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13 October 2000

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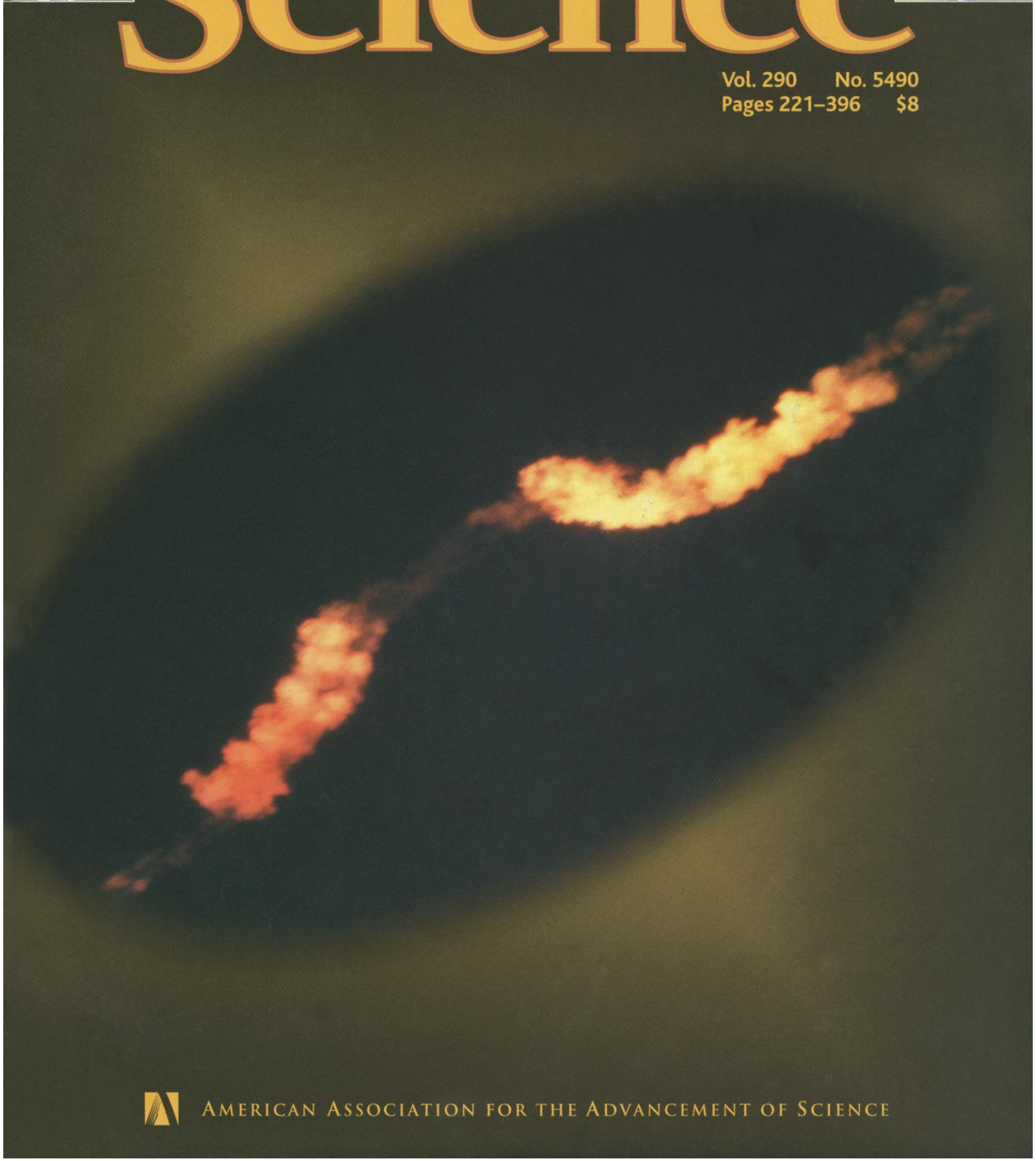

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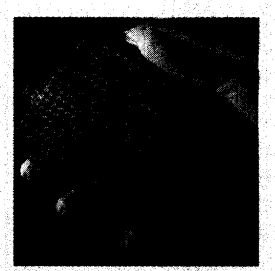

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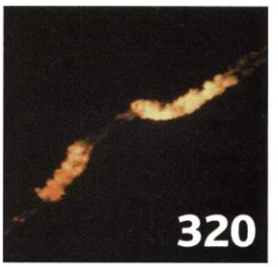

COVER A photograph of the wind-sheared dust cloud left by a brilliant fireball over the Yukon Territory, Canada, in the early morning of 18 January 2000. The fireball was produced by the atmospheric entry of a 5-m-diameter asteroid. Surviving fragments fell across an area at least 16 km long by 5 km wide on the ice of Tagish Lake in British Columbia. Initial work on the Tagish Lake meteorite suggests that it may represent the most primitive solar system material yet studied. [Photo: M. MacDonald]

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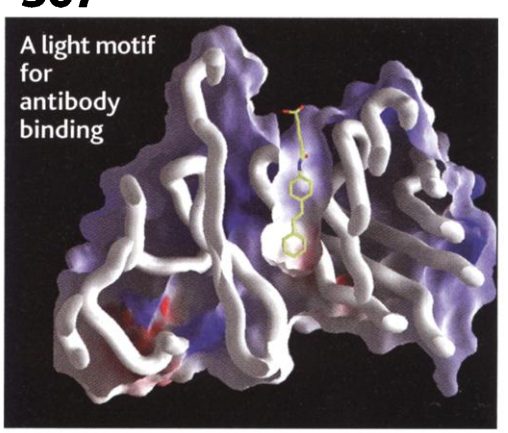

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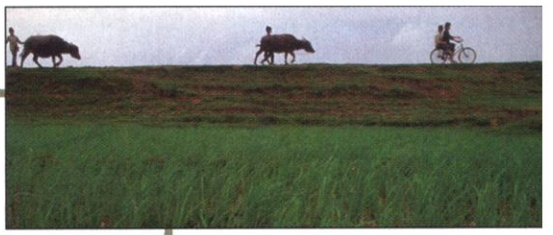

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Rice genomics for the future

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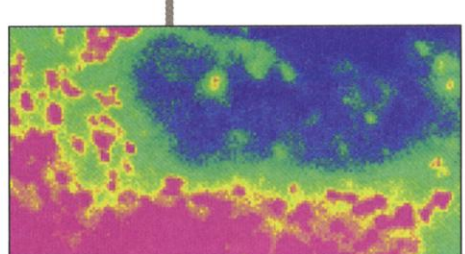
The Ascent of Atmospheric Sciences P. J. Crutzen and V. Ramanathan

In this month's essay, Paul J. Crutzen and Veerabhadran Ramanathan chart some of the courses by which atmospheric sciences evolved from their beginnings, with curious scientists teasing apart the complexity of the air they breathe, into an ever more multidisciplinary enterprise that routinely generates globally consequential knowledge.



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Imaging Rac GTPase in living cells

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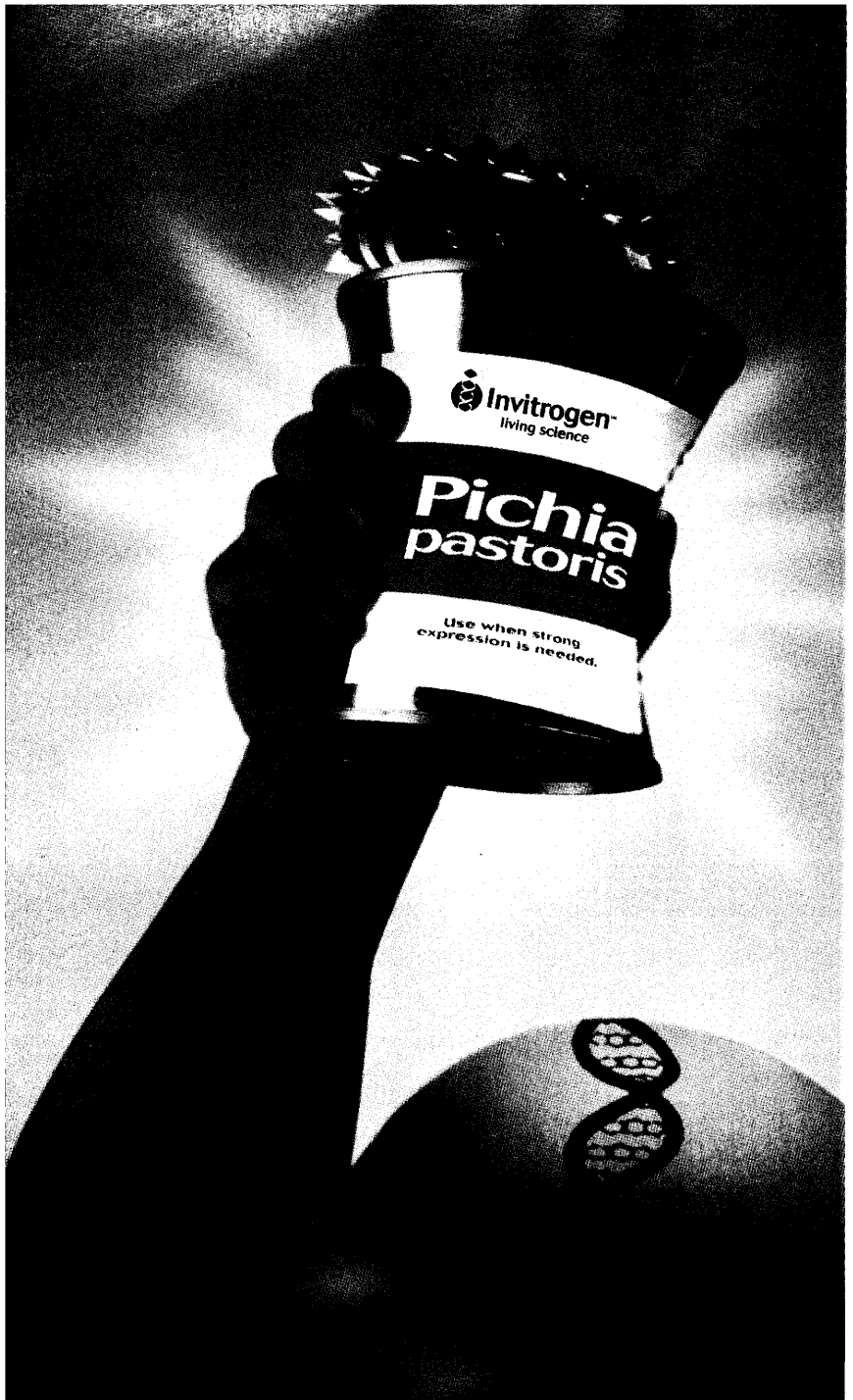

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MESSING WITH THE CARBON CYCLE

Human activities have altered the carbon cycle, largely through carbon dioxide (CO_2) emissions from fossil fuels. Glacial-interglacial cycles also have seen large changes in CO_2 concentrations, but present and projected future conditions lie outside the range sampled during the last 420,000 years. Falkowski *et al.* (p. 291) discuss what is known about the carbon cycle and its connections to other nutrient cycles and examine some of the concomitant changes in biogeochemical and climatological processes. They conclude that natural sinks may slow the rate of increase in atmospheric CO_2, but that there is no natural "savior" waiting to assimilate all of the anthropogenic CO_2 in the coming century.

BRIGHT BLUE ANTIBODIES

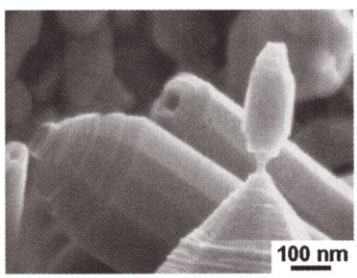
With the exception of photosynthetic and photosensing reactions, most interactions of proteins with small molecules (such as enzymes with substrates) are thought of in terms of ground-state interactions. Simeonov *et al.* (p. 307; see the Perspective by Brauman) have elicited monoclonal antibodies that change the dynamics of the excited state of a bound antigen, in this case an analog of *trans*-stilbene. In solution, this molecule isomerizes rapidly and shows no fluorescence, but some antigen-antibody complexes exhibited a strong blue fluorescence—even though the antibodies were elicited against this molecule in its ground state. Structural and spectroscopic studies attribute the change in fluorescence to the formation of an exciplex state in which the excited molecule interacts with a tryptophan residue in the binding pocket.

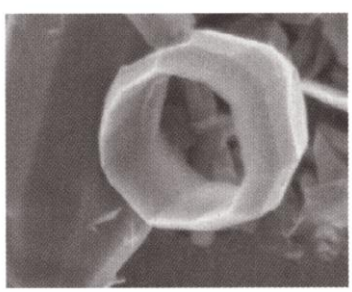
NANOCRYSTAL QUANTUM DOT LASERS

Electrons in nanocrystal quantum dots often can be treated as "particles in a box," and thus the separation between energy levels can be varied by changing the size of the semiconductor nanocrystal. Previous work has suggested that the excitation dynamics within the dots presented an intrinsic barrier to fully exploiting these properties. Klimov *et al.* (p. 314) show that a close-packed system of nanocrystal quantum dots can be used to circumvent the barrier, and they demonstrate optical gain and stimulated emission that was determined by the dot size. The results may be used to develop a new class of widely tunable, temperature-stable semiconductor lasers.

POLYHEDRAL GRAPHITE FROM A NANOTUBE CENTER

Unusual forms of carbon have been found in the processing remains of other materials; nanotubes were seen in discarded soot from fullerene synthesis. Gogotsi *et al.* (p. 317) report a similar remnant discovery, that of polyhedral graphite crystals in the pores of commercial glassy carbon samples that





were grown under hydrothermal conditions. Electron microscopy reveals that carbon nanotubes seed the growth of several radially joined, highly ordered graphite crystals. These crystals have diameters up to 1 micrometer, and their faces, which are remarkably equal, range in number from 7 to 14. They also show high conductivity and mechanical strength.

THE FALL OF TAGISH LAKE

At dawn on 18 January 2000, a fireball was witnessed, heading south to southeast across the Yukon Territory and parts of Alaska and British Columbia. On 25 and 26 January, pieces of the meteoroid that created this fireball were collected on frozen Tagish Lake and stored in a freezer to limit any contamination of the sample. Additional fragments were collected several months later, and their spatial distribution was carefully mapped. From these observations, field expeditions, and chemical analyses conducted in several laboratories, Brown *et al.* (p. 320; see the cover and the Perspective by Grossman) conclude that the Tagish Lake meteorite is a primitive chondrite that probably originated in the outer asteroid belt. It contains abundant presolar grains (such as nanodiamonds and silicon carbide) and has experienced significant aqueous alteration. Its chemical composition is unlike those of other primitive chondrites, and its fortuitous preservation will allow additional study without significant concern about terrestrial contamination.

SOUTHERN COMFORTS

The Younger Dryas was a cooling event that interrupted the last deglaciation for more than a millennium about 13,000 years ago in many parts of the Northern Hemisphere. Whether the Younger Dryas affected climate in the Southern Hemisphere lies at the heart of our lack of understanding of its causes. Bennett *et al.* (p. 325; see the Perspective by Rodbell) have collected sediment cores from lakes in Chile and conclude from pollen analyses that temperatures in that region were stable during the Younger Dryas chronozone. These results strengthen the case that the Younger Dryas was a Northern Hemispheric phenomenon and that the southeastern Pacific Ocean did not cool during that time.

EXAMINING REASONS FOR SEX

The evolution of sex remains one of the biggest challenges for evolutionary biology. Keightley and Eyre-Walker (p. 331) have carried out a direct test of the mutational deterministic (MD) hypothesis, an explanation which requires that the genome-wide deleterious mutation rate (U) exceeds one per generation. They estimate U in a range of vertebrate and invertebrate species, and find that it is considerably below 1 in many obligate sexual organisms. Also, U is linearly related to generation time, which suggests that low U values are a property of organisms with short generation times. They conclude that sexual reproduction is not maintained by the removal of deleterious mutations.

LOCATION, LOCATION, LOCATION

Stem cells of various sorts are particularly difficult to study because they are rare and usually quiescent. Using genetic abla-

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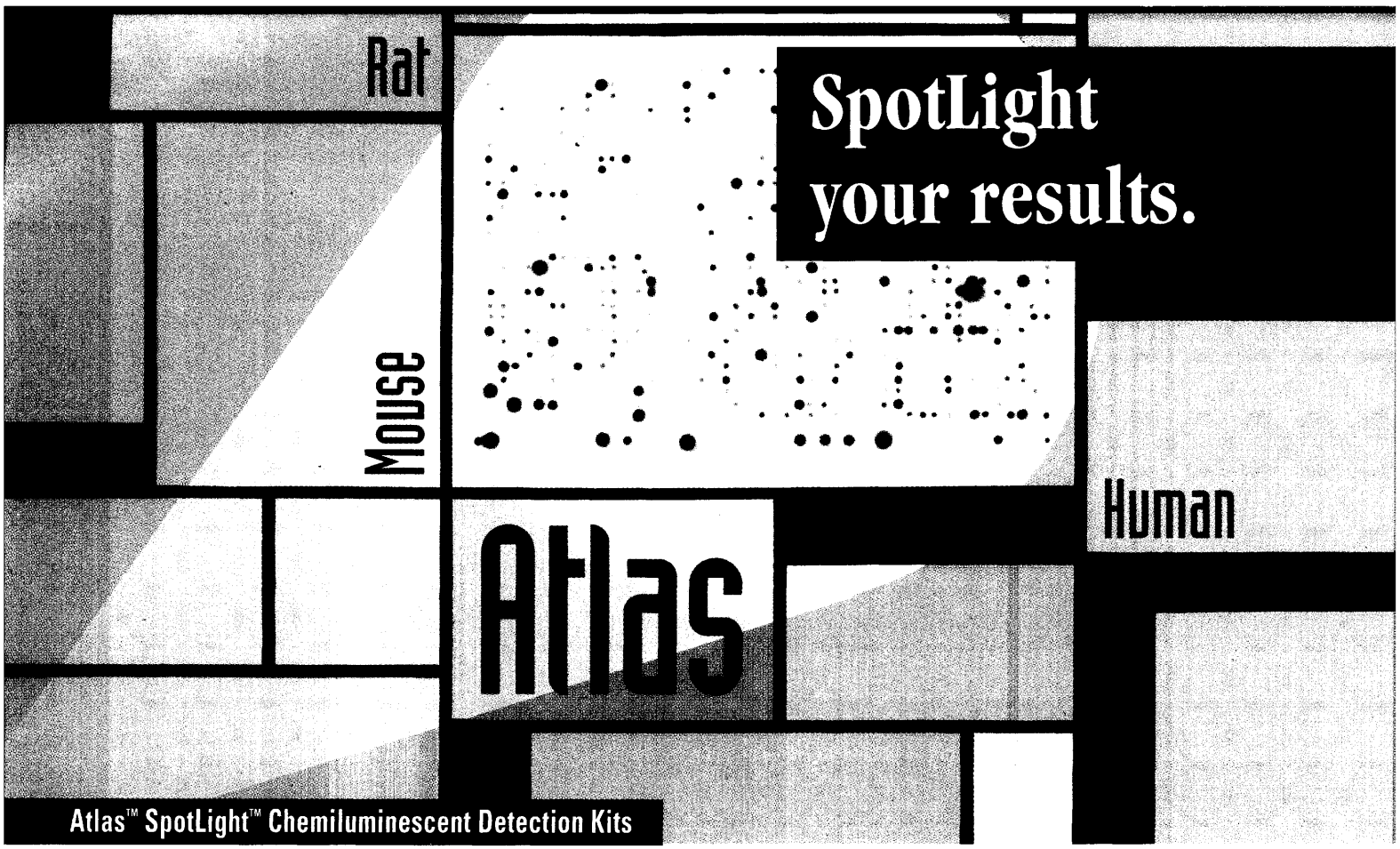
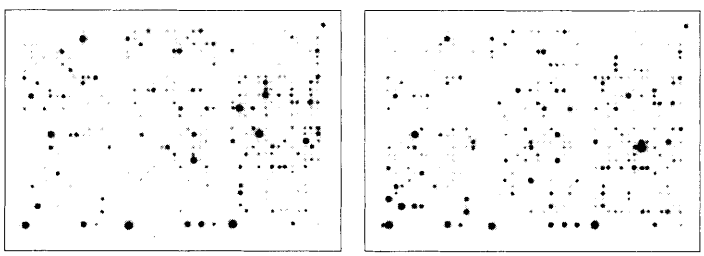


Illustration inspired by the art of Piet Mondrian (1872–1944).

Human Brain **Human Placenta**



The Atlas™ Human 1.2 II Array visualized using chemiluminescent detection. Array hybridization was performed with biotinylated cDNA probes prepared from 2 µg of human brain poly A⁺ RNA or 2 µg of human placental poly A⁺ RNA. Hybridization and detection were performed with the SpotLight™ Chemiluminescent Detection Kit(K1032-1)*. Results were visualized by exposing blots to film for 10 minutes.

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THIS WEEK IN *SCIENCE*

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tion in *Drosophila*, Xie and Spradling (p. 328) were able to remove germ-line stem cells from the ovarioles in the ovary and observe how surrounding somatic cells help nurture their replacement. Three types of ovariolar somatic cells form a niche where replacement cells are reprogrammed into becoming stem cells.

WATCHING THE SIGNALS

How signaling molecules function is not only a matter of when, but also a matter of where. Kraynov *et al.* (p. 333) demonstrate that activation of the small guanosine triphosphate–binding protein Rac1 can be visualized in real time in living cells. Activation of Rac1, known to induce actin-based morphological changes, was restricted to sites of actin polymerization, independent of overall intracellular Rac distribution. Thus, cells can produce distinct behaviors through specific distributions of activated Rac1.

NUCLEAR MOTORS?

The roles of actin and actin-related proteins in the nucleus remain debatable but may include chromatin remodeling and RNA splicing. Pestic-Dragovich *et al.* (p. 337) report that an isoform of the actin-dependent motor myosin I β appears to form a complex with RNA polymerase II in the nucleus and that the actin-based motor also regulates RNA synthesis in vitro. These observations suggest the possibility that the motor and polymerase together may power transcription.

CREATING A SEPARATE IDENTITY

Regulating the distribution of plasma membrane proteins in budding yeast, as reported by Takizawa *et al.* (p. 341), requires a combination of messenger RNA localization to the growing bud by an actomyosin-driven process and a membrane-diffusion barrier comprised of a ring of septin filaments that prevents the membrane protein from diffusing into the mother cell. Thus, as in higher eukaryotic cells, a barricade to diffusion defines distinct membrane compartments and maintains asymmetric protein distribution.

VIDEO GAME AFTEREFFECTS

The relation between sleep and memory is still poorly understood. Stickgold *et al.* (p. 350; see the news story by Helmuth) analyzed hypnagogic imagery, the types of visual images experienced just before falling asleep, after long sessions of playing the computer game Tetris. They compared amnesia patients, normal volunteers without any prior experience playing the game (novices), and players with considerable Tetris experience (experts). All three groups reported similar highly stereotyped images. Because amnesics described the same kind of experience, this finding indicates that declarative memory processes do not underlie the effect. Rather, the images seem to be more akin to priming of perceptual processes, a function that is fully intact in amnesics.

INSERTING A HAIRPIN

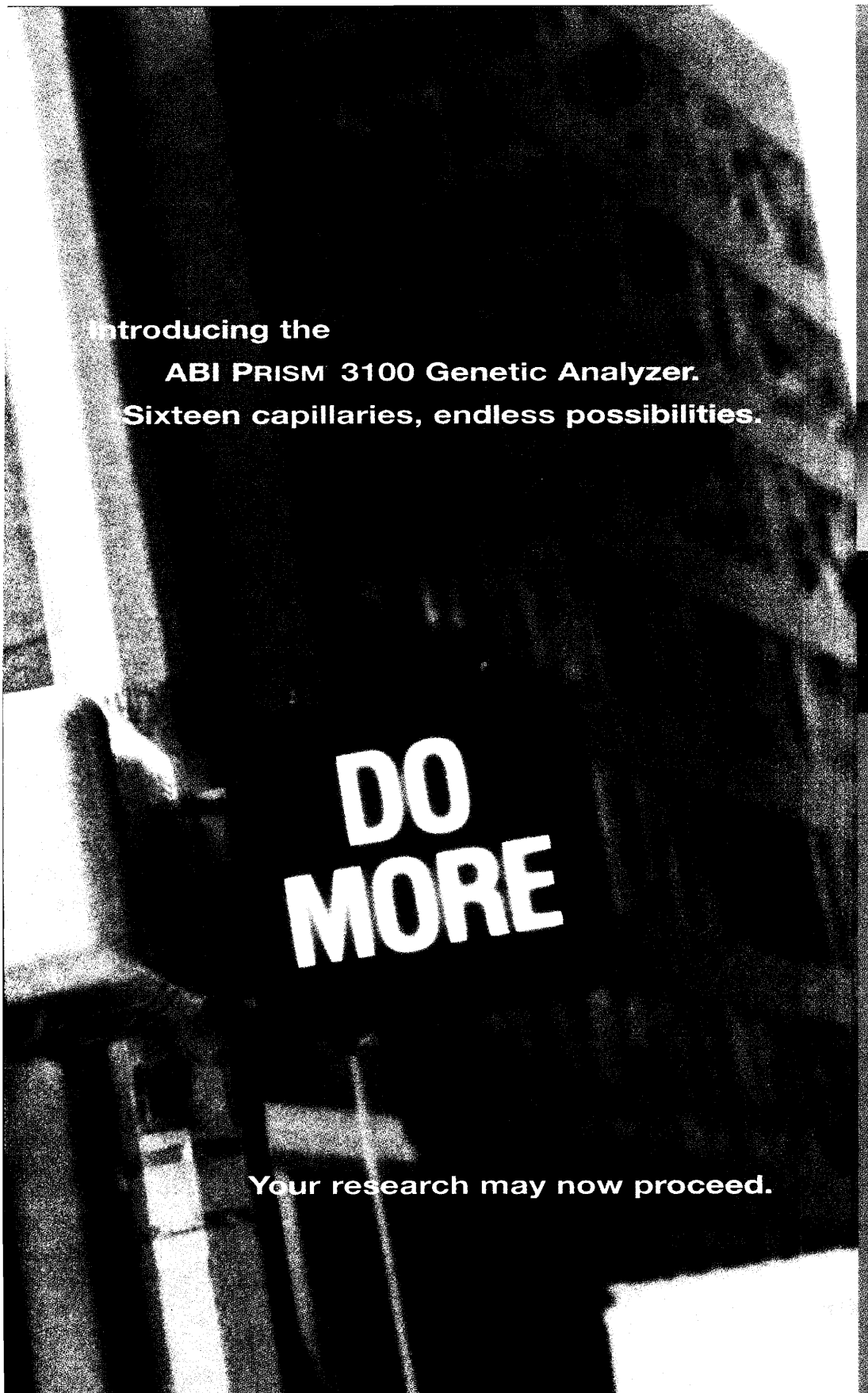
Ticks harbor intriguing endosymbiotic bacteria with pared down genomes, called *Rickettsia*, which appear to be living relatives of mitochondria. Blood feeding triggers replication of the bacteria, which are then injected into vertebrate hosts, where they reside less benignly. Ogata *et al.* (p. 347) show that *Rickettsia conorii* harbors a distinctive repetitive insert in its genome that encodes a hairpin RNA. The insert appears to parasitize the open reading frames that encode several conserved proteins and may lead to the evolution of new protein structures; a useful trick for an organism with a minimalist genome.

FORCING FLOWERS

For widely distributed plants, adjusting the time at which they burst into flower in the spring can help the population get the most from both cooler and warmer climes. In some plants, vernalization—exposure to a period of cold temperatures—is required to regulate flowering. Johanson *et al.* (p. 344) have cloned the gene primarily responsible for the vernalization requirement in *Arabidopsis*. Natural mutations in the gene *FRIGIDA* account for variations in flowering time between different ecotypes of *Arabidopsis*.

DAMAGE INFLICTED BY A BACTERIAL TOXIN

Bacterial pathogens often secrete toxins that harm their host organisms. The food poisoning bacterium, *Campylobacter jejuni*, secretes a multisubunit toxin known as cytolethal distending toxin. Lara-Tejero and Galán (p. 354; see the Perspective by Coburn and Leong) examined the characteristics of the toxin and found that one of the subunits acted as a DNase and could cause cell cycle arrest and cytoplasmic distention on its own when microinjected into target cells.



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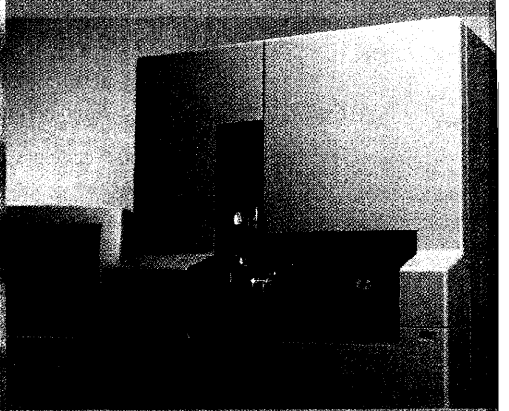

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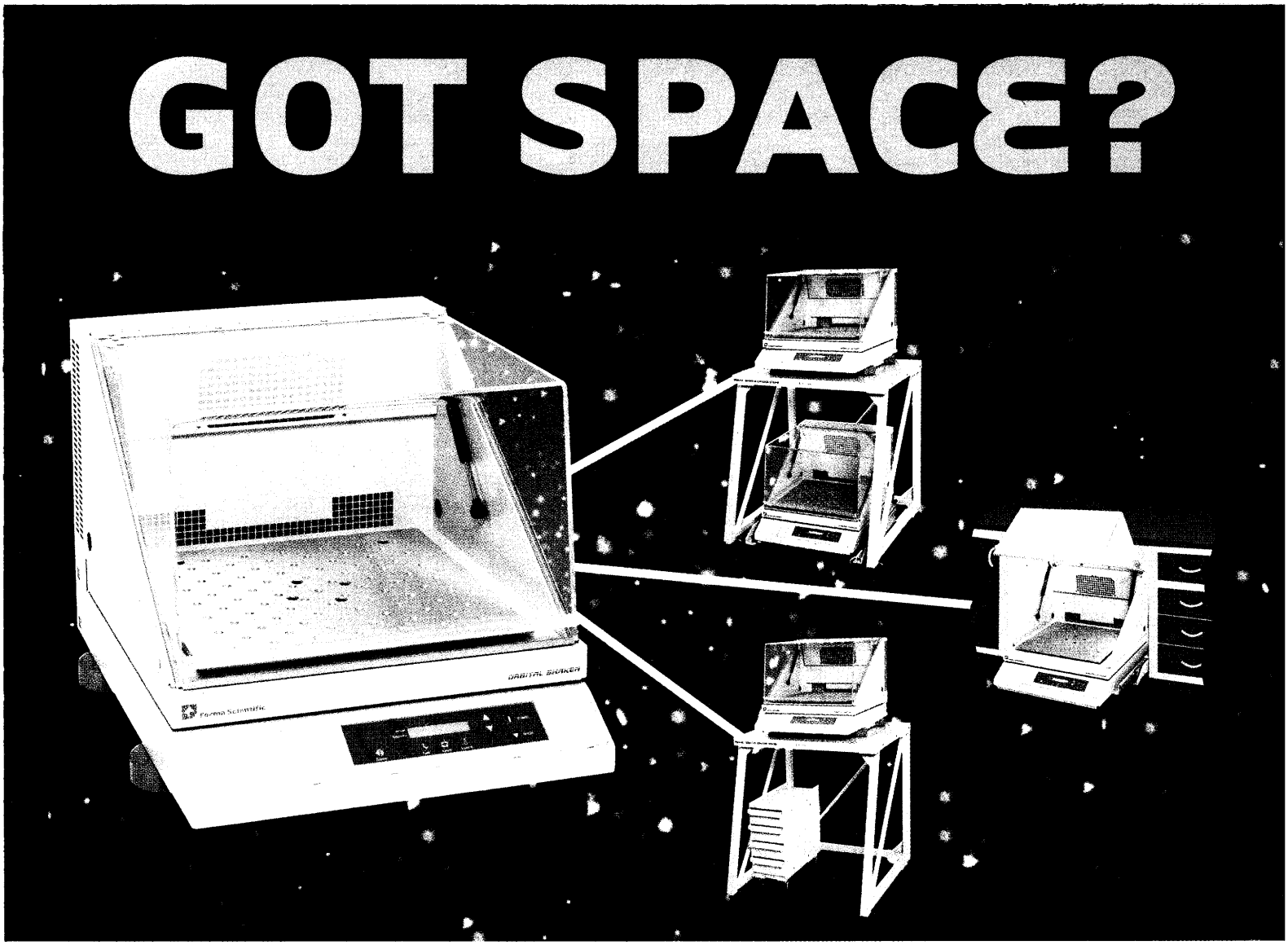

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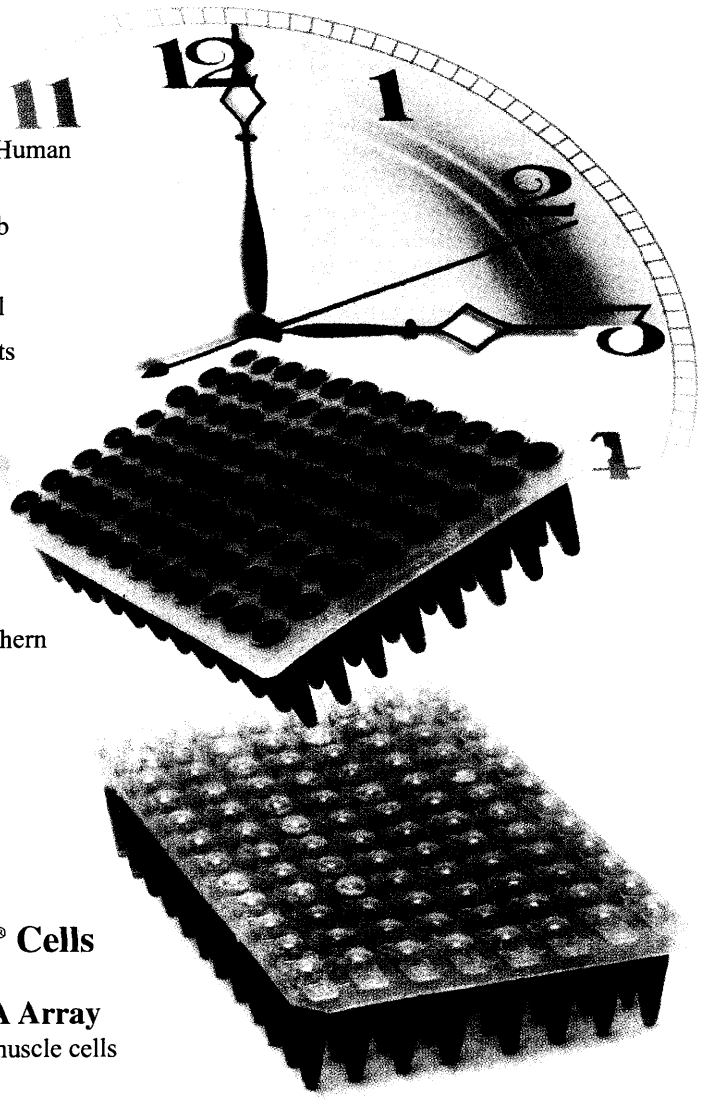

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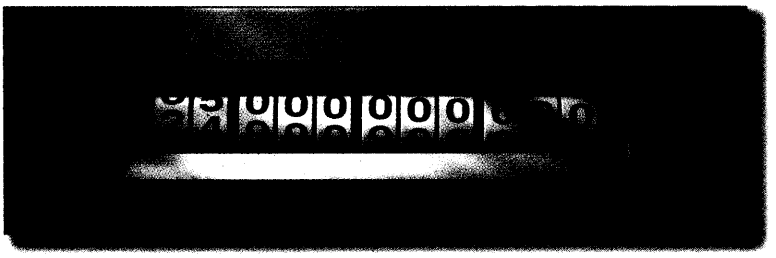

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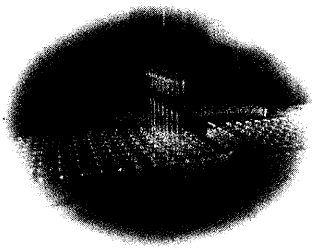

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- do not differentiate between RNA and DNA
- do not hybridize to mRNA with short poly A tails
- do not allow for DNase treatment of the sample
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- More representative mRNA population
- Reduced DNA contamination
- Hybridizes to mRNAs with shorter poly A tails
- Allows for DNase treatment during preparation
- Less ribosomal RNA contamination

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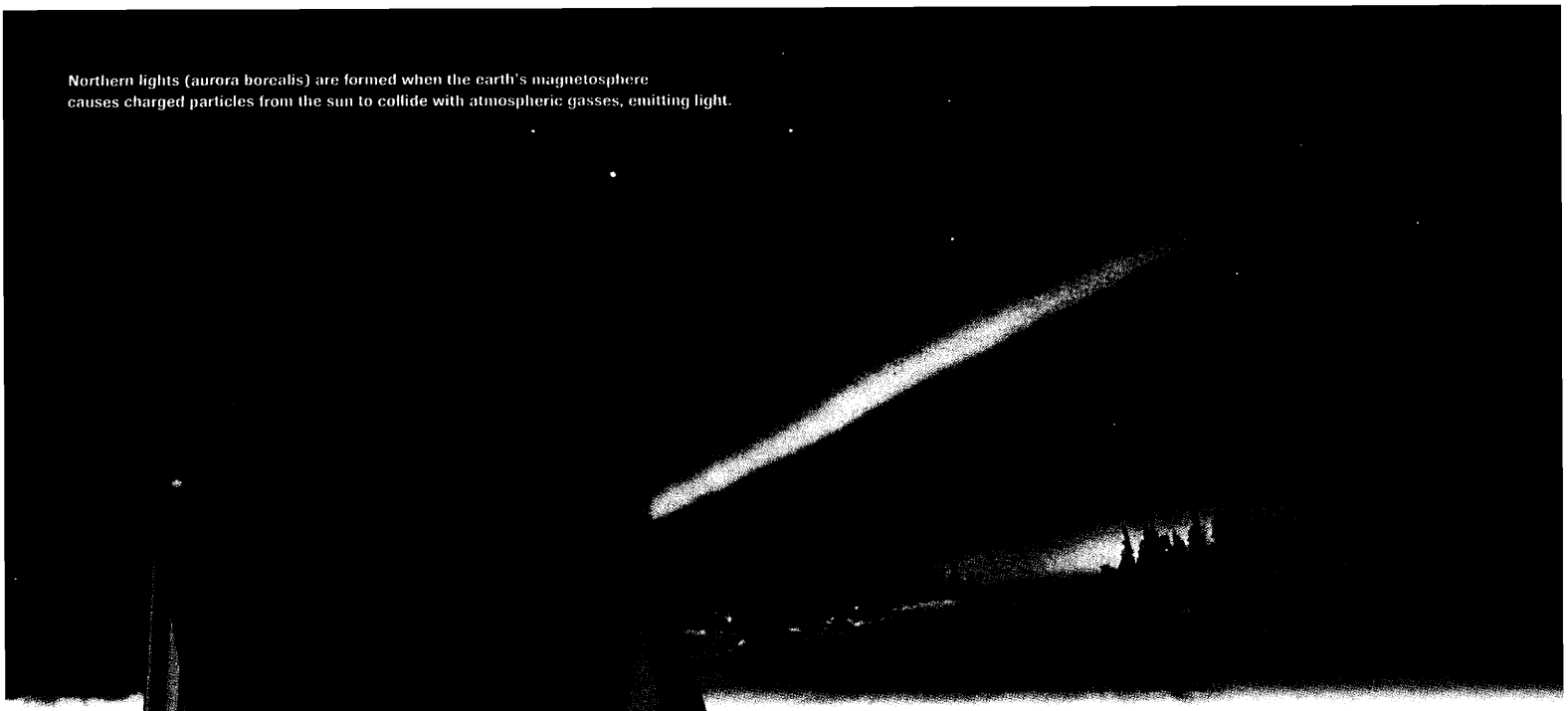

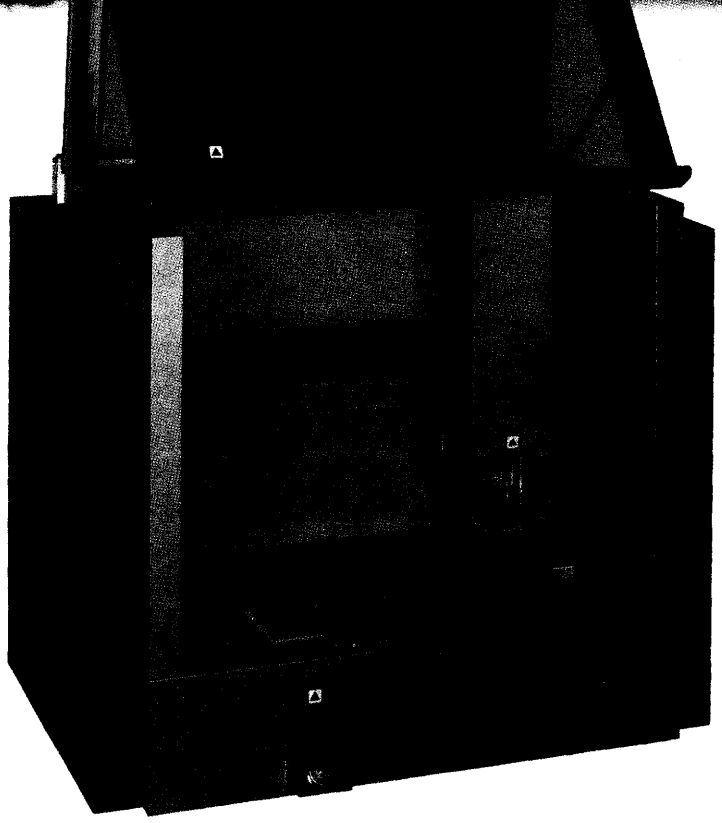

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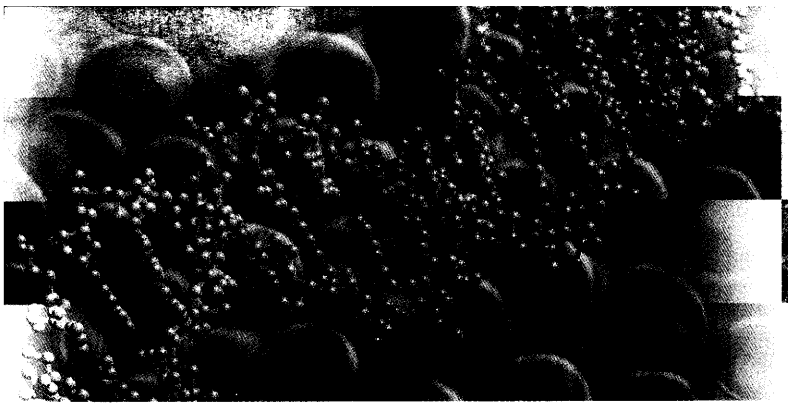

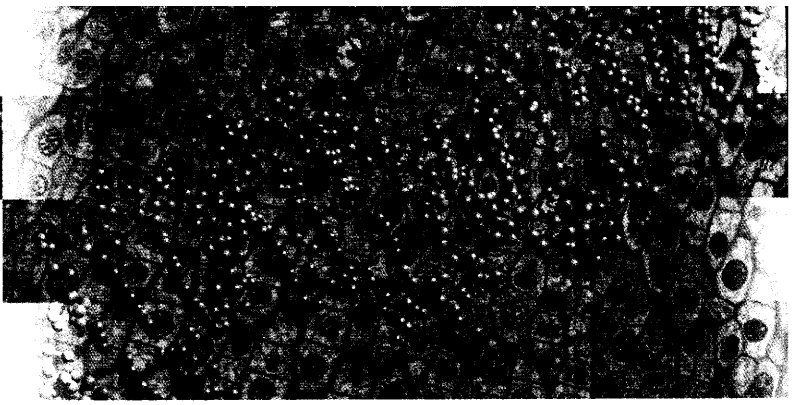

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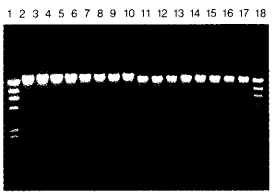
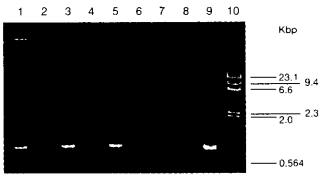
- Ultra-pure genomic DNA
- Extremely high-molecular DNA, with no degradation
- Reproducible high yields
- Rapid, easy handling
- Wide range of applications, also for animal blood



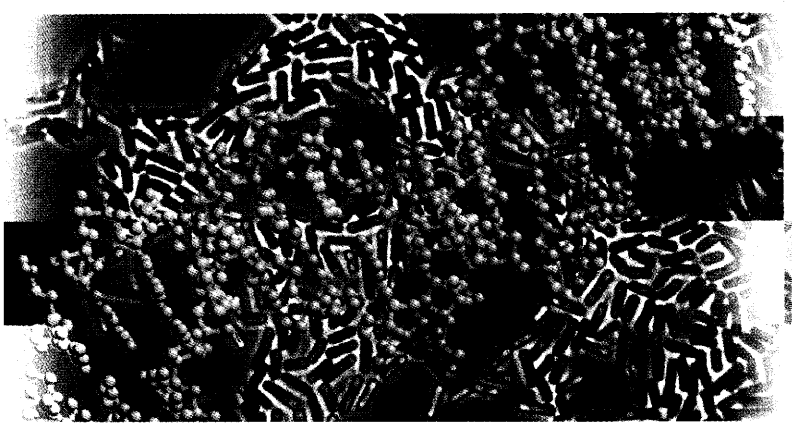
● Yields obtained using the Eppendorf Perfect gDNA Blood Kit and from a competing product. 200 µl fresh human whole blood, 5 µl eluate volume applied.
Lanes 1 and 18: λ *Hind* III Marker
Lanes 2 to 9: Eppendorf gDNA Blood Kit
Lanes 10 to 17: Competing kit

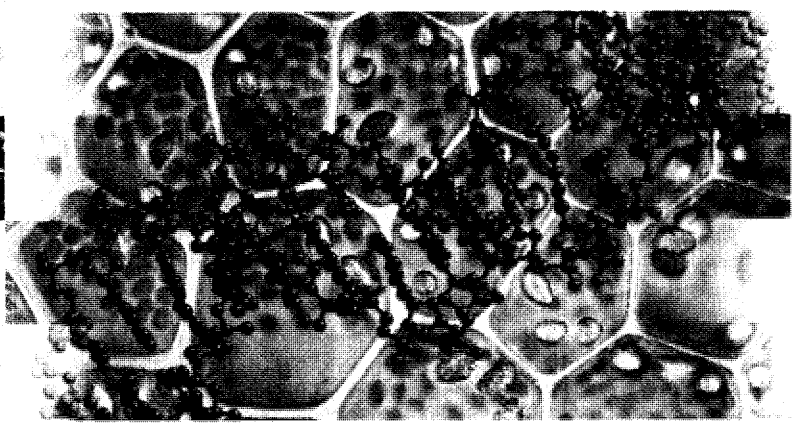
Perfect RNA

- High-quality total RNA
- Extremely high yields
- Outstanding results in sensitive downstream applications (e.g. RT PCR*, Northern Blot, cDNA synthesis)
- Different formats available



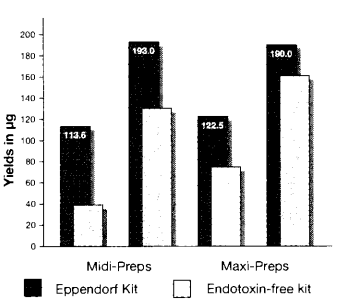
● RT-PCR analysis of total RNA isolated using the Eppendorf Perfect RNA Kits:
Lanes 1 and 2: Perfect RNA Kit (Mini Scale) total RNA
Lanes 3 and 4: Perfect RNA Kit (Midi Scale) total RNA
Lanes 5 and 6: Perfect RNA Kit (Maxi Scale) total RNA
Lane 7: No Reverse Transcriptase control.
Lane 8: Negative PCR control.
Lane 9: Positive control.
Lane 10: λ DNA-Hind III marker.





Perfectprep Plasmid

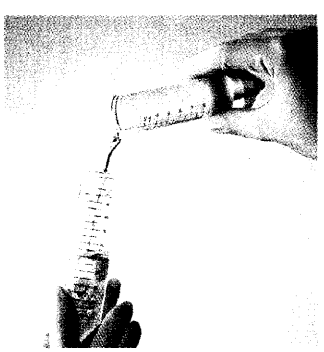
- Ultra-pure plasmid DNA in next to no time
- High yields
- Outstanding results in sensitive downstream applications (e.g. sequencing, cloning, transfection)
- Easy to handle
- Different formats available



● Yields obtained using the Perfectprep Kit and a competitor's kit from different bacteria strains with high-copy and low-copy plasmids

Phase Lock Gel

- Simplified phenol/chloroform extraction
- Up to 30 % higher nucleic acid yields
- Simple pipetting or decanting of the aqueous DNA solution
- Reduced periods of contact with phenol vapors



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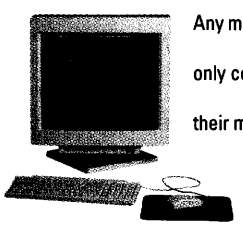

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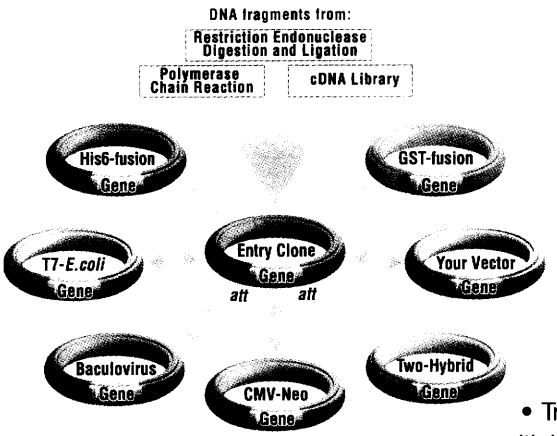

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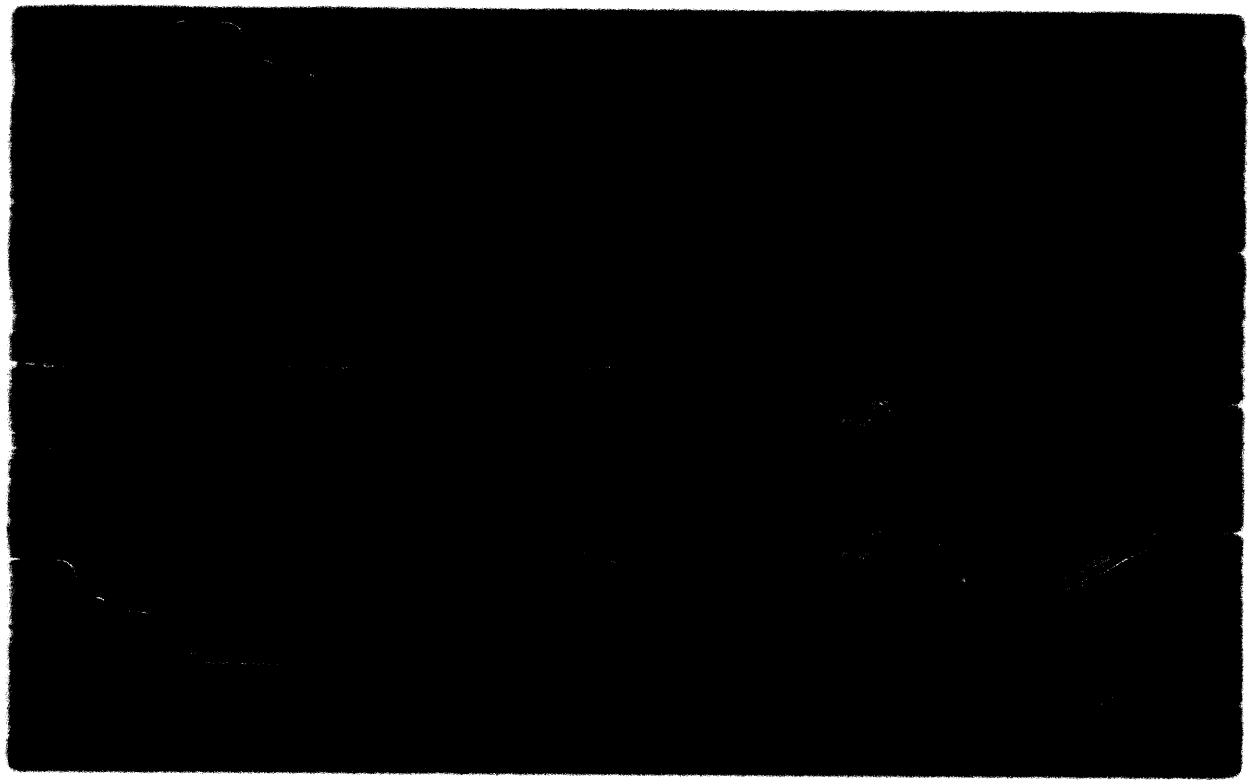

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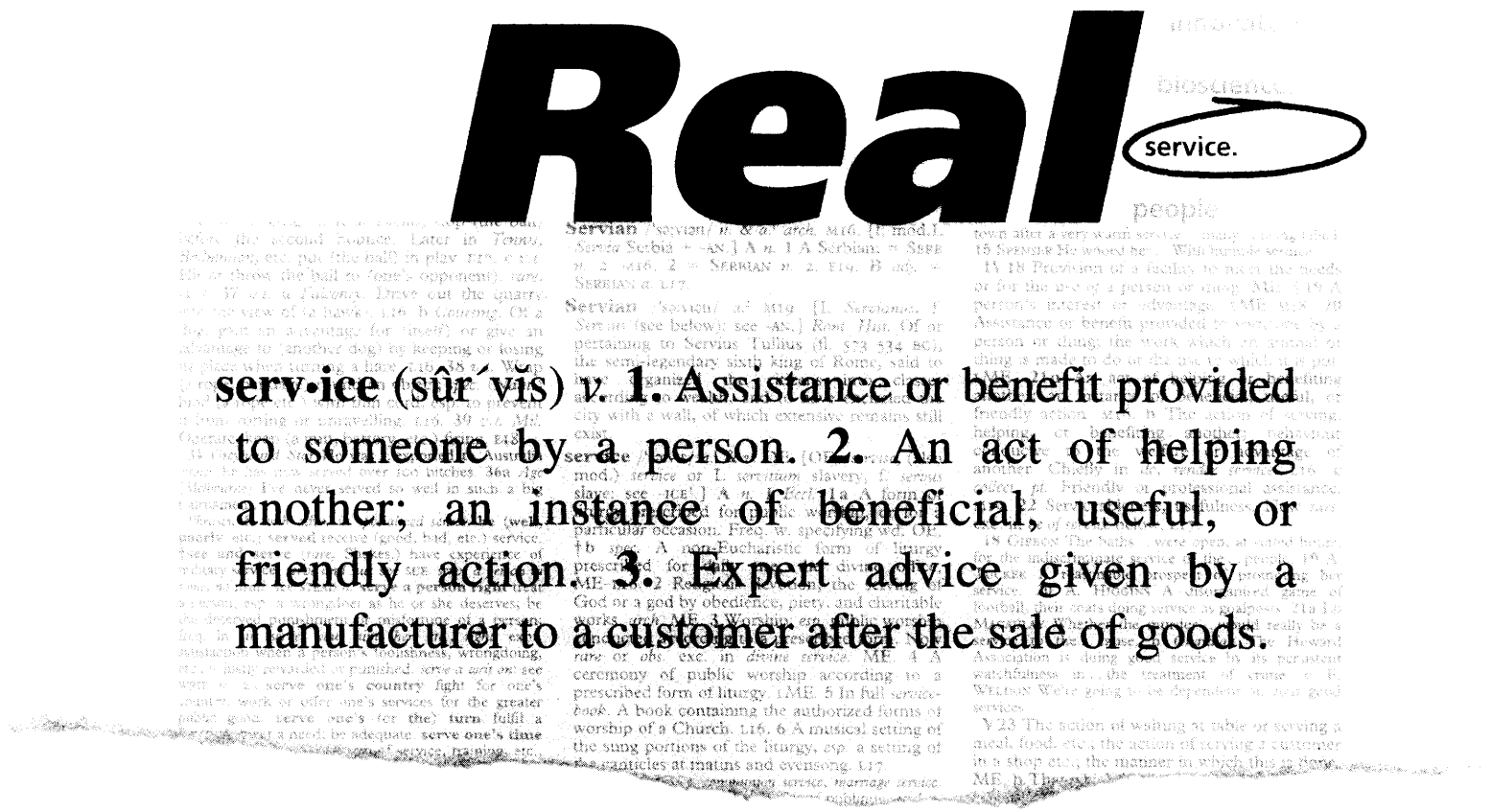

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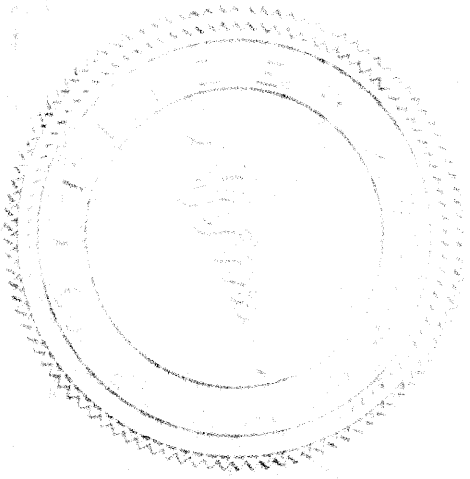

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Pfizer is proud to announce the 2001 Competitive Awards Program for scientific research related to doxazosin

The Pfizer Competitive Awards Program provides grants to members of the medical community to be used for the study of doxazosin. In past years the program has involved internationally respected researchers and has yielded exciting scientific information.

Proposals for the 2001 Competitive Awards Program must be received by October 31, 2000.

Submission of a proposal under the 2001 Competitive Awards Program is not made in confidence, and shall not create or be conditioned on any obligation or restriction on the part of Pfizer with regard to its use.

For more information contact the local Pfizer Medical Director or Dr Patricia Walmsley at Pfizer Inc., 235 East 42 Street, NY, NY 10017 or call 212-573-2638 or e-mail doxazosinawardsprog@pfizer.com.

The winners of last year's Pfizer Competitive Awards Program

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University of Buenos Aires
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Paulos Berhanu
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Albert Szent-Gyorgyi
Medical University
Szeged, Hungary

Manuel Labios Gomez &
Colleagues
University Hospital
Valencia, Spain

Dulcenombre Gomez-Garre
& Colleagues
Autonoma University
Madrid, Spain

Robert Hogikyan & Colleagues
University of Michigan
Medical School
Ann Arbor, MI, USA

Majid Kalani & Colleagues
Karolinska Hospital
Stockholm, Sweden

Antonio Lopez-Farre & Colleagues
Jimenez Diaz Foundation
Madrid, Spain

Kalman Toth & Colleagues
University Medical School
of Pecs, Hungary

Johann Wojta
University of Vienna, Austria

Judges: Stevo Julius, Lewis Landsberg, and Hans Lithell

Urology

Richard K. Babayan & Colleagues
Boston University School
of Medicine
Boston, MA, USA

Michael B. Chancellor & Colleagues
University of Pittsburgh
Pittsburgh, PA, USA

Ada Elgavish
University of Alabama at
Birmingham
Birmingham, AL, USA

Natasha Kyprianou
University of Maryland
Baltimore, MD, USA

Chung Lee & Colleagues
Northwestern University
Medical School
Chicago, IL, USA

Robert M. Levin
Albany College of Pharmacy
Union University
Albany, NY, USA

Paul D. Walden
NYU School of Medicine
New York, NY, USA

E. Lynette Wilson
NYU School of Medicine
New York, NY, USA

Judges: Georg Bartsch, Claus Roehrborn, and William Steers

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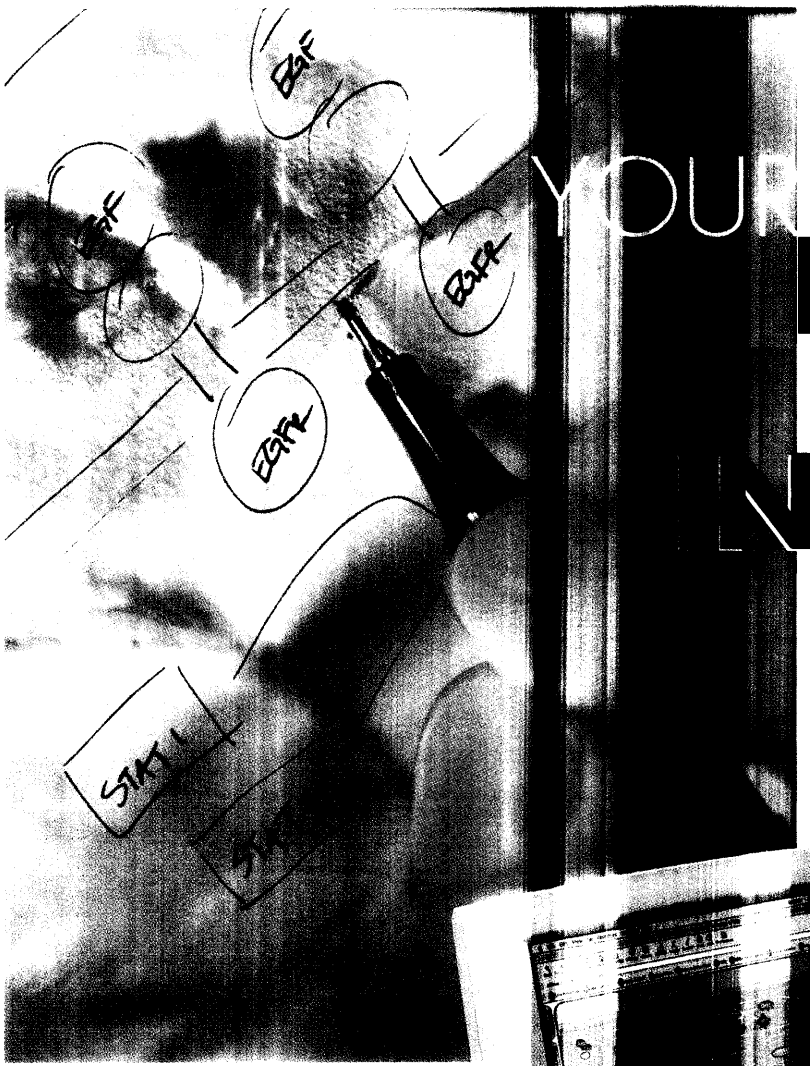

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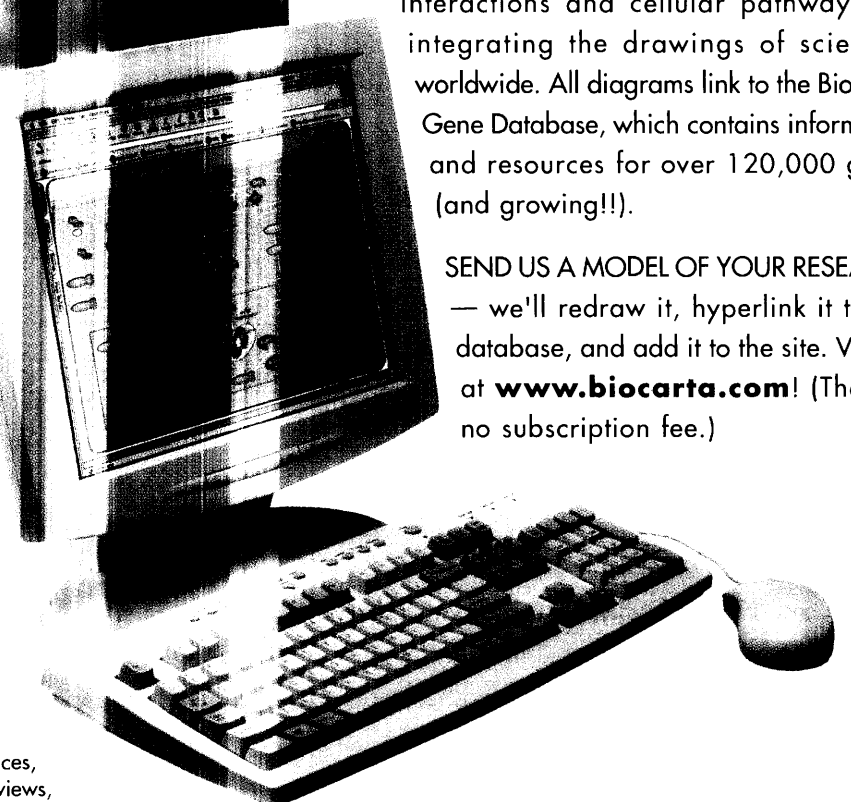

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