AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

# SCIENCE

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VOL. 263 • PAGES 581–724

INSIDE:
**Science After the Cold War**


# THE HIGHEST-EFFICIENCY CHEMICALLY COMPETENT CELLS AVAILABLE

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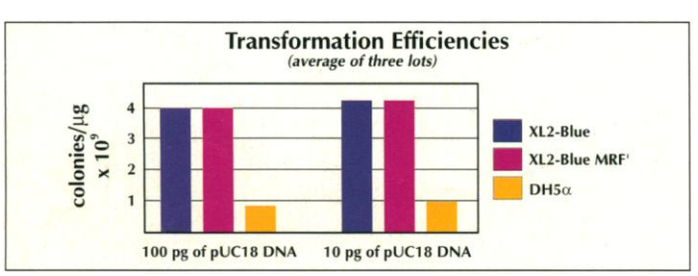
* Patent pending

** The Polymerase Chain Reaction (PCR) process is covered by patents owned by Hoffmann-La Roche. Use of the PCR process requires a license.

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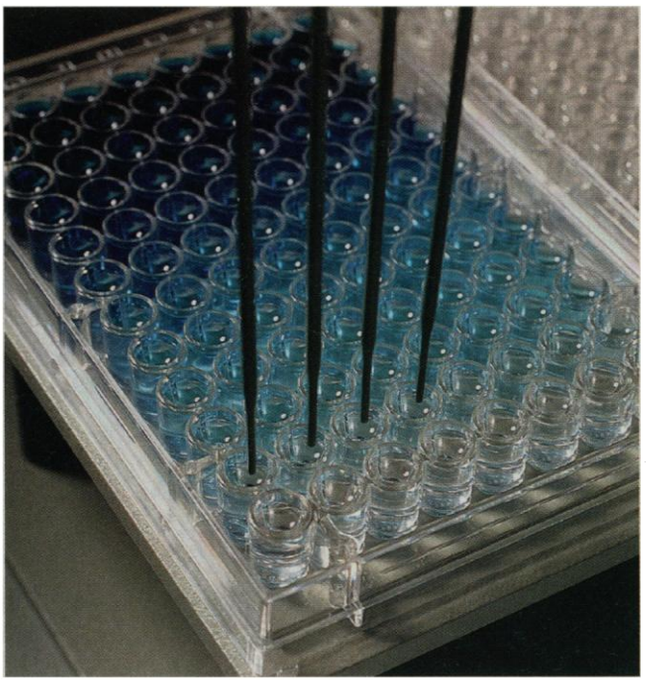

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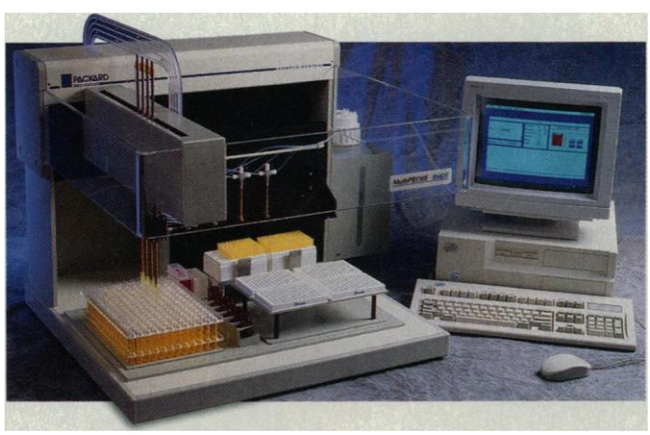


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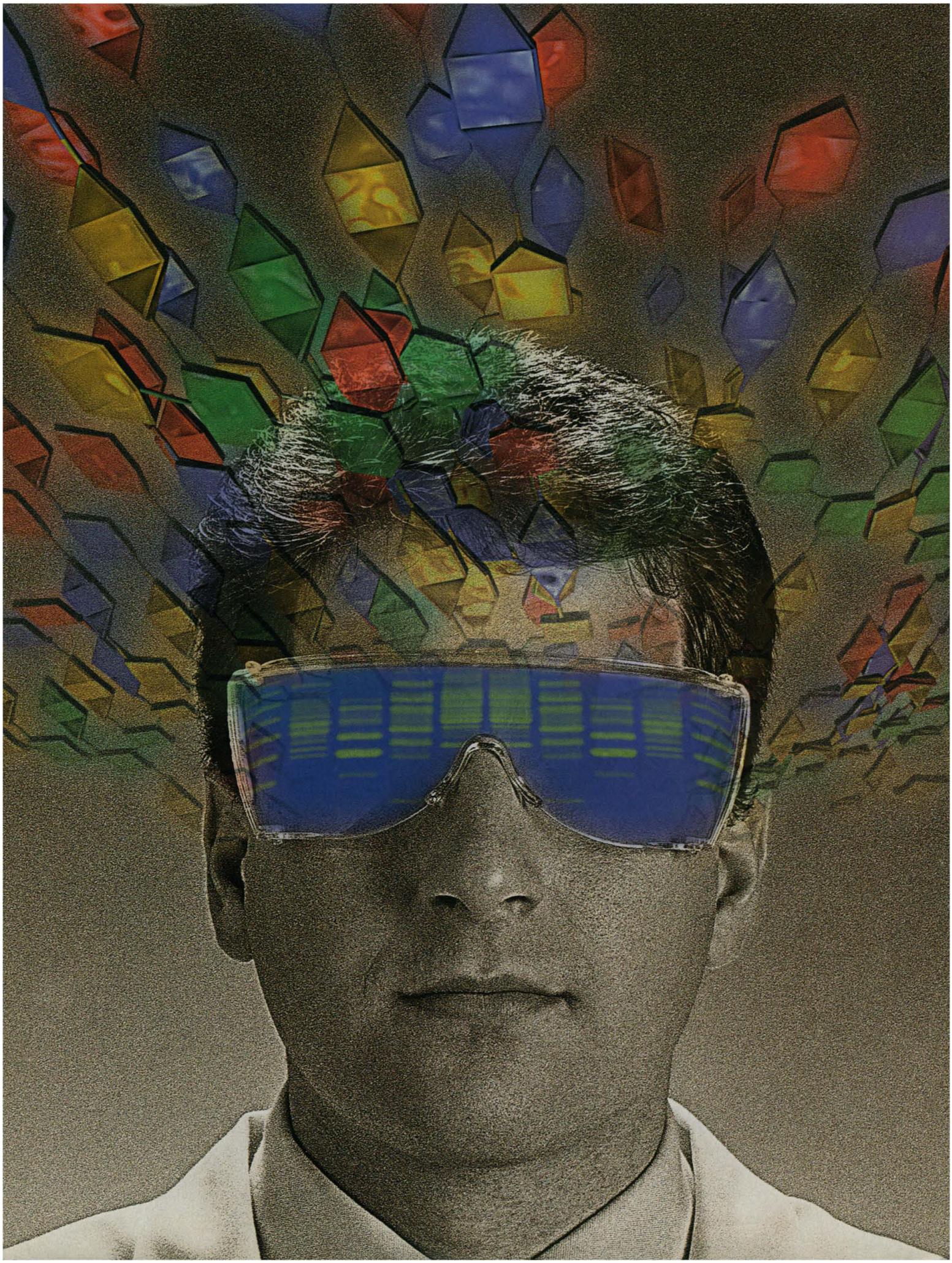

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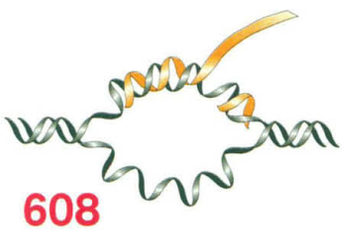
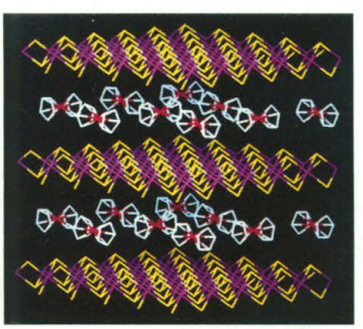


**608**

**Finding gems in the 'junk DNA'**



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**Multipurpose materials**

## NEWS & COMMENT



## RESEARCH NEWS



## POLICY FORUM



## SCIENCE AFTER THE COLD WAR



## PERSPECTIVES



## ARTICLE



## DEPARTMENTS

COVER

A platinum replica revealing the cytoplasmic face of a phagosome containing a mycobacterium. The phagosome was isolated from a bone marrow–derived murine macrophage, fixed in glutaraldehyde, and frozen on a liquid helium–cooled copper block before freeze-drying and rotary replication. The photomicrograph was scanned and colorized with Adobe Photoshop. See page 678 and the Perspective on page 637. [Photomicrograph: David G. Russell]


## RESEARCH ARTICLE

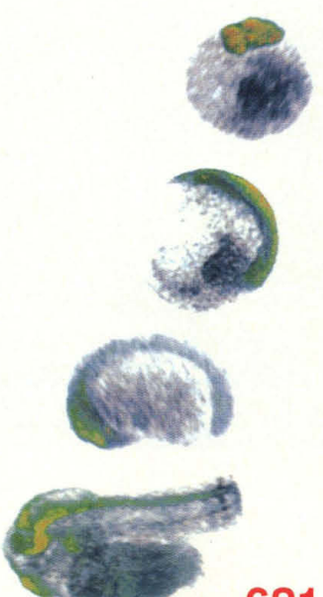


## REPORTS



## TECHNICAL COMMENT





**681**

**MRI looks inside embryos**

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■ Indicates accompanying feature


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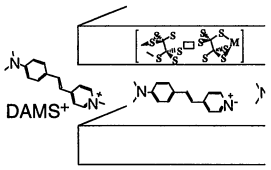
edited by PHIL SZUROMI

## Lining up

A number of organic compounds exhibit useful nonlinear optical properties, such as frequency doubling, but only when the molecules are packed in an environment that lacks a center of symmetry so that the dipoles have a net orientation. Lacroix *et al.* (p. 658; see the Perspective by Nicoud, p. 636) demonstrate an intercalation approach for achieving alignment. The organic cation $DAMS^+$, a stibazolium dye, was intercalated directly into the layers of $CdPS_3$ or $MnPS_3$ to form a highly crystalline powder. The resulting structure spontaneously aligned $DAMS^+$ and produced frequency doubling effects several hundred times that of urea. The manganese compound also exhibits a permanent magnetic moment below 40 K.




■

## Tropical temperatures

Records of paleoclimate during the last glacial maximum have suggested that temperatures in the tropics cooled by about 5°C over land but less than 2°C over oceans. Reproducing this variability has posed a problem for climate models. To evaluate the ocean paleotemperatures better, Guilderson *et al.* (p. 633) applied two independent thermometers—oxygen isotopes and strontium-calcium ratios—to Barbados corals. The results of both thermometers were consistent and imply that the surrounding waters were actually 5°C cooler than they are today. Cooling may reflect a shift toward the equator in mid-latitude cloud decks.

## Why models are only models

Numerical modeling of complex systems and processes is finding increased applications in many fields as the power of computers grows and is having greater impact in the arena of public policy. Focusing on hydrologic and geochemical models, Oreskes *et al.* (p. 641) discuss the philosophical underpinnings of models and ways that the models and their results can be used and interpreted. Because such models are inherently open systems, they argue that verification or validation is not possible and that their primary value is heuristic.

## Mainly in the plain

At the Last Glacial Maximum, several large internally drained lakes formed in the western United States and elsewhere; the Great Salt Lake is the tiny remnant of one of these, Lake Bonneville. Hostetler *et al.* (p. 665) investigated the importance of local climate feedbacks (for example, lake-effect precipitation) produced by Lake Bonneville and its smaller companion to the west, Lake Lahontan, using a combination of a regional climate model and a general circulation model. The results suggest that the larger size of Lake Bonneville was a result of increased lake-effect precipitation within its own drainage basin.

■

## Lifting a finger

The determinants of specificity for proteins that bind to DNA are critical for the proper functioning of many events, such as the regulation of which genes are actively transcribed at various times during development. One of the motifs found in DNA-binding proteins is the zinc finger, so-called because a hairpin loop of protein (the finger) is held together by a zinc atom. Only a handful of high-resolution structures of zinc finger proteins have been solved. Rebar and Pabo (p. 671) have used the phage display method to select for other zinc finger sequences that specifically recognize DNA. By creating a library of possible zinc finger domains, the constraints for recognition as well as approaches for design may become clearer.

■

## Closely followed

Magnetic resonance imaging has been used to follow the development of embryos of the frog, *Xenopus laevis*. Jacobs and Fraser (p. 681) injected a physiologically inert gadolinium conjugate as a contrast agent into a single blastomere at the 16-cell stage. The living embryo could then be imaged repeatedly through the course of its development. Any sort of two-dimensional image could be extracted from the series of three-dimensional images. With a resolution in the range of 10 cubic micrometers, the progeny of the single injected blastomere can be observed, whether deep within or on the surface of this visually opaque embryo, through neurulation.

■

## The NO cascade

Nitric oxide elicits diverse biological reactions. It serves as a neurotransmitter and also to promote relaxation of blood vessels, yet in large quantities it also mediates the neurotoxic effects of glutamate, an excitatory neurotransmitter. Zhang *et al.* (p. 687) describe a serpentine chain of events that begins with nitric oxide, acting as a free radical, damaging DNA. This damage activates an enzyme that covalently attaches adenosine 5'-diphosphoribose (ADP-ribose) to proteins. Finally, the high rate of consumption of ADP-ribose depletes the cell of energy and of a necessary cofactor for energy-producing reactions.

■

## Controlling arousal

The mesopontine cholinergic neurons function in the production of electroencephalographic (EEG) arousal. Modulation of these neurons could be a key factor in the behavioral state. Rainnie *et al.* (p. 689) found that the mesopontine cholinergic neurons are under the tonic inhibitory control of adenosine (AD), which is a released extracellularly during brain metabolism. Thus, factors that affect the extracellular levels of AD, such as prior wakefulness, would be predicted to have effects on the arousal state.

■

## Required for learning

In insects, the mushroom bodies (MBs) of the brain are thought to function in the processing and storage of chemosensory information. De Belle and Heisenberg (p. 692) have used hydroxyurea to specifically delete the MBs from the brains of fruit flies during development. Flies without MBs cannot perform a classic conditioning paradigm that tests associative learning of odor cues and electric shock, yet they can discriminate odors and show normal locomotion and courtship behaviors. These data demonstrate that the MBs are required for odor associative learning in *Drosophila*.

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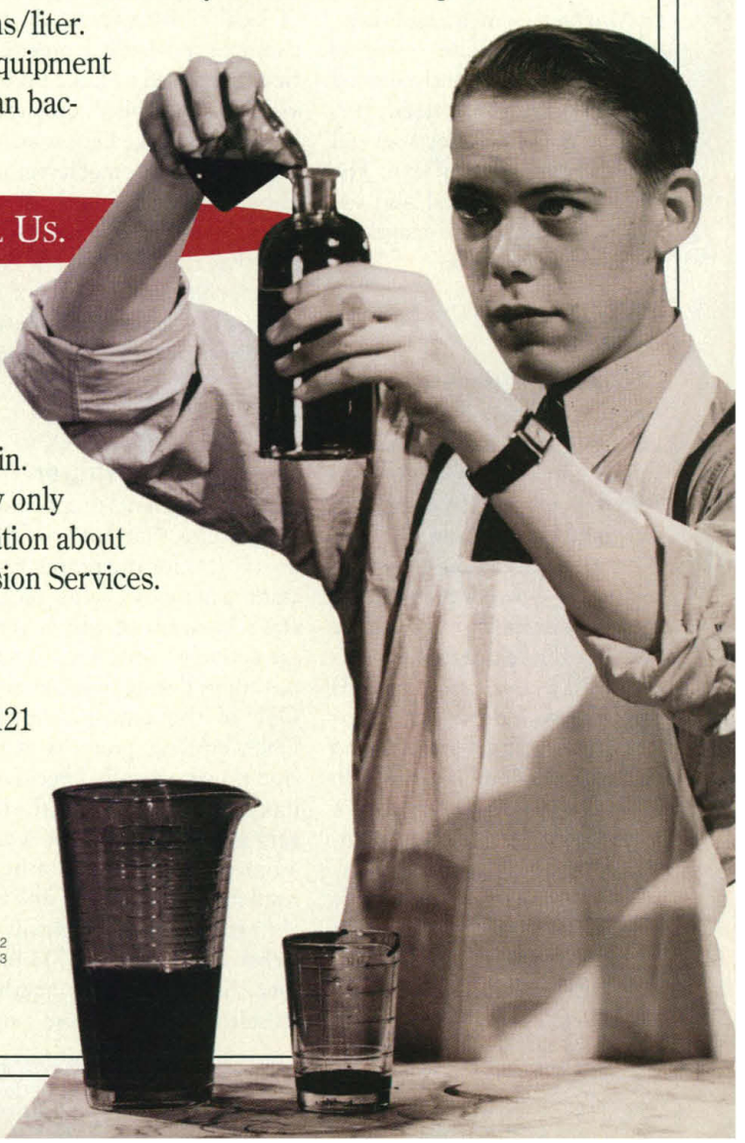

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| DNA Exonuclease Assay | All Pass | All Pass | 2 | 1 |
| DNA Ligation/Recut Assay | All Pass | 2 | 2 | All Pass |
| Nicking Assay | All Pass | 1 | 2 | 2 |
| Unit Assay | All Pass | 5 | 3 | 4 |

= One Failure

*Summary: Seven out of ten restriction endonucleases from each competitor failed one or more of our quality tests.*

†Enzymes tested in the manufacturers' recommended buffers: *Bam*H I, *Bgl* I, *Cla* I, *Eco*R I, *Hind* III, *Kpn* I, *Not* I, *Pst* I, *Sal* I, and *Sst* I (*Sac* I)

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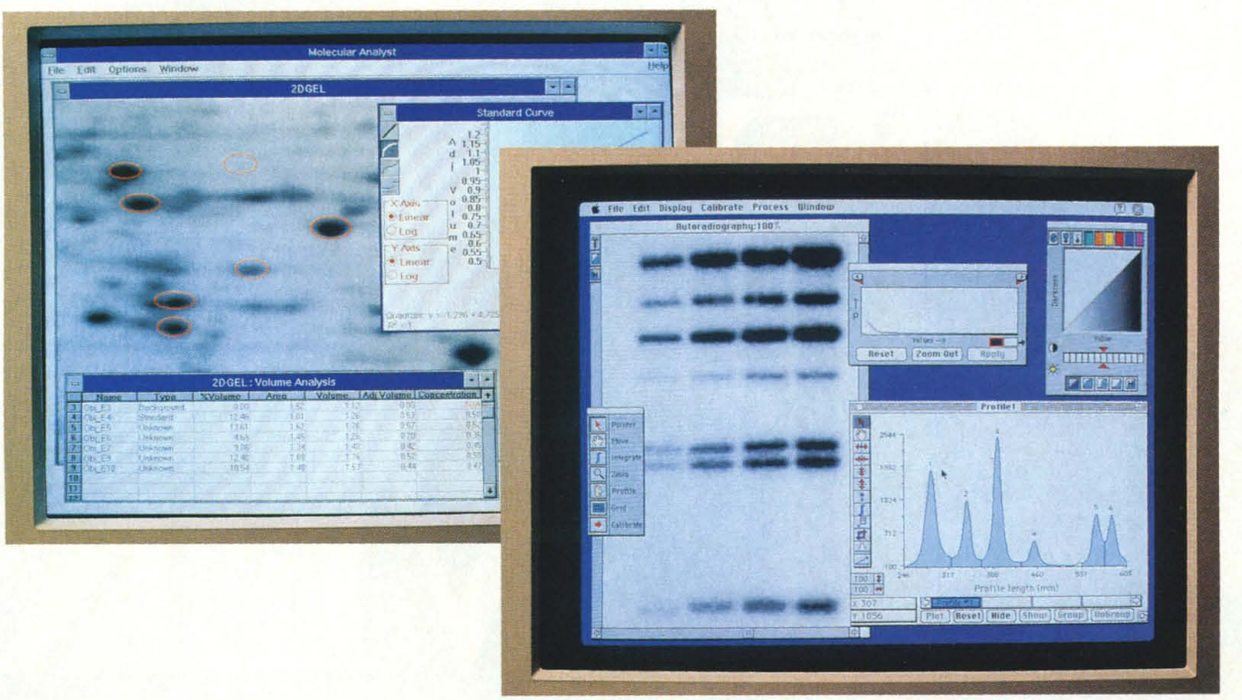


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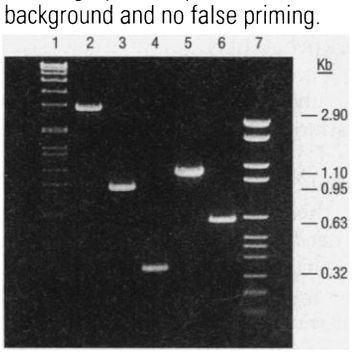
Each lot of *Taq* DNA Polymerase undergoes a unique self-priming assay to ensure that the enzyme is essentially free of endogenous DNA fragments.

The highest level of product purity is provided so that you achieve specific, high-yield amplification with no background and no false priming.




**Specific amplification of five different single-copy genes from human genomic DNA using Boehringer Mannheim *Taq* DNA Polymerase.** Lanes 1-7: DNA MWM VII, p53, Cystic fibrosis, FKBP 12, Collagen, Erythropoietin, DNA MWM VI.

**Just one specific piece of a PCR system**

*Taq* DNA Polymerase is just one specific enzyme in a full line of PCR products that includes these new items:

- **PCR Core Kit**–a complete kit for high-yield polymerase chain reactions
- **PCR Core Kit$^{PLUS}$**–high-yield PCR plus prevention of "carry over" contamination
- **PCR Nucleotide Mix**–ready-to-use nucleotides premixed in ratios optimized for PCR.

## Licensed to perform

Boehringer Mannheim is a fully licensed supplier of PCR products, and your purchase conveys to you a license to perform PCR for research purposes.

## Give us your specifics today

Rely on Boehringer Mannheim for all your PCR needs. Contact your Boehringer Mannheim representative for more information, or call us to place your order at 1-800-262-1640 (514-686-7141 in Canada).

These products are sold under licensing arrangements with Roche Molecular Systems and The Perkin-Elmer Corporation. Purchase of these products is accompanied by a license to use them in the Polymerase Chain Reaction (PCR) process in conjunction with an Authorized Thermal Cycler.



BOEHRINGER MANNHEIM PCR HIGH PERFORMANCE

*Leaving the Limits Behind*

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# Honey, I shrunk the recorder.

Gould shrinks the best of recording systems into a space not much bigger than this page. Introducing the TA11 Recording-System Portable. The first system that brings 4, 8 or 16 channels of conditioning, monitoring, capturing, storing, recording and communicating down to a portable size. At a very economical price.

Measuring just 14″W x 16″D x 7⅜″H and weighing approximately 28 lbs., the rugged TA11 features built-in, programmable signal conditioning suitable for most of your industrial applications, plus a unique 11″ chart.

For easy operation, we've included traditional, push-button recorder controls for basic functions. A flip-up LCD panel with proven touchscreen technology provides straightforward setup and control of advanced functions. It also minimizes paper waste by allowing you to set up and monitor traces without running the chart. And because it displays in real time, you can work more efficiently, viewing slow-changing signals as they occur.

The TA11 takes flexibility even further with multi-channel, logical OR triggering for capturing transients. It also offers two levels of waveform capture memory for up to 8MS of total memory. Allocate it to all 16 channels, and you can have up to 512kS per channel. And for storing data and setups, there's a built-in RAM card.

Once again, Gould puts its expertise to work for you, condensing high-performance recording system capabilities to create a whole new class of instruments. Starting at under $10,000. Call Gould at (216) 328-7000 for details, or for immediate response, complete the FAST ACTION FAX and send it today.

## FAST ACTION FAX (216) 328-7400

**Yes!**

- ☐ Have a Gould Representative call me to arrange a demonstration
- ☐ Rush me a free TA11 technical brochure
- ☐ **My needs are more short term at this time. Please send me information on the advantages of renting from GE Rental/Leasing (1-800-GE-RENTS).**

SCI 2/94

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Name: _____

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City: _____ State: _____ Zip: _____

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FAX or mail coupon/photocopy (you may affix business card) to Gould Inc., Test and Measurement Group, 8333 Rockside Road, Valley View, OH 44125.

**Circle No. 12 on Readers' Service Card**

# Half-Day DNA. And That's Just The Half Of It.


Synthesizing primers, probes, linkers, or gene fragments? Cut your time — and your reagent use — in half with the Millipore Expedite™ Nucleic Acid Synthesis System.

For instance, a pair of 20-mer PCR primers can be synthesized in about an hour and worked up in about 15 minutes, so you can start using your new DNA before noon.

How's that possible? Because no matter how many columns you're running — 1, 2, 3, or 4 — the total cycle time is under 4 minutes. The Expedite system's exclusive alternating phase synthesis allows columns to act independently, so each is always synthesizing.

Expedite reagents speed things along further. Oligonucleotides made with Expedite brand chemistry can be deprotected in only 15 minutes at 55°C or 2 hours at room temperature.

But speed is just half the story. The Expedite system's patented microfluidics plate provides for extremely low internal volume. Reagent delivery to the column is cut by as much as 50% over other systems. So, you get more couplings per chemistry changeout; more DNA synthesized per dollar.

Now you've got the whole picture. So how about an Expedite video demo? Just give us a call and we'll send it to you, expeditiously. 1-800-872-0071.

MILLIPORE



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# Introducing the first benchtop Superspeed centrifuge with floor model performance.

# The new SORVALL® SUPER T 21.

Announcing the latest in Superspeed technology. The new SORVALL® SUPER T 21 delivers the value of 3 centrifuges in one. First, it's the only Superspeed in the world with the capacity, g-force and performance comparable to a floor model. Second, it's a refrigerated microcentrifuge. And finally, it's a benchtop.

## Space saver.

Limited lab space is a reality, and centrifuges in a remote location can slow your research. The SUPER T 21 has been created to meet your need for a personal Superspeed that can fit easily on a benchtop, right in your lab. It's available now...when and where you need it most.

## The first Superspeed to use a CFC replacement.

The new SUPER T 21 is the first Superspeed in the world to use one of DuPont's new SUVA® replacements for traditional chlorofluorocarbon refrigerants. The new SUVA® refrigerant is used with a new standard refrigeration system built expressly for the SUPER T 21 and has, on average, 95% less ozone depletion potential than today's CFCs.

## Easy, whisper-quiet operation.

User-friendly, one-touch operator controls make everyday run set-ups quick and easy. Just set speed, temperature and time, then press start. And the maintenance-free DC brushless drive creates less than 62dB of noise, making the SUPER T 21 easy to work around.

## Introducing new SUPER-LITE™ rotors.

Along with the SUPER T 21, DuPont is introducing a new series of SUPER-LITE™ rotors, which weigh up to 50% less than typical Superspeed rotors. Significantly less weight means faster acceleration and deceleration times. And these new rotors have specially designed covers for easy handling.

These new SORVALL Superspeed rotors are independently tested* for containment of biohazardous samples. This is your assurance of maximum biosafety protection in the event of tube failure. They also accept all current SORVALL Superspeed tubes, bottles and adapters.

## SORVALL®... the world leader in Superspeeds.

The SUPER T 21 is the latest innovation in SORVALL technology from DuPont, the recognized world leader in Superspeeds. All SORVALL centrifuges are manufactured under an ISO 9000 quality system registered by BSI and UL. Your assurance of unsurpassed quality in centrifugation.

For more information, call 1-800-551-2121 and get the benchtop Superspeed that fits where you need it – when you need it most.

* Tested by Biosafety Unit, Division of Biologics, PHLS CAMR, Porton Down, U.K.

**SORVALL®... a better choice.**

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