

# Science

10 September 1999

Vol. 285 No. 5434  
Pages 1629-1808 \$8

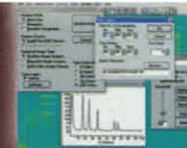
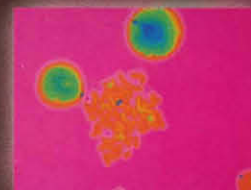


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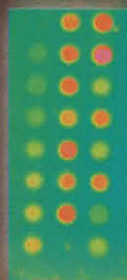


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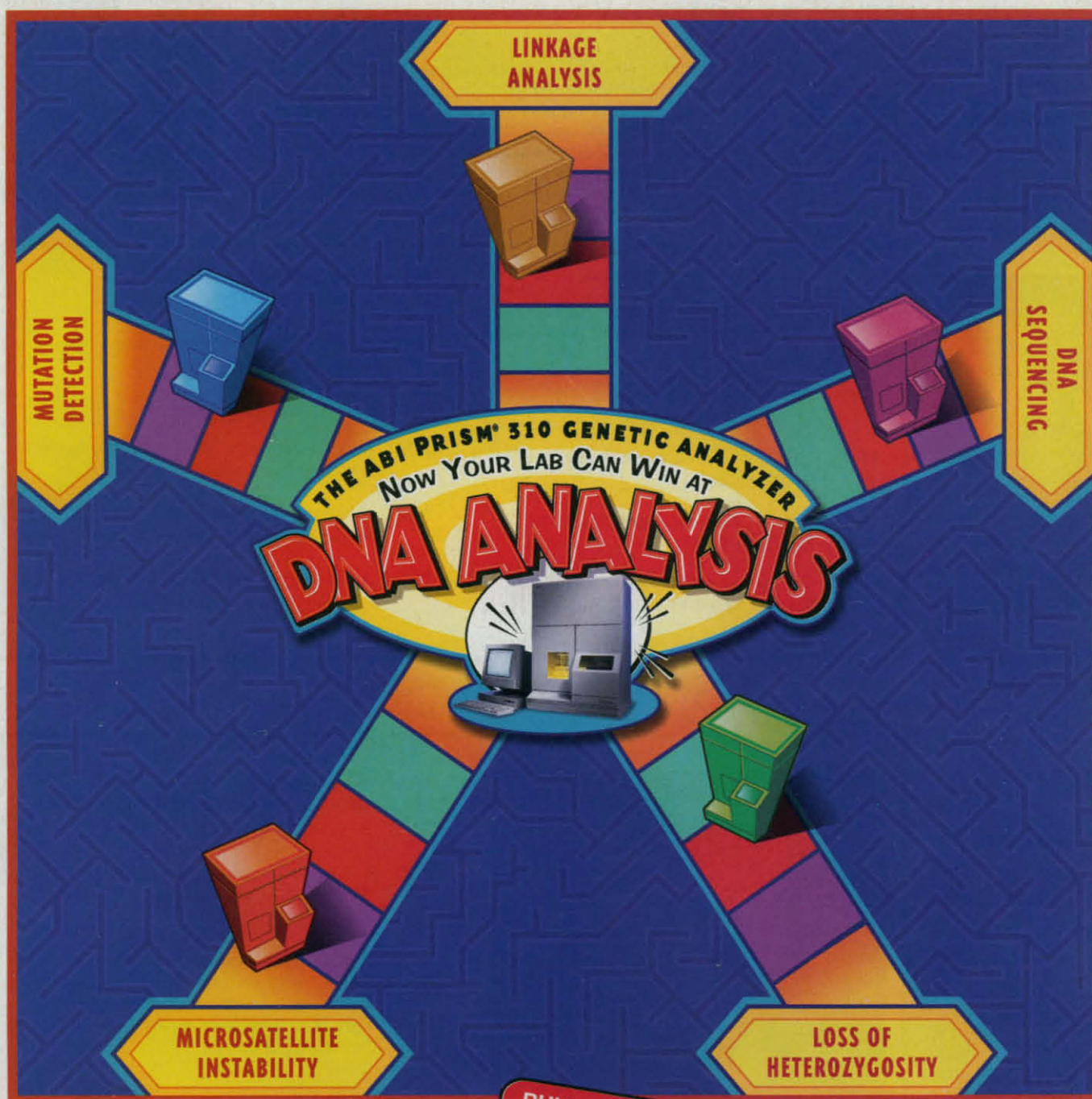
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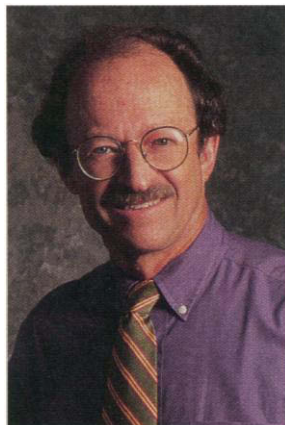
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**COVER** NASA Hubble Space Telescope image of galactic nebula NGC 3603 with a young star cluster (center) and evolved blue supergiant Sher 25 (ringed star, upper left center). Giant nebula cloud (right) contains "amorphous" silicate dust grains. Similar extraterrestrial dust grains called GEMS (glass with embedded metal and sulfides), which were collected in Earth's stratosphere, may be remnants of the nebula cloud from which our solar system formed. [Image: W. Brandner, E. K. Grebel, Y.-H. Chu]

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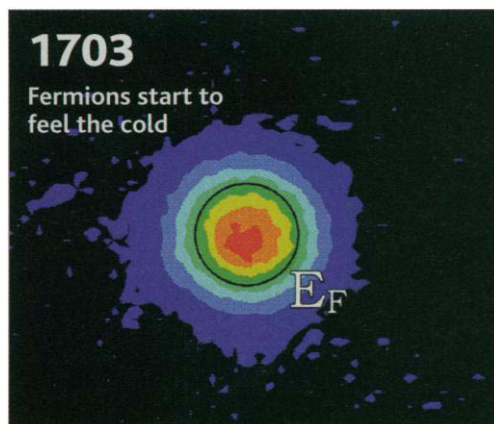
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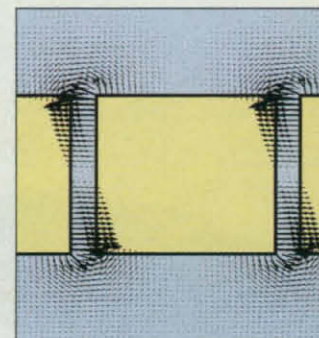
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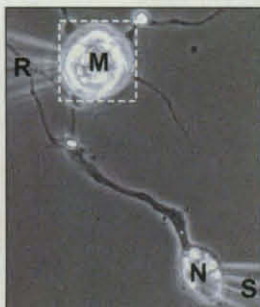


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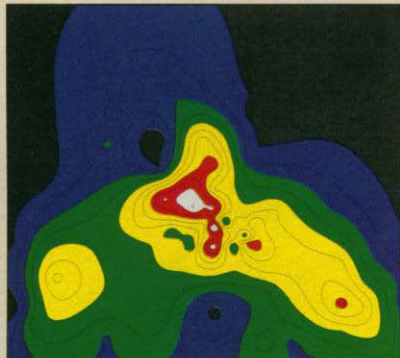
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## CORTICAL RESPONSES OF COCHLEAR IMPLANTS

Cochlear implants can be effective in treating hearing loss in adults. However, in patients with congenital or prelingual deafness, such treatment is usually much more effective for children, which suggests that cortical



plasticity plays a key role in their success. Klinke *et al.* (p. 1729; see the Perspective by Rauschecker) studied the delicate interactions between sensory information and the self-organization of the developing auditory cortex by stimulating the auditory cortex of congenitally deaf white kittens with cochlear implants and analyzing the behavior and the physiological responses of these animals. Their results demonstrate quantitatively that artificial electrical stimulation of sensory neurons in these kittens can result in relatively normal cortical responses.

## GETTING A GRIP ON OZONE

Changes in atmospheric ozone concentrations at different latitudes and altitudes are continuously monitored from satellites, balloons, and the ground. Intercalibration between different instruments and methods is crucial for obtaining reliable vertical ozone trends. Randel *et al.* (p. 1689) review the results of a reevaluation of the available data from 1979 to 1998, which showed decreases in ozone in both the upper and lower stratosphere. The upper stratospheric results agree with model calculations of ozone loss due to anthropogenic chlorine emissions. Dynamic processes complicate interpretation of the lower stratospheric trends. McKenzie *et al.* (p. 1709; see the news story by Brown) demonstrate that long-term decreases in ozone over Lauder,

New Zealand, have indeed led to significant increases in ultraviolet radiation intensities during recent decades.

## CALIBRATING CAPACITANCE BY COUNTING ELECTRONS

An important goal in metrology is to replace physical standards with measurements made of fundamental quantum properties—hence, meter bars have been replaced by the multiples of a particular wavelength of emission from krypton. Keller *et al.* (p. 1706) show how capacitance can now be standardized in terms of the capacitance generated by a countable number of electrons. An electron pump made from single-electron transistors is used to deposit a large but known number of electrons onto a capacitor; the voltage drop that results allows the capacitance to be measured.

## TOWARD FERMIONIC QUANTUM DEGENERACY

The use of cold atomic vapors Bose-Einstein condensation allowed this macroscopic quantum state to be studied for particles that interact weakly, unlike the case for Bose condensates in helium superfluids and superconductors. Strong interactions also plague similar studies for Fermions. In order to study quantum degenerate Fermionic states, cold conditions are needed so that the de Broglie wavelength of the particles is comparable to the particle-particle separation, and weakly interacting particles are needed so that each quantum state is singly occupied. By evaporatively cooling a two-spin component Fermionic gas comprising  $7 \times 10^5$  potassium-40 atoms to just several hundred nanokelvin, DeMarco and Jin (p. 1703; see the news story by Voss) provide experimental evidence for the onset of quantum degeneracy in a Fermi gas.

## STARDUST MEMOIRS

Detailed studies of interplanetary dust particles (IDPs) collected from Earth's stratosphere have shown that some of these particles are composed of enstatite, forsterite, and glasses with embedded metals and sulfides. Bradley *et al.* (p. 1716; see the cover) have now succeeded in obtaining infrared spectra of these sub-micrometer-sized IDPs using an intense synchrotron light source. Some features in the IDPs' spectra match with infrared spectral features of comets Halley and Hale-Bopp, a late-stage Herbig Ae/Be star, some molecular clouds, and some young

stellar objects. These spectral connections enhance the link between solar system material (represented by the IDPs) and non-solar system material (represented by interstellar or circumstellar dust associated with comets and other astronomical objects) and provide a way to examine stellar contamination of our solar system.

## TOWARD HYBRID NANODEVICES

The fabrication of nanodevices will likely be faced with a significant manufacturing challenge—the formation of well-defined crystalline interfaces between different device components. Zhang *et al.* (p. 1719) show that nanoscale heterostructures can be fabricated with high control over the interface structure by a diffusion-controlled solid-solid reaction at the contact area between a silicon carbide nanorod or particle and a single-wall carbon nanotube. The method is also demonstrated for several transition metal carbides. The contact area represents the smallest interface at which a carbon nanotube can form.

## DISTRACTING THE GUARDIAN

Inactivation of the p53 tumor suppressor gene, the "guardian" of the genome, is usually viewed as an unfavorable event, and much research has been directed at therapeutically restoring p53 function in tumors. However, p53 has another role in the context of cancer—it is causally involved in the toxic side effects associated with conventional radiation or chemotherapy. Komarov *et al.* (p. 1733; see the news story by Ferber) identify a small-molecule inhibitor of p53, called pifithrin- $\alpha$  (PFT- $\alpha$ ), and show that this drug can protect cells from p53-mediated apoptosis induced by a variety of cancer drugs and radiation. Intraperitoneal injection of PTF- $\alpha$  improved the survival of mice treated with lethal doses of gamma radiation.

## FAR-REACHING FUNGUS

The quest for the factors controlling diversity in ecological communities can turn up surprises. In a simple 4-year experiment using tall fescue, an invasive grass in the northeast United States, Clay and Holah (p. 1742) show that the presence or absence of a host-specific symbiotic endophytic fungus in the fescue has pronounced effects on the species diversity of the experimental community. The presence of the endophyte confers superior

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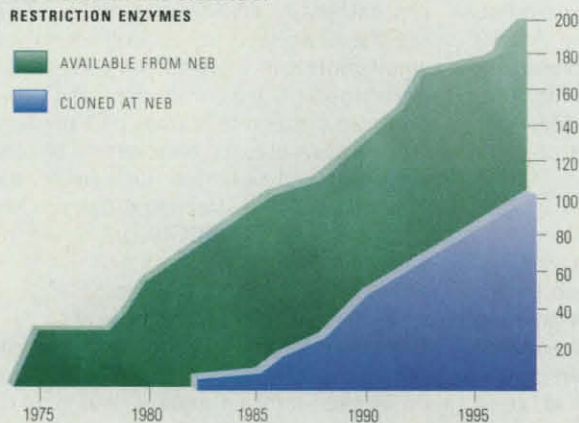
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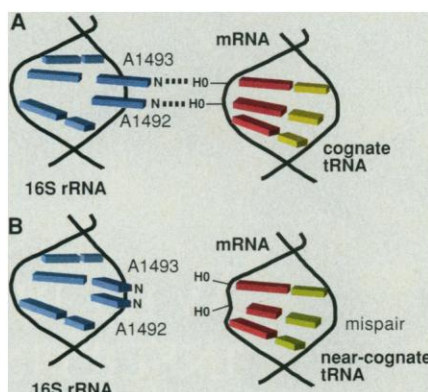
# THIS WEEK IN SCIENCE

CONTINUED FROM PAGE 1637

competitive ability on the grass, which depresses diversity and permanently alters the trajectory of the community.

## FAITHFUL TRANSLATIONS

Proofreading enzymes help maintain the fidelity of DNA sequences during replication, in part by recognizing the weaker hydrogen bonding of mismatched bases. The ribosome appears to perform a similar function during translation of messenger RNA (mRNA) into polypeptides. Yoshizawa *et al.* (p. 1722) examined the recognition of proper base pairing in RNA double helices by making compensatory mutations in the ribosome. They find that two



adenosine bases in the 16S ribosomal RNA make contacts that recognize that the appropriate interaction of codon-anticodon (mRNA-transfer RNA) has been established, which, in turn, enables the appropriate amino acid to be linked to the nascent chain of amino acids. These bases form hydrogen bonds to two of the ribose hydroxyl groups in the mRNA; changing the natural hydrogen-bond donor to an acceptor abolished the necessary interaction and viability.

## SEX, MUTATIONS, AND FITNESS

How sexually reproducing and asexual species deal with and take advantage of spontaneous gene mutations is the subject of two reports. Davies *et al.* (p. 1748) combine two approaches for estimating rates and effects of deleterious mutations and show that there is a huge discrepancy in the results. Standard mutation-accumulation experiments, which measure effects of mutation in terms of fitness, greatly underestimate the actual rate of deleterious mutation in DNA. In experiments in the nematode *Caenorhabditis elegans* exposed to a mutagen, around

96% of deleterious mutations at the DNA level had no perceptible effect on the fitness of the organism. Thus, it appears that there may be at least two classes of deleterious mutation—those of large effect and those of small effect. This result lends support to the idea that sex evolved and is maintained by the ability of sexual populations to withstand a higher genomic deleterious mutation rate than can asexuals. RNA viruses, which show high mutation rates in nature and have potentially large population sizes, are excellent tools for investigating adaptive evolution in asexual populations. In experimental populations of vesicular stomatitis virus, Miralles *et al.* (p. 1745) show how beneficial mutations represent the best of several competing mutations (a phenomenon known as clonal interference) and quantify the rate of these mutations. Their results have implications not only for the understanding of evolution in asexual organisms, but also for the dynamics of viral drug resistance and viral eradication programs.

## OUT OF TIMELESS

The rhythmic cycles of the circadian clock can be reset by light; a brief pulse can advance or delay the clock timing mechanism by several hours. In the fruit fly *Drosophila*, a sharp drop in the amount of one of the components of the clock, a protein called timeless, occurs after light stimulation and resets the clock. Naidoo *et al.* (p. 1737) have shown that this drop is caused by degradation of timeless by the all-purpose protein-destruction organelle, the proteasome, after the protein is tagged with ubiquitin.

## SMALL BUT MIGHTY

How does the binding of a molecule to a cell-surface receptor change the biochemistry inside the cell? To test exactly how the receptor protein moves when the ligand binds, Ottemann *et al.* (p. 1751; see the Perspective by Gerstein and Chothia) strategically attached spin labels to various parts of the aspartate receptor. The relative movement of these probes after aspartate binding revealed that one of the transmembrane helices of the receptor moved in a piston-like fashion about 1 angstrom relative to the other transmembrane helix to influence intracellular events. This tiny motion appears to rule out other likely mechanisms, such as rotation, association, or a scissor or seesaw movement of the receptors.

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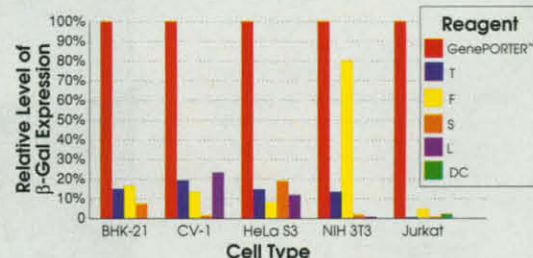
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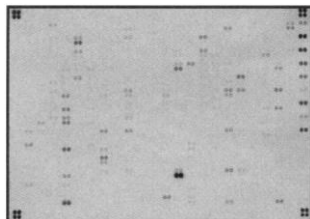
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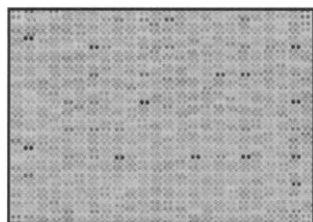


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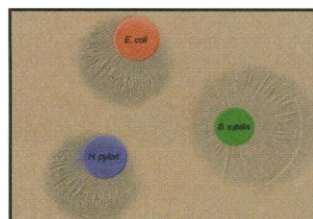
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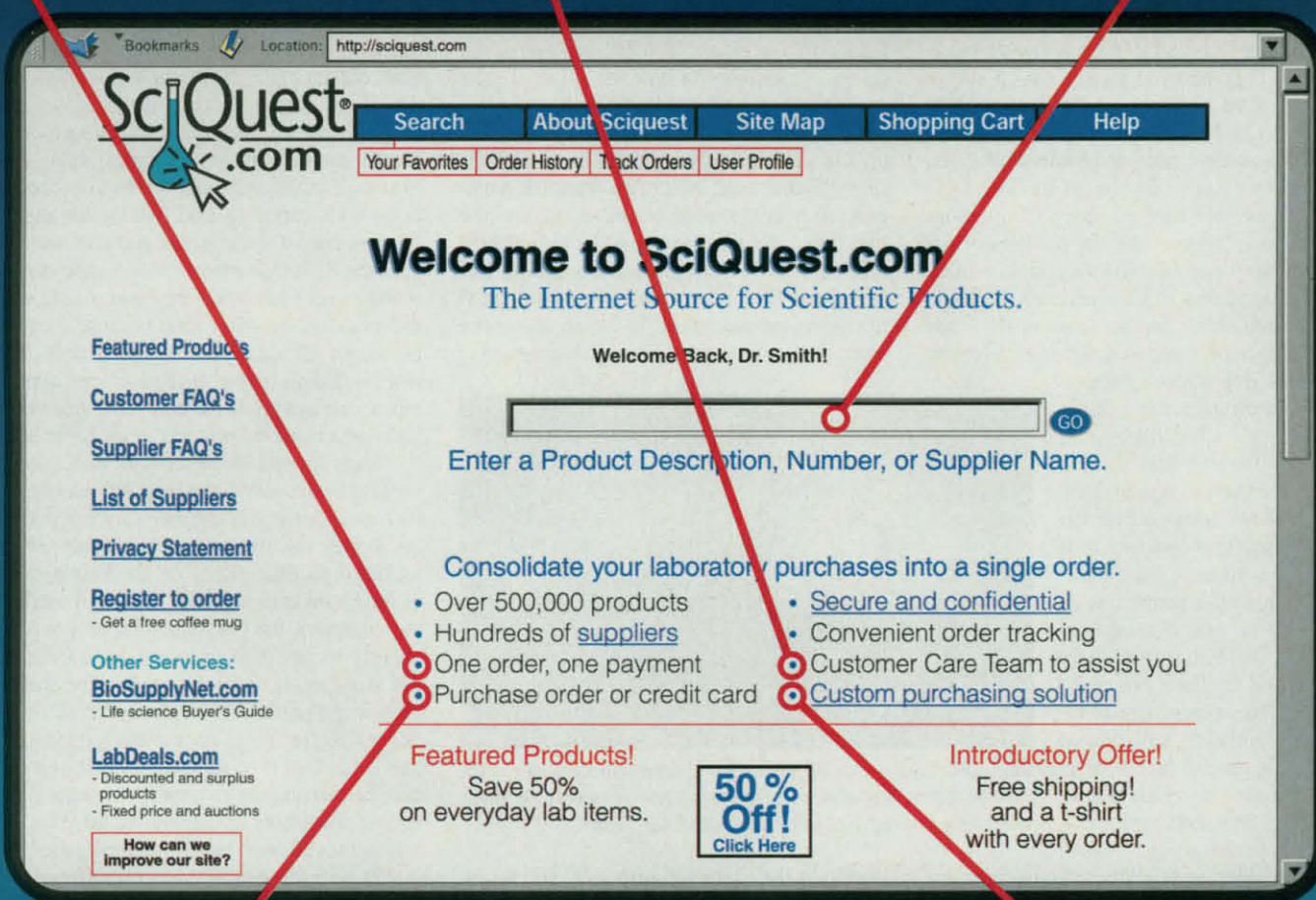


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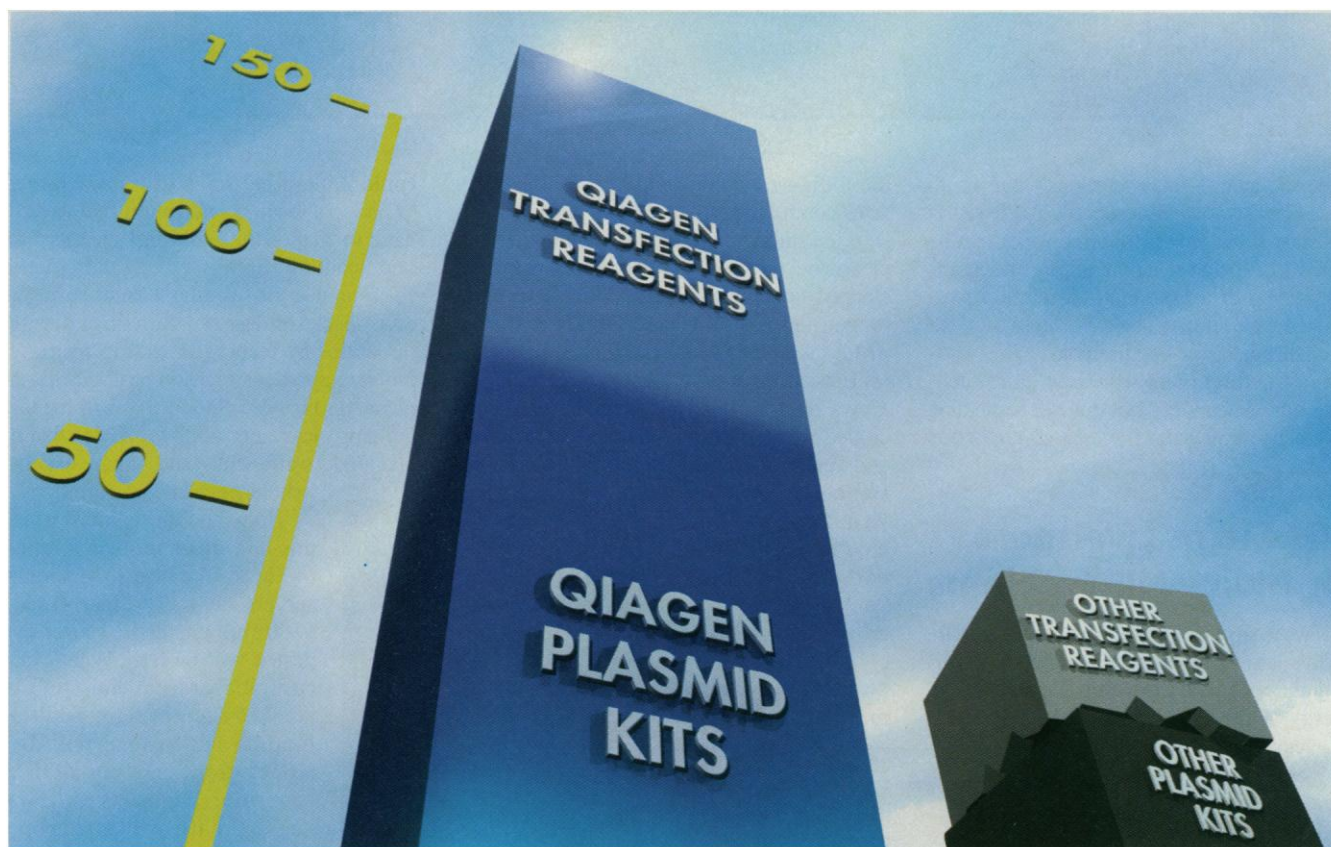
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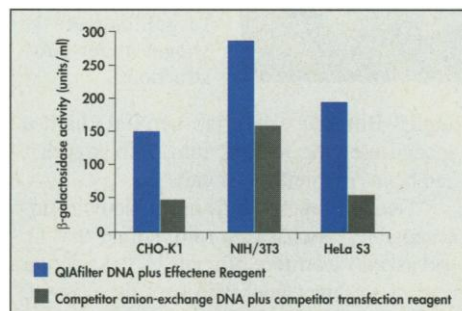
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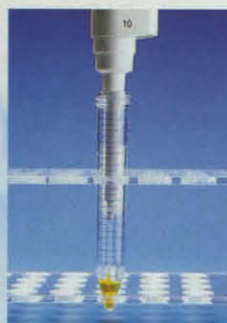
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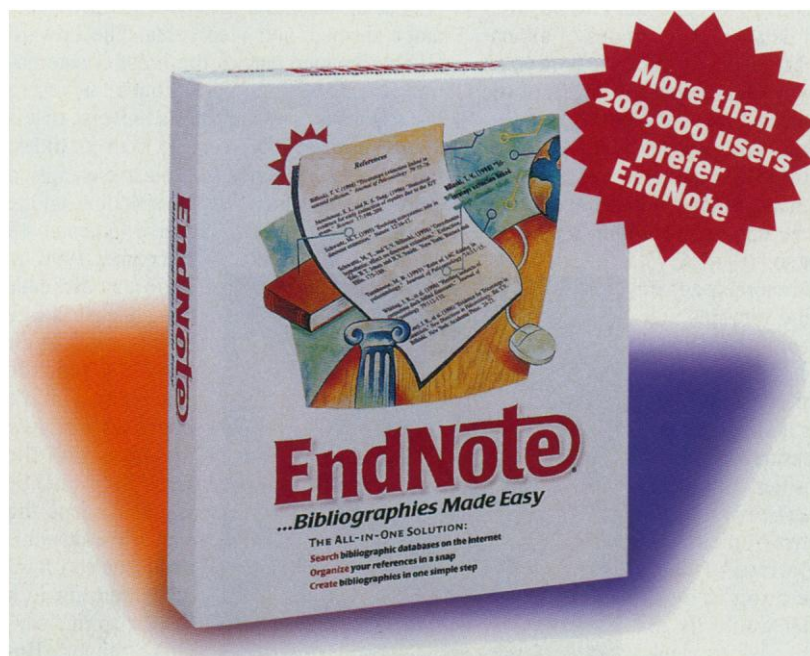
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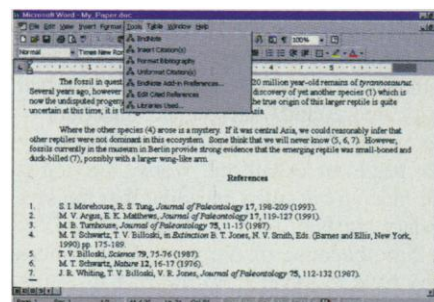


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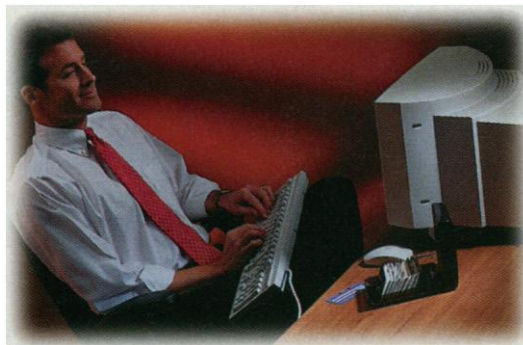
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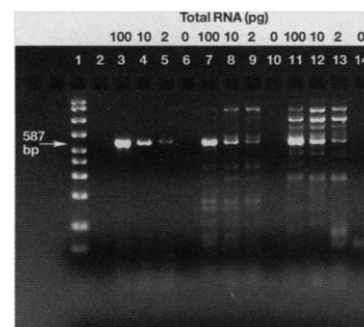


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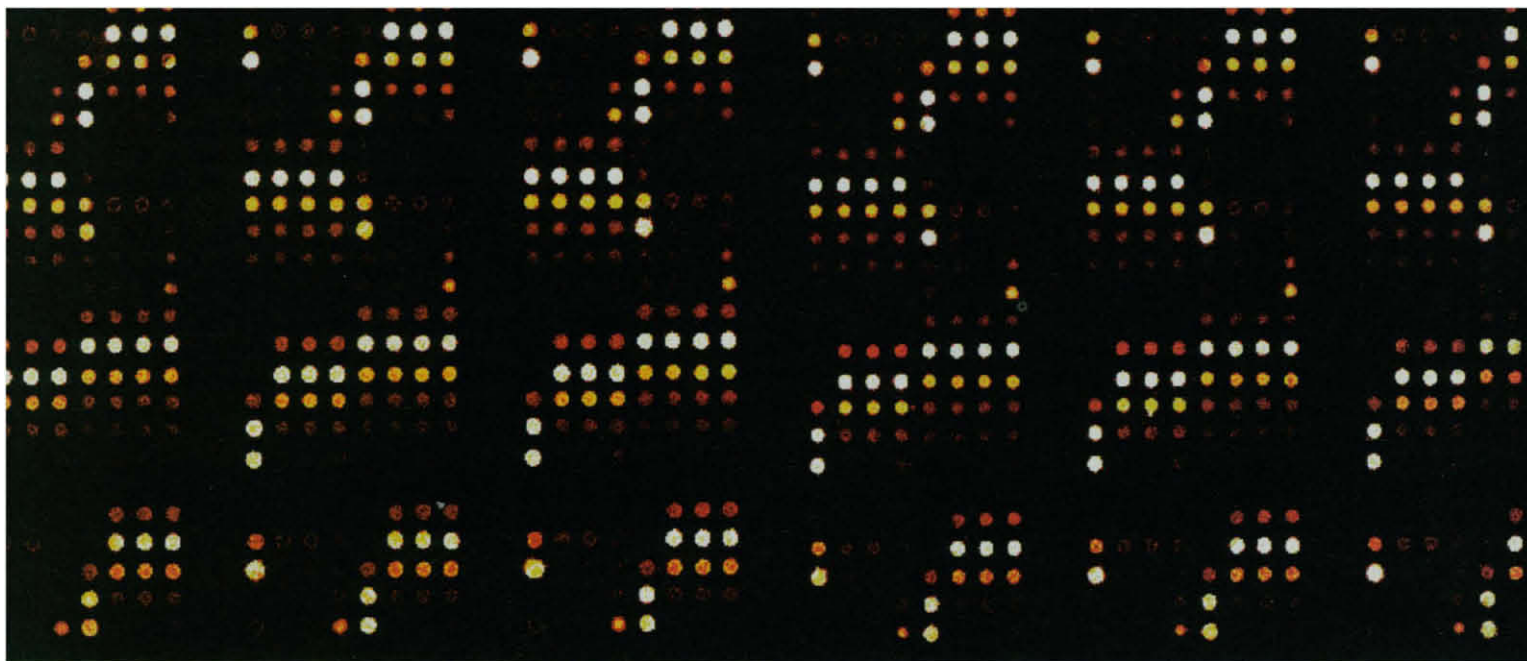


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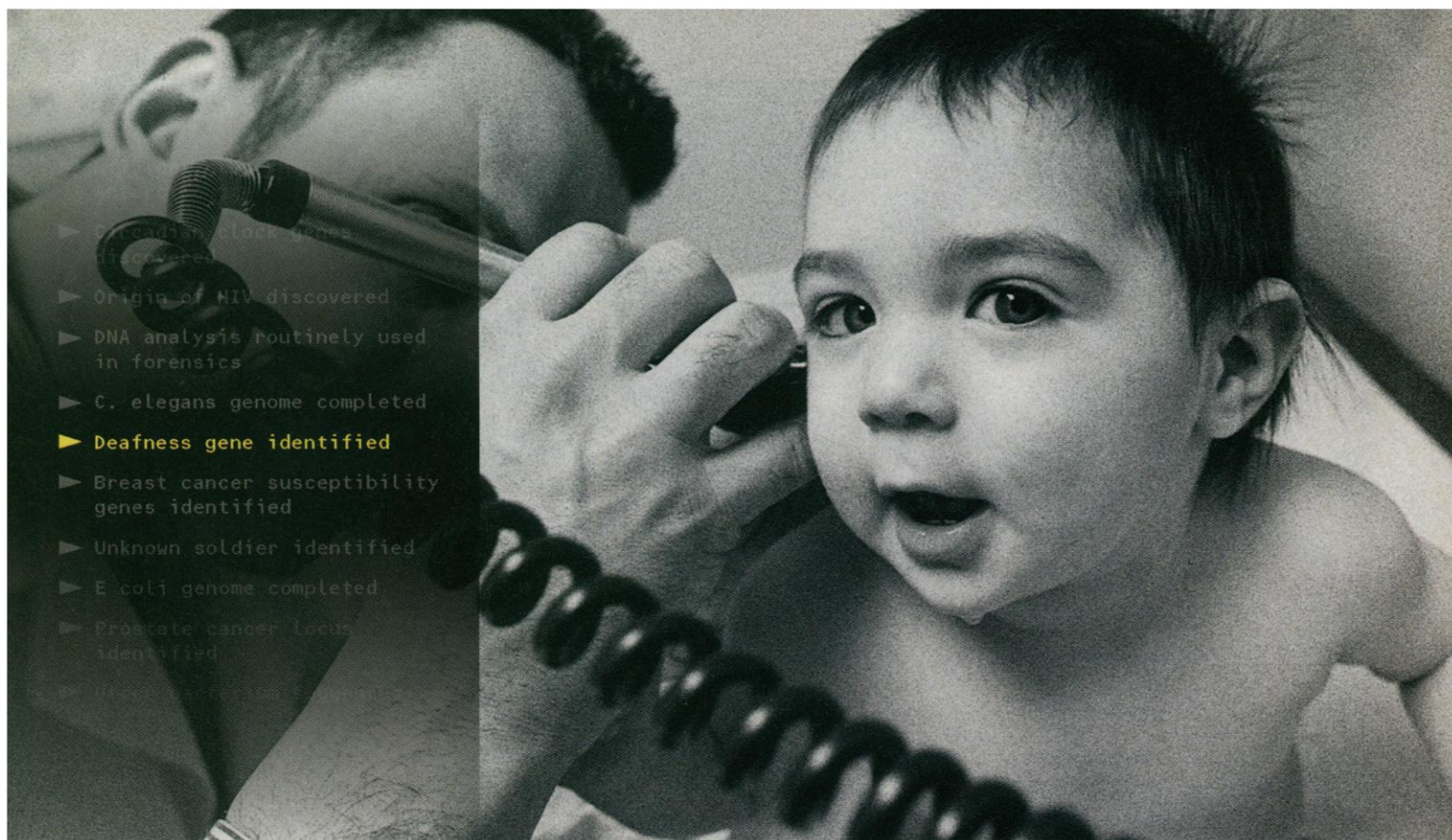
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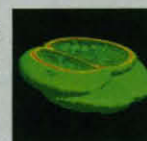
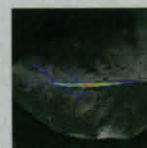
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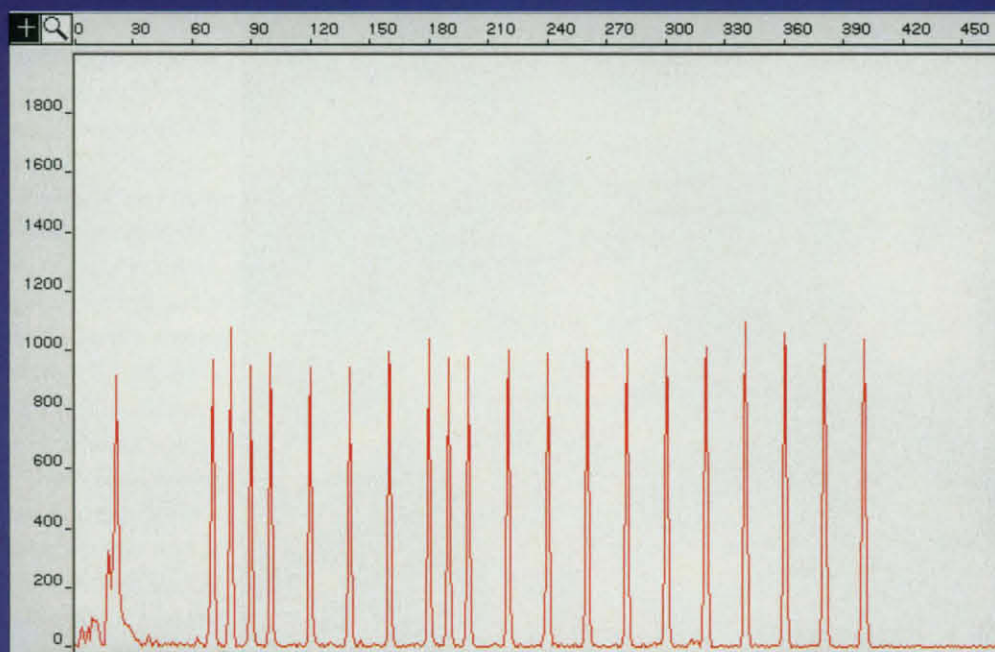
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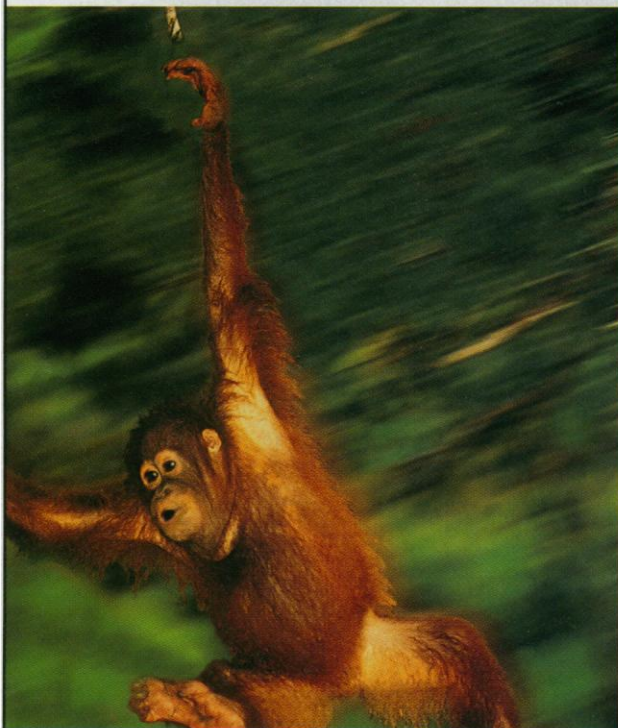
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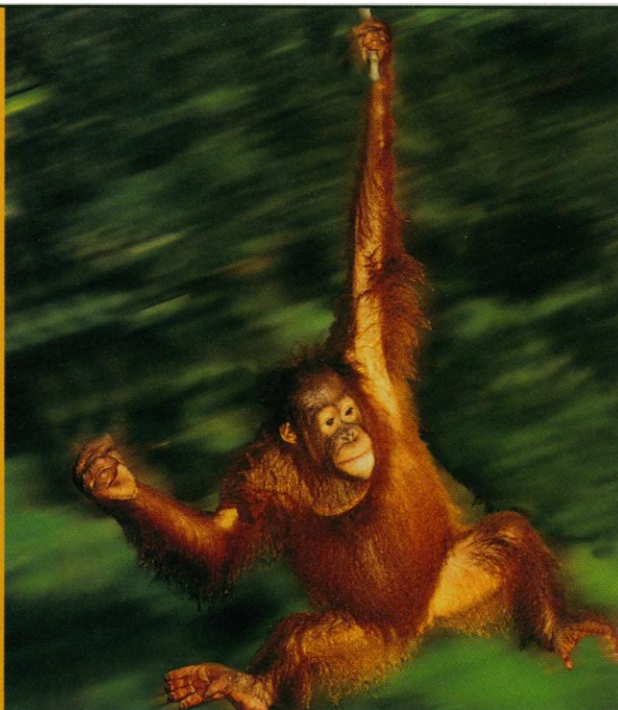
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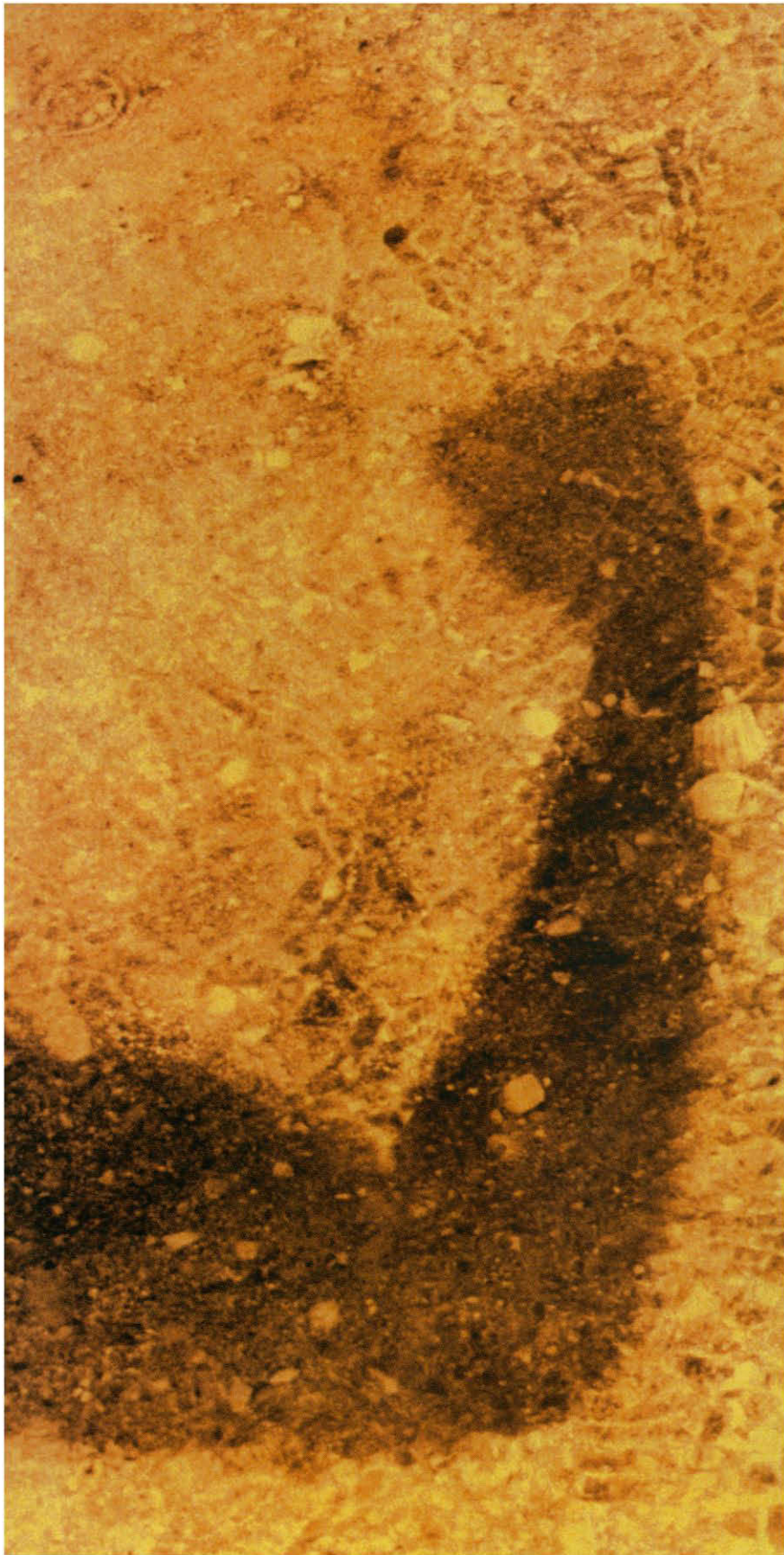
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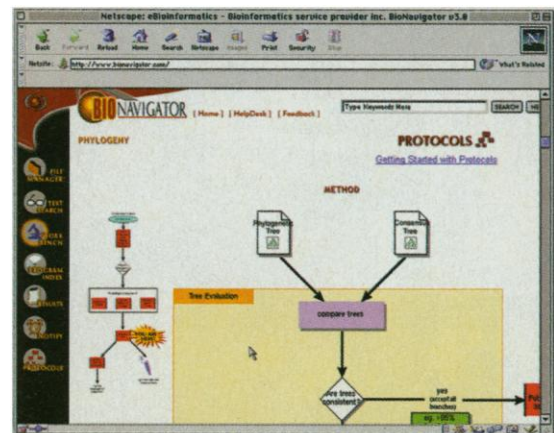
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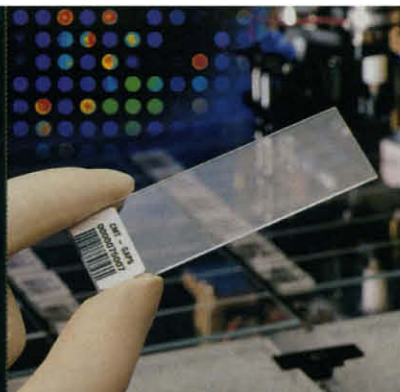
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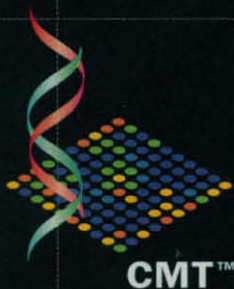
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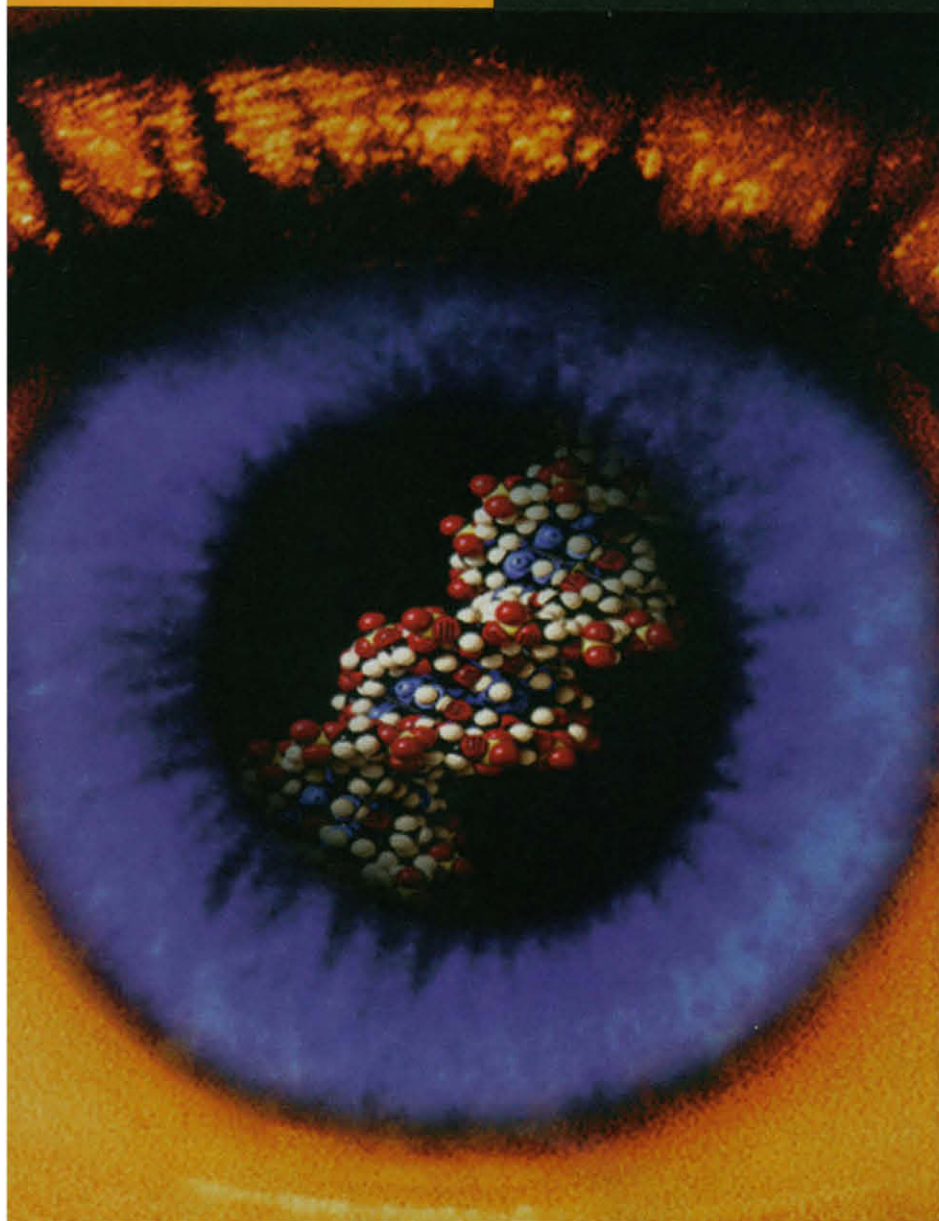
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