2 March 2001

Science

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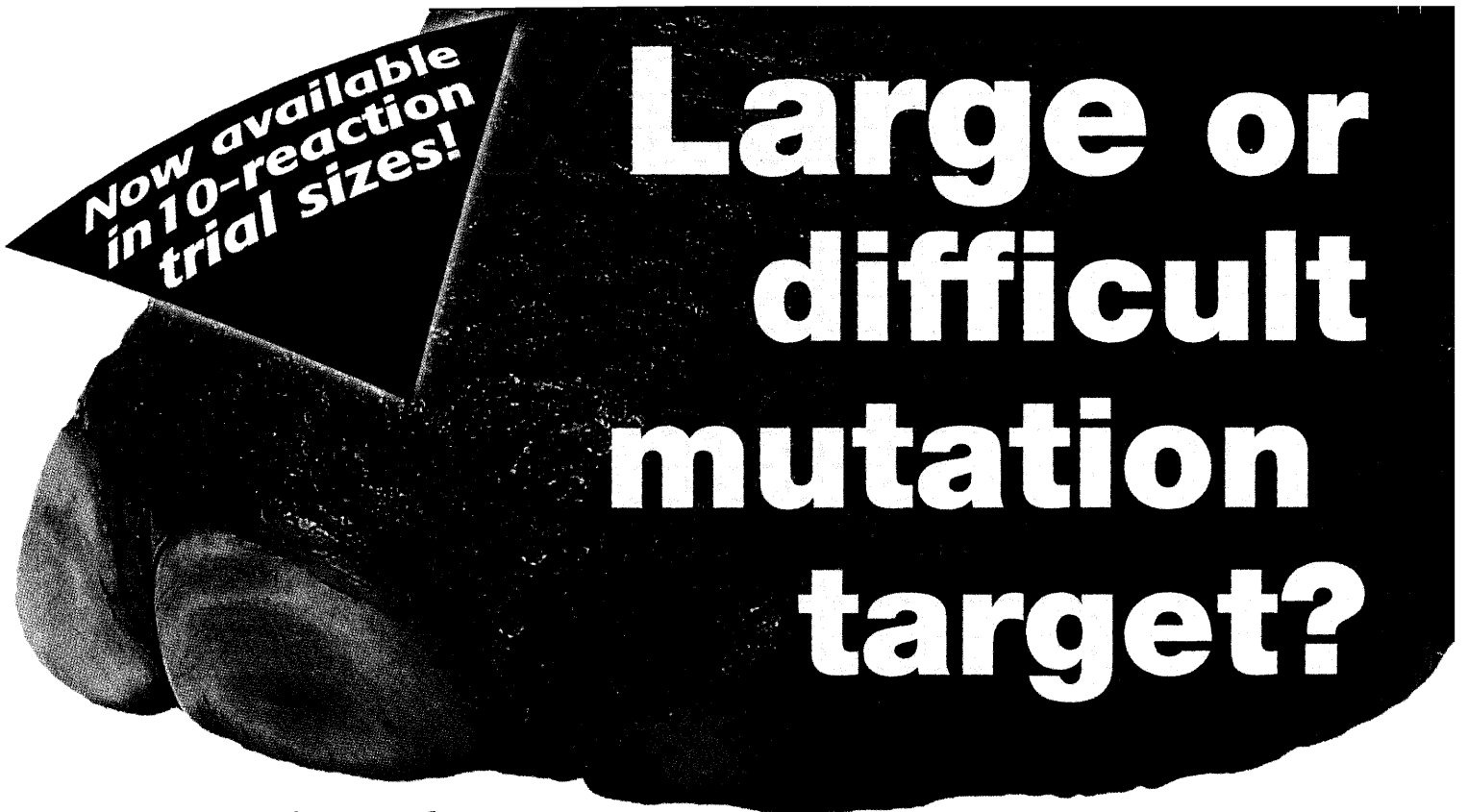
Pages 1651–1846 $9

Human Evolution: Migrations

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



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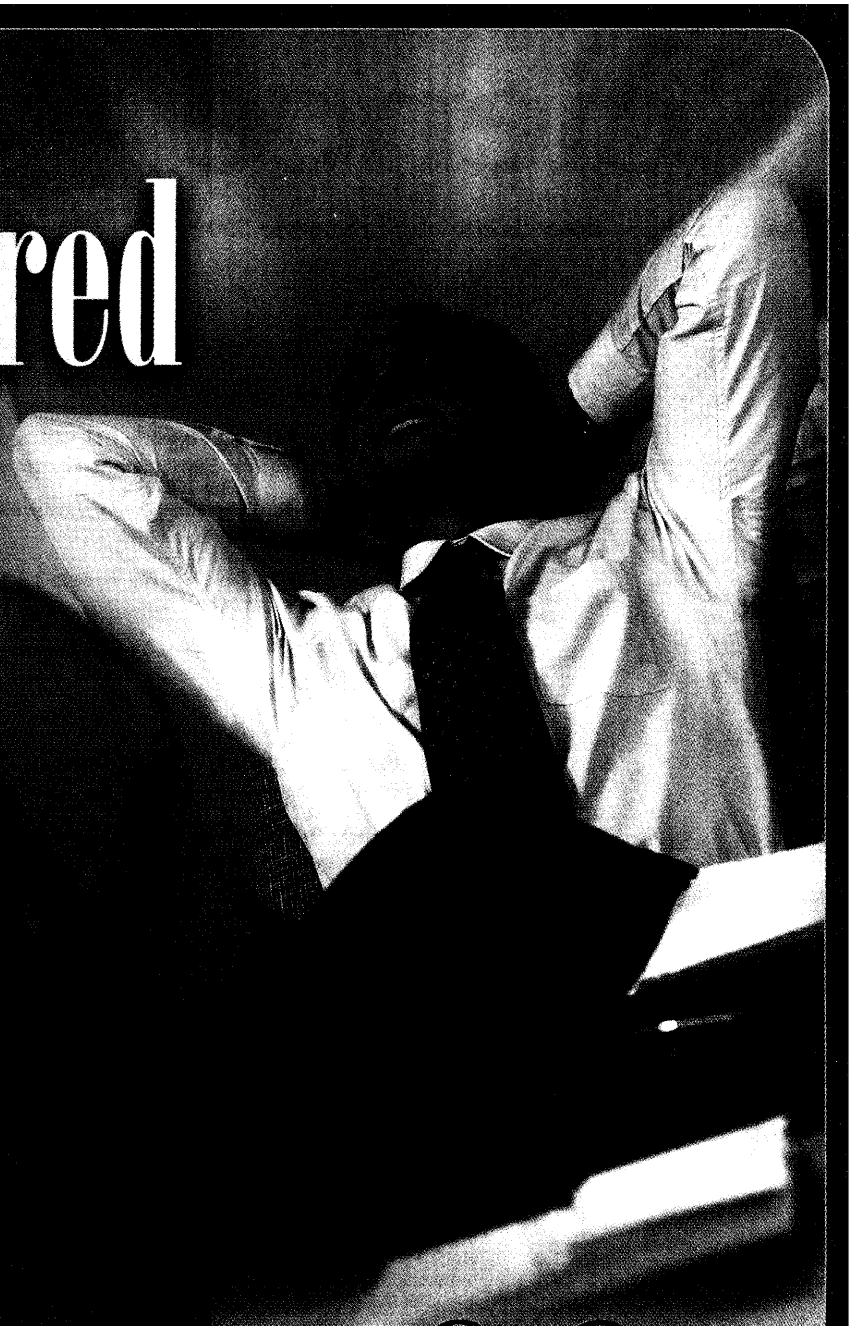

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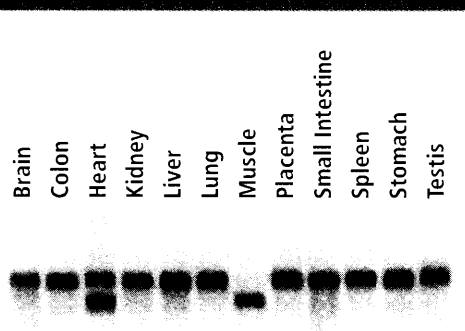

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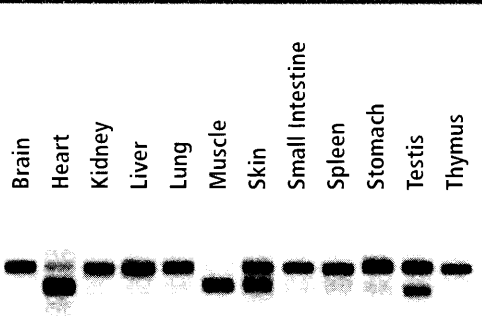
Mouse 12 major tissues
(Probed with β-actin)



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Science

Volume 291 2 March 2001 Number 5509

NEWS

NEWS OF THE WEEK

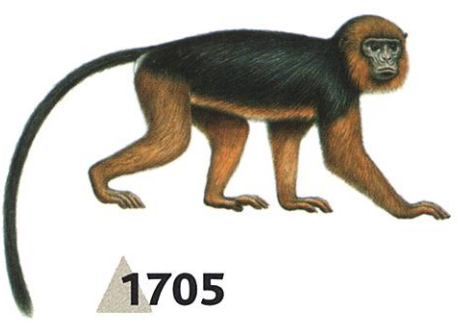
NEWS FOCUS

SCIENCE'S COMPASS

ESSAY

BOOKS *ET AL.*

PERSPECTIVES



HUMAN EVOLUTION: MIGRATIONS

NEWS

REVIEWS

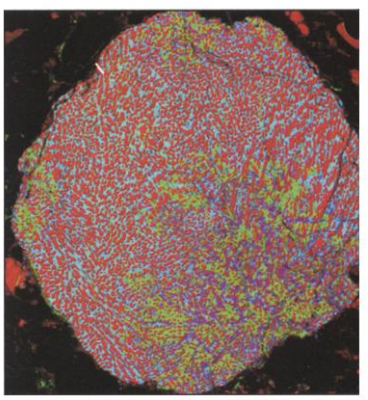
COVER 1721

Scientific reconstructions reveal the faces of 1.7-million-year-old male and female hominids from Dmanisi, Georgia. These people (considered to be either *Homo ergaster* or *H. erectus*) represent the first human migrants out of Africa. Their journey and those of other ancient humans are explored in the special section on human migrations and evolution. [Skull reconstructions, Elisabeth Daynes; photography, Philippe Plailly/Eurelios. The reconstructions are a scientific collaboration with Leo Gabunia of the Academy of Sciences of Georgia, David Lordkipanidze of the State Museum of Georgia (both in Tbilisi), and Marie-Antoinette de Lumley of the Institute of Human Paleontology in Paris.]

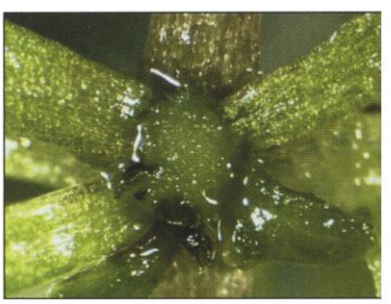
RESEARCH

RESEARCH ARTICLE

REPORTS



1776
Chondrule origins



1797
Life without telomerase

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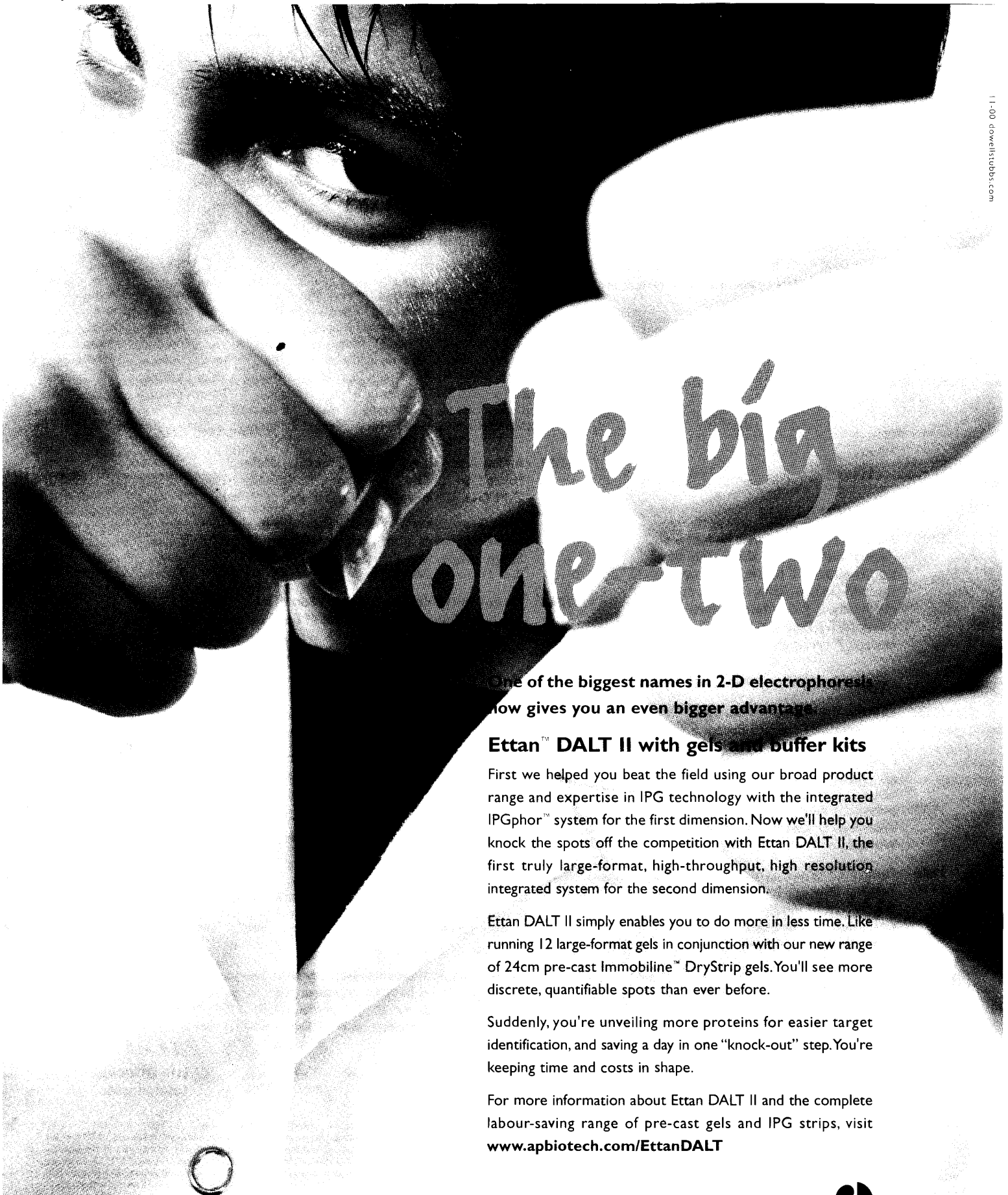

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Observation of Fermi Pressure in a Gas of Trapped Atoms
A. G. Truscott, K. E. Strecker, W. I. McAlexander, G. B. Partridge, R. G. Hulet

PERSPECTIVE: **Standing Room Only at the Quantum Scale** K. M. O'Hara and J. E. Thomas

Within a cold gas mixture of bosons and fermions, heat-removing collisions with the bosons are found to lead to sympathetic cooling of the fermions to quantum degeneracy.

Preferential Localization of Effector Memory Cells in Nonlymphoid Tissue D. Masopust, V. Vezys, A. L. Marzo, L. Lefrançois

PERSPECTIVE: **Local Heroes in the Struggle for Immunity** C. R. Mackay and U. H. von Andrian

Localizing in nonlymphoid tissues may allow memory CD8$^+$ T cells to provide faster protection against invading pathogens.

Sonic Hedgehog Control of Size and Shape in Midbrain Pattern Formation S. Agarwala, T. A. Sanders, C. W. Ragsdale

The pattern of SHH expression directs the size, shape, and orientation of cell populations in brain development.

science's stke www.stke.org

Book Review: A Signal Transduction Primer D. K. Blumenthal

Commentary on the book *Principles of Molecular Regulation.*

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Global: Diversity in the 21st Century: Underrepresented Minorities in Science

In our March special feature issue, minority scientists, mathematicians, and engineers discuss the hurdles they have faced and the successes they have achieved in their careers.

UK: Writing Up (Method) A. Lord

Taking a leaf out of management guru Mark McCormack's book can make thesis writing a piece of (rather chewy) cake.

UK: Writing Up (Madness) H. Marshall

Even if you don't have the gene for list making, you *can* finish your thesis. With a nod to the list makers, Marshall offers a list of reasons why you should.

US: Web Resources for Foreign National Postdocs E. Klotz

A critique of two Web sites offering practical advice to scientists arriving in the U.S. who need to figure out, for example, how to get a driver's license or open a bank account.

Canada: What Are You Worth? L. McKarney

Results of the latest Biotechnology Human Resources Canada survey suggest that management is still in the salary hot spot.

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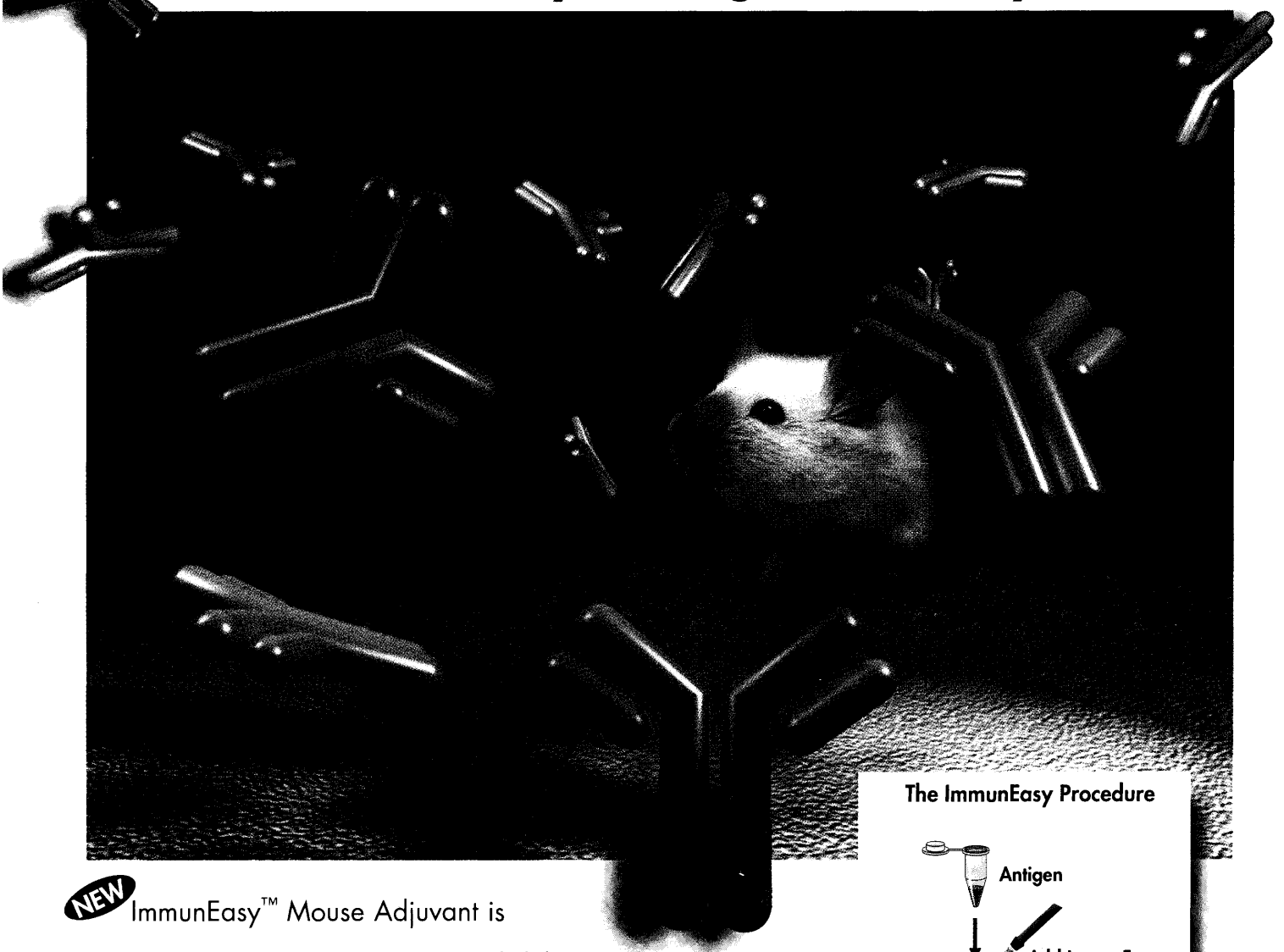

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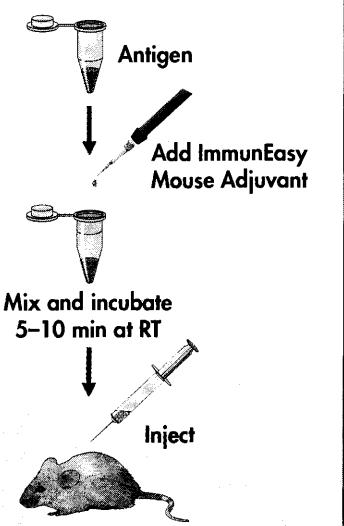

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THIS WEEK IN Science

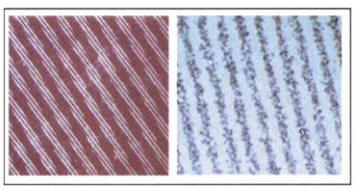
edited by Phil Szuromi

Vortex Magnetism

The most familiar characteristics of superconductors are their ability to maintain a current without dissipation, and to exclude small magnetic fields (the Meissner effect). However, type-II superconductors, which include the cuprate family of high-temperature (high-T_c) superconductors, can sustain a supercurrent in large magnetic fields. In such materials, nonsuperconducting vortices containing a single quantum of magnetic flux penetrate the superconductor and are dispersed throughout the superconducting fluid. The spin dynamics of the vortices are thought to play a role in the properties displayed by the high-T_c superconductors, but little is actually known of the magnetic properties of the vortices. Lake *et al.* (p. 1759) used neutron scattering to look directly at the magnetic structure of the vortices of an optimally doped superconductor and provide evidence that the spins within the vortices show a strong tendency to order antiferromagnetically.

1763 Holding Its Charge

Materials that can retain trapped electrical charge or polarization, known as electrets, could provide a convenient route to nanofabrication or data storage if they could be patterned readily on a fine scale. Jacobs and Whitesides (p. 1763) show that flexible rubber stamps coated with a metallic conductor can, upon contact and application of a voltage pulse through the layers, induce a charge pattern in poly(methyl methacrylate) (PMMA) film on a conductive support. Areas up to a square centimeter could be patterned at a resolution of 150 nanometers in less than 20 seconds, and particles could be assembled on the charged surfaces. Such charge transfer was incomplete when stiffer substrates supported the patterned electrode.



Mix and Unmatch

Combinatorial chemistry creates large libraries of compounds—and also large separation problems. A convenient way to keep track of different reactions is to attach one of the reactants to a solid support and use the support to separate molecules after the reactions are finished. However, in many cases, the solid support can limit the type and speed of reactions that can be performed. Luo *et al.* (p. 1766) show that by tagging reactants with fluorinated species of different chain length, mixtures of compounds can undergo reactions in a single pot and then be sorted quickly by fluorous chromatography.

Reversible Crystal Steps and Wrinkles

Photochromic materials, which undergo reversible reactions that can be driven back and forth with two different wavelengths of light, can be of use in data storage and memories. However, in many of these materials, thermal reactions can drive one state to the other, which limits the material's utility. Irie *et al.* (p. 1769; see the Perspective by Scheffer and Scott) recently reported on a compound that photochemically forms and breaks an intramolecular ring reversibly but that does not undergo thermal reactions. They now present atomic-force microscopy studies of the surfaces of single crystals of this compound before and after ultraviolet (UV) and visible irradiation. After a short induction period, UV irradiation changed the colorless crystal to blue and produced surface steps on one surface and valleys on another. These effects could be reversed by bleaching with visible light. Comparison with x-ray diffraction studies show that the crystal expands and contracts in steps of one unit cell, which suggests possible applications as a nanoscale actuator.

Super-Intense Superchron

Geodynamo simulations suggest that during long periods of time when Earth's magnetic field was not reversing (a superchron), the magnetic dipole was stronger. Previously measured paleointensities of the magnetic dipole for the last 165 million years do not corroborate this relation. Tarduno *et al.* (p. 1779; see the Perspective by Banerjee) measured the paleointensities of plagioclase crystals for a series of lava flows that erupted from the Rajmahal Traps, India, within a 3-million-year period during the Cretaceous Normal Polarity Superchron. These measurements yielded a much higher paleointensity than previous measurements on whole rocks. Observations and simulations can now be coupled, thus clearing the way for understanding how the geodynamo works when the field is stable and when it flips.

The First Chondrules?

Chondrules are millimeter-sized rounded fragments of glass and crystals found in the most primitive meteorites called chondrites. They may have formed by flash-heating events in the solar nebula. Krot *et al.* (p. 1776) studied two atypical chondrites that contain zoned iron-nickel metal grains. The petrographic and chemical characteristics suggest that they formed in one large region that vaporized the materials and created the chondrites by gas-liquid fractionation. The unaltered nature of the chondrites and the large heating region required for their formation indicate that they formed early in the lifetime of the solar nebula.

Sex Antiseptic

Sexually transmitted diseases are the bane of many organisms, yet little is known of the host responses in the male genital tract when encountering pathogens during sex. Li *et al.* (p. 1783) have discovered an antimicrobial peptide that is secreted specifically from a region of the epididymis of male rats and that has primate homologs. This peptide, with sequence similarity with defensins, may not only protect against invading microorganisms such as gonococci and treponemes but may also aid the maturation of sperm during normal development.

CONTINUED ON PAGE 1661

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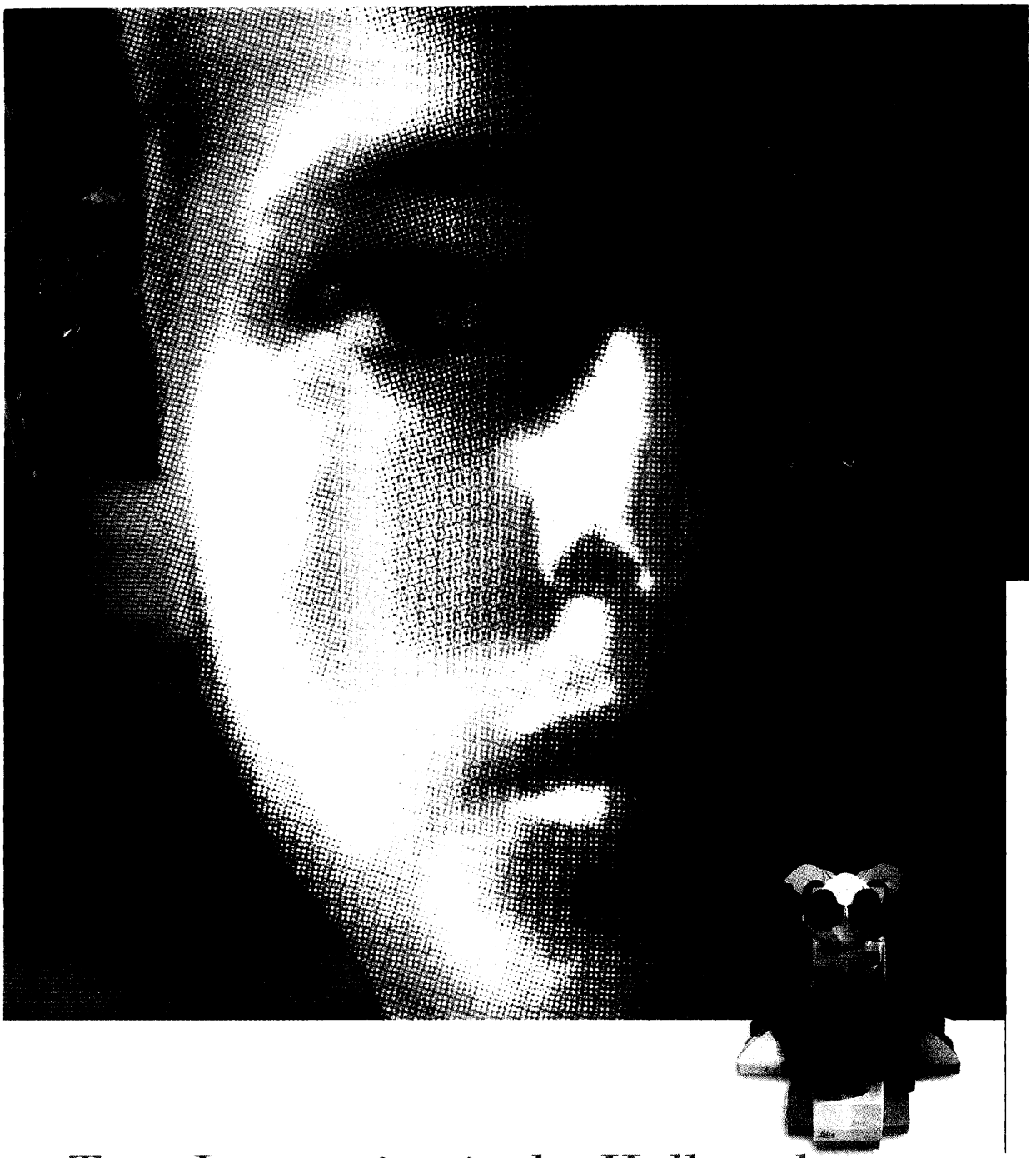

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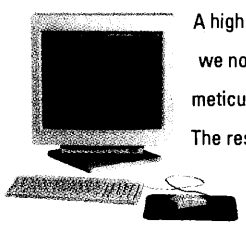

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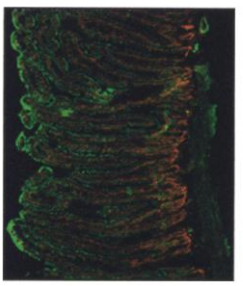
Annals of Mammals

The relationships among the major groups of mammals have long been of great interest—and debate. Liu *et al.* (p. 1786; see the Perspective by Springer and de Jong) present a meta-analysis of a large body of molecular and morphological phylogenetic data to produce a "supertree" of the family-level relationships among the placental mammals. Encouragingly, they find a substantial degree of congruence between molecules and morphology in the sense of placement of families within orders, which argues convincingly for the continued importance of the use of both kinds of data.

Equipping Bacterial Antibiotic Laboratories

Drug discovery largely has been a process of screening natural products from microorganisms and plants, identifying a promising lead, and then tinkering with the chemical structure in the laboratory to improve pharmacokinetics and diminish side effects. Recently, there have been efforts to shift the tinkering stage back into the natural producers in order to co-opt the unparalleled skill with which enzymes achieve stereospecificity. Pfeifer *et al.* (p. 1790; see the news story by Ferber) have taken an alternative approach by transferring the polyketide biosynthetic genes from the producer of erythromycin, *Saccharopolyspora erythraea*, to the bacterial workhorse, *Escherichia coli*. This strain of *E. coli* yields the core of erythromycin in quantities comparable to that of the parent.

Eat Your Spinach



Fans of "Popeye" cartoons will know the importance of dietary iron. However, how the iron that we eat actually gets out of the gut for absorption into the body has been a bit of a mystery. The ferric form of iron is quite insoluble and must be converted to the ferrous form to become bioavailable. McKie *et al.* (p. 1755) have identified a protein in the gut that appears to be the key to iron absorption. The protein, duodenal cytochrome b, can reduce dietary iron into a form that can be transported across the gut wall. EX

How to Grab a Membrane

After endocytosis, endosomes fuse with one another. One targeting factor appears to be the production of phosphatidylinositol 3-phosphate in membranes; this lipid head group is then recognized by so-called FYVE domains found on some endosomal fusion proteins. Kutateladze and Overduin (p. 1793) present an analysis of the structure of the FYVE domain of early endosome antigen 1 in complex with phosphatidylinositol 3-phosphate and suggest a mechanism by which these interactions may promote endosome recognition.

Life Without Telomerase

The integrity of eukaryotic genomes has been linked to the function of telomeres, the DNA sequences that cap the ends of chromosomes. Studying the mustard weed *Arabidopsis thaliana*, Riha *et al.* (p. 1797) examined the fate of plants deficient in telomerase, the enzyme that maintains telomeres. The mutant plants survived for 10 generations, although the plants in the later generations showed increasing evidence of cytogenetic damage. Such toleration of telomere dysfunction contrasts sharply with what has been observed in animals and reflects the remarkable plasticity of plant development and genome organization.

Of Digits and Distractors

Visual attention and working memory both have been studied for many years. De Fockert *et al.* (p. 1803; see the news story by Wickelgren) present both behavioral and functional brain imaging data to show that working memory load in the prefrontal cortex regulates the level of processing in posterior visual cortices. In particular, greater activation of the prefrontal cortex reduces the ability to discriminate between relevant and distractor stimuli and actually leads to poorer task performance.

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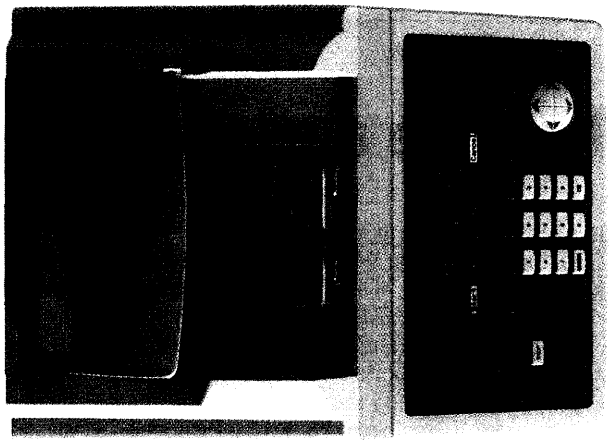
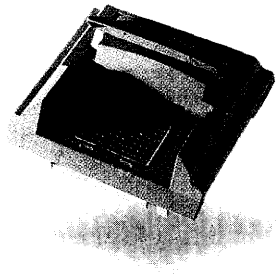
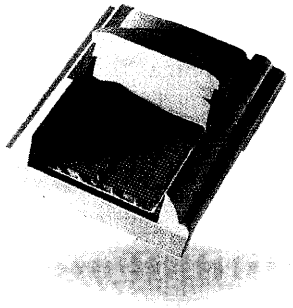
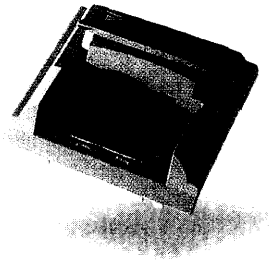




96-well 0.2 mL block



Dual 384-well 0.02 mL block



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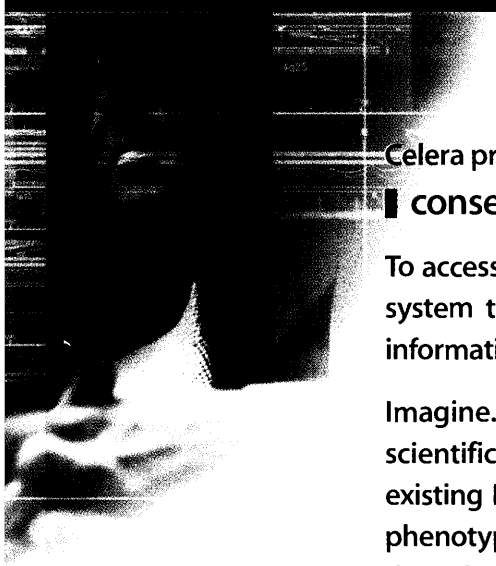

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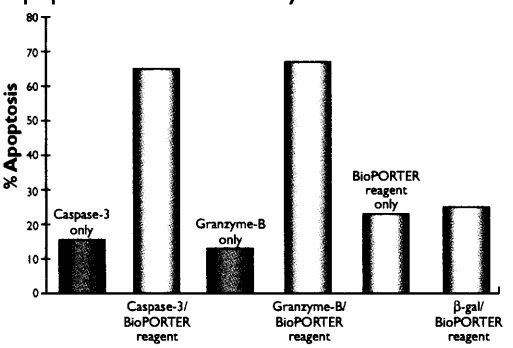

Granzyme B (450 ng), Caspase-3 (3.3 ng) or β-galactosidase (2 µg) were added to Ki-Ras 267 cells (prostate cancer) with or without BioPORTER reagent. 24 hours after protein delivery, cells were directly analyzed for apoptosis by flow cytomerty using an Annexin V-FITC assay kit.

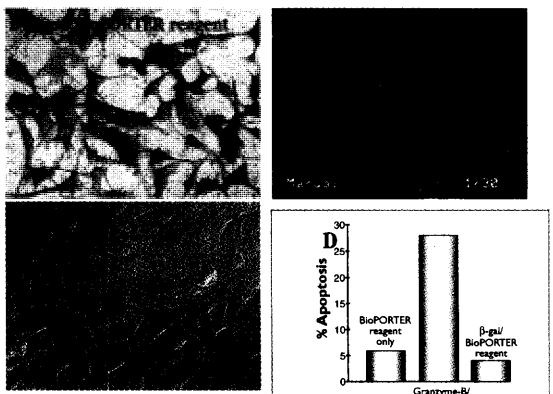

Fig. B/C FITC-Antibody or β-gal Delivery Into Mouse Fibroblasts
FITC-labeled antibody (2 µg) or β-gal (0.5 µg) were delivered with 2.5 µl of BioPORTER reagent into NIH/3T3 cells grown on coverslips in serum free conditions. Cells were examined 4 hours after protein delivery.

Fig. D Functional Granzyme-B Delivery Into Jurkat Cells
Granzyme-B (450 ng) or β-gal (1 µg) were delivered into cells growing in serum-free medium. 24 hours after protein delivery, cells were directly analyzed for apoptosis by flow cytomerty using Annexin V-FITC.

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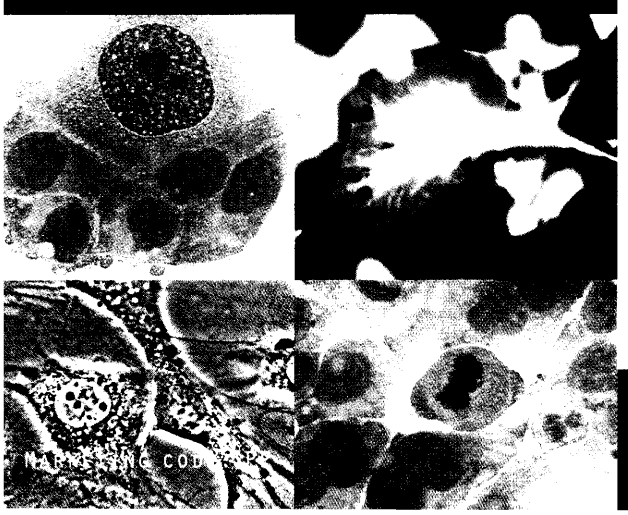

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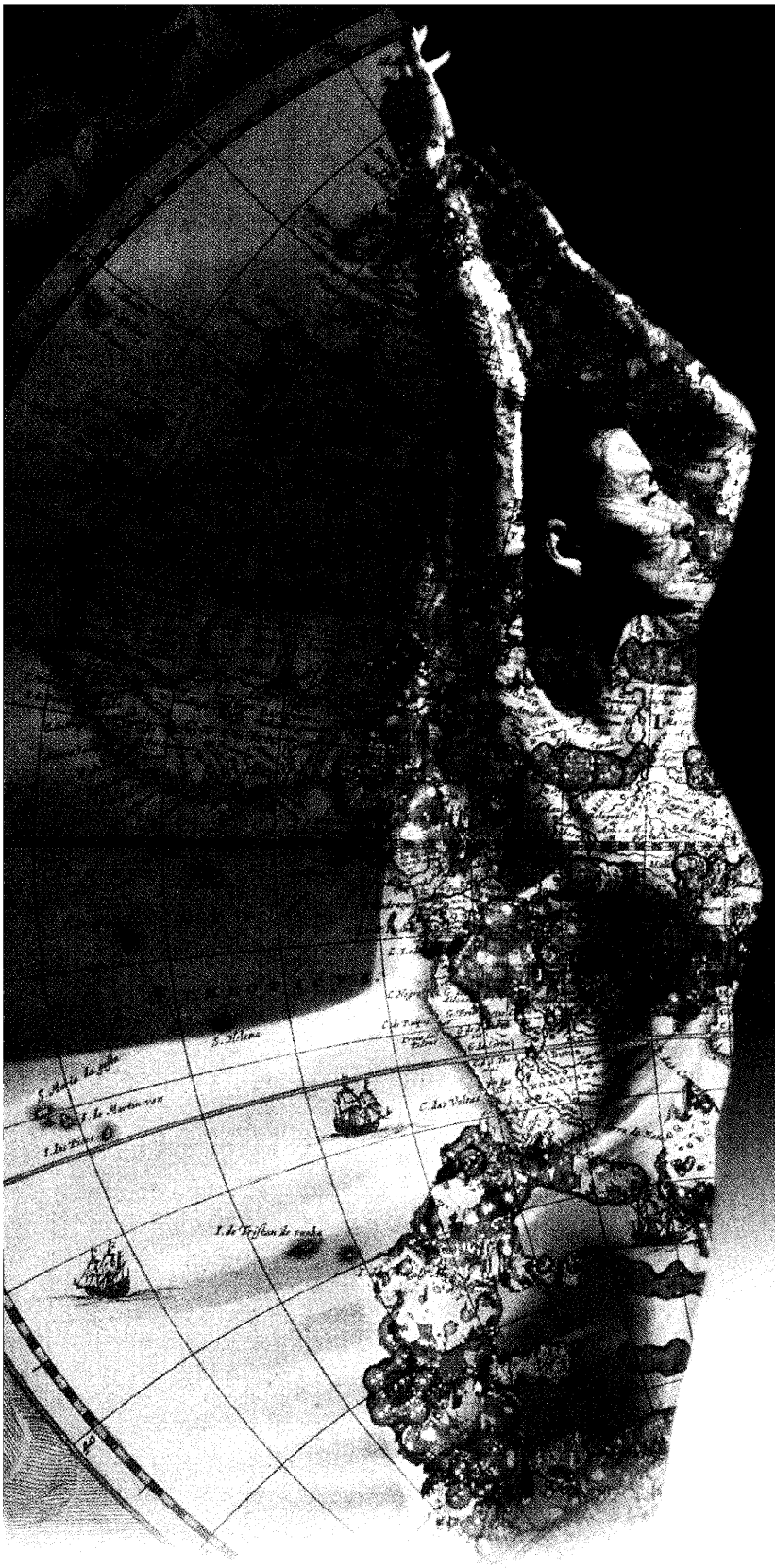

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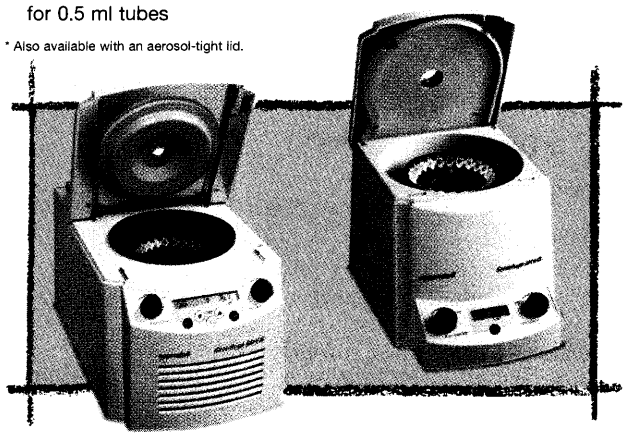

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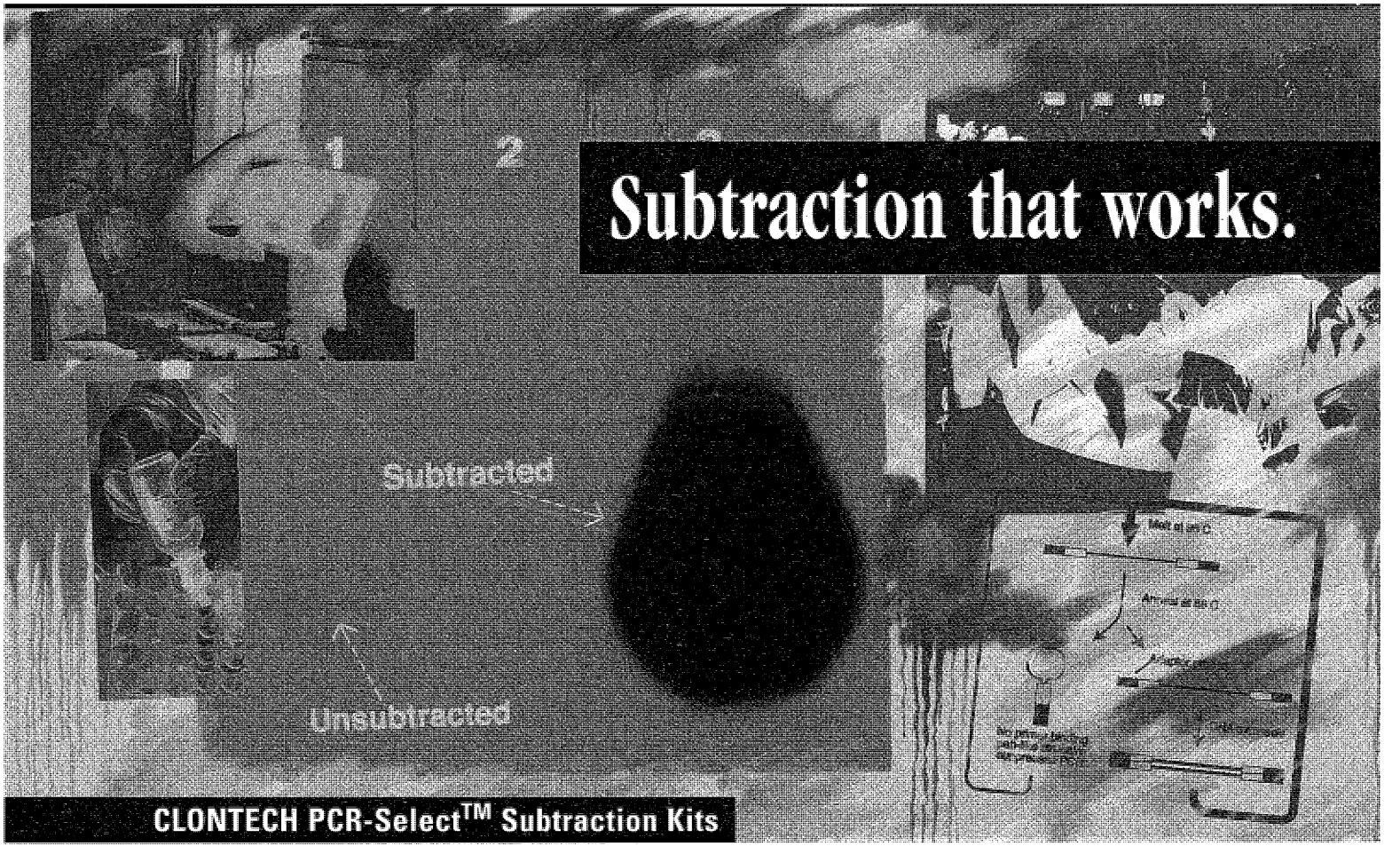

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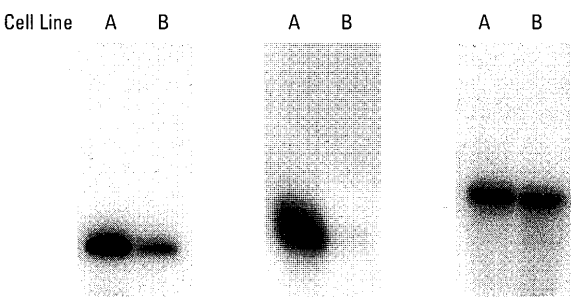

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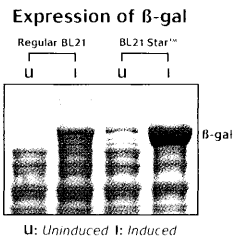

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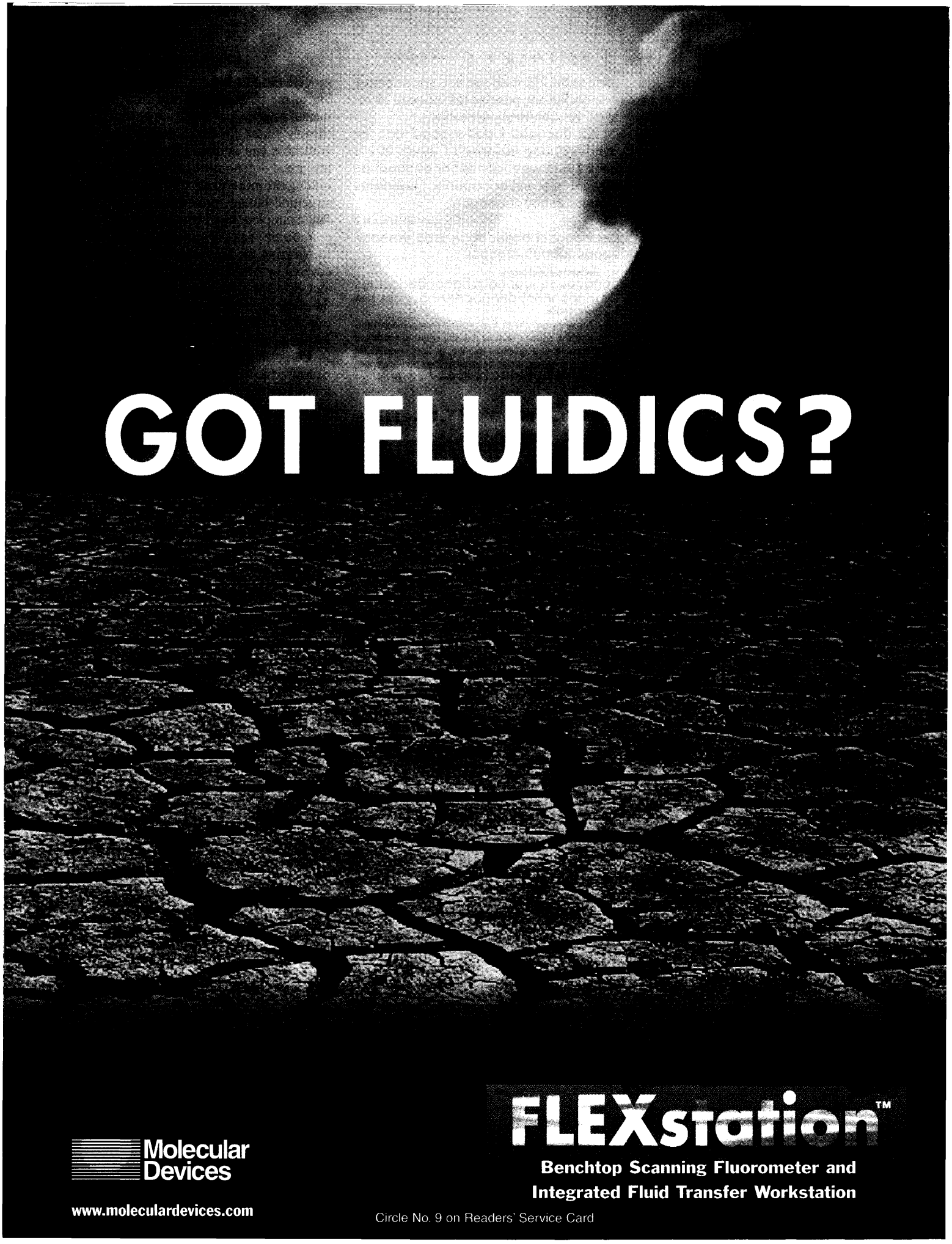
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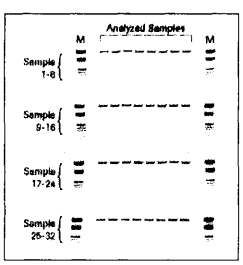
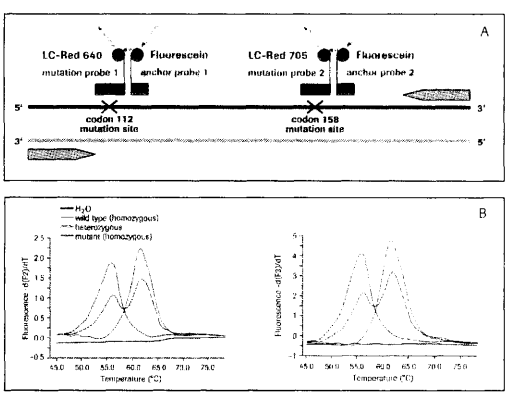


Genomic DNA isolation from 32 samples of human whole blood using MagNA Pure LC. *No visible intra-assay variance.*



Dual-color genotyping using the LightCycler Instrument.
A. *Schematic of the PCR.*
B. *Melting curve analysis was performed on different genotypes at codons 112 and 158 of the Apo E sequence (in channels 2 and 3) to discriminate wild type, heterozygous, and mutant genotypes.*

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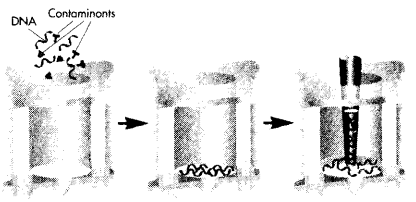

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