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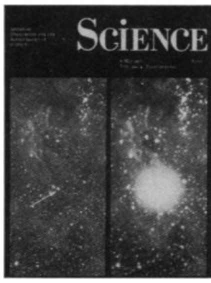

COVER Supernova 1987A—an exploding star. On 23 February 1987, light and neutrinos reached Earth from the brightest supernova in almost 400 years. "Before (left) and after (right)" photos show the star that exploded and the supernova shortly after outburst. Photographs were taken using the 3.9-meter Anglo-Australian Telescope in New South Wales, Australia. See page 750. [Courtesy of David Malin, copyright 1987, the Anglo-Australian Telescope Board]

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This Week in SCIENCE

Insight into vision

A visual image has color, depth, movement, form, and texture (page 740). Anatomic and physiologic studies in monkeys and perception studies in humans indicate that these components are processed by separate channels and that the segregated, parallel processing begins in the eye and continues as far into the brain as has been probed. There is also some supportive clinical evidence that distinct circuits process individual components of an image: stroke victims sometimes have selectively short-circuited vision, experiencing, for example, loss of only one segment of vision such as color vision. The experimental studies and the insights they provide into the structure, function, and evolution of the visual system are described by Livingstone and Hubel. It is enigmatic that visual images seem to be unified, when, in fact, processing keeps the parts of the whole separate from one another.

Highlighting differentiation

STREPTOMYCETES are soil bacteria that form colonies in which physically distinct cells perform specialized functions (page 768). It takes several days for a colony to mature. Substrate mycelium cells initially burrow down into the medium on which the colony is growing; later aerial mycelium cells grow upward out of the substrate cells and eventually produce spores. When and where various genes are turned on and off within the colony during this complex differentiation process has now been studied by Schauer *et al.* through the use of a "reporter" gene cluster, *luxAB*. This cluster was transferred into streptomycetes cells next to different genes; as indigenous genes were expressed during differentiation, their promoters concurrently turned on nearby *luxAB* genes. The location of active genes was devilishly simple to identify because, when the *luxAB* gene cluster is turned on, the enzyme luciferase is produced and light is emitted: steps in morphologic differentiation are in this way spatially and temporally illuminated.

Fast-forward chemistry

A state-of-the-art laser system has made it possible to directly observe steps in a chemical reaction that goes from reactant to product within 500 femtoseconds (10^{-15} seconds) (page 777). In the prototype experiment, the retinal prosthetic group of bacteriorhodopsin, a light-sensitive bacterial membrane protein that pumps protons through the membranes of *Halobacterium halobium*, was observed to isomerize from a trans to a cis configuration. Mathies *et al.* experimentally induced the chemical transformation with 60-femtosecond optical pulses; dynamic structural changes were followed spectrophotometrically with 6-femtosecond resolution. The spectroscopic signature (a direct monitor of a structural change) at 150 femtoseconds showed the prosthetic group twisting; the torsional displacement of the prosthetic group resulted in a permanent change in the molecule's geometry.

Inside Uranus

NEW models of the interior of Uranus and new ways of testing these models have been developed since Voyager II took a close-up look at the distant planet in 1986 (page 779). Uranus consists of ice, gas, and rock and has a powerful but uneven magnetic field. Nellis *et al.* have investigated in the laboratory how methane, ammonia, and a mixture of water, ammonia, and isopropanol called synthetic Uranus—all thought to be prevalent on the planet—behave under simulated planetary conditions. During passage of a strong shock wave, the materials were molecularly ionized and dissociated. Conductivity was strong within certain high temperature and pressure ranges, accounting for (and constraining calculations of) the internal dynamo that produces the planet's magnetic field. All materials deep within the planet are likely to be dense and stiff; conditions in Uranus might thus be right for production of diamond-like carbon, nitrogen, and oxygen.

Hand bones and tools

HAND bones discovered at the 1.8-million-year-old Swartkrans site in South Africa indicate that the extinct hominid *Paranthropus robustus* could have made and used tools (page 781). Bone and stone artifacts suitable for digging or preparing foods were also found. It had not before been appreciated that *P. robustus*, like contemporaneous species *Homo habilis* and *Homo erectus*, had grasping fingers and a human-like thumb. However, the shapes, sizes, and muscle insertion sites of the 22 hand bones found indicate similarities to human hands and major differences from monkey and ape hands, which are adapted for power grasping during climbing. *Paranthropus robustus* had a small brain and large teeth, and the species' extinction has been attributed to a presumed combination of low intelligence and an inability to use tools and engage in other sophisticated behaviors; Susman suggests that, since it is now clear that *Homo* did not have a monopoly on the capacity to use tools, some other explanation must be found for the survival of *Homo* and not *Paranthropus* species (see also Lewin, page 724).

The bottom lines

THE explosion of the 10-million-year-old blue star Sanduleak −69°202 into Supernova 1987A was astronomical in every way: the energy output in the first second exceeded by two orders of magnitude the energy output of the sun through its entire lifetime, supernova neutrinos from the star's collapse were detected deep within the earth, temperatures may have reached 10 billion kelvin in the exploding star's core, and astronomers and astrophysicists were afforded the opportunity of a lifetime—to test old theories and formulate new ones about how stars live and die (page 750).

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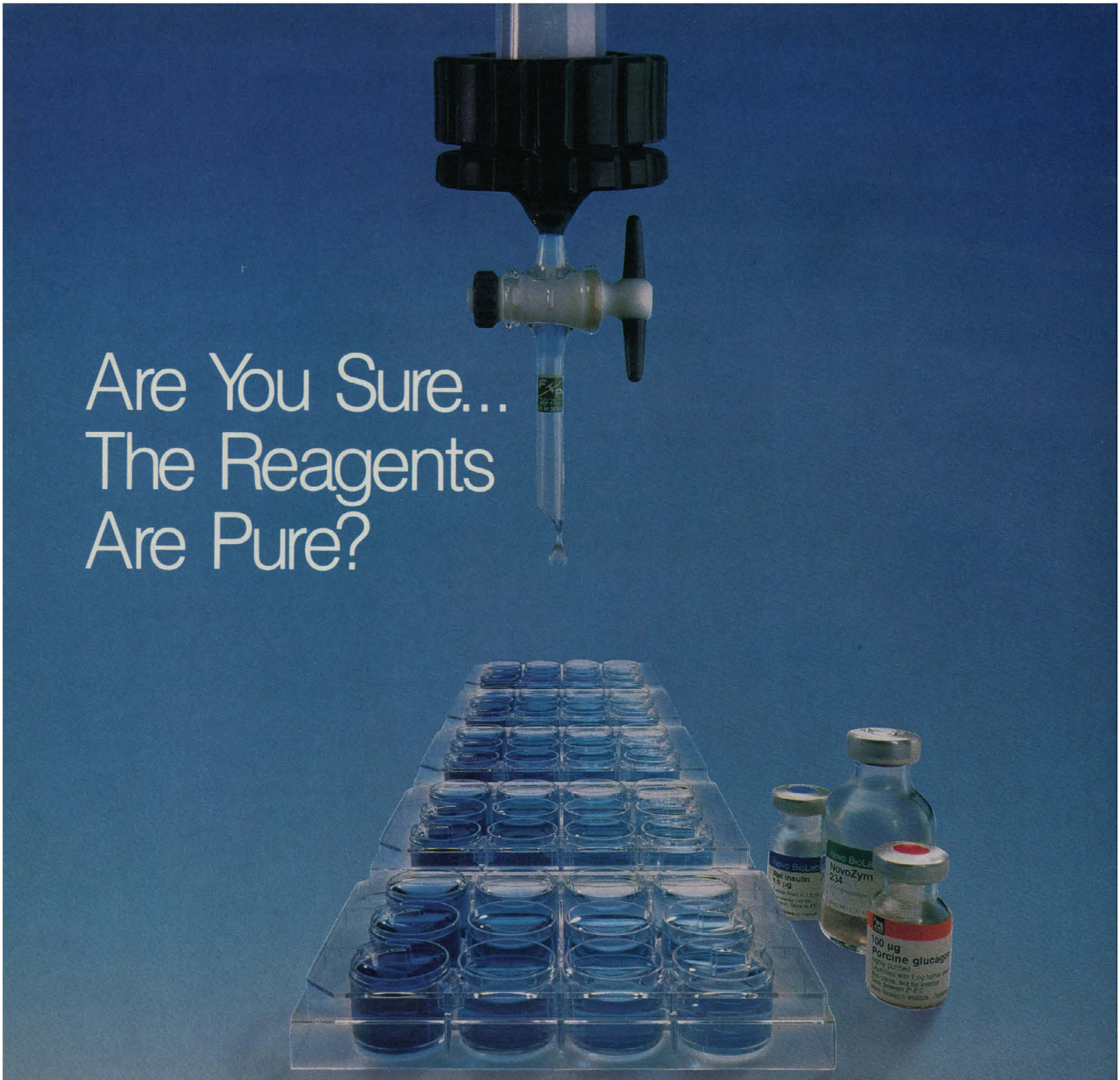

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6 MAY 1988
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World Competition in Biotechnology

Virtually every developed country and many developing countries have targeted leadership in biotechnology as a national goal. In efforts to compete with the United States in applications of molecular biology to produce pharmaceuticals, would-be competitors are latecomers, with limited prospects. But in agriculture, the picture is quite different, and the United States could become second-rate. In the United States, generous support of biomedical research for decades led to great advances in molecular biology and to the training of a large number of talented people capable of advancing the biomedical sciences. Would-be competitors have limited reservoirs of expert personnel. Another favorable factor for the United States has been an abundance of venture capital, which was in short supply elsewhere. For some possible competitors the cost of development and clinical trials of pharmaceuticals ($75 to $100 million) needed to gain approval from the U.S. Food and Drug Administration is an inhibiting factor.

In contrast to federal support of biomedical research, funds for basic research in plant biology have been meager and the sums provided individual investigators have been tiny. Consequently, the knowledge base of the molecular biology of plants is limited. The level of conventional agricultural science in other countries is comparable to that here, and in some instances possibly superior. Expertise in the new biotechnology is widespread. Average yields of wheat per hectare in the Netherlands are more than twice those in the United States as are yields in the United Kingdom. There are mitigating factors, but these do not cancel the contrasts in yields. Our balance of agricultural trade has dwindled.

The crop surpluses in the United States have been used as an argument for curtailing research. However, if we move slowly in exploiting new biotechnology, we will lose competitiveness fairly rapidly. The time span and the investment required to introduce modified plants or symbiotic bioengineered microorganisms is small compared with that required for pharmaceuticals. Economics is one reason for pursuing vigorous development of plant biotechnology. Other benefits include diminished need for fertilizers and pesticides. Were productivity to be increased, less land would be required for crops, with less related soil erosion.

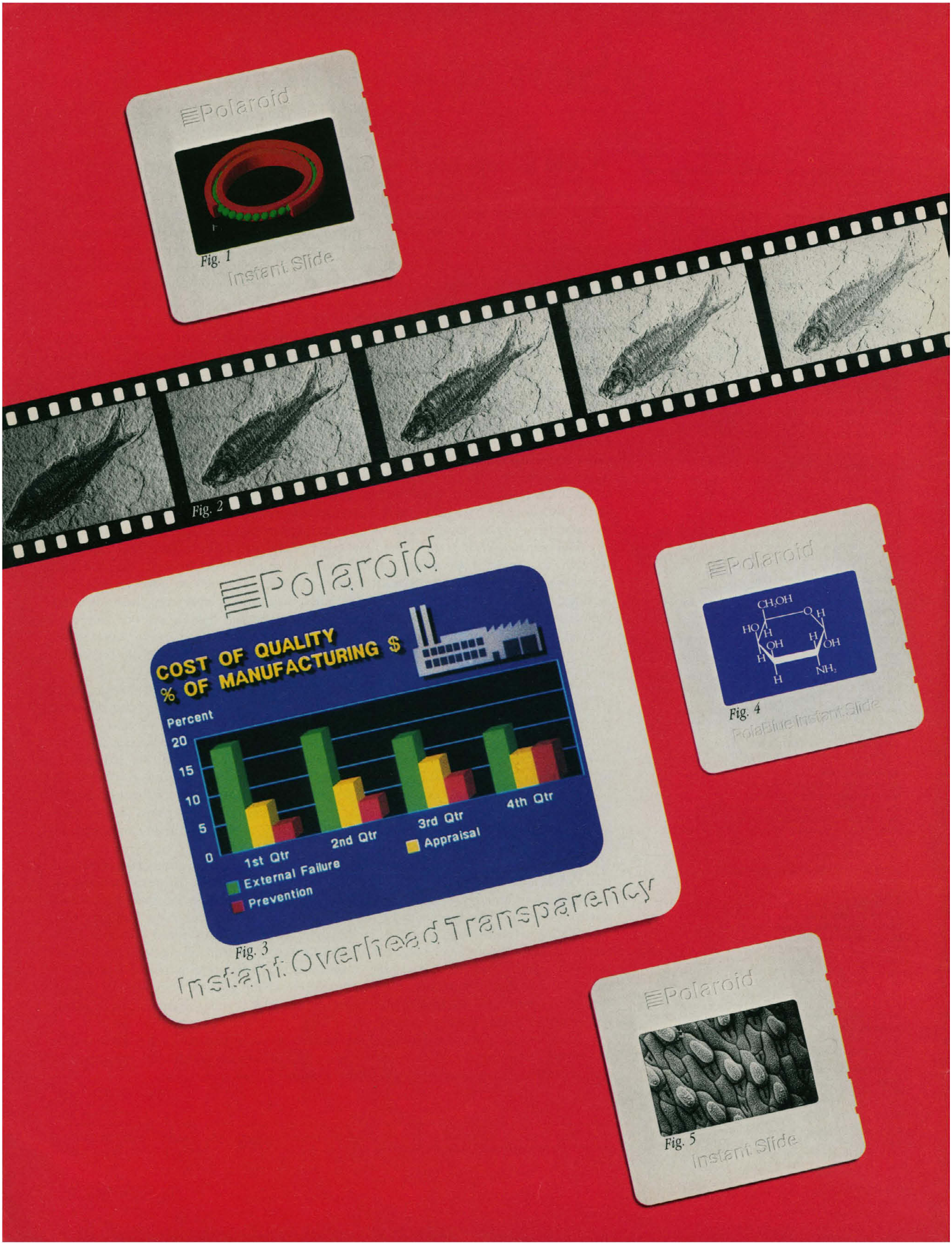
Major companies are devoting substantial funds to agricultural biotechnology. Their efforts are complemented by many new, small outfits. But progress has been greatly impeded by regulatory processes and legal actions. Although some caution in introducing new technologies is warranted, caution has been overdone. For example, there has been concern about introducing into the field a corn plant with a single altered gene. But Howard A. Schneiderman has pointed out that to convert a corn plant into a weed would require hundreds of genetic changes, because corn does not have a "weedy personality."* Regulations should take into consideration the basic characteristics of plants into which a gene or genes are to be incorporated. Some of our crop varieties require human assistance for survival.

Another area in which progress is being impeded is in the introduction of beneficial soil microorganisms. A prejudice exists against organisms whose DNA has been modified by recombinant technology. But during most of this century, rhizobia (designed to enhance nitrogen fixation) have been added to millions of acres of agricultural soil. Roughly 10^{18} rhizobia improved through mutation by chemicals or radiation are added each year. This release has not produced a negative environmental impact. Inoculants of selected mycorrhizae have greatly helped in restoring wastelands. In estimating potential hazards of introducing modified organisms, the gene's location in the genome is important. A gene located on a plasmid is much more likely to be transferred to another organism than is a gene that is part of a chromosome.

Advances in molecular biology have created great opportunities for advances in agriculture. The United States can persist in a policy of starving agricultural basic research and of overregulating biotechnology. Others may not follow such a path.

—PHILIP H. ABELSON

*H. A. Schneiderman, "Biotechnology: A key to America's economic competitiveness in health care and agriculture," speech at the Second Annual American Society for Microbiology Conference on Biotechnology, San Diego, CA, June 1987.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Biology Teaching

As a biology teacher with 28 years of experience, mostly in high school, and as a biology textbook author, I wish to join in the great frog debate: dissection versus frog integrity. My students did some dissection, yet I feel that requiring a student to sue in order to avoid participation is silly. If a student of mine occasionally objected to doing dissection, with or without specifying a reason, I retained my equanimity. The student simply retreated to the back of the room and took up another assignment. More often than not, with the rest of the class happily (and noisily) engaged, the dissenting student would edge forward to see what all the excitement was about. Sometimes the boy or girl would have second thoughts and ask to join in the dissection. When such an activity has to depend on legal sanctions, its educational value is likely to be nil.

Why excitement at frog dissection? The reason is that I used live frogs, never pickled specimens of any kind. Just before class I pithed them—in a preparation room out of the students' sight. Thus the tissues and organs remained fresh and functioning. Excitement was generated by seeing the beating heart alternately flushing and paling. Often an enthralled boy or girl called me over and said in wonder: "Look, it's still beating!" Students marveled at an isolated heart continuing to pulsate in saline, at the intestine slowly writhing in peristalsis, at the gastrocnemius responding to nerve stimulation. These close-ups of glistening, functioning, living tissues generate a perception of life processes not matched by reading a textbook, by computer simulation, by audiovisual media, or by classroom lectures or discussions, however lively.

Yet dissections were not numerous in my course. I depended much more on behavioral studies of living animals, and to a lesser extent on studies of plants and microbes. Before the frog dissection lesson the students were given live frogs to observe in a variety of situations. An even more intriguing animal was the edible Burgundy snail, *Helix aspersa*. As science chairman in a high school on New York City's Lower East Side, with funds for supplies very limited, I had the task of providing 1500 biology students with living materials. But the Italian fish stores on Second Avenue provided snails at $1 a pound (100 snails). With 2 pounds of snails and a few heads of lettuce, the student body had a fascinating lesson.

Frogs and snails, alas, are no longer available. Frogs have become scarce and expensive. *Salmonella* infections have restricted the importation of Burgundy snails, and when they are available they cost far more than a penny apiece. But we should not despair. Resources of living materials are almost unlimited; the limiting factor is teacher ingenuity. If three or four beans are put in a jar of water and incubated overnight, on the next day the culture will be swarming with bacteria. Students seemed never to tire of watching the swarming culture, with spirilla and bacilli vigorously swimming about. Nor did I ever tire of watching the bacteria through the microscope.

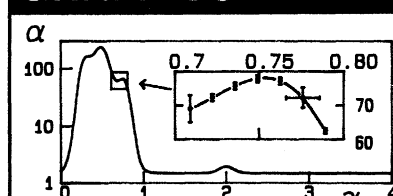
These activities were not "experiments," and I did not call them that. We referred to them as "lab exercises." In a large high school class, with limited resources, a rigid time limitation, and a limited student background, it is difficult to do genuine, honest, scientific experiments. Many so-called student experiments are faked or fudged; or the results are determined a priori. The common pressure on students to get the "right answers" also destroys the scientific validity of the "experiments." In the kinds of activities described above there are no "right answers." Any function of an organism or of its organs that a student observed and accurately reported was the right answer.

Are these activities "science"? I think not. They are more in the nature of natural history or "pre-science." For this I offer no apology. James Watson began as a bird watcher. As a boy Charles Darwin collected beetles and birds' eggs. As the Chinese proverb puts it: "Tell me and I hear. Show me and I observe. Involve me and I understand." It is a standard axiom in education, honored more in the quotation than in the observance, that students learn by doing; learning is an active process. I tried to have my students "do," and many of them have gone into science as a profession or vocation.

Robert B. Eckhardt reports that he found his biology course dull (Letters, 18 Mar., p. 1361). Horrors! Living creatures are endlessly fascinating to people and especially to young people. Give students live animals or living tissues to work with and they cannot help but find biology interesting. More than a few of my former students have told me that they were first attracted to biology when they watched and tested the beating heart of a freshly pithed frog.

Stanley L. Weinberg
*Iowa Committee of Correspondence,
Ottumwa, IA 52501*

Erratum: In Mark Crawford's story "Budget crunch stalls Super Collider" (News & Comment, 1 Apr., p. 17) the caption accompanying the photograph was incorrect. The superconducting magnet pictured was 4.5 meters long, not 17 meters, as stated.



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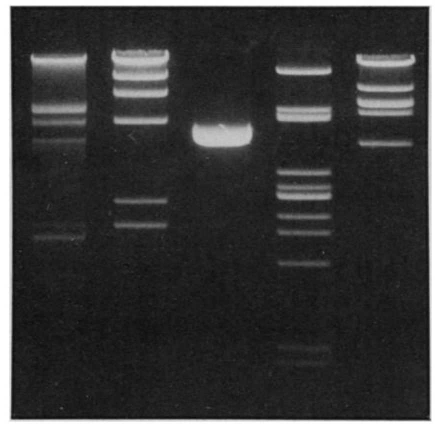

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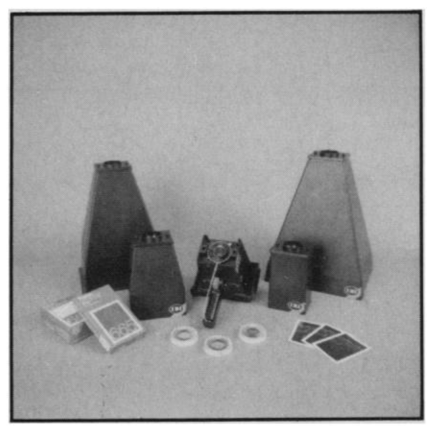

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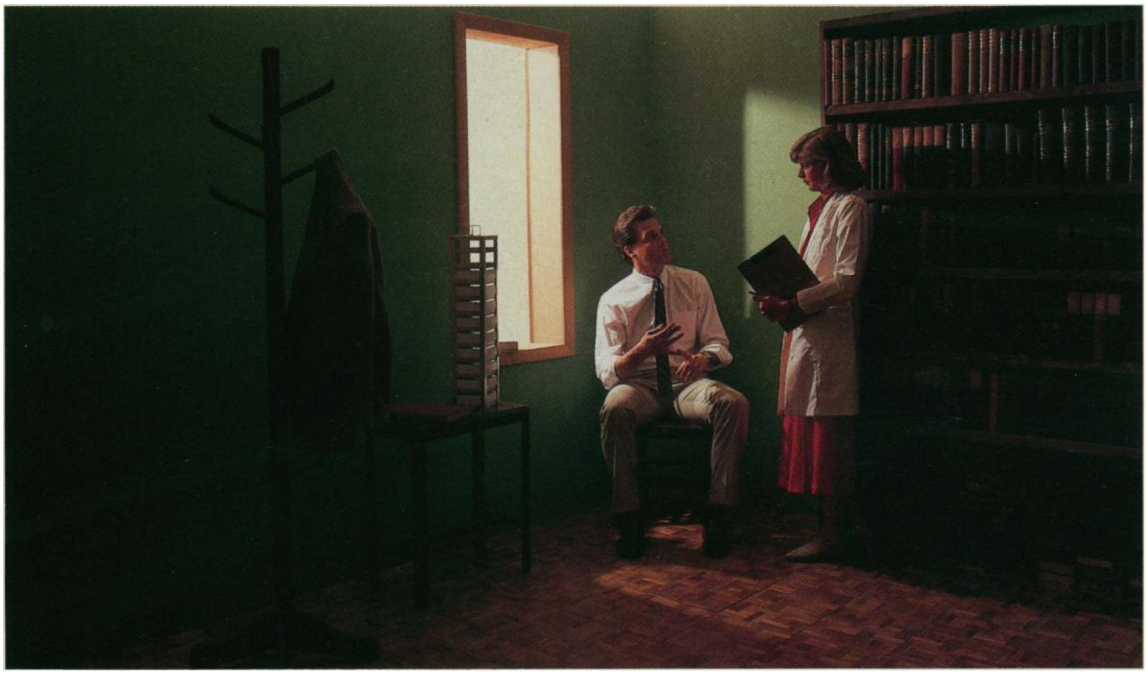

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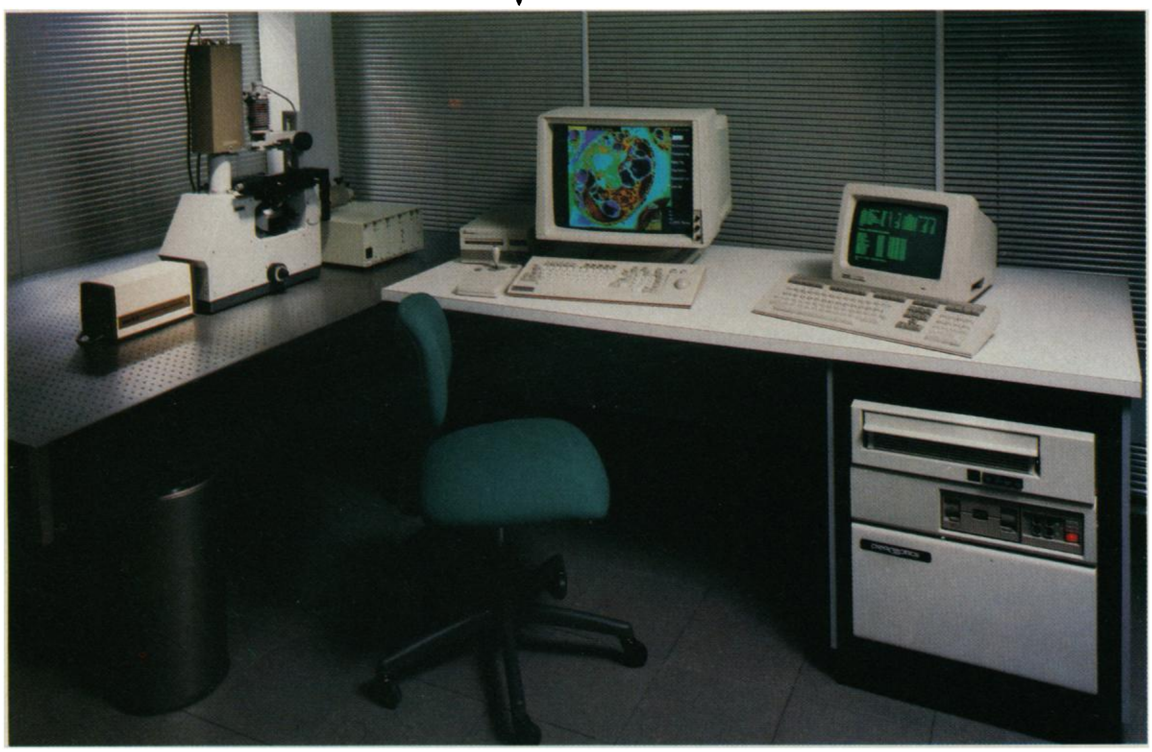

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ADDENDUM
1988 GUIDE TO BIOTECHNOLOGY PRODUCTS AND INSTRUMENTS

TO: ALL SCIENCE SUBSCRIBERS

It has come to our attention that the Du Pont Company's listing in our *Guide to Biotechnology Products and Instruments* was not reflective of Du Pont's broad product offering for biotechnology research. The Du Pont Company should have been listed under the following headings:

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antibodies, affinity-purified
antibodies to cell surface markers
antibodies to cell surface receptors
antibodies to chemicals
antibodies to complement components
antibodies to cytoskeletal proteins
antibodies to drugs
antibodies to enzymes
antibodies to growth factors
antibodies to hormones
antibodies to human blood-group antigens
antibodies to immunoglobulins
antibodies to lectins
antibodies to lymphokines and monokines
antibodies to peptides
antibodies to retroviruses
antibodies to tumor antigens
antibody-enzyme conjugates
immunoglobulins
monoclonal antibodies, custom synthesis of
monoclonal antibodies to antibiotics
monoclonal antibodies to cell surface receptors
monoclonal antibodies to DNA
monoclonal antibodies to hormones
monoclonal antibodies to immunoglobulins, human
monoclonal antibodies to immunoglobulins, mouse
monoclonal antibodies to infectious agents
monoclonal antibodies to lymphokines and monokines
monoclonal antibodies to retroviruses
monoclonal antibodies, other
viral antigens

BACTERIAL ANALYSIS AND CHEMICALS

retrovirus reagents
retrovirus test kits

CELL CULTURE

lymphocyte separation materials

CENTRIFUGES

centrifuge accessories
centrifuge rotors
centrifuge tubes
centrifuges, cell-washing
centrifuges, continuous-flow
centrifuges, general-purpose: below 5000 rpm
centrifuges, hemocrit
centrifuges, micro
centrifuges, refrigerated: below 25,000 rpm
centrifuges, tabletop
centrifuges, ultra

CHROMATOGRAPHY

chromatography, affinity: ready-to-use immobilized supports
chromatography, column: column packings
chromatography, column: columns
chromatography, gel-filtration: protein columns
chromatography, HPLC: column-packing materials
chromatography, HPLC: column packings
chromatography, HPLC: columns
chromatography, HPLC: prepacked columns
chromatography, HPLC supplies
chromatography, ion-exchange: HPLC specialty resins
chromatography, ion-exchange: prepacked columns
chromatography, liquid: products

ELECTROPHORESIS

electrophoresis equipment, DNA: sequencing
electrophoresis equipment, gel
immunoelectrophoresis products
protein transfer paper and media

GENETIC ENGINEERING

amino acids, radiolabeled
amino acids, trinitrophenyl
blotting supplies
cloning vector M13 and derivatives
cloning vector pBR322 and derivatives
3' deoxyadenosine 5' triphosphate
deoxynucleosides
deoxyribonuclease I, pancreatic
deoxyribonucleoside triphosphates
deoxyribonucleotide triphosphates, radiolabeled
deoxy sugars
dideoxyribonucleotide triphosphates
DNA labeling kit, 3' end
DNA labeling kit, 5' end
DNA, M13
DNA polymerase I, Klenow fragment
DNA probes
DNA sequencing reagents, dideoxy
DNA sequencing reagents, Maxam-Gilbert
DNA size markers
dopamine agonist
fermenter accessories
growth factors
mRNA, rabbit globin
nick translation kits
nucleosides, radiolabeled
nucleotide analogs
nucleotides
nucleotides, cyclic
oligonucleotide synthesizers, automated
oligonucleotides

oligonucleotides, insolubilized
oligonucleotides, primer
peptide synthesis reagents
peptide synthesizer
peptides, biologically active
polynucleotide kinase
polynucleotide kinase, T4
protein immunoblotting
purine and pyrimidine bases
ribonucleotides
ribonucleotides, radiolabeled
RNA probes
software, sequencing
solid-phase protein synthesis, chemical cleavage reagents
solid-phase protein synthesis, couplers for solid support
solid-phase protein synthesis, reagents for modification of reactive groups
synthesis equipment, automated
transcription systems
translation systems, prokaryotic DNA-directed
translation systems, rabbit reticulocyte lysate
translation systems, wheat germ

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angiotensin
bicuculline
Bolton-Hunter reagent
bradykinin
carbohydrates and derivatives
chloramphenicol
cortisol
coumarin dyes
eicosancids
endorphins
enkephalins
estradiols
fatty acids and derivatives
interleukins, recombinant
inulin
iodinated compounds
leukotrienes
lipase substrates
lipids
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neuropeptide
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prednisone
pregnadien compounds
pregnenolone
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prostaglandins
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γ radiation standards
silver stain
somatostatin
sterols
substance P
testosterone
thromboxanes
thyrotropin releasing hormone
thyroxine
trilodothyronine (T)
vasopressin

NUCLEAR INSTRUMENTS

autoradiographic cassettes
autoradiographic chemicals and film
autoradiographic enhancers
chemicals, carbon 14-labeled
chemicals, stable isotope-labeled, other
chemicals, tritium-labeled
detectors, nuclear radiation
elements, isotopically enriched
gases, isotopically labeled
radiation calibrators
radiation decontaminants
radioactive sources, calibrated
radiochemical sources
radiodecontamination kits
radioimmunoassay equipment
radioimmunoassay supplies
radioisotopes
scintillation chemicals
scintillation vials
β sources
γ sources
standards, liquid scintillation counting
standards, radiochemical
synthesis services, radioactive compound

TECHNICAL MATERIALS AND SCIENTIFIC APPARATUS

instrument calibration and repair
instrument services, contract
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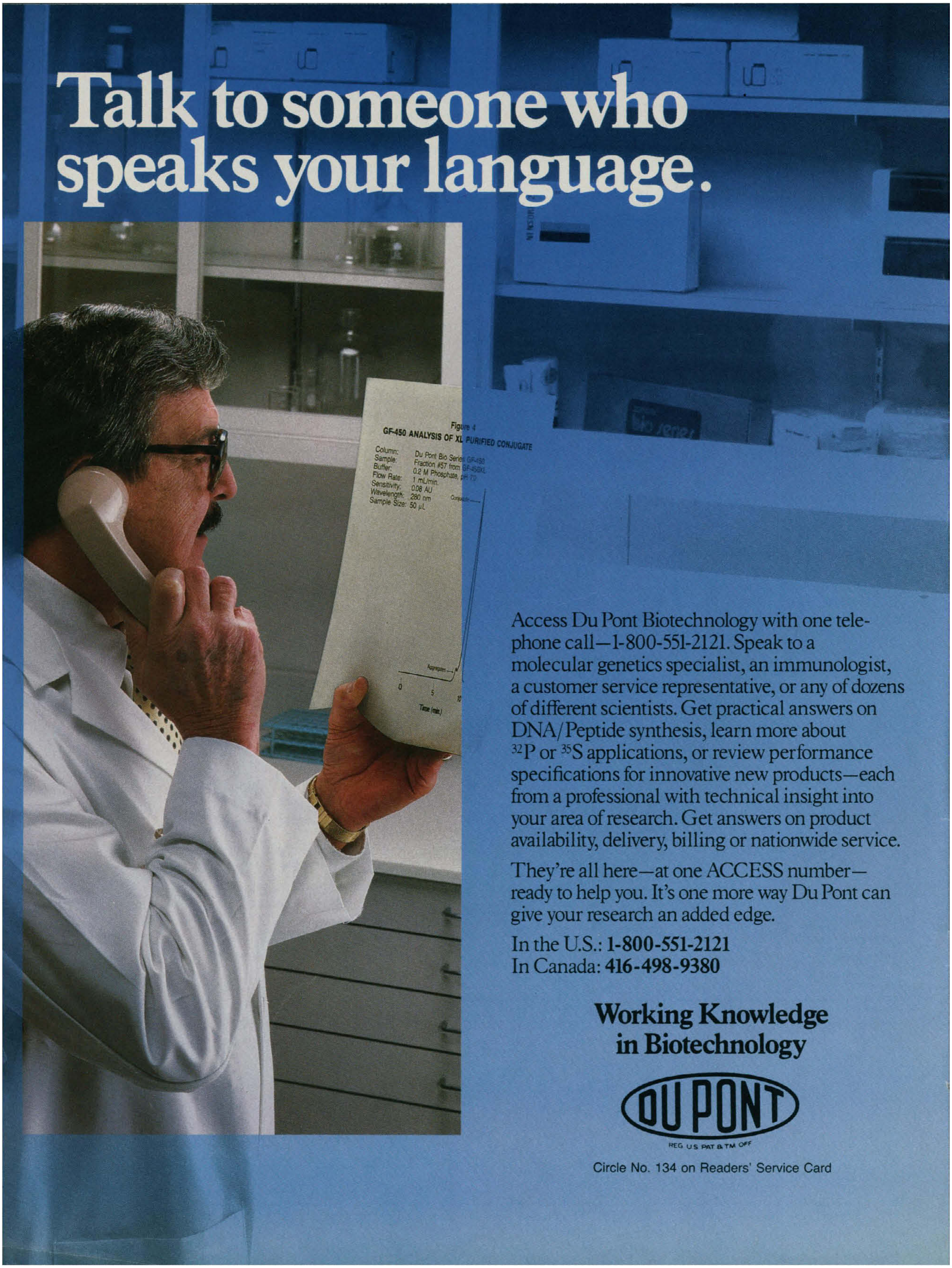
instruments, used
separation and purification equipment
shielding, radio frequency

Please add this addendum to your 1988 *Guide to Biotechnology Products and Instruments.*

Patricia A. Morgan, *Managing Editor*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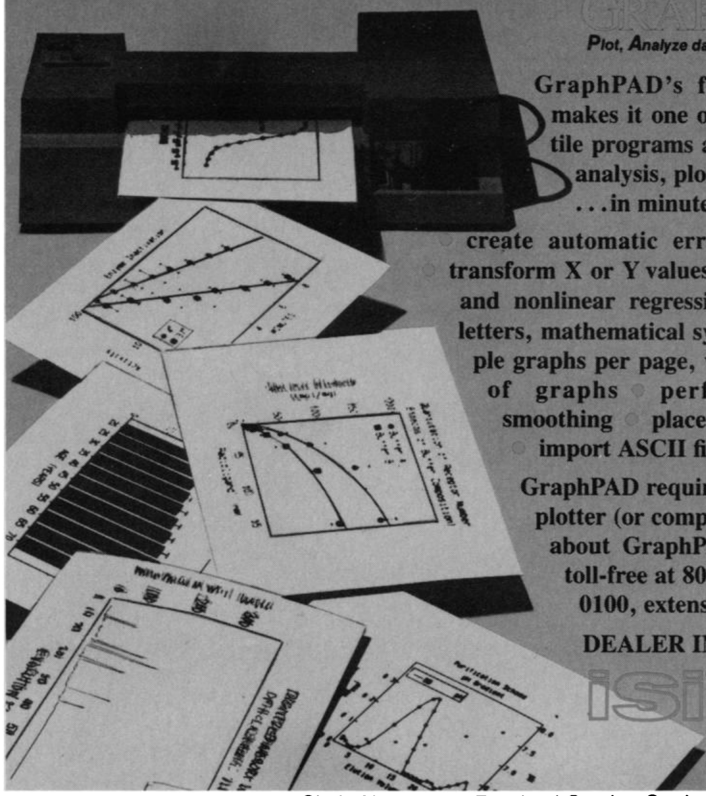

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LOWRY by G. A McPherson calculates protein concentrations measured by the standard technique of Lowry *et al.* (1951). A hyperbolic equation is used to fit the standard curve and calculate concentrations of unknown samples.
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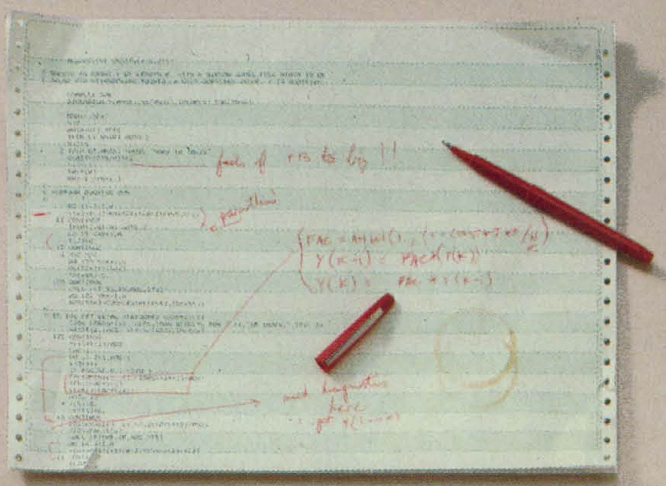

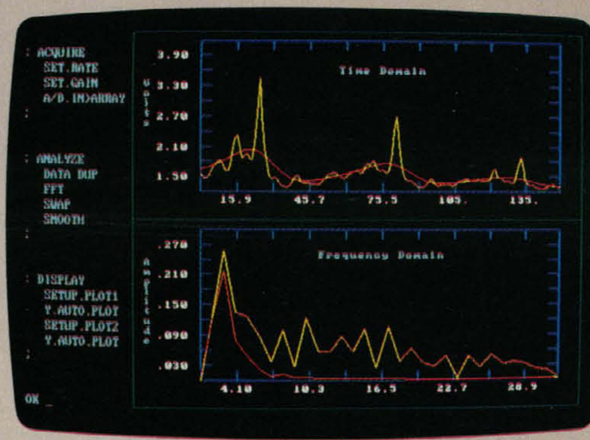

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Books Received

α, β, γ ... Z. A Primer in Particle Physics. L. B. Okun. Harwood Academic, New York, 1987. xii, 114 pp., illus. $25; paper, $9. Translated from the Russian by V. I. Kisin.

The Amundsen Photographs. Roland Huntford, Ed. Atlantic Monthly Press, New York, 1987. 199 pp., illus. $35.

Archimedes. E. J. Dijksterhuis. Princeton University Press, Princeton, NJ, 1987. 457 pp., illus. Paper, $15. Reprint, 1956 edition, with a bibliographic essay by Wilbur R. Knorrs.

Assignment Problems in Parallel and Distributed Processing. Shahid H. Bokhari. Kluwer, Norwell, MA, 1987. xxiv, 154 pp., illus. $40. Kluwer International Series in Engineering and Computer Science.

Atomic Absorption and Emission Spectroscopy. Ed Metcalfe. Published for Analytical Chemistry by Open Learning, London, U.K., by Wiley, New York, 1987. xxii, 289 pp., illus. Paper, $23.95.

Computing and Change on Campus. Sara Kiesler and Lee Sproull, Eds. Cambridge University Press, New York, 1987. xiv, 255 pp., illus. $24.95.

Deformation of Sediments and Sedimentary Rocks. M. E. Jones and R. M. F. Preston, Eds. Published for The Geological Society by Blackwell Scientific, Palo Alto, CA, 1987. viii, 350 pp., illus. $90. Geological Society Special Publication no. 29. From a conference, London, U.K., April 1985.

Developmental Control of Globin Gene Expression. George Stamatoyannopoulos and Arthur W. Nienhuis, Eds. Liss, New York, 1987. xxviii, 614 pp., illus. Progress in Clinical and Biological Research, vol. 251. From a conference, Airlie, VA, Sept.–Oct. 1986.

Dinosaurs Past and Present. Vol. 2. Sylvia J. Czerkas and Everett C. Olson, Eds. Natural History Museum of Los Angeles County, Los Angeles, CA, and University of Washington Press, Seattle, WA, 1988. xiv, 149 pp., illus. $35. Based on a symposium, Los Angeles, CA, Feb. 1986.

Directory of Statistical Microcomputer Software. 1988 Edition. Wayne A. Woodward *et al.* Dekker, New York, 1987. iv, 744 pp. Paper, $59.75.

Dismantling a Myth. The Role of Fat and Carbohydrates in Our Diet. Wolfgang Lutz. Thomas, Springfield, IL, 1987. xx, 267 pp., illus. $31.75. Translated from the German edition (1967).

Introduction to Superanalysis. Felix Alexandrovich Berezin. A. A. Kirillov, Ed. Reidel, Dordrecht, 1987. xii, 424 pp. $109. Mathematical Physics and Applied Mathematics, vol. 9. Translated from the Russians by J. Niederle and R. Kotecký.

Logic, Philosophy of Science and Epistemology. Paul Weingartner and Gerhard Schurz, Eds. Hölder-Pichler-Tempsky, Vienna, 1987 (U.S. distributor, Kluwer, Norwell, MA). 430 pp., illus. Paper, $79. From a symposium, Kirchberg am Wechsel, Aug. 1986.

Man and Wolf. Advances, Issues, and Problems in Captive Wolf Research. Harry Frank, Ed. Junk, Dordrecht, 1987 (U.S. distributor, Kluwer, Norwell, MA). xviii, 439 pp., illus. $137.50. Perspectives in Vertebrate Science, vol. 4. Based on a conference, Flint, MI, Oct. 1981.

Methods of Assessing the Reinforcing Properties of Abused Drugs. Michael A. Bozarth, Ed. Springer-Verlag, New York, 1987. xiv, 658 pp., illus. $39.

Mitochondria. A Practical Approach. V. M. Darley-Usmar, D. Rickwood, and M. T. Wilson, Eds. IRL Press, McLean, VA, 1987. xvi, 321 pp., illus. Paper, $34. Practical Approach Series.

Model Systems in Neurotoxicology. Alternative Approaches to Animal Testing. Abraham Shahar and Alan M. Goldberg, Eds. Liss, New York, 1987. xxii, 432 pp., illus. $78. Progress in Clinical and Biological Research, vol. 253. From a conference, Tiberias, Israel, Nov. 1986.

Modeling Multigroup Populations. Robert Schoen. Plenum, New York, 1987. xii, 308 pp., illus. $29.50. Plenum Series on Demographic Methods and Populations Analysis.

Multiple Scattering Theory of Point Defects in Metals. Electronic Properties. Ingrid Mertig, Eberhard Mrosan, and Paul Ziesche. Teubner, Leipzig, 1987. 220 pp., illus. DME 27.50 Teubner-Texte zur Physik, vol. 11.

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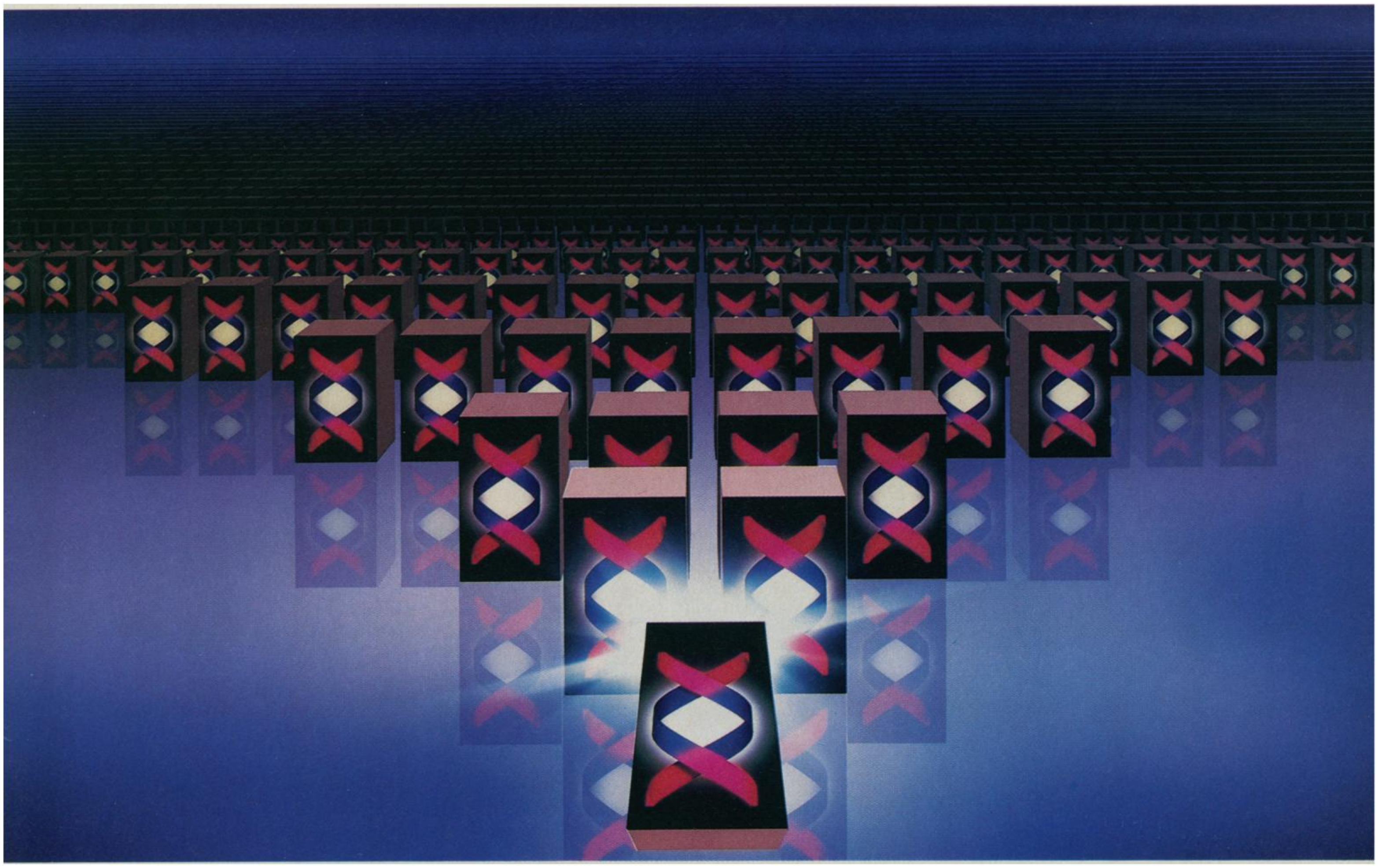

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