18 June 1999

Science

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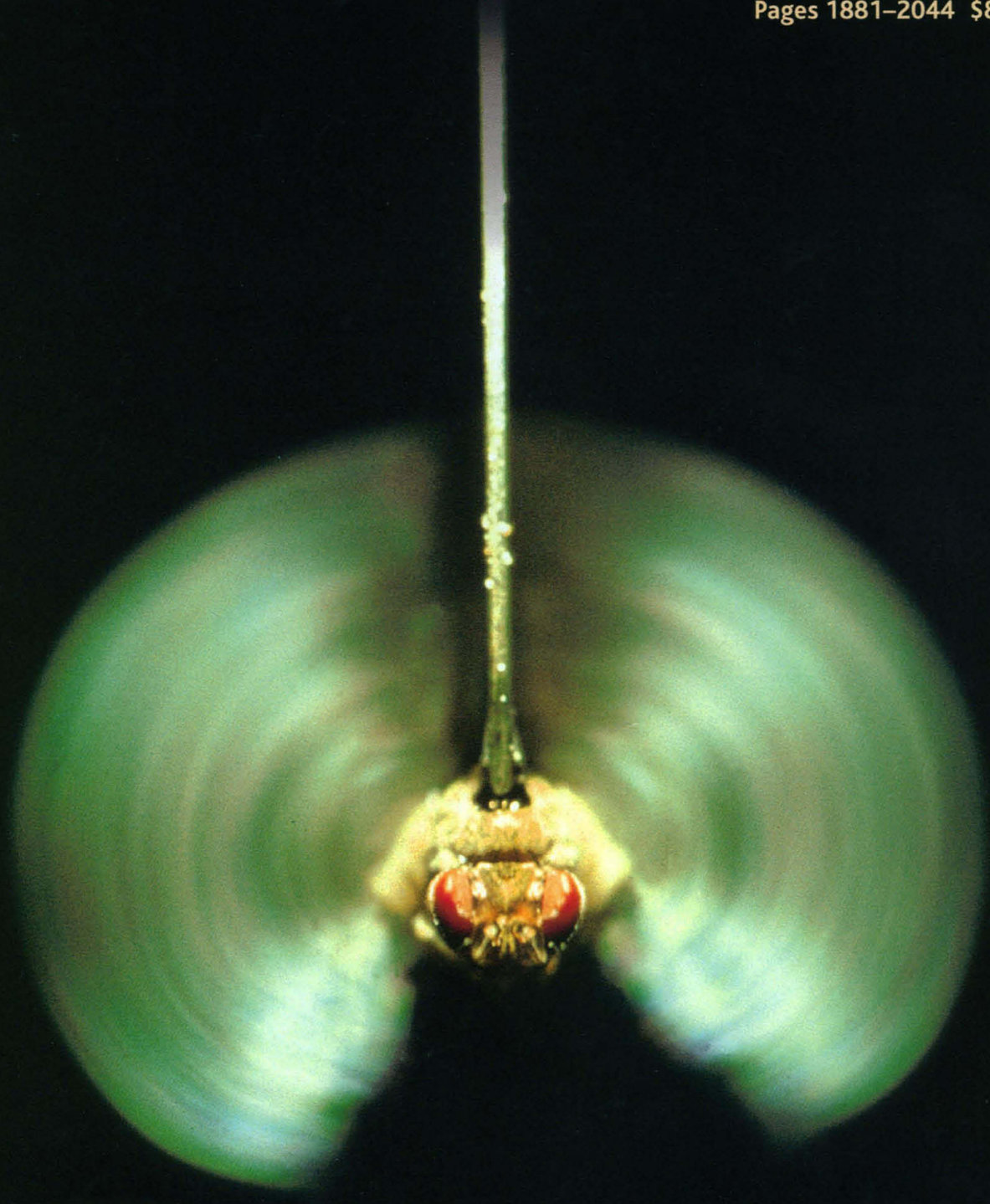

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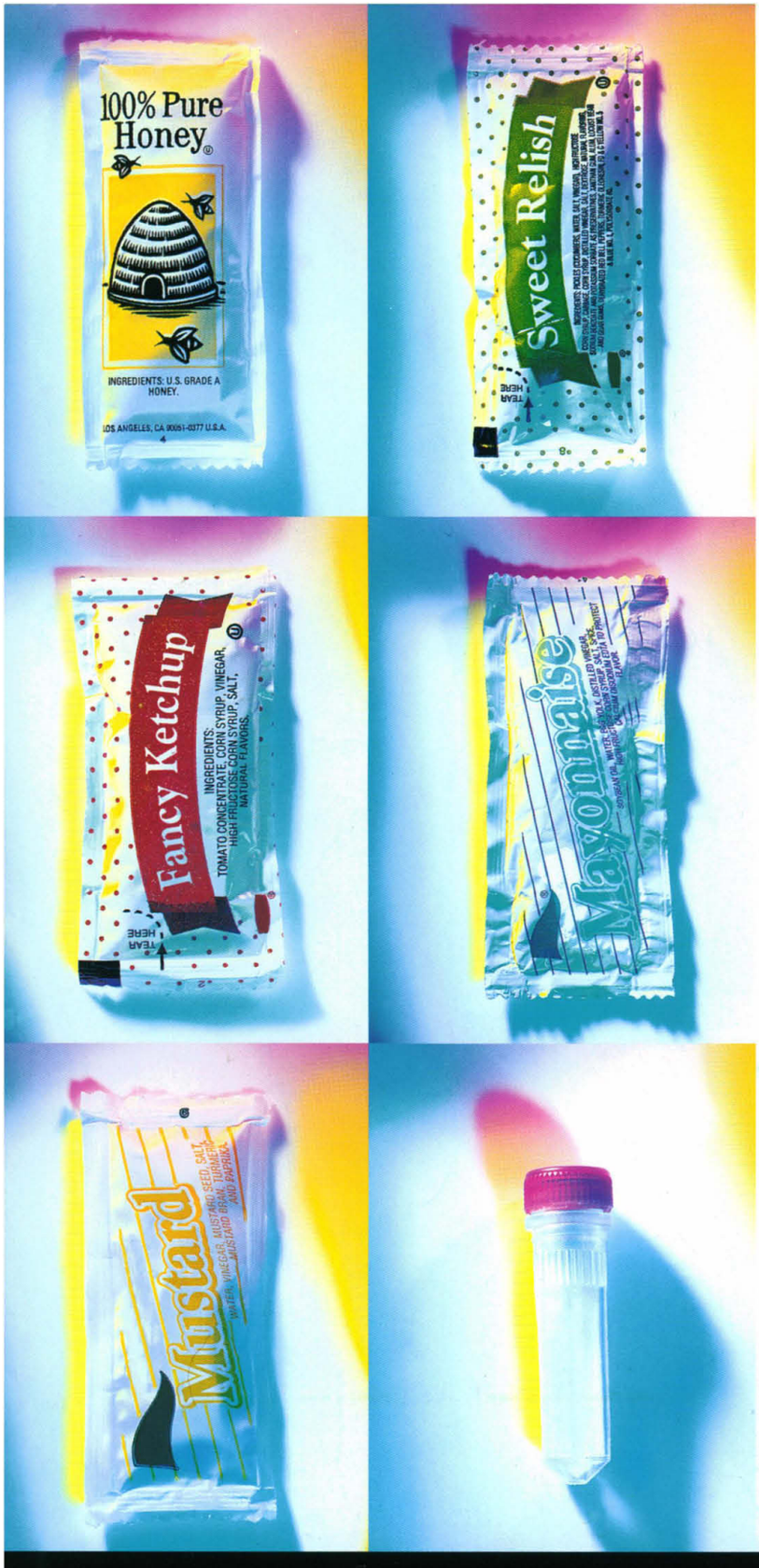

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VOLUME 284 18 JUNE 1999 NUMBER 5422

Science

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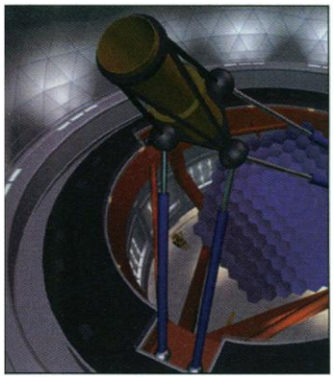
COVER A fruit fly tethered to a fine steel wire demonstrates the large stroke amplitude (160 degrees) and high stroke frequency (200 hertz) typical of small insects. Conventional steady-state aerodynamic theory fails to explain how insects generate enough force to remain airborne. Studies using robotic models of flapping wings have begun to uncover the unsteady mechanisms that insects use to fly and maneuver. [Image: Michael Springer/Gamma Liaison]



1913
Astronomers get wide-eyed

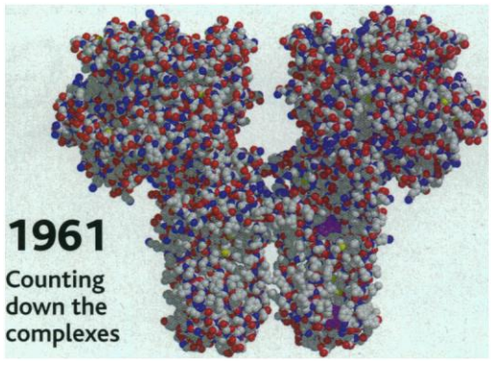
NEWS

NEWS OF THE WEEK

NEWS FOCUS

RESEARCH

RESEARCH ARTICLES



REPORTS

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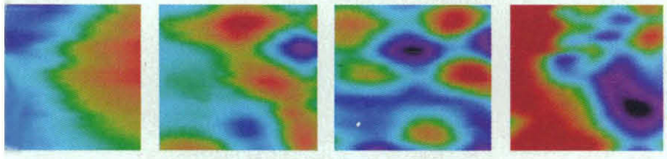
SCIENCE'S COMPASS

1935

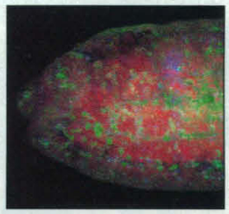
Radical effects

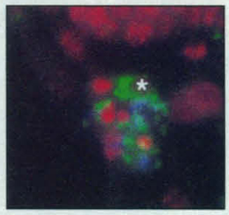


1969

Magnetism bubbling away

www.sciencemag.org/cgi/content/full/284/5422/1891a





1991

Phagocytosis of corpses

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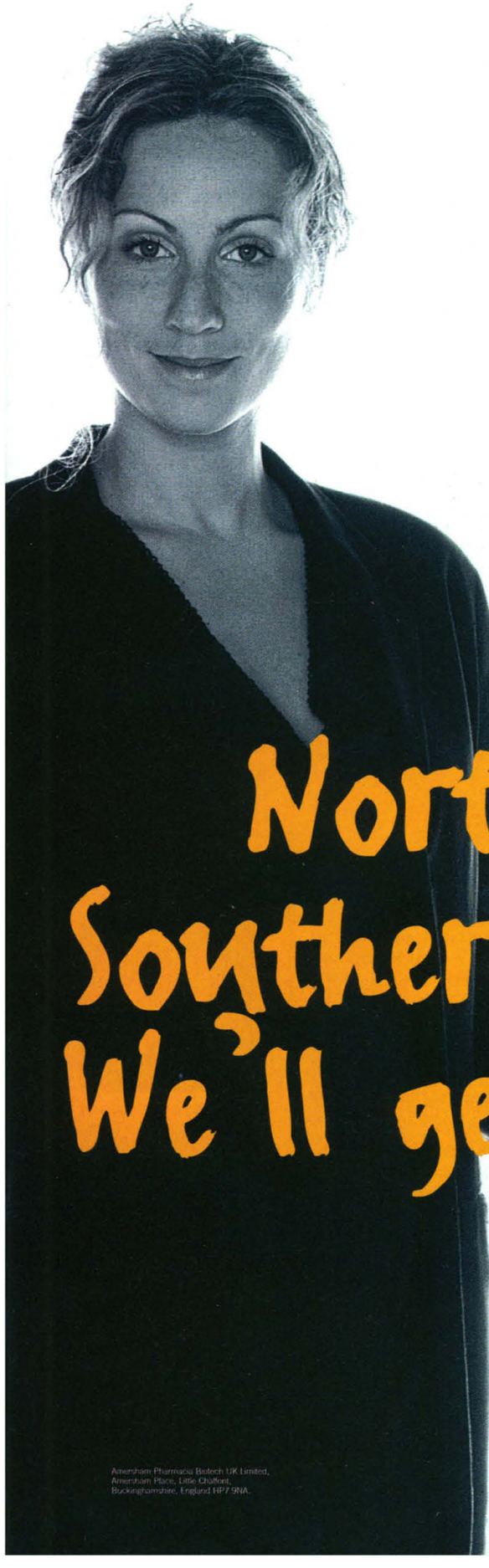

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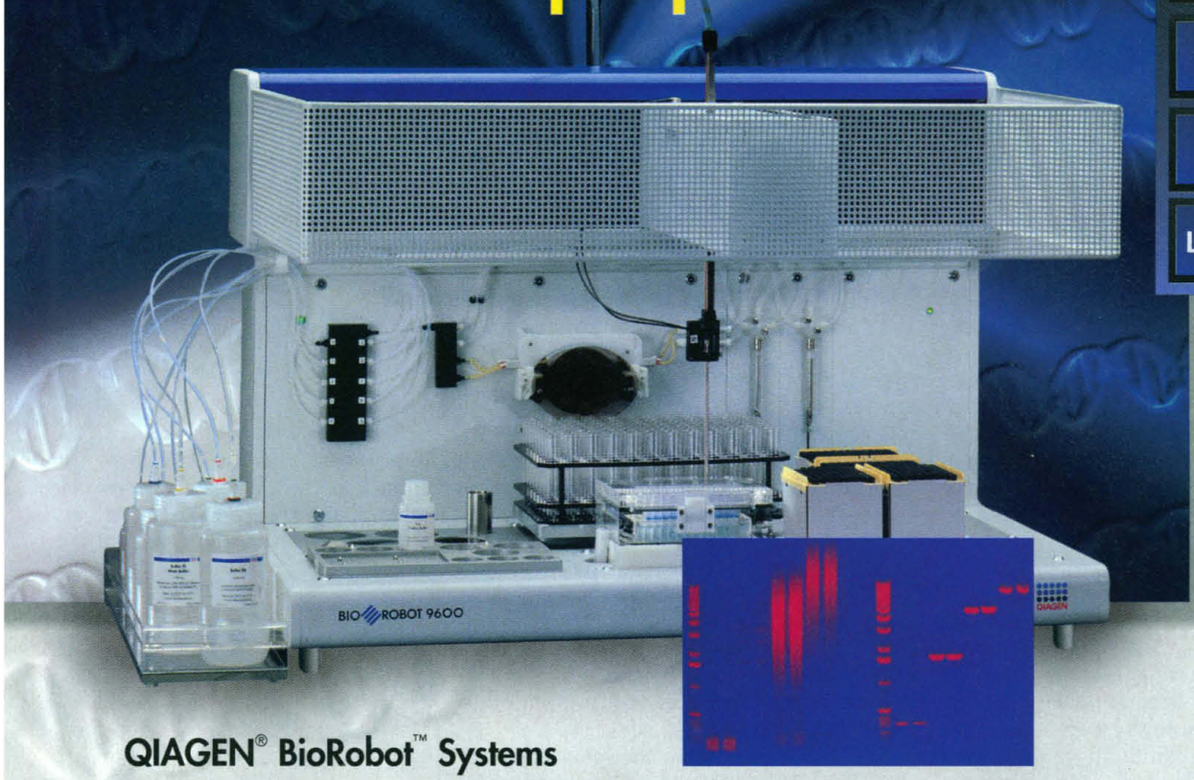

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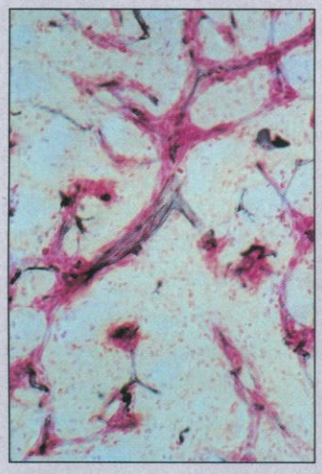
BALANCING BLOOD VESSELS

Solid tumors need a blood supply in order to grow. Conventional models suggest that most tumors initially grow as avascular masses that induce growth of new blood vessels once they reach about 1 millimeter in size. Holash *et al.* (p. 1994) show that, at least for some tumors, early events in tumor angiogenesis may be more



complex. Experimentally induced tumors in rodents (C6 gliomas) initially grew by "coopting" preexisting blood vessels from the surrounding tissue. Surprisingly, these coopted vessels then regressed (which resulted in transient tumor regression, only to be replaced by newly made vessels that facilitated tumor growth. The expression patterns of anti-angiogenic angiopoietin-2 and pro-angiogenic vascular endothelial growth factor suggest that these proteins are involved in a critical balancing act that helps determine whether a tumor successfully establishes itself in the host.

MAINTAINING THEIR BOUNCE

A rubber ball game has been played in Mesoamerica since at least 1600 B.C., and ancient figurines as well as bands used to hold together tools, such as axes, were also made of rubber. Historical records noted the superior elastic properties of the Mesoamerican rubber, which gave the balls their bounce and other artifacts their formability. Hosler *et al.* (p. 1988; see the news story by Stokstad) studied the modern latex processing methods of workers in Escuintla, Mexico, and compared the mechanical and chemical properties of modern unprocessed and processed latex with ancient rubber (processed latex). After the sticky latex is extracted from the *Castilla elastica* tree, it is mixed with the juice from morning glory vine (*Ipomoea alba*). The addition of the morning glory vine gives the latex its enhanced elasticity and formability.

FLOATING ELECTRONS FOR QUANTUM COMPUTERS

Quantum computers offer the possibility of solving highly complex problems that cannot be solved with classical computers. The development of these computers is hindered, however, by the lack of physical systems suitable for their implementation. Ideally, a system should consist of a large number ($>10^6$) of interacting particles (or qubits), whose states can be readily manipulated. Platzman and Dykman (p. 1967) propose a system that consists of two-dimensional arrays of electrons ($>10^8$ per square centimeter) floating on superfluid liquid helium and discuss how the interacting qubits could be manipulated and read out.

OLD LEAVES IN THE CO_2 RECORD

Ice core records have shown that atmospheric carbon dioxide (CO_2) concentrations increased abruptly during major deglaciations and decreased during glaciations; however, it has been difficult to obtain comparable records at lower latitudes. Wagner *et al.* (p. 1971) now present a detailed CO_2 record from the beginning of the Holocene based on stomatal frequency signatures in fossil birch leaves preserved in a bog in the Netherlands. The data reveal that CO_2 dropped even during a short-lived cooling event in the beginning of the Holocene known as the Preboreal Oscillation (~11,000 years ago), and may indicate that early Holocene CO_2 concentrations may have exceeded "preindustrial" values.

DO NOT DISTURB

Researchers have observed not only increasing annual average atmospheric carbon dioxide (CO_2) concentrations but also an increased seasonal amplitude of CO_2 concentrations at high latitudes. Explanations for this trend have been hard to verify. Zimov *et al.* (p. 1973) have monitored the seasonal amplitude of carbon exchange over disturbed and undisturbed sites in forest tundra in northeast Siberia and found that disturbed sites show a much higher CO_2 amplitude than undisturbed ones. Increased disturbance, for example, through fire and grazing, which results in species replacements, may account for the observed seasonal amplitude effects.

THIS WON'T HURT A BIT...

It is normal to experience pain as well as the uneasiness associated with the expectation of painful sensations. Ploghaus *et al.* (p. 1979) have applied functional magnetic resonance imaging to study the parts of the brain that are involved in these feelings. They describe a clear dissociation between the anticipation of pain and the experience of pain itself. Discrete areas in the brain, such as in the prefrontal cortex, the insula, and the cerebellum, are activated by anticipation of pain, whereas discrete but nearby locations mediate the actual pain experience. These findings may help us to better understand and treat a number of clinical pain syndromes.

THE BUZZ ON FLY FLIGHT

How do flies fly? Although steady states have proven amenable to theoretic and analytic approaches both in aerodynamics and enzyme kinetics, the regime of non-steady state behavior is miserly with its secrets. Dickinson *et al.* (p. 1954; see the cover and the Perspective by Dudley) have built a large-scale model of the wings of *Drosophila* and analyzed the forces generated in flight. They confirm that "delayed stall" is responsible for producing lift during the translational portion of the wing stroke. At the end of each half-stroke, when the direction of the wing reverses, they find that two rotational mechanisms, "Magnus effect" and "wake capture," operate synergistically to provide large lift transients.

ANOXIC ENERGY PATHWAYS

Oxidative phosphorylation uses the energy derived from the sequential transfer of electrons to pump protons across the mitochondrial inner membrane; this proton gradient is then used to synthesize adenosine triphosphate. Five integral membrane enzyme complexes participate in this process; the crystal structures of two of these (complexes III and IV) and much of a third (complex V) have been determined in recent years. Iverson *et al.* (p. 1961; see the Perspective by Hederstedt) present the 3.3 angstrom structure of fumarate reductase,

CONTINUED ON PAGE 1891

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DELIVERING LIVER

In mammals, the liver differentiates from foregut endoderm after receiving signals from the adjacent cardiac mesoderm. Jung *et al.* (p. 1998) used cultured tissues from mouse embryos to evaluate the role of fibroblast growth factors (FGFs) in the initial specification of cells to become liver and their subsequent morphogenetic outgrowth. They found that FGF1 and FGF2 could induce expression of liver-specific genes, whereas FGF8 (but not FGF1 and FGF2) promoted outgrowth of the liver bud. Modified inactive FGF receptors were used to block signaling from the cardiac mesoderm. Thus, organ precursor cells can be cultured and their differentiation controlled by adding factors normally secreted by adjacent tissue in the embryo.

UNSTICKING THE *BUBBLEGUM* MUTANT

Accumulation of very long chain fatty acids (VLCFAs) in the brain results in a neurodegenerative disorder in humans called adrenoleukodystrophy (ALD). Min and Benzer (p. 1985; see the news story by Barinaga) describe a new *Drosophila* mutant that is characterized by dramatic dilation of photoreceptor axons (hence, the name *bubblegum*) caused by excessive accumulation of VLCFAs. Supplementing the diet of *bubblegum* flies with glyceryl trioleate oil (one of the components of "Lorenzo's oil," which was originally used to treat ALD patients) reduced VLCFA levels and, when given at the larval stage, prevented VLCFA accumulation and neurodegeneration. Although the mutant proteins in ALD and *bubblegum* are involved in different steps of the VLCFA-oxidation pathway, *bubblegum* flies may prove a valuable tool for screening new drugs to treat this incurable disease.

TAILORING CARBOHYDRATE SYNTHESIS

Complex carbohydrates serve a great variety of functions in biological systems, from forming the structural foundations for plant cell walls to specifying blood group identity. One type, the hemicelluloses, interweaves with cellulose microfibrils to form the plant cell wall. The identity of the terminal sugar residue affects the biochemical properties of the hemicellulose and thus the physical characteristics of the cell wall. Perrin *et al.* (p. 1976) cloned from *Arabidopsis* a xyloglucan fucosyltransferase, the enzyme responsible for adding a terminal fucosyl residue on the principal hemicellulose of dicotyledonous plants. Identification of this enzyme may allow many of the other highly specific enzymes that direct carbohydrate synthesis in plants to be isolated and may eventually lead to directed manipulation of complex carbohydrate structures.

TECHNICAL COMMENT SUMMARIES

Wind and Climate on Mars

The full text of these comments can be seen at www.sciencemag.org/cgi/content/full/284/5422/1891a

M. P. Golombek (Perspectives, 5 March 1999, p. 1470) found that the data from several missions to Mars support the idea that Mars once had a "warmer and wetter environment with vastly different erosion rates" and that much of the landscape has "changed little from when it was created by catastrophic floods some 1.8 to 3.5 billion years ago."

C. B. Leovy comments that "Golombek's estimate of erosion rate, based on the assumption of constancy of the wind regime over several billion years, should be scaled upward by a factor of at least 10^5" and that "wind modification of the surface has probably been much more important, and modification by flowing water may have been correspondingly less important, than Golombek infers."

In response, Golombek agrees that there are "uncertainties in deriving quantitative erosion rates from landed surface views of a planet," but maintains that significant wind-related erosion on Mars is "basically incompatible with the observed suite of erosional forms and the estimated rate of erosion for these ancient terrains."

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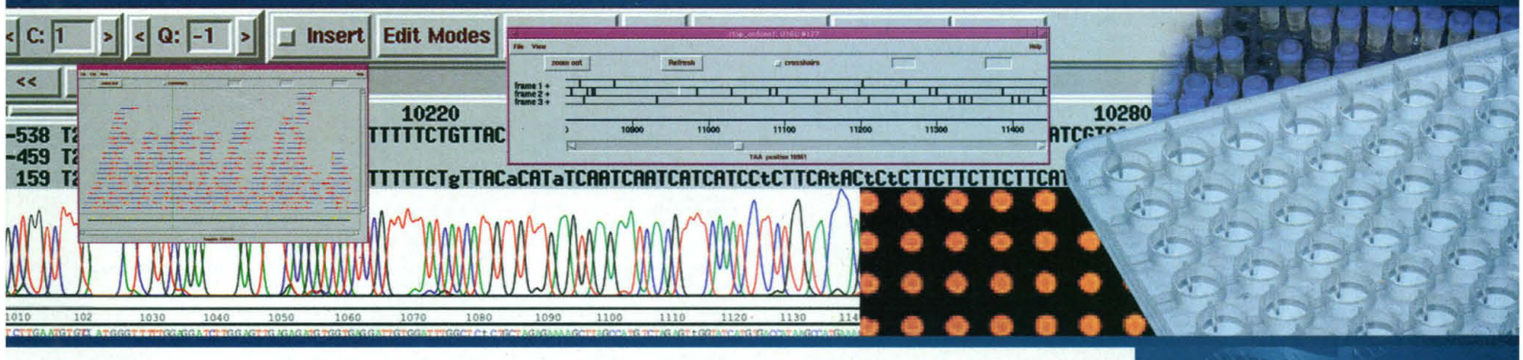

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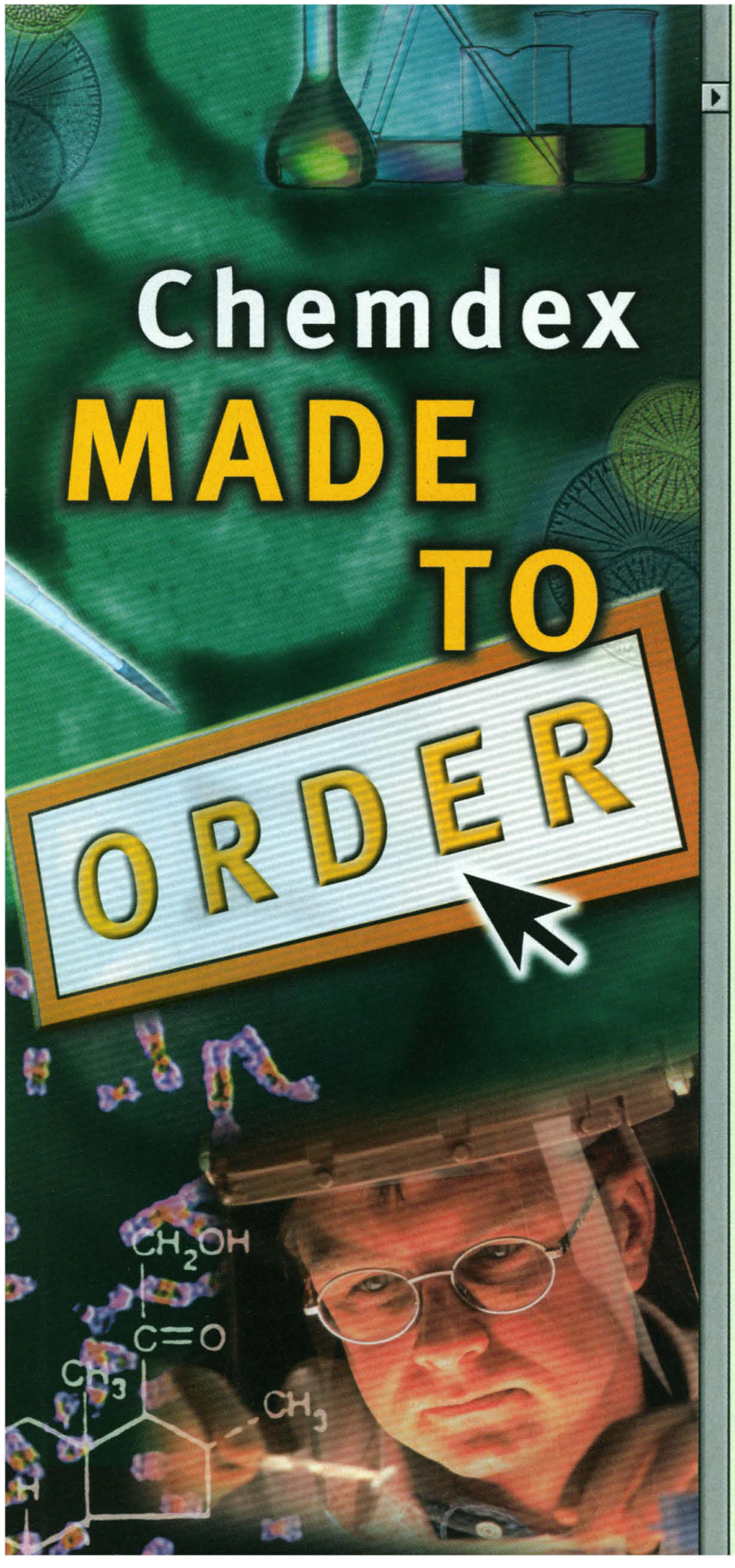

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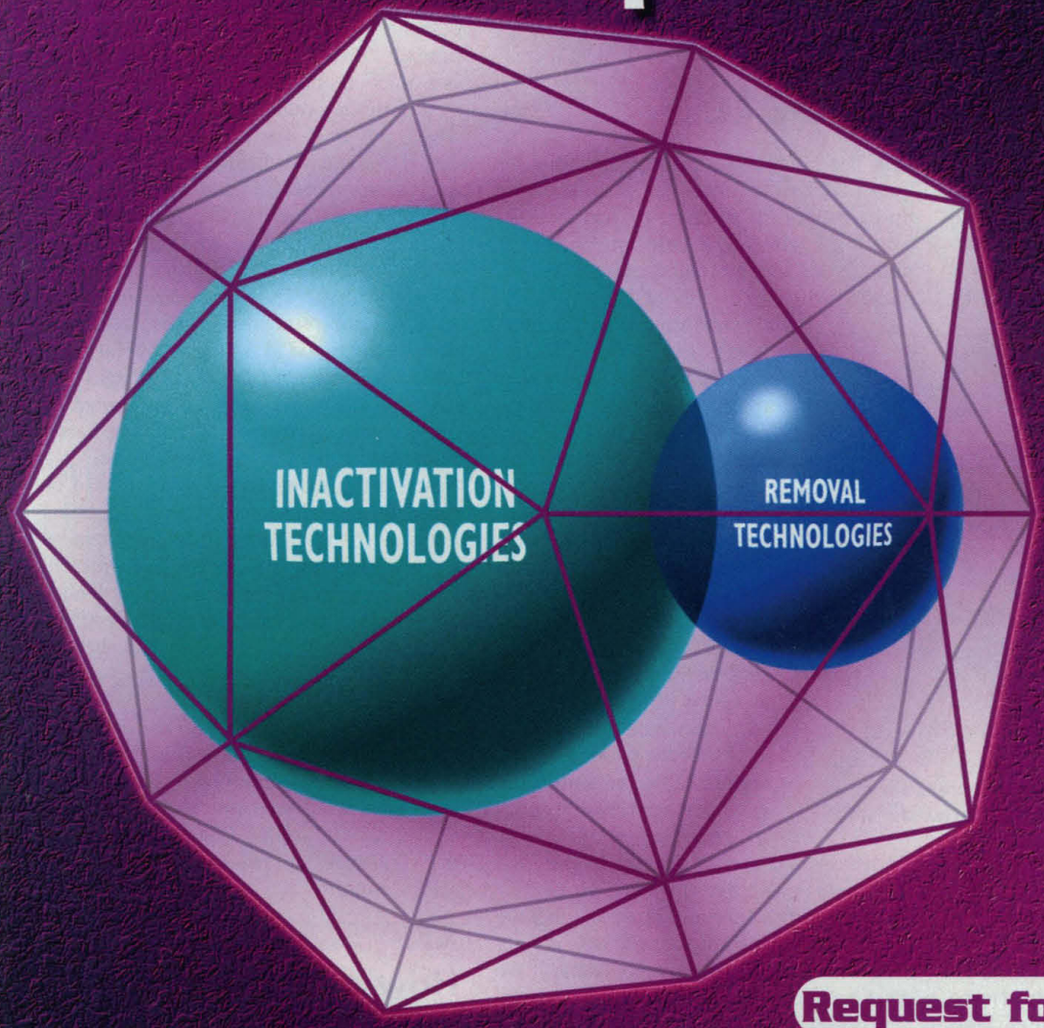

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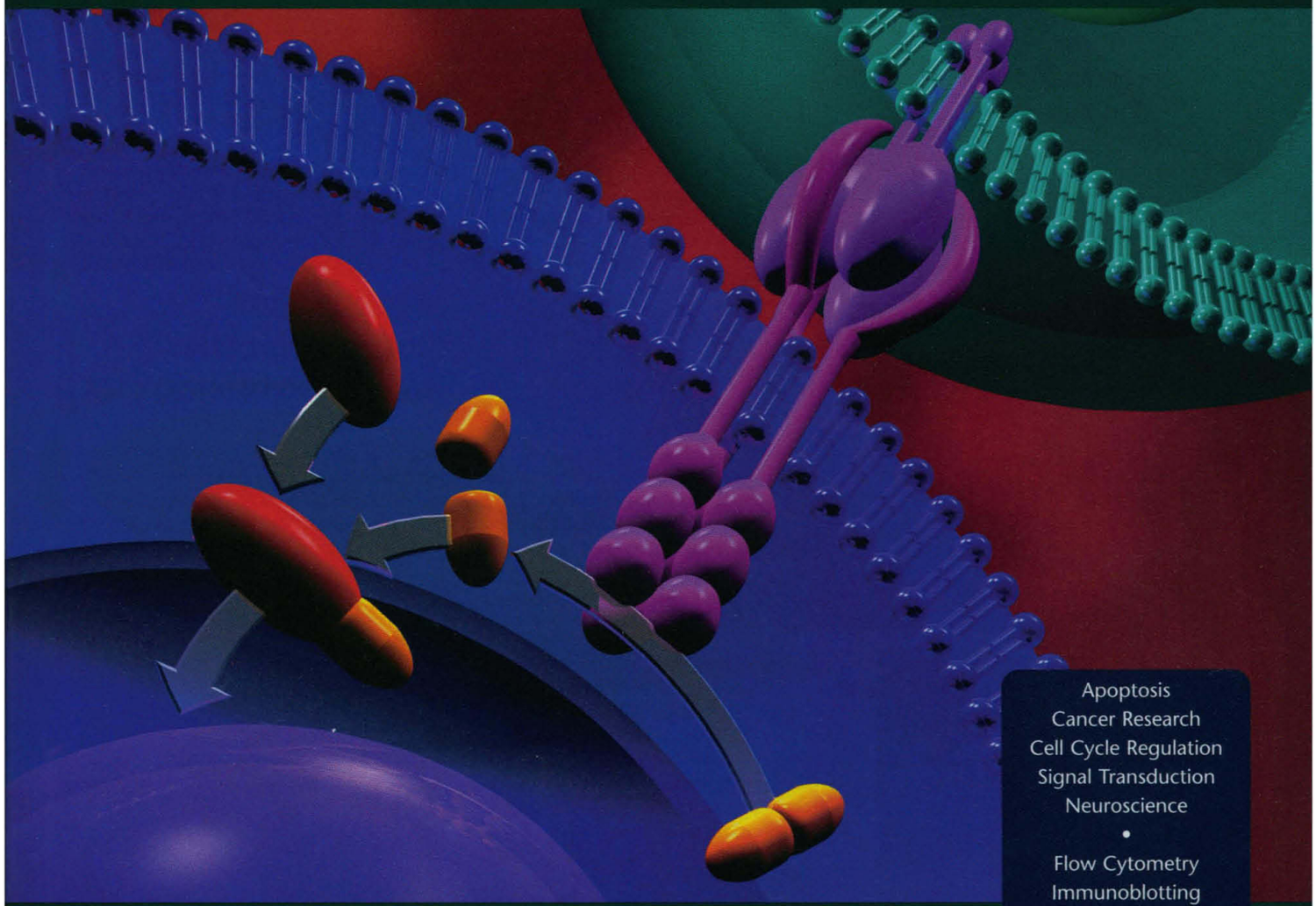

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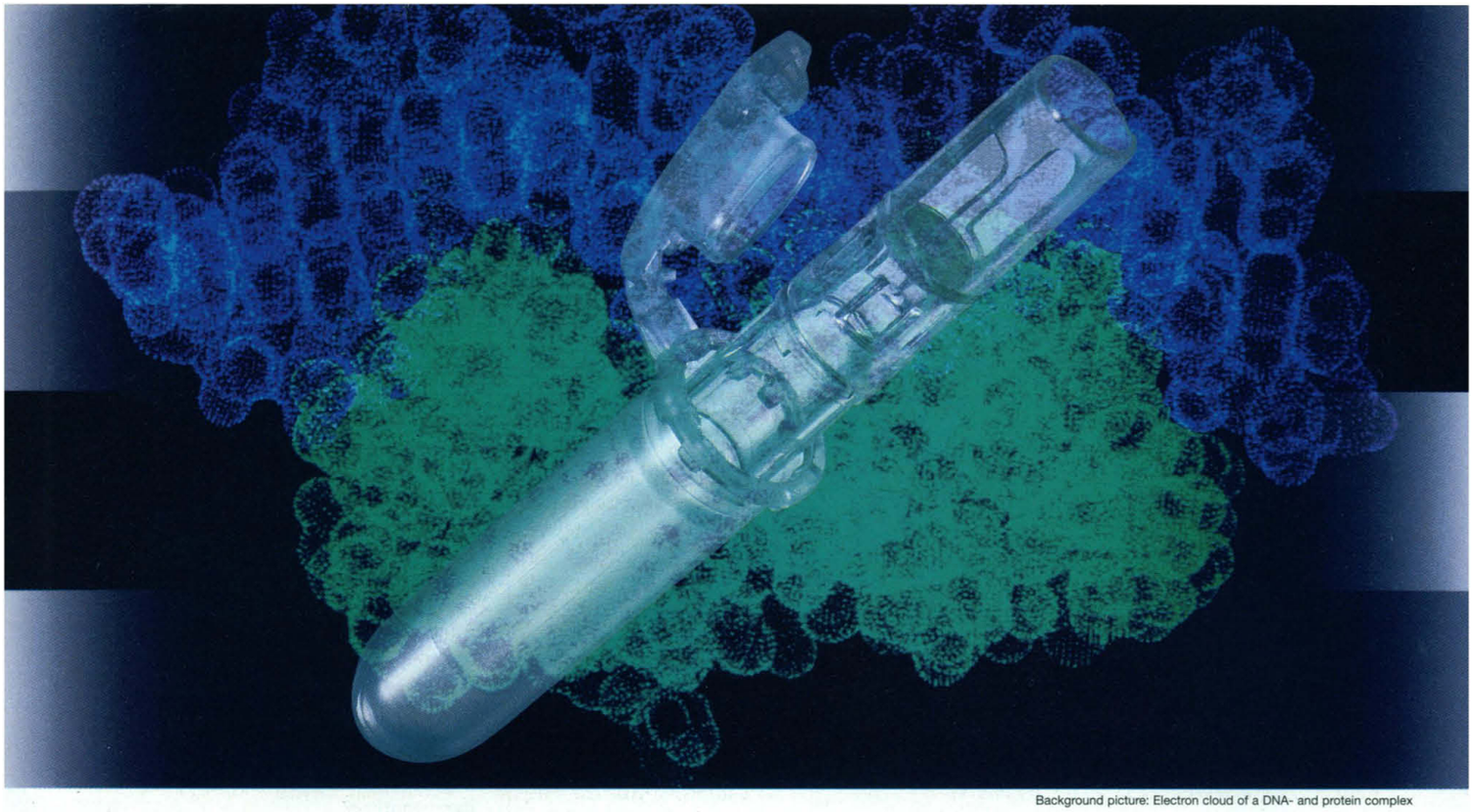

Background picture: Electron cloud of a DNA- and protein complex

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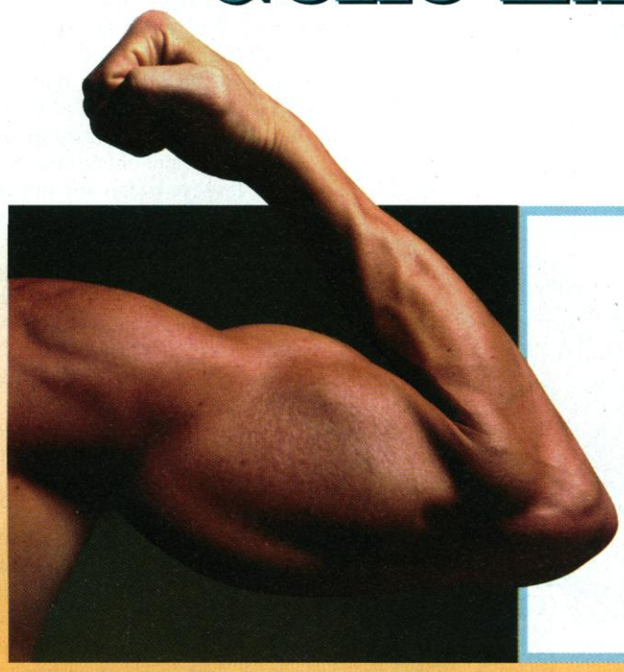

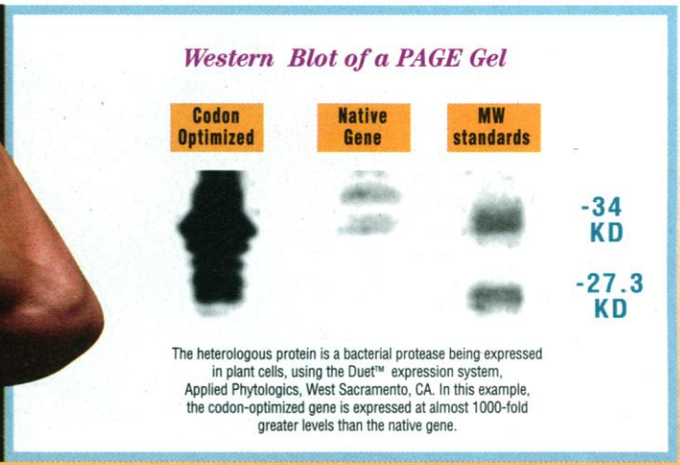

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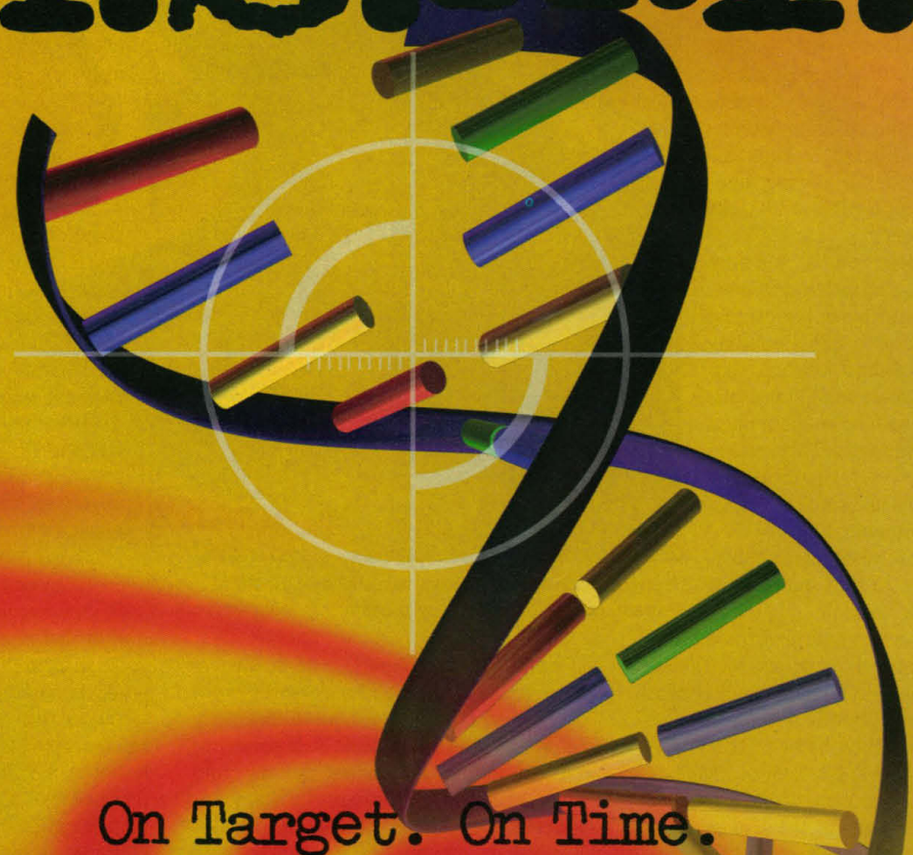

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Introducing The One R

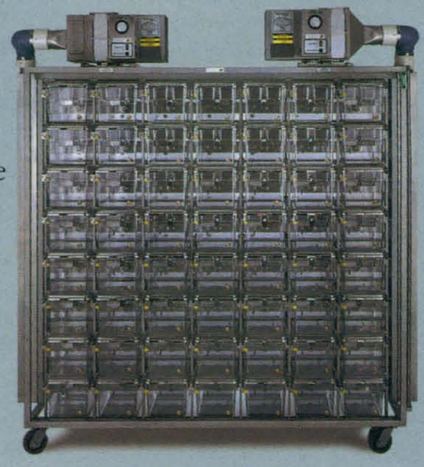
*a*re your animal rooms crammed with odd, assorted cages? Do you find it difficult to negotiate your way around? Are you losing precious time handling and cleaning outmoded equipment?

How would you like to house more animals per square foot, maximize available space, *and* comply with both the Animal Welfare Act and the ILAR Guide* recommendations? Would streamlining animal care and greatly reducing labor and costs make your job easier?

We have the answer: One Rack™

Our One Cage™ High Density Housing System features a single, double-sided rack that can accommodate 112 units and house 560 mice, 448 hamsters, 224 rats, or 112 guinea pigs. *This represents up to a 273% increase in animal populations.*

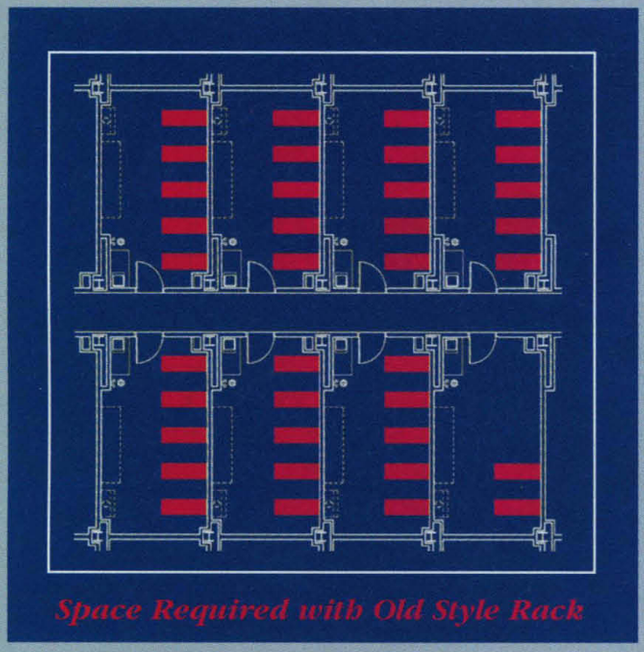
One Rack offers a dramatic impact on facility space: Normally, a facility housing 2,200 rats would require 37 racks housing 30 cages with 60 rats per rack (based on old-style racks). Compare this to 10 One Cage racks housing 224 rats per rack.)



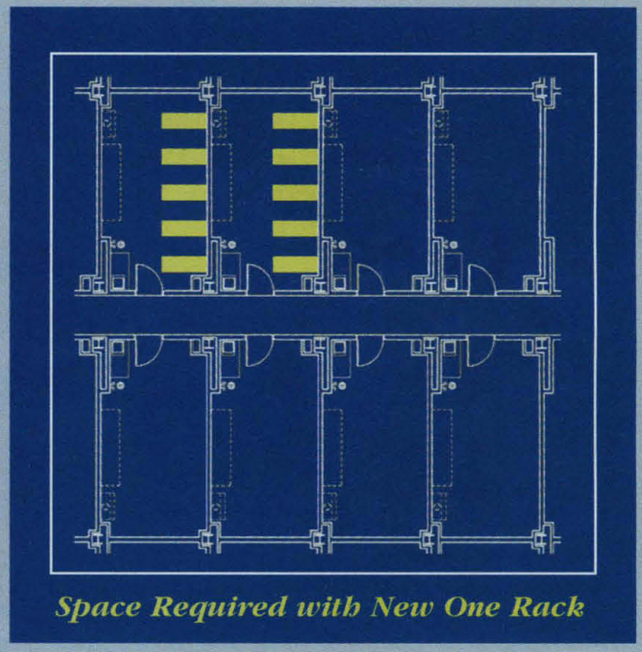
The One Cage™ High-Density Housing System.

*Based on the Animal Welfare Act of 1966 as ammended 1985 and the Guide for the Care and Use of Laboratory Animals, Institute of Laboratory Animal Resources, Commission of Life Sciences, National Research Council, National Academy Press, 1996.

Only ack™ System



Space Required with Old Style Rack



Space Required with New One Rack

The number of animal rooms required can be reduced from eight to two based on a plan of five racks per room.

With One Rack, you can house more rodents in less space, while meeting interior cage height and floor space requirements.

In addition, our environmental control system supplies HEPA filtered air into the cage and introduces a clear plastic canopy that functions as a hood, capturing air exiting the cage through the filter top. The cage is secured in the rack by a manual lock that provides visual indication the cage is secure.

One Cage™ and See-Through™ System
Lab Products also provides See-Through Racks featuring the One Cage and house up to 84 units per rack.

Each cage is suspended from a perforated shelf that serves as a cage cover. These mobile units are ideally suited for various biomedical research studies including toxicology, breeding and many others. With the new One Cage, our See-Through systems have become more flexible than ever.

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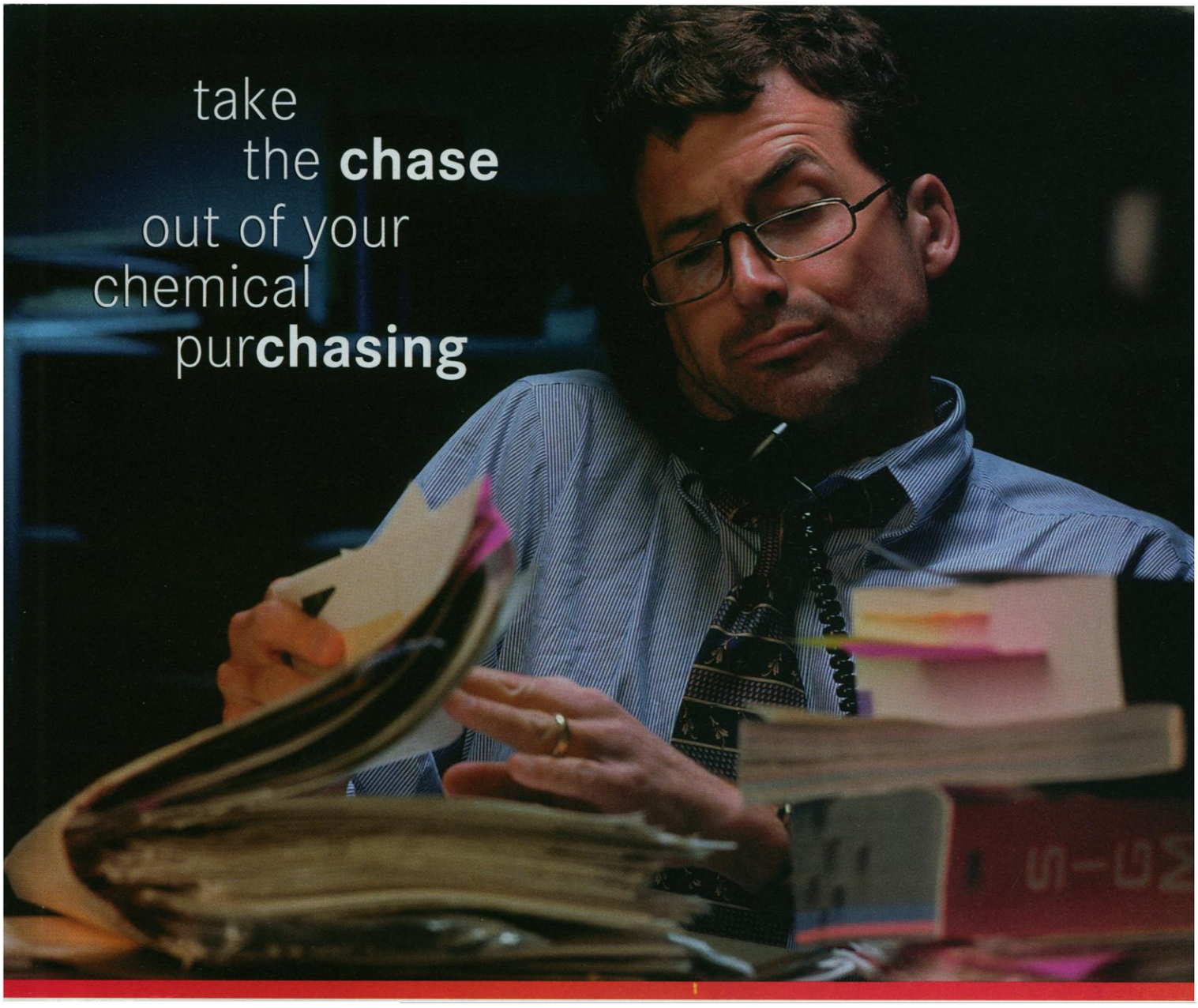

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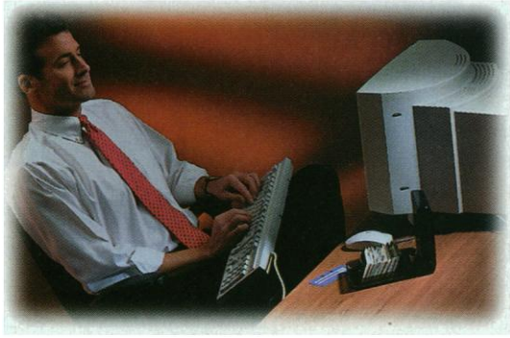

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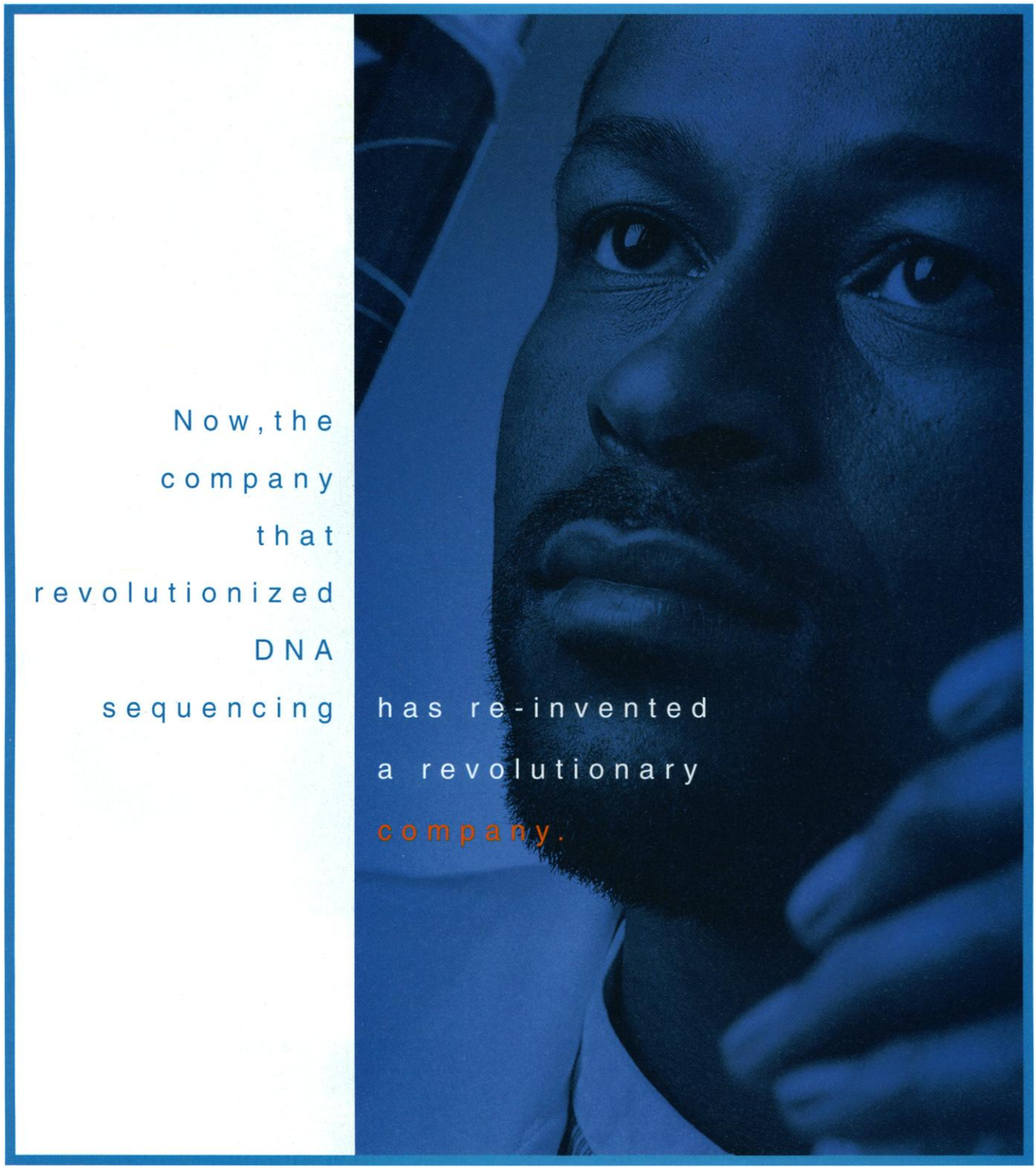

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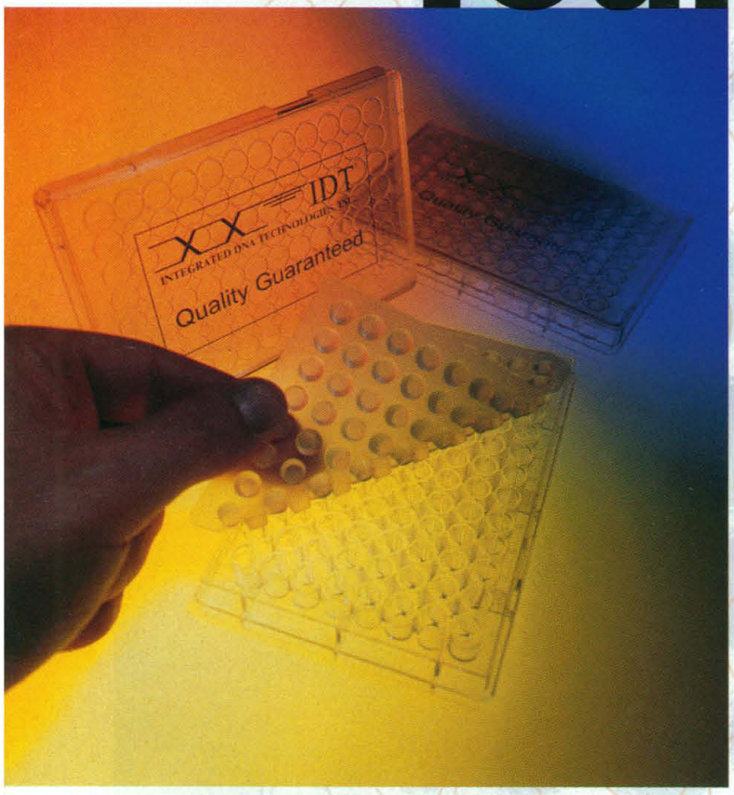

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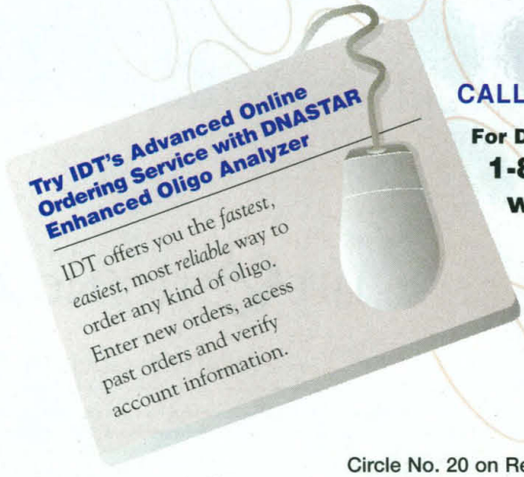

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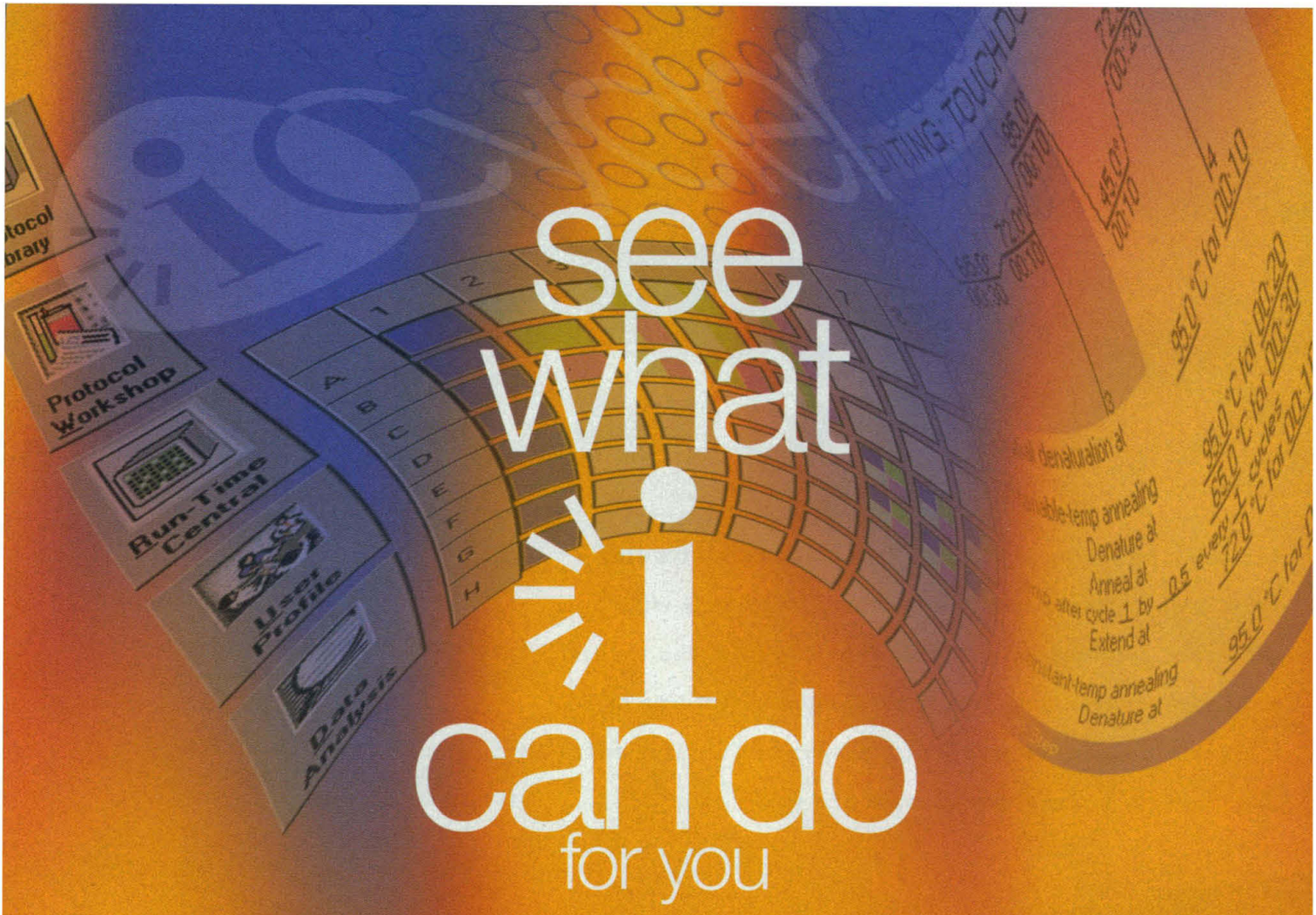

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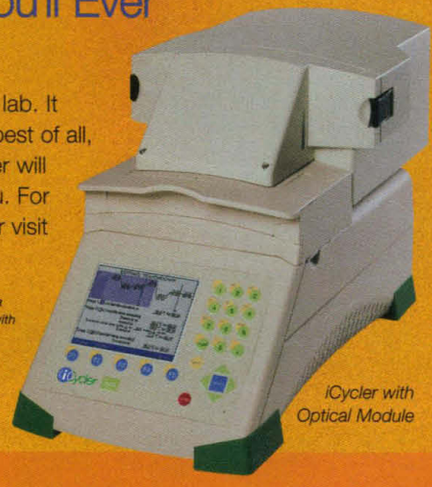

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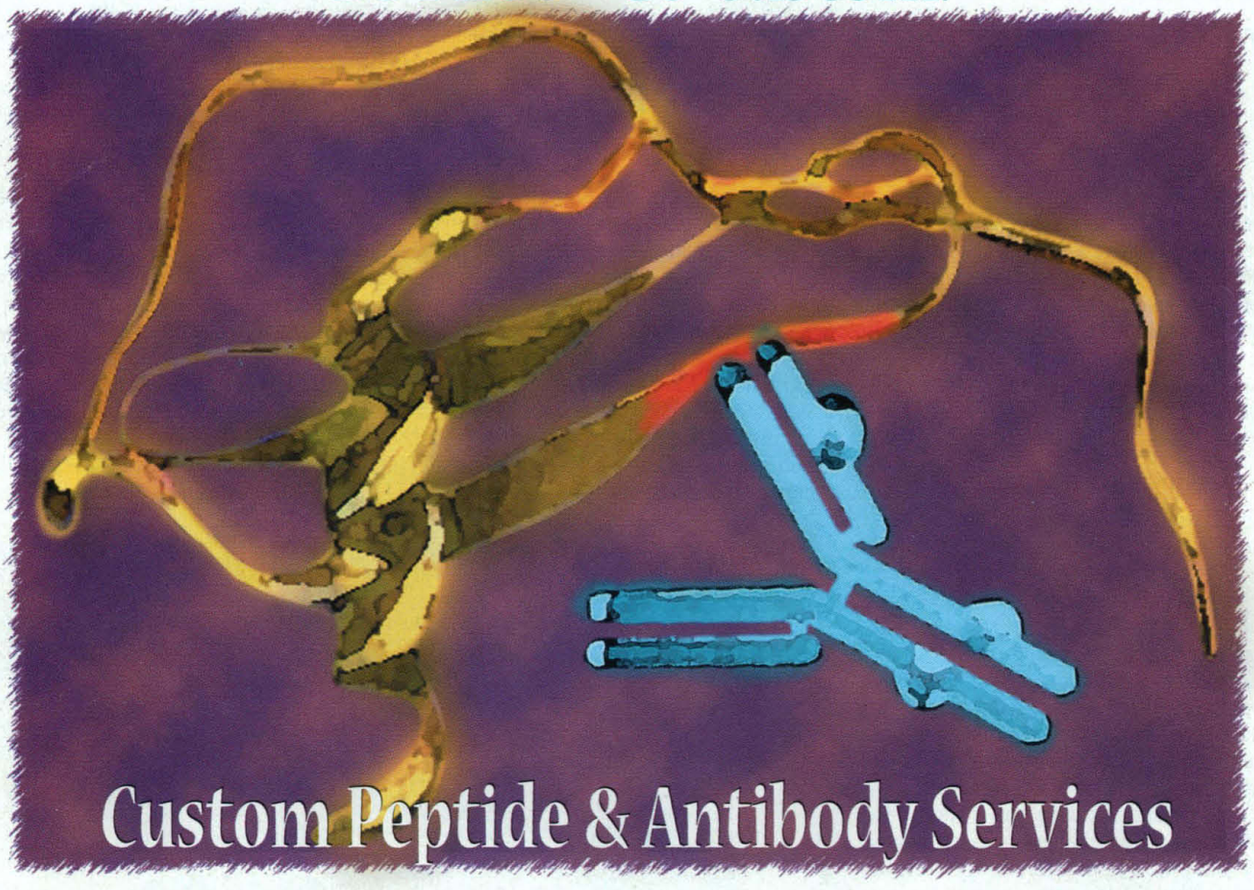

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