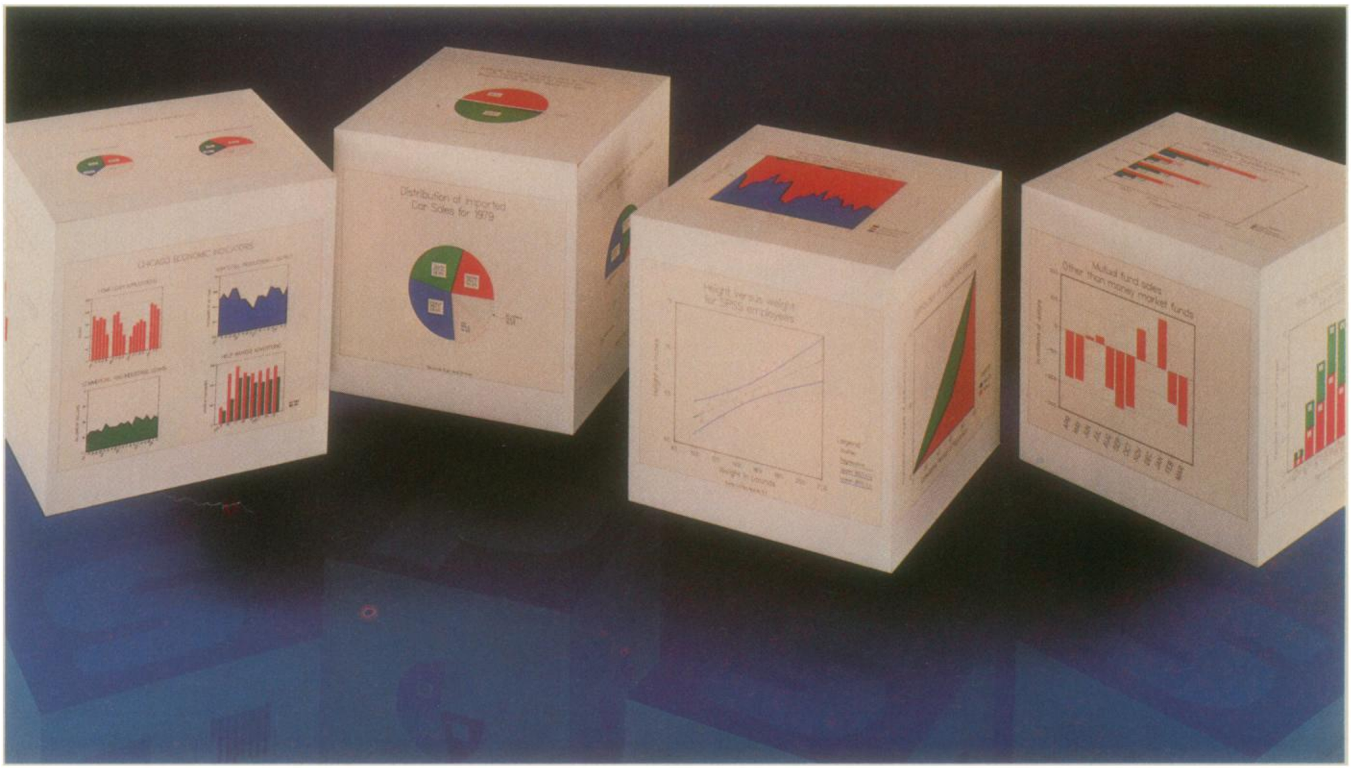

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R & D at Bell Laboratories

Bell Laboratories is esteemed for its innovative excellence, creativity, and enlightened policies with respect to basic research. Other companies have been notably innovative and some have contributed to the advancement of science. But, in general, sponsorship of basic research by industry has left much to be desired. Some major research-oriented companies give freedom to a small fraction of their staff and are willing to forgo short-term benefits from them. Virtually all companies place heavy emphasis on obtaining proprietary advantages through the work of their scientists. This is, of course, expectable. But it can be carried too far. Emphasis on proprietary advantage creates an atmosphere of secrecy. Even after patents have been obtained, scientists often do not publish results of basic research. Few managements encourage publication. In this respect, Bell Laboratories is exemplary. Last year, its members published about 2300 papers, most of them in peer-reviewed journals. That seven of its scientists have received the Nobel Prize attests to the level of excellence of work at the laboratories. Research there has created new fields of science, such as radio astronomy. Its work in basic physics and related materials sciences has led research throughout the world. The discovery of the transistor led to a great expansion of solid state electronics that is the basis of modern communications and a host of consumer products as well as computers.

Bell Laboratories is the focus for research and development in the Bell System, which includes Western Electric, a manufacturing arm, and most of the major telephone companies of this country. At the beginning of 1981, Bell Laboratories employed 12,000 scientists and engineers of whom about 3000 were Ph.D.'s. As is common with companies carrying on R&D work, about 90 percent of the effort is devoted to development.

Good industrial laboratories have some advantages over academic institutions. For example, they tend to be better equipped and they are more effective in conducting interdisciplinary research. Another advantage is the ease with which results of basic research are conveyed to those who can use them in development and, conversely, the ease with which engineers can communicate their needs to scientists.

In the course of numerous visits to Bell Laboratories, I have noted many instances of good interaction between scientists and engineers. An important ingredient in channeling basic research toward useful objectives is a clearly stated mission. At Bell Laboratories everyone understands that the mission is to provide new telecommunications technology. This includes equipment designs, the engineering and planning of a telecommunications network, and the technology for its operation and maintenance. It is the function of research to support this mission. Within this framework, the latitude for individual scientists is remarkably broad. Research is for the most part concerned with the creation of new knowledge that will lead to technological development over the long term.

In the effort to attain excellence in research at Bell Laboratories, management has at least two objectives. One is the obvious wish to create an in-house capability for leadership. The second is to provide a good interface with research that is being conducted elsewhere. By very active participation in scientific meetings and by publishing, Bell scientists become well known throughout the world and are sought out for informal conversations. In addition, outside scientists exchange much information during visits to Bell Laboratories. By contrast, many companies maintain such a tight policy with respect to release of information that their employees are not particularly welcomed by other scientists.

Spokesmen for the Reagan Administration have held out the hope that with tax breaks, companies might be inclined to support more basic research. However, most companies do not seem to know how to create conditions under which research can flourish and at the same time be useful. They cannot be expected to attempt a slavish imitation of Bell Laboratories, but they could learn lessons there.—PHILIP H. ABELSON

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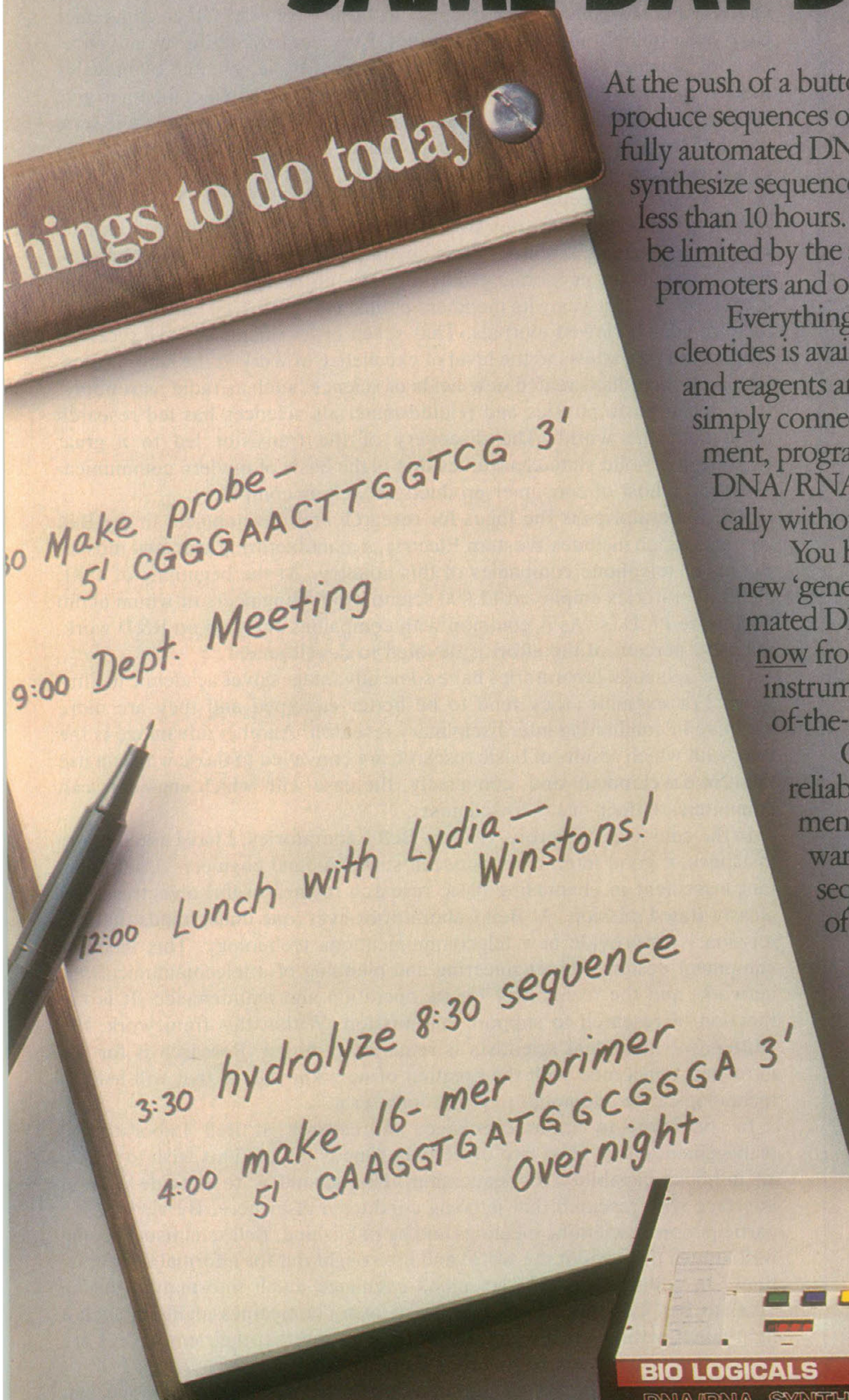

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