27 August 1999

Science

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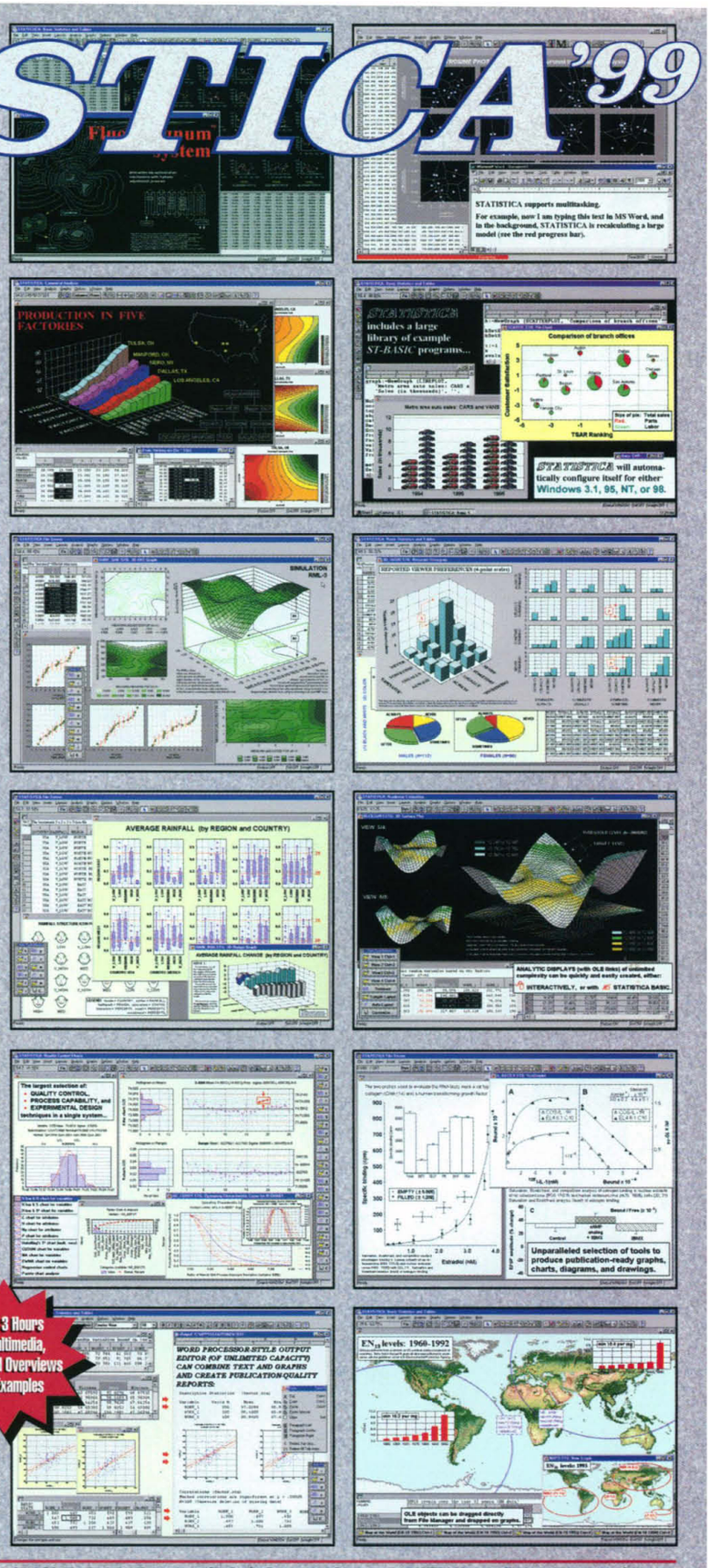

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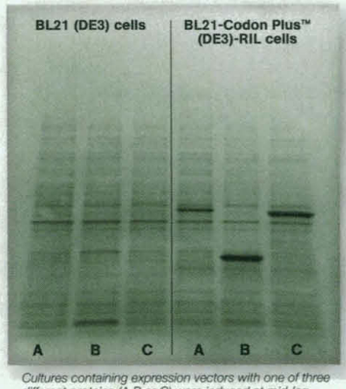

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VOLUME 285 27 AUGUST 1999 NUMBER 5432

Science

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COVER Forelimb bones (longest, ~19 cm) and jaw (~8 cm) of a new partial hominoid skeleton from an ~15-million-year-old site at Kipsaramon, Kenya, superimposed on a digital elevation model of western Kenya and eastern Uganda. The skeleton represents a new genus, *Equatorius*, and will help clarify the origins of the group that includes humans and the living great apes. [Photos: Steven C. Ward]

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Bees do it best

NEWS

NEWS OF THE WEEK

NEWS FOCUS

1342
A magnet for biologists

DEPARTMENTS

RESEARCH

REPORTS

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SCIENCE (ISSN 0036-8075) is published weekly on Friday, except the last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals Mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Domestic individual membership and subscription (51 issues): $110 ($62 allocated to subscription). Domestic institutional subscription (51 issues): $325; Foreign postage extra: Mexico, Caribbean (surface mail) $55; other countries (air assist delivery) $90. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request, GST #1254 88122. Publications Mail Agreement Number 1069624. **Printed in the U.S.A.**

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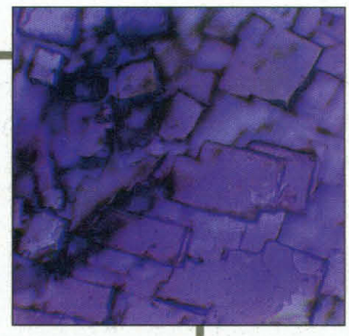
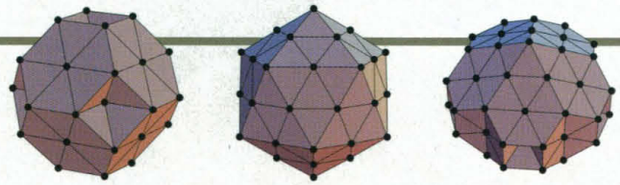


1364

A dash of salt from the early solar system



1368

The lowest energy cluster of atoms

1408

Deafness—mice lend an ear

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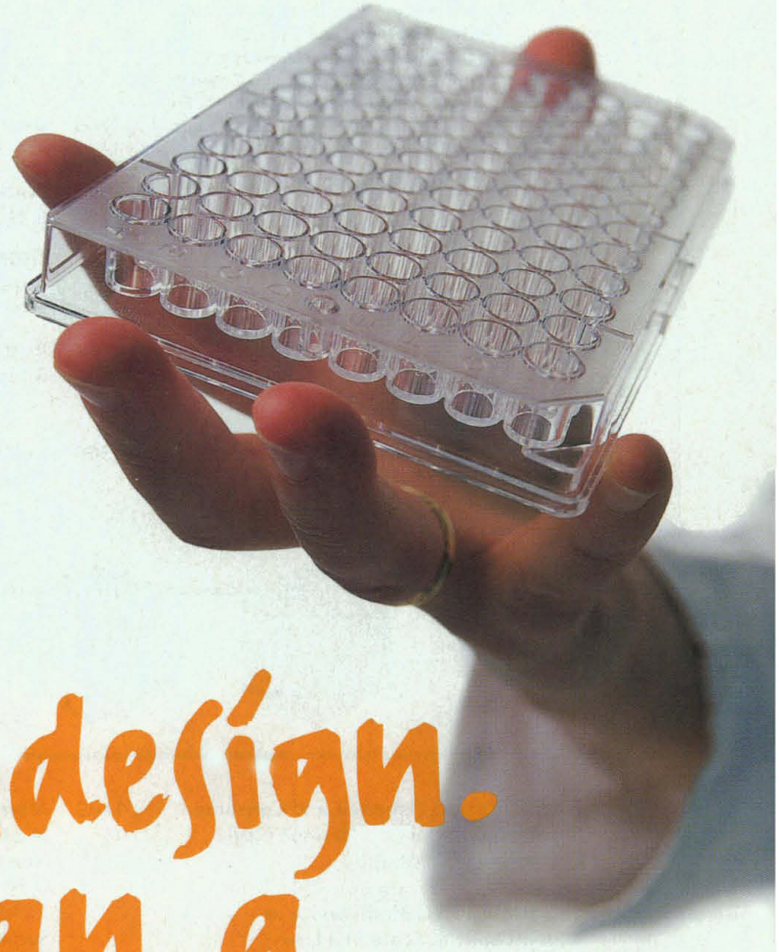

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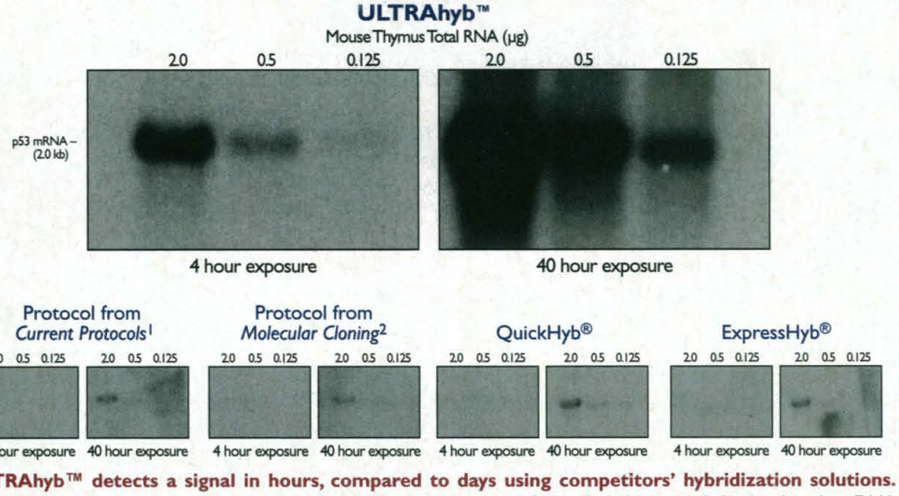

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1. *Current Protocols in Molecular Biology*, 1994. Ausubel, F.M. and others, editors. John Wiley & sons, Inc.
2. *Molecular Cloning: A Laboratory Manual*, 1989. Sambrook, J. Fritsch, E.F., Maniatis, T. Cold Spring Harbor Laboratory Press.

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STAYING SMALL

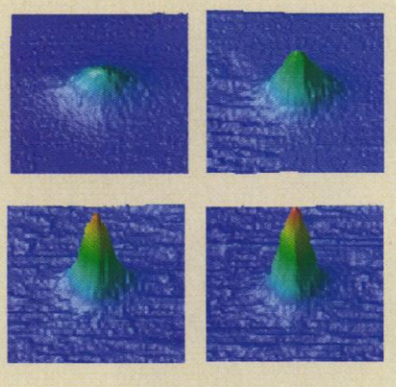
Many technologically important metal oxides perform better as their crystallite and pore sizes decrease, but grain size usually increases during the firing of precursor sols. Wu *et al.* (p. 1375) show that treating the precursor sols with a reagent that scavenges hydroxyl groups can limit increases in grain size for oxides of tin, titanium, and zirconium, apparently by avoiding agglomeration through interacting hydroxyls and by nucleating extremely small silica particles that inhibit grain boundary motion. Treating the precursor sols dramatically improved the sensitivity of tin oxide sensors for carbon monoxide.

PROCESSED PARENTS OF METEORITES

Meteorites represent our most abundant samples of extraterrestrial materials, and among the different classes of meteorites, the chondrites are assumed to represent the most primitive materials from other objects in our solar system. Chondrites can provide important clues about aqueous alteration processes that occurred on parent bodies present in the early solar system (see the Perspective by Clayton). Zolensky *et al.* (p. 1377) analyzed halite (NaCl salt) aggregates that they found within a pristine, H-group, ordinary chondrite that fell in the dry, west Texas town of Monahans in 1998. The purple halite crystals contain KCl crystals and fluid inclusions of NaCl and KCl brines that formed while the material was still part of its parent body. This finding suggests the presence of flowing water on the parent body, and therefore the aqueous alteration, occurred on the parent body when this chondritic matrix was formed. Carbonaceous chondrites may represent primordial material formed in the solar nebula, mainly through condensation of minerals from the hot gas and dust. Brearley (p. 1380) examined Allende, the most extensively studied of all of the carbonaceous chondrites, with high-resolution transmission electron microscopy and identified nanometer-sized grains of pentlandite (an iron sulfide) and amorphous carbon within the iron-rich olivines of the matrix material. This assemblage could not have been formed by condensation in the solar nebula, and the author suggests that these olivines formed by dehydration of serpentine on the parent body. Thus, rather than being the classic example of nebular condensation, Allende may have been more extensively processed on its former asteroidal home than previously thought.

PERSISTENT *d*-WAVES

It has been established that the pairing of electrons in the hole-doped high-temperature superconductor yttrium barium copper oxide well below the transition temperature T_c do so with a *d*-wave symmetry. There is, however, little data to show how the



pairing occurs at temperatures near T_c —an important region to understand if a correct theory is to be developed. Kirtley *et al.* (p. 1373) used a modified superconducting quantum interference device, or magnetic microscope, to monitor the half-integer magnetic flux quantum, a signature of *d*-wave pairing. They show that it persists all the way up to T_c, thus providing direct evidence that the superconductor is predominantly *d*-wave.

HOMINID ORIGINS

The clade containing the great apes and humans apparently arose in the middle Miocene, about 15 million years ago. Ward *et al.* (p. 1382) describe a new hominid from Kenya that apparently represents a member of the stem radiation of this clade and allows grouping of several enigmatic fossils into a new genus. The hominid skeleton contains not only large parts of the jaw and many teeth, but also many other bones including several ribs and parts of the arms and hands (see the cover). The size of these bones suggests that the hominid weighed about 27 kilograms. This fossil may provide a link between early African and Asian hominids, as discussed in a news story by Zimmer.

LEAVES THAT BEAT THE HEAT

The Triassic-Jurassic (T-J) boundary marks the third largest faunal mass extinction in Earth history. There was also a 95% turnover of floral species. Based on fossil leaf anatomy, McElwain *et al.* (p. 1386) reconstruct the environmental conditions at the T-J boundary, in particular CO_2 concentrations and climate. They suggest that a large greenhouse warming effect imposed a severe selective constraint on plants, such that only those with narrow, dissected leaves could avoid lethal leaf temperatures.

AGE-OLD EXPRESSIONS

As organisms age, their cells and tissues change in numerous ways. Now Lee *et al.* (p. 1390) have started to define the molecular basis of these changes with the aid of DNA arrays. By examining the expression of a battery of 6500 genes in mice, they see that, with age, genes associated with the stress response are expressed more, and those that control general metabolism or biosynthesis are expressed less. However, when the mice are fed fewer calories (a treatment that is know to increase life span), these the older animals retain the younger pattern of gene expression—another finding in favor of a leaner diet.

SPERM AND SELENIUM

In mammals, selenium is required for male fertility—selenium deficiency results in impaired sperm motility. Previous studies indicated that the sperm mitochondria-associated cysteine-rich protein (SMCP) is the selenoprotein that functions in male fertility. Ursini *et al.* (p. 1393; see the news story by Strauss) now show that phospholipid hydroperoxide glutathione peroxidase (PHGPx), and not SMCP, represents the selenoprotein necessary for sperm maturation. PHGPx is enzymatically active in early spermatogenesis but inactive in mature spermatozoa. During the latter stage of spermatogenesis, insoluble PHGPx is a structural protein that, when absent in conditions of selenium deficiency, may explain defects in sperm structure and motility.

A GLOBAL ANALYSIS REVEALS NEARBY EFFECTS

The way in which ecological communities respond to removal or addition of species or resources is an important—and controversial—route to understanding ecosys-

CONTINUED ON PAGE 1327

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CONTINUED FROM PAGE 1325

tem processes. There is abundant theory and data on these questions, but most of the data are from freshwater systems. In a meta-analysis, Micheli (p. 1396) has synthesized data from numerous marine environments over a wide range of spatial and temporal scales. In patterns that are remarkably consistent across scales, he finds that the top-down effects of carnivore removal (for example, by marine fisheries) and the bottom-up effects of nutrient addition (for example, nitrogen loading to coastal waters from agricultural activity) affect adjacent trophic levels but cascade only weakly through the entire ecosystem.

ADOPTING NEW HABITS

Studies of blue tits in the southern mainland of France have revealed that one of two populations—one that inhabits evergreen oak woodland—is maladapted: Nesting is synchronized with the peak abundance of caterpillars in deciduous oak forest (where the other population resides) rather than coinciding with the later appearance of food in the evergreen forest. In this case, gene flow swamps local adaptation. Now, Blondel *et al.* (p. 1399) have discovered an instance of intraspecific variation at the microgeographic scale. On the island of Corsica, two isolated populations of blue tits only 25 kilometers apart differ in breeding and morphological traits, each adapted to local conditions. Thus, isolation can lead to local adaptation even in a bird species that is highly mobile.

A GTP-DEPENDENT TRANSCRIPTION FACTOR

The class II transactivator (CIITA) is a global transcription factor that regulates the expression of the major histocompatibility complex (MHC) class II genes involved in antigen presentation in the immune response. Rather than binding to DNA directly, it binds to the MHC promoter binding factor RFX5. Harton *et al.* (p. 1402; see the Perspective by Mach) now show that CIITA is an unusual guanosine triphosphate (GTP) binding protein, in that GTP binding has direct effects on the protein's transcriptional activity. Mutations in CIITA that decrease GTP binding also decrease its transactivation activity, but this activity can be restored with analogous sequences from the small GTP-binding protein Ras. Like some members of the Ras superfamily, CIITA is an inefficient GTPase. Functional analyses show that GTP binding helps CIITA directly regulate its localization to the nucleus.

FIBROCYTES AS HEARING AIDS

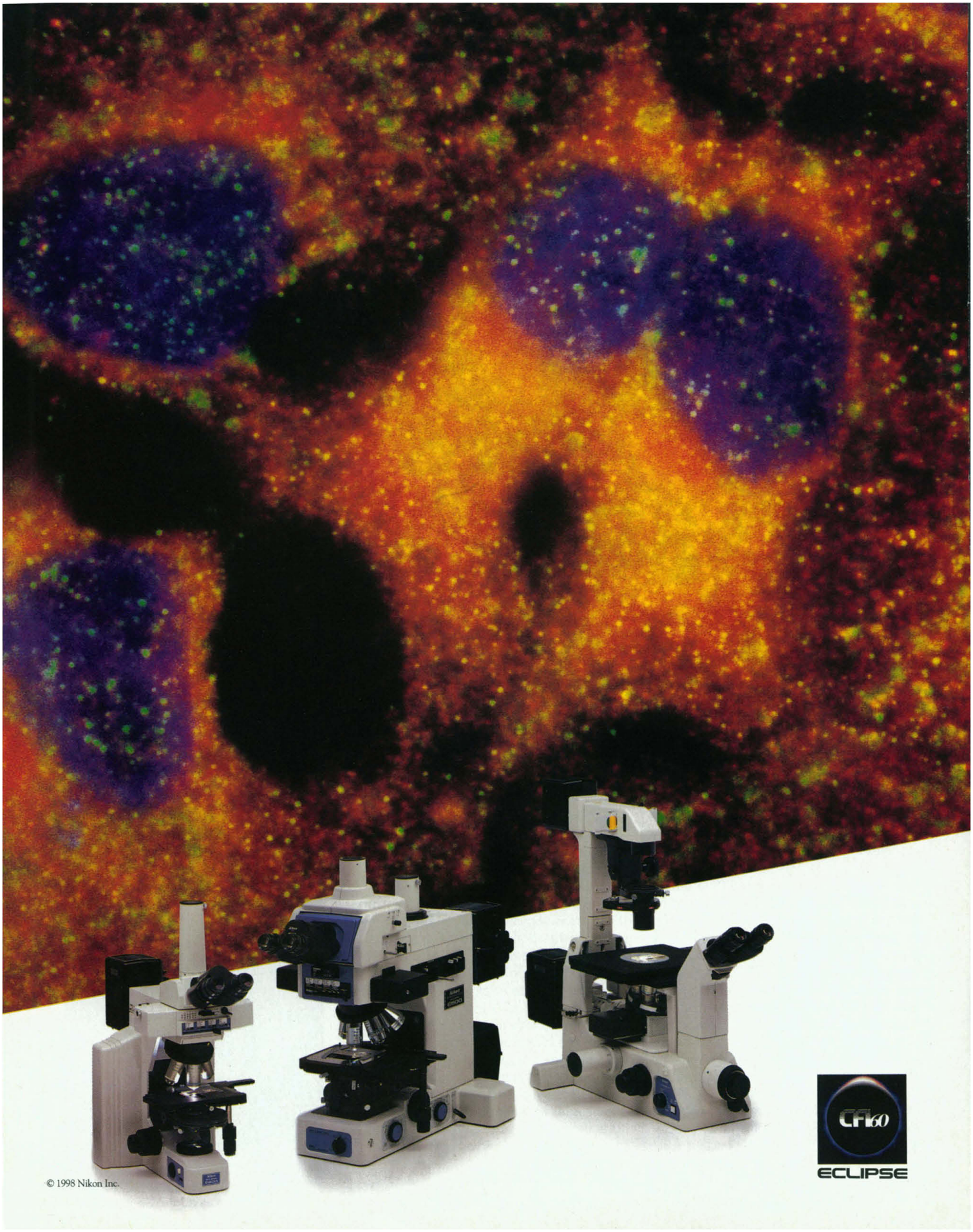
X-linked nonsyndromic mixed deafness (DFN3) is caused by mutations in the gene encoding transcription factor Brn-4. To investigate possible pathogenetic mechanisms, Minowa *et al.* (p. 1408; see the Perspective by Steel) established a mouse model of the disorder by targeted mutagenesis. The Brn4-deficient mice were profoundly deaf and showed a substantial reduction in endocochlear potential. There were no gross defects in the middle ear or cochlear structures, but severe pathological anomalies were seen in fibrocytes, a population of cells implicated in the regulation of cochlear potassium homeostasis. Thus, DFN3 differs from many other forms of deafness in that it appears to arise from malfunction of a nonsensory cell type.

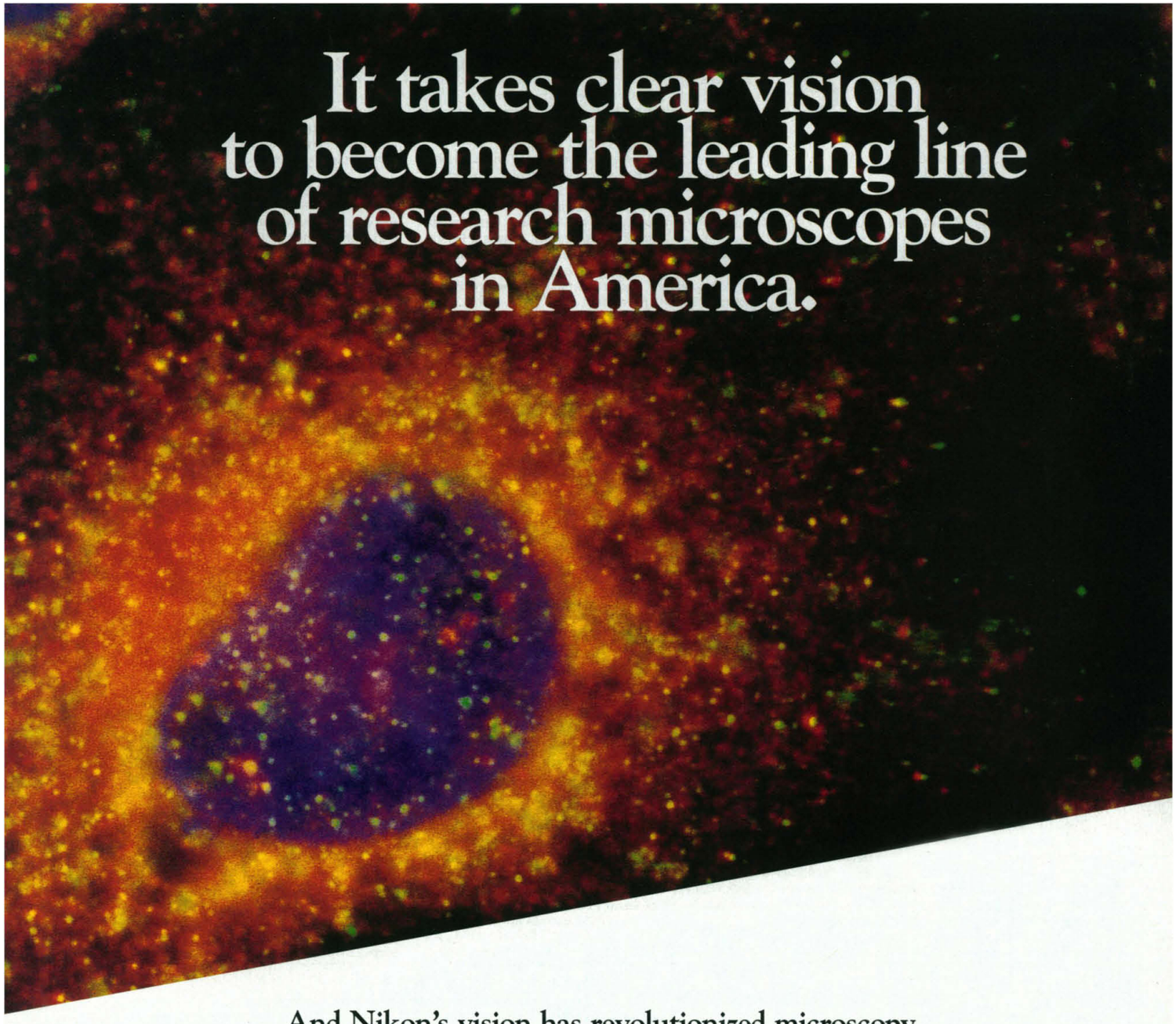
CONTRASTING MECHANISMS

Until now, two types of neuronal adaptation in the visual cortex have been described. One is an almost instantaneous gain control that normalizes cortical responses, and the other a slow adaptation developing over seconds. Müller *et al.* (p. 1405) describe a novel phenomenon in response to a short presentation of a high-contrast stimulus. The time course of their adaptation is in between the two previously described mechanisms and is pattern specific. A stimulus at one orientation will skew the orientation tuning curve of a complex cell away from the stimulus orientation. This finding might be a mechanism for improving the discriminability of subtle differences in orientation for successive eye fixation.

LTD AND INTERNEURONS

Traditionally, long-term potentiation (LTP) or depression (LTD) studies in the hippocampus have focused on the major synaptic connections between the principal neurons, the large neurons within these areas. However, the degree of fine-tuning in the brain would be enormously enhanced if the same type of plasticity were also possible on the smaller interneurons. Laezza *et al.* (p. 1411) describe a mechanism of LTD induction in a subpopulation of interneurons in the CA3 region of the hippocampus that depends on the combined activation of presynaptic metabotropic receptors and calcium-permeable postsynaptic AMPA receptors. This finding adds another dimension to plasticity and potential processing pathways the mammalian central nervous system.





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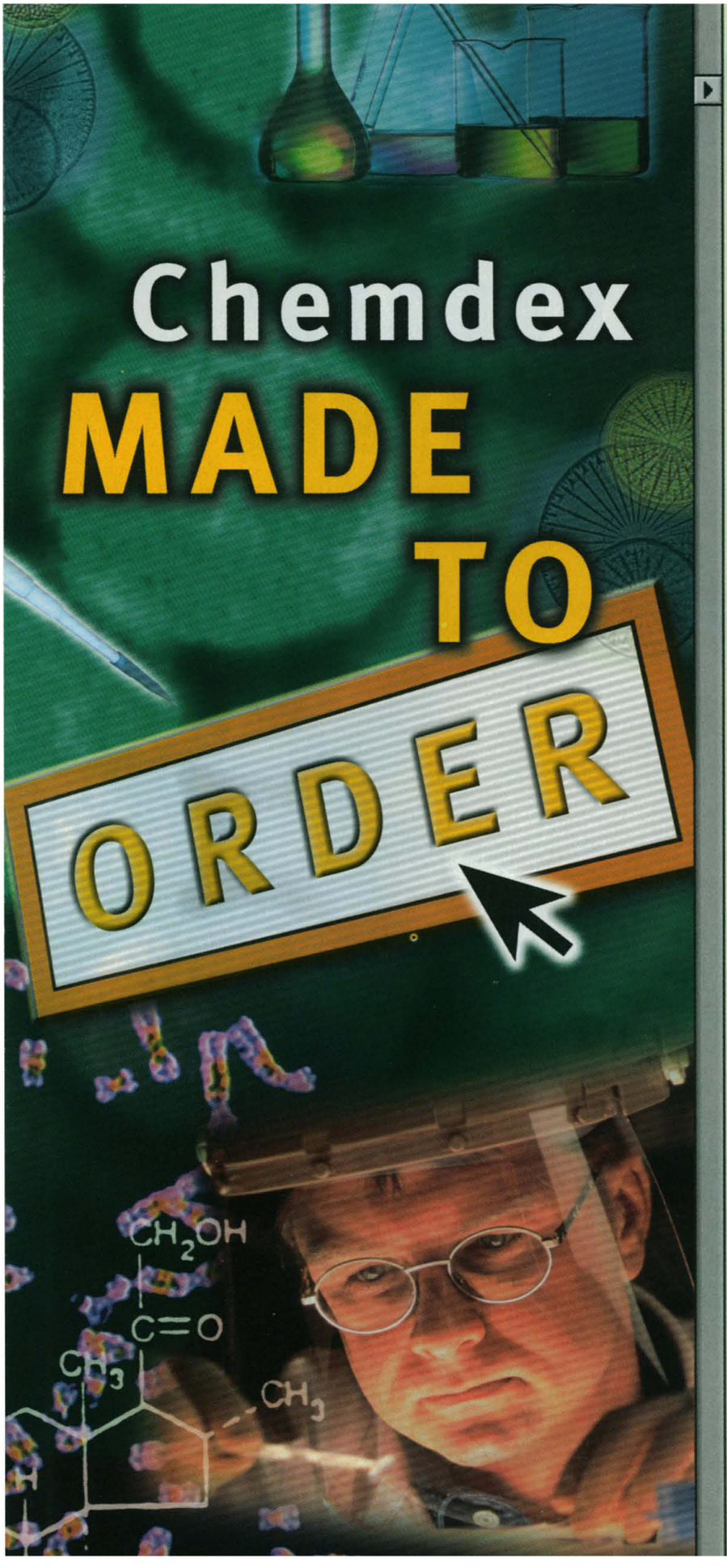

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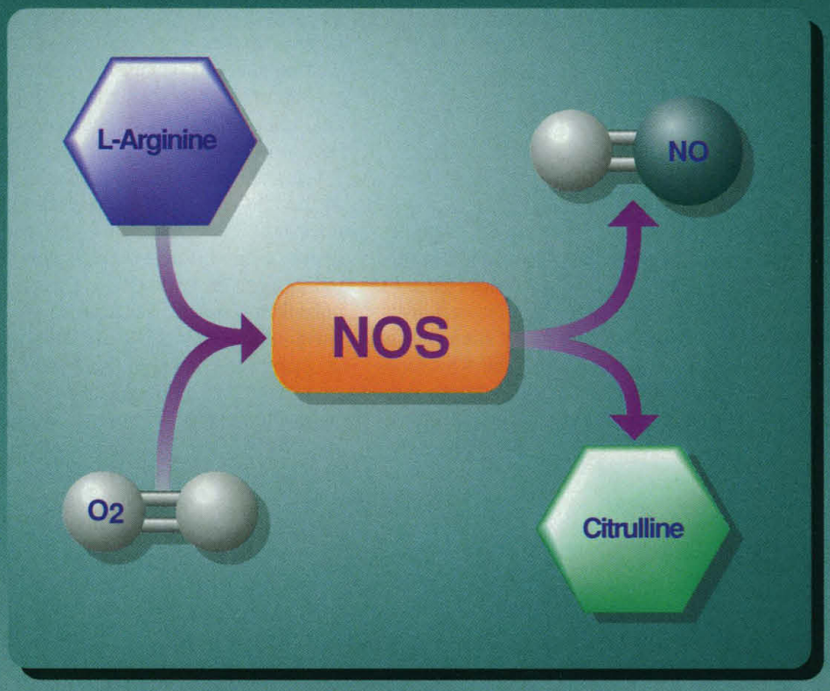

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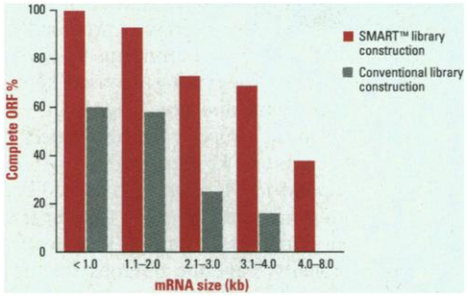

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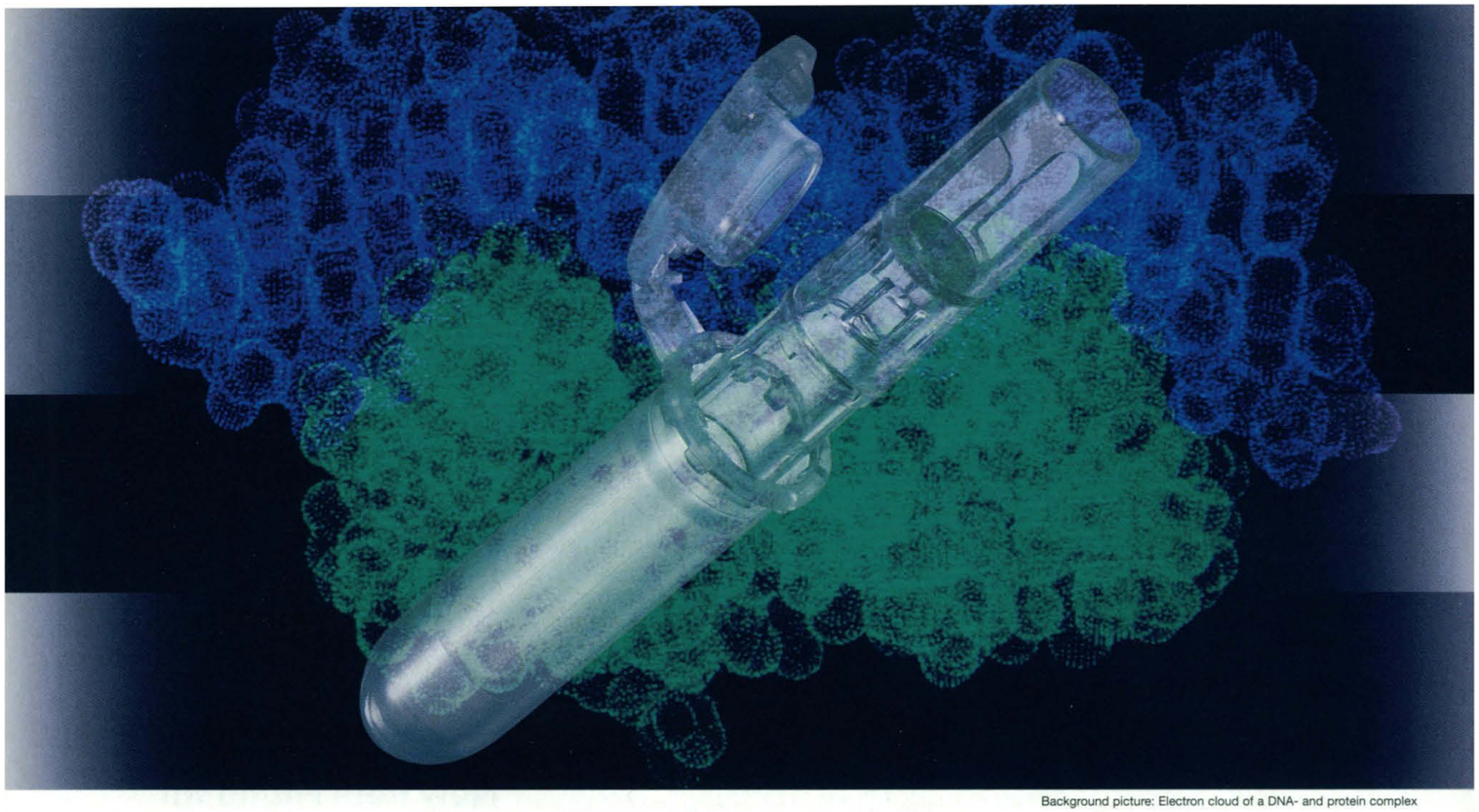

Background picture: Electron cloud of a DNA- and protein complex

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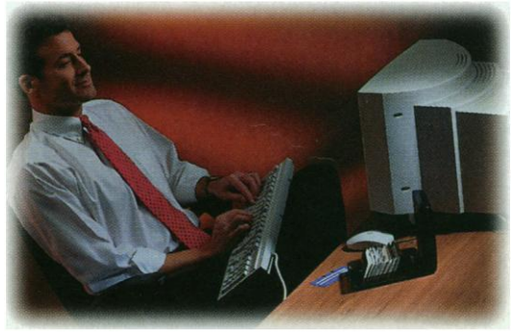

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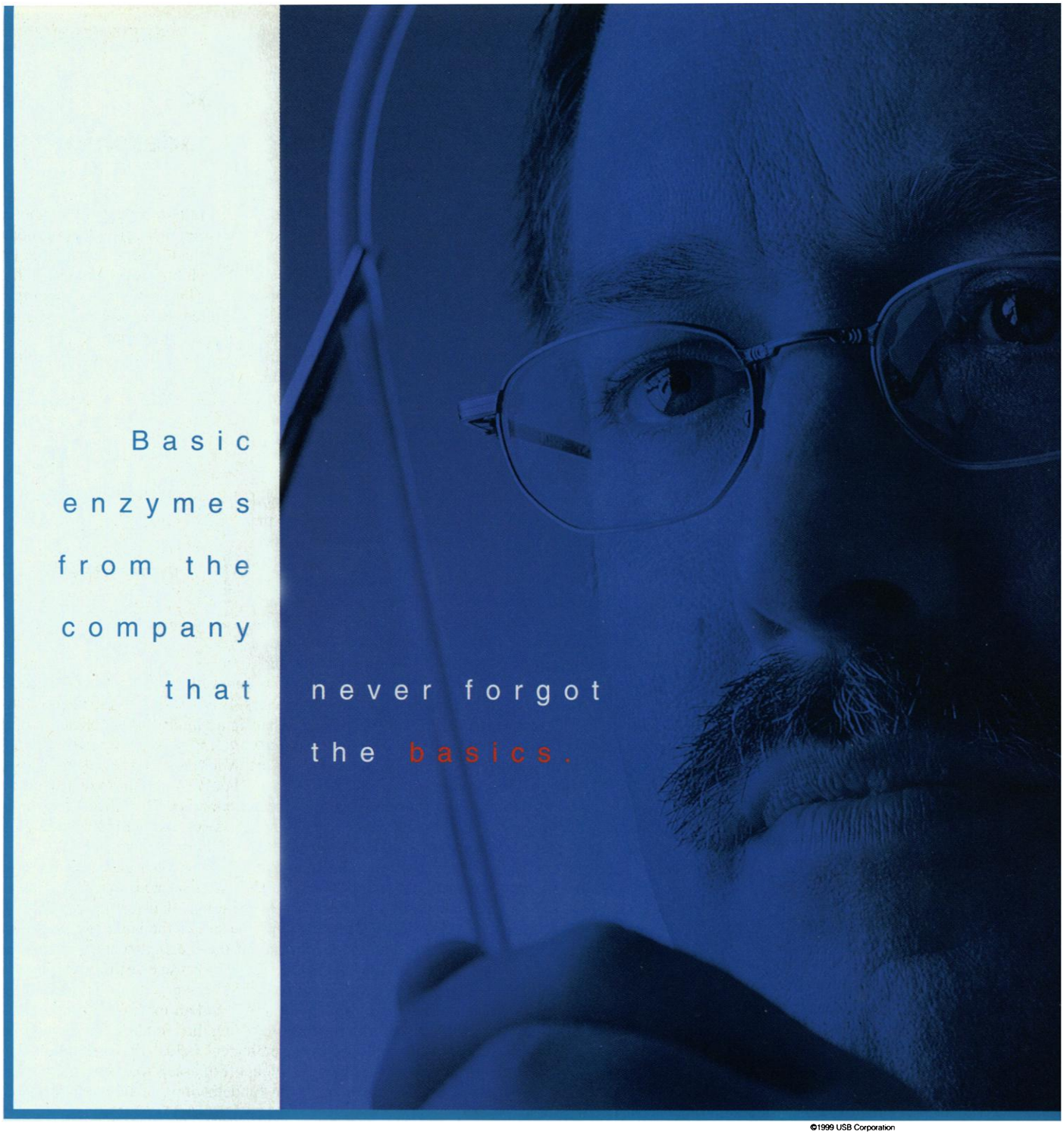

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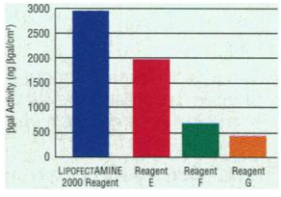

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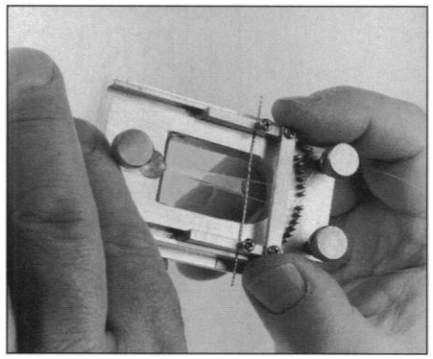

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