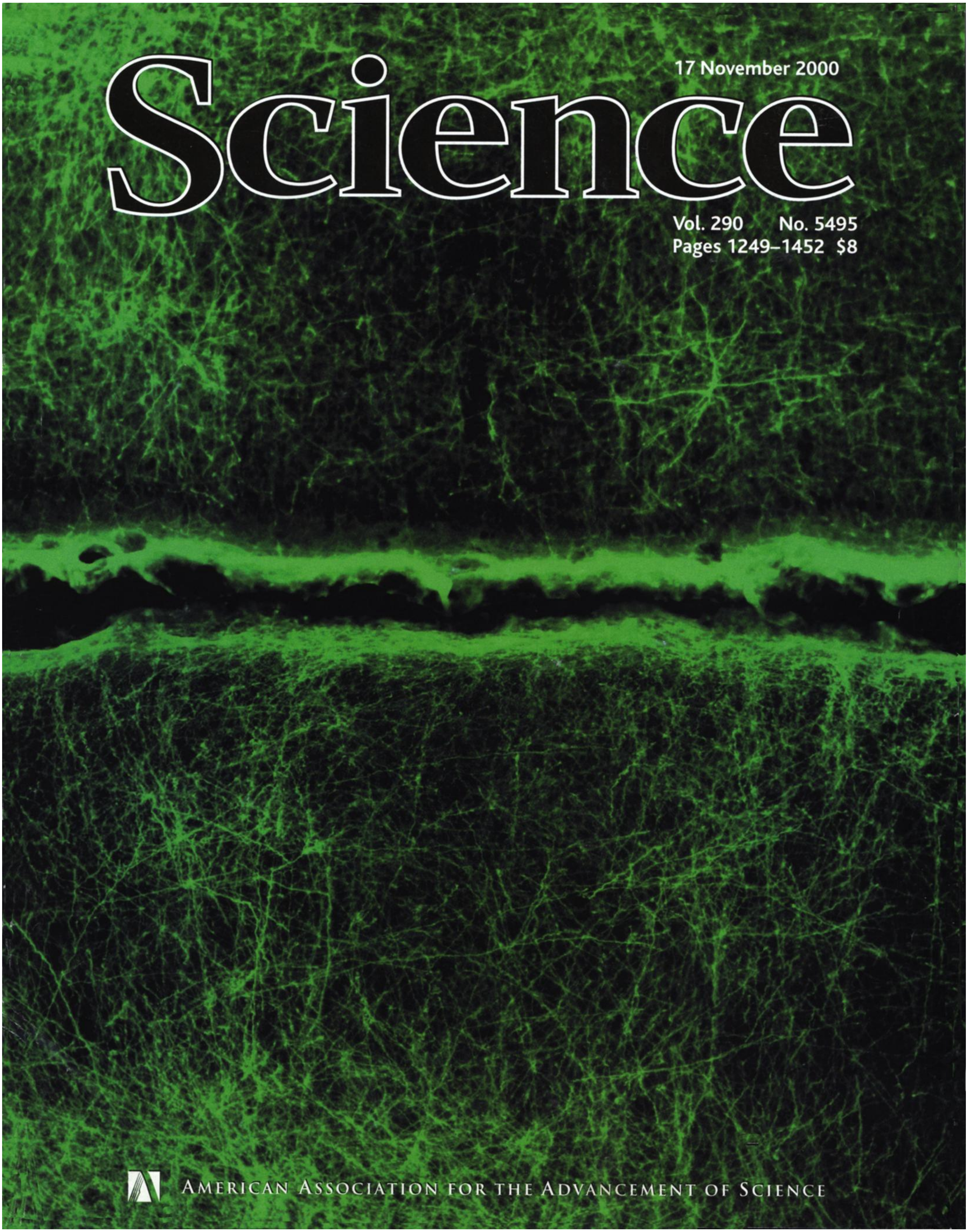
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Science

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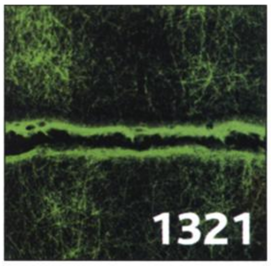
COVER Two slices from the visual cortex of the ferret, showing clusters of neuronal axons (green network) extending toward the brain's surface (green band) (image width, ~1 mm). These ocular dominance columns, previously thought to require activity in the eyes for proper formation, are now shown to form rapidly early in development (bottom) and, at least initially, to be independent of eye input (top). [Image: J. C. Crowley and L. C. Katz]



1280
Ritalin and preschoolers

NEWS

NEWS OF THE WEEK

NEWS FOCUS

DEPARTMENTS

RESEARCH

RESEARCH ARTICLE

REPORTS

1331
Knot your regular nanotube fiber

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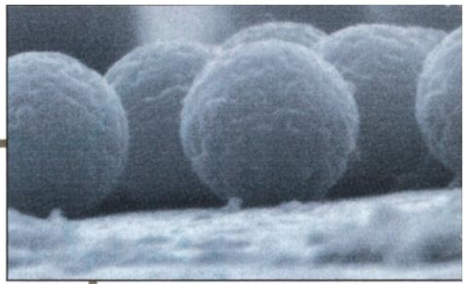

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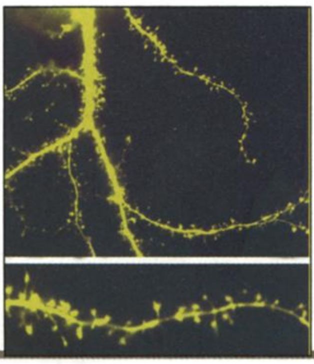
Biosensors bounce into the limelight

SCIENCE'S COMPASS



1364

Of spines and synapses

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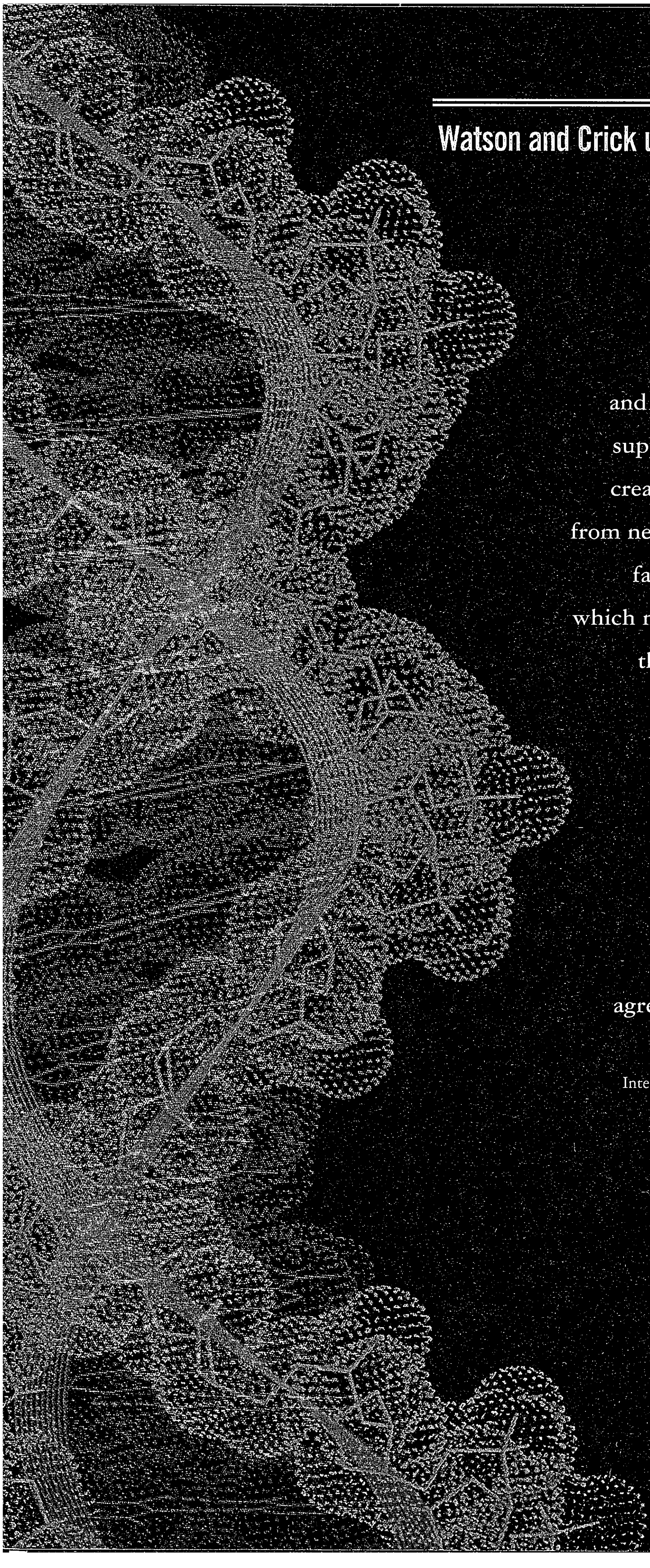

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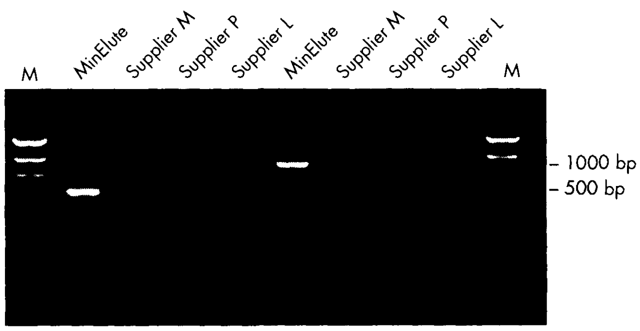

*A 500 bp and a 1000 bp fragment purified using the MinElute Gel Extraction kit and 3 different silica-based DNA purification kits from the suppliers indicated. From each eluate 2 µl aliquots were loaded onto a 1.5% agarose gel. **M**: markers*

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DIPOLAR PHASE SEPARATION

The phase separation of simple fluids at a critical temperature into a high-density liquid and a lower density gas can be readily modeled in terms of a competition between hard-core repulsive forces and an attractive short-range (van der Waals) isotropic force. In dipolar fluids, such as ferrofluids or electro-rheological fluids, the attractive force is caused by long-range, anisotropic dipolar forces. Accurate modeling of these more complex systems has remained elusive. Tlusty and Safran (p. 1328; see the Perspective by Pincus) recast the problem to take into account the natural tendency for the diploar molecules to form chains and branches. The results of the model reveal that such an approach can describe experimental data in which the low-density phase consists of repulsive individual chains, and the higher density phase comprises more attractive branches.

NANOTUBE FIBERS TIE THE KNOT

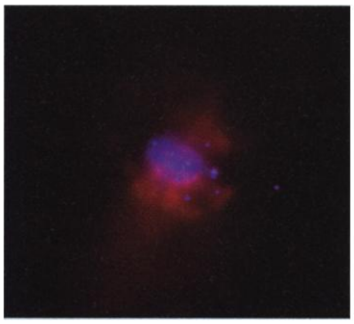
One method used to enhance the mechanical strength of organic polymers is to stretch and align the molecules before they are drawn into a fiber. Vigolo *et al.* (p. 1331; see the Perspective by Baughman) show how flow-induced alignment can be used to orient single-wall carbon nanotubes (SWNTs) in solution before they are formed into macroscopically long ribbons with widths ranging from a few to 100 micrometers. The raw nanotube soot is dispersed in aqueous solution through sonication with a surfactant and then injected into a solution that condenses the fibers. The fibers exhibit a mechanical modulus of 15 gigapascals, lower than that of individual SWNTs but greater than the 1-GPa or lower modulus typically seen for unoriented nanotube sheets. Unlike classical carbon fibers, the nanotube fibers show plastic behavior before they break—and can even be tied into knots.

EARTHQUAKE PATTERNS

In 1992, the magnitude 7.3 Landers earthquake in the Mojave Desert of southern California was followed 2 hours later by the magnitude 6.5 Big Bear earthquake to the west. Seven years later, the magnitude 7.1 Hector Mine earthquake occurred to the east. The timing of these events and other data indicate that Big Bear was triggered by Landers, but it has not been clear whether the Hector Mine quake can be associated with Landers. Wyss and Wiemer (p. 1334) have analyzed the change in the rate of seismicity between 1981 and 1999 in the area around Landers. They show that after Landers, the number of small earthquakes that occurred during the next 7 years in the Hector Mine area increased by an order of magnitude. Thus, the Landers earthquake altered the near-field stress regime, triggering the Hector Mine earthquake after a relatively long period of time of increased but low-level seismicity.

HOT AND MASSIVE STARBURST

Messier 82 (M82) is considered to be a prototypical starburst galaxy, and its proximity to the Milky Way (located just outside the Local Group) makes it an important target for observations aimed at understanding star formation. Griffiths *et al.* (p. 1325) have used the



high-spatial-resolution imaging spectrometer on the Chandra X-ray Observatory to probe the interior of this galaxy. They found a high-temperature (about 40 million kelvin), high-pressure plasma in the center of M82 that is probably related to supernovae. They also distinguished about 20 x-ray point sources that are probably massive binary stars, many of which may harbor black holes.

SEDIMENTARY JOURNEY

Geophysical observations of the core-mantle boundary (CMB) indicate the presence of zones or a thin layer of low seismic velocities and high electrical conductivity. Buffett *et al.* (p. 1338; see the news story by Kerr) suggest a sedimentation model at the CMB to explain these two observations. In their model, silicate sediments "pond" at the top of the outer core along with interstitial iron-rich liquid. Iron liquid and other lighter elements can be extracted from the core into the mantle by viscous compaction and could explain, for example, the traces of core elements sampled at hotspot plumes. The removal of lighter elements could also enhance the vigor of mantle convection and improve the efficiency of the geodynamo.

INVERTED CO_2

The rate at which fossil-fuel CO_2 emissions are absorbed by the ocean and the terrestrial biosphere is important for understanding the modern carbon cycle and for evaluating emission management strategies. Bousquet *et al.* (p. 1342; see the Perspective by Fung) used an inverse model with 20 years of atmospheric CO_2 measurements in order to infer year-to-year changes in the regional carbon balance of oceans and continents during the period from 1980 to 1998. On a global scale, terrestrial carbon fluxes were approximately twice as variable ocean fluxes. Tropical land ecosystems produced most of the interannual variability in the Earth's carbon balance during the 1980s, whereas in the 1990s, mid- and high-latitude land ecosystems of the Northern Hemisphere caused most of the important shifts in the carbon balance.

FOOD FOR MODELING

Understanding simple ecological communities under laboratory conditions should provide a foundation for understanding the dynamics of organisms in the wild. Fussmann *et al.* (p. 1358) report the correspondence between laboratory experiments on a system with a nutrient (nitrogen), an alga, a rotifer herbivore, and a nonlinear mathematical model that incorporates nutrient concentration and the population density of both predator and prey. The model makes several predictions according to the interplay of these variables: either extinction of the predator or both predator and prey, coexistence of both species at equilibrium, or coexistence as stable predator-prey cycles. In 15 out of 16 trials, run over a period comparable to an average summer growing season, the model successfully predicted the experimental outcomes.

EVALUATING HABITAT FRAGMENTATION

There is growing interest in spatial synchrony in animal population dynamics, and Earn *et al.* (p. 1360) now report a way to make theoretical predictions about the population consequences of conservation corridors and other manipulations of movements of endangered species. For any given pattern of dispersal, their models determine the likelihood of synchronous fluctuations

CONTINUED ON PAGE 1259

THIS WEEK IN *SCIENCE*

CONTINUED FROM PAGE 1257

in species abundances and corresponding probabilities of local and global extinction. The results can be used to evaluate proposals for conservation measures and schemes for pest control.

SOME TRACKS ALREADY LAID

Development of the cortical connections between eye and brain has long been thought to be a process by which certain anatomical structures form in response to visual activity. By observing earlier time points in development, Crowley and Katz (p. 1321; see the cover and news story by Wickelgren) now show that the ocular dominance columns thought to be a result of activity-dependent refinement are actually present well before visual activity and the other related neuronal interconnections. Thus, the critical period, which refines and supports further visual capacity, seems to be operating on pre-established anatomical structures, rather than directing the formation of those structures.

SYNAPTIC RIPENING

Although synapses have been studied in great detail, the basic mechanisms underlying synapse formation are still poorly understood. El-Husseini *et al.* (p. 1364) studied the effects of the synaptic scaffolding protein PSD-95 on excitatory synapse maturation in cultured hippocampal neurons. Chronic overexpression of PSD-95 accelerated synapse maturation both pre- and postsynaptically. PSD-95 increased synaptic accumulation of glutamate receptors. This effect occurred in both excitatory pyramidal neurons and inhibitory interneurons and required the localization of PSD-95, but not its guanylate kinases domain, to synapses. Finally, overexpression of PSD-95 caused an increase in the number and size of dendritic spines.

CUTTING BACK ON SUGARS

Alternative genetic systems that could be synthesized under prebiotic conditions are of interest in studies of the origin of life. Schöning *et al.* (p. 1347; see the Perspective by Orgel) have synthesized oligomers in which nucleosides of the tetrose sugar, threose, are joined by phosphodiester bonds to form "TNAs." Tetroses are simpler to synthesize than pentoses because they can be made from two identical two-carbon fragments. Complementary TNA strands form stable double helices with Watson-Crick base pairing, and the TNAs also form stable double helices with RNA and DNA.

THE RIGHT BITE

Leishmaniasis constitutes a spectrum of disfiguring and disabling human diseases found throughout warmer parts of the world that are caused by several species of intracellular protozoan parasites called *Leishmania*. The *Leishmania* species are transmitted to humans and many wild and companion animals by the bite of tiny but annoying sand flies. Kamhawi *et al.* (p. 1351) have shown in mice that the bite of uninfected sand flies (*Phlebotomus papatasi*) alone will prevent *Leishmania major* infection of the mice during subsequent biting by infected sand flies. A delayed type hypersensitivity reaction, triggered by an as-yet unknown component of sand fly saliva, is the basis for this protection.

CALCIUM AND INFECTIONS

One of the most prevalent fungal respiratory diseases of human beings is caused by *Histoplasma capsulatum*. This pathogen lurks as a mold in the soil, but if it is disturbed and inhaled by a mammal, it undergoes a temperature-triggered transformation into a pathogenic yeast that can spread from the lungs via intracellular parasitism of macrophages. Schurtz Sebghati *et al.* (p. 1368) have used novel methodology that will likely be broadly applicable to other important fungal pathogens to define the role of a calcium-binding virulence factor in pathogenesis. Unlike the mold form, the yeast form can survive low calcium conditions within macrophage compartments.

TWO FACES OF CYTOTOXIC MOLECULES

Perforin and interferon-γ (IFN-γ) are two powerful products used by $CD8^+$ T cells in response to viruses and some bacteria. Perforin is exclusively cytotoxic, whereas IFN-γ has multiple antimicrobial effects. Another function for these effector molecules—distinct from that of fighting infection—has now come to light. Badovinac *et al.* (p. 1354) infected gene-deficient mice with bacteria or viruses and observed that the growth and eventual decline of the responding $CD8^+$ T cells required expression of perforin and IFN-γ, respectively. In addition, IFN-γ modified which clones of T cells responded to a given antigenic epitope presented by the viruses and bacteria. This unexpected regulatory role of perforin and IFN-γ in the cytotoxic immune response may prove important in future vaccination strategies.

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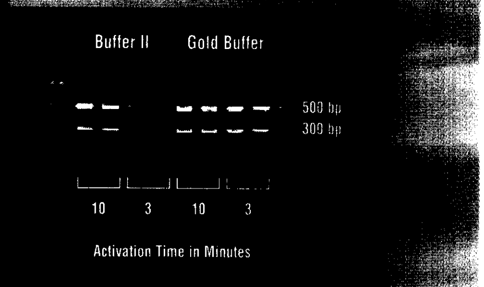

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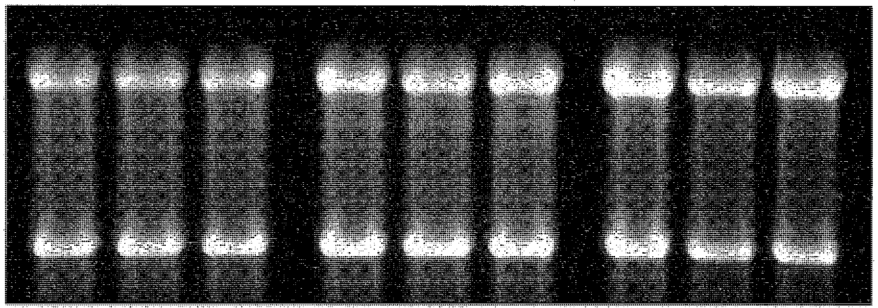

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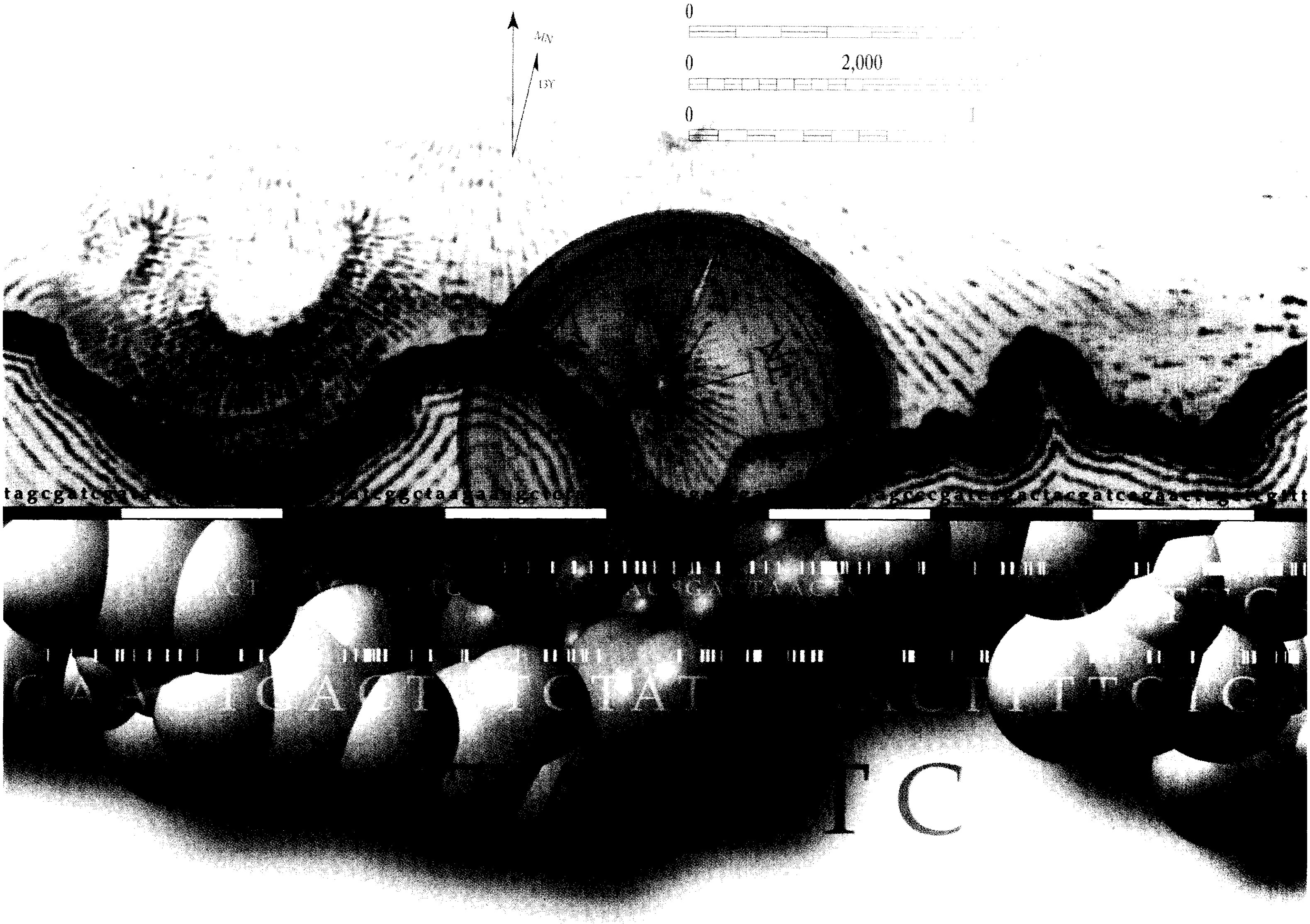

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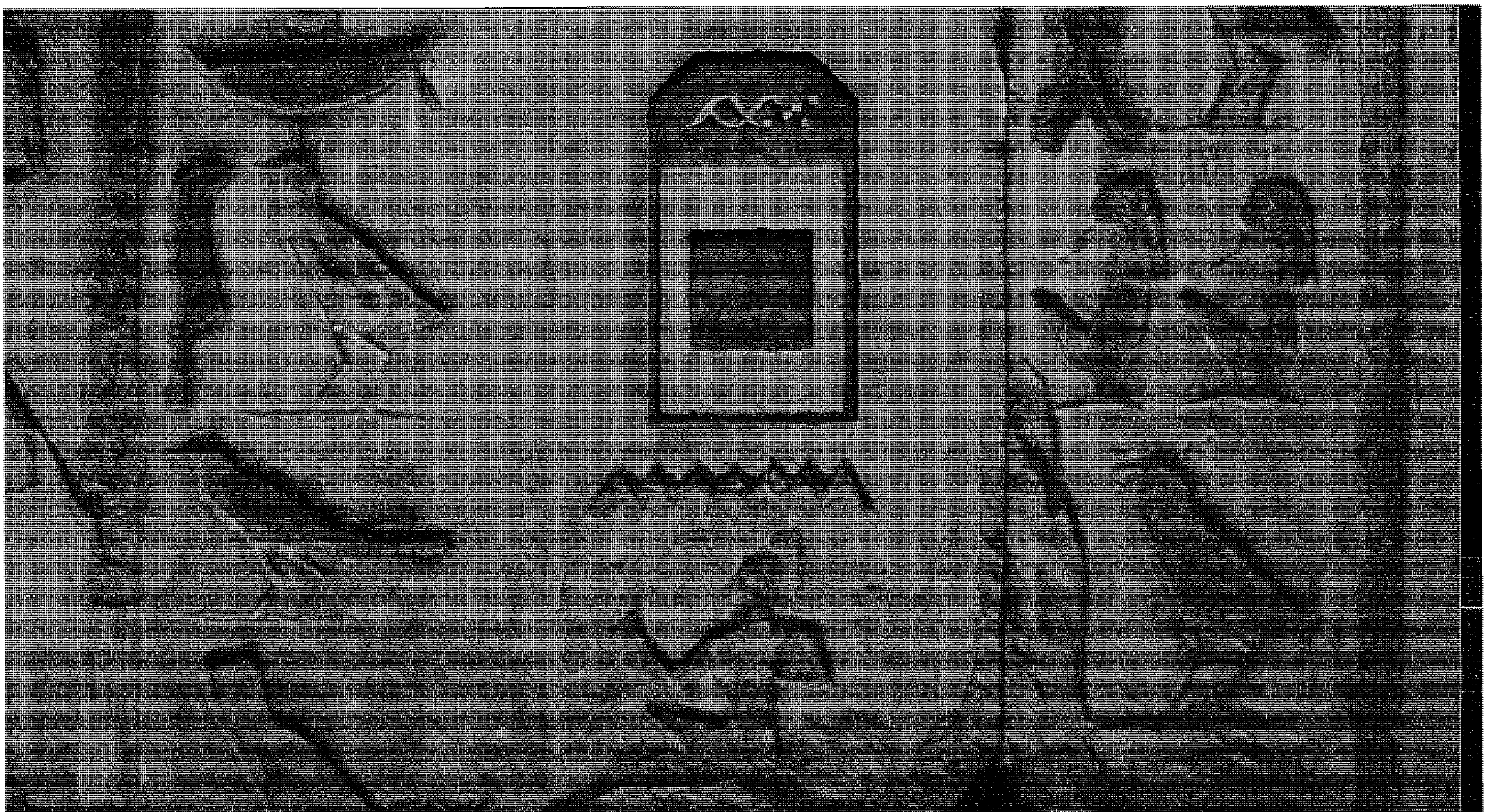

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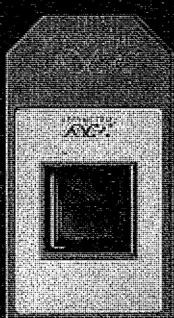

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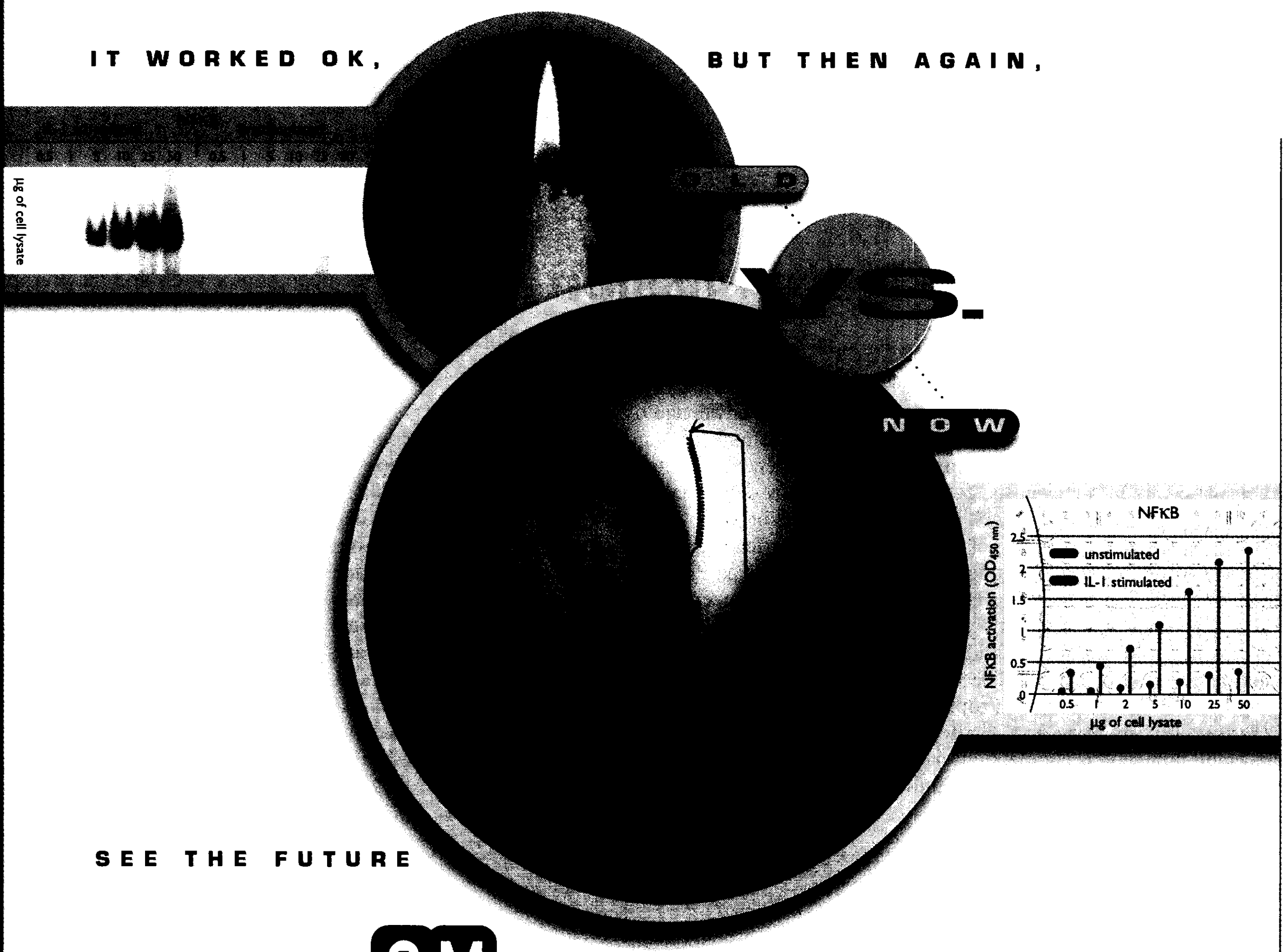

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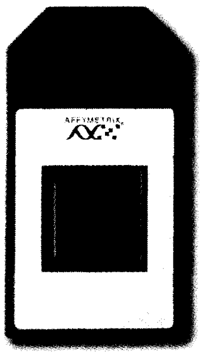

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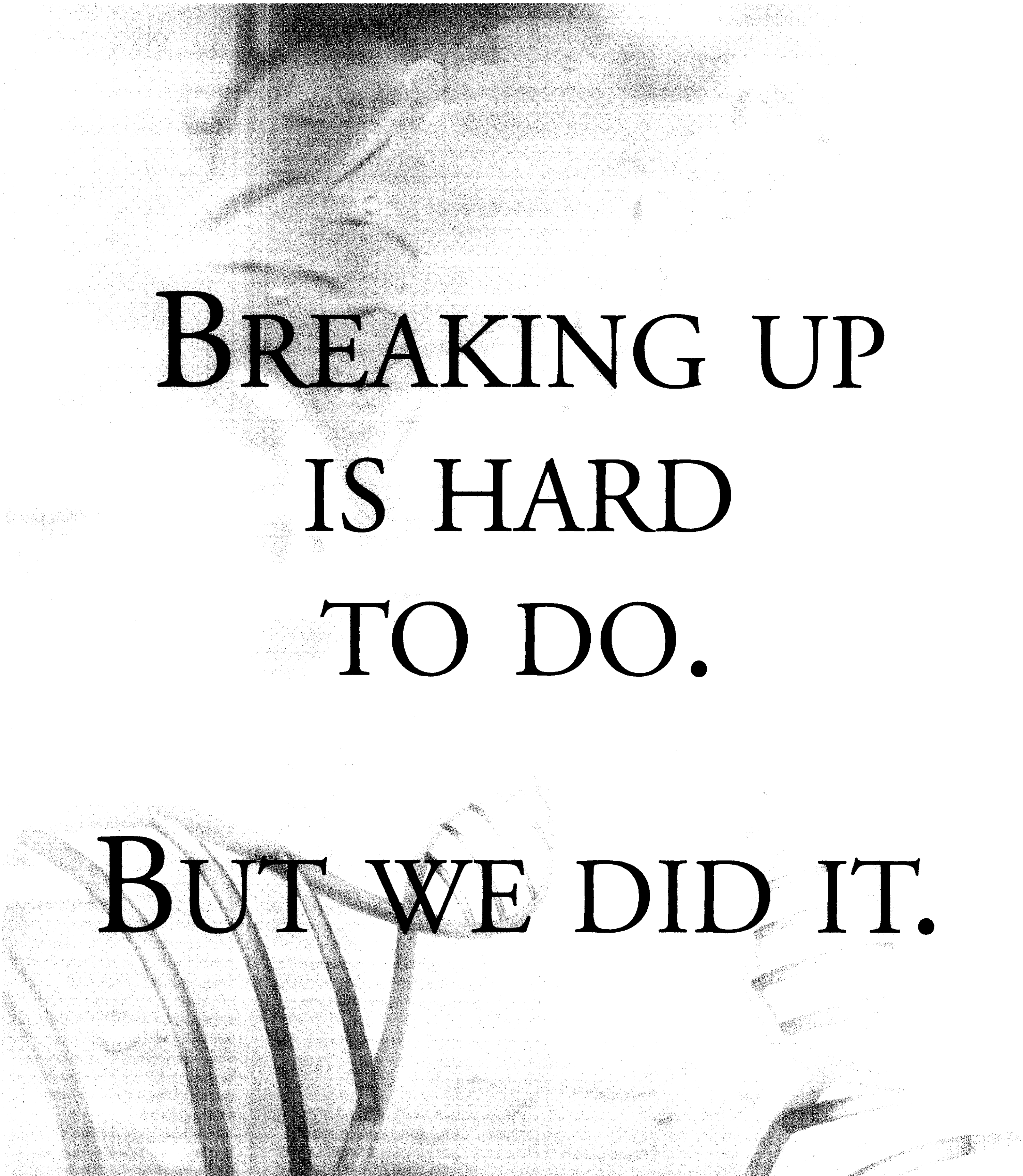
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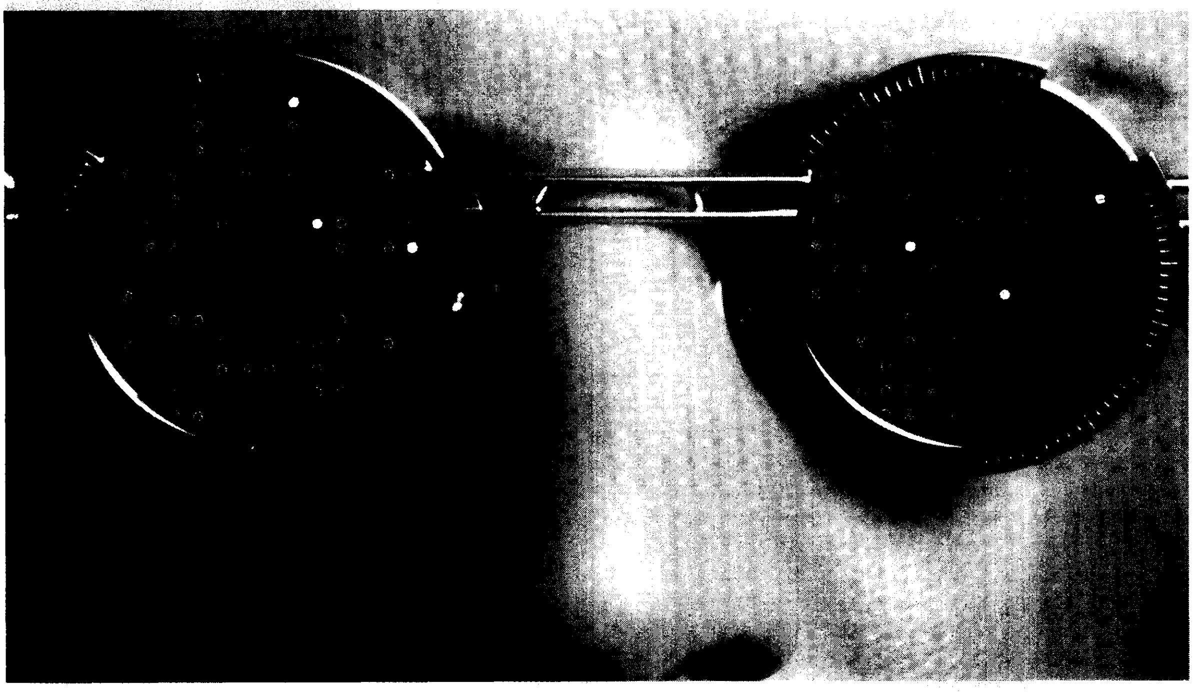

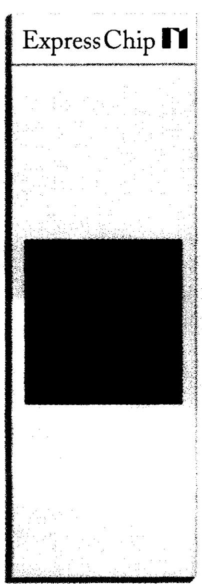

If you need to simultaneously analyze over one thousand gene expressions, there's no better choice than ExpressChip™ DNA Microarrays from Mergen. Each ExpressChip kit contains two duplicate glass slides pre-spotted with oligonucleotides, and reagents for probe hybridization and signal amplification.

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