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# Science

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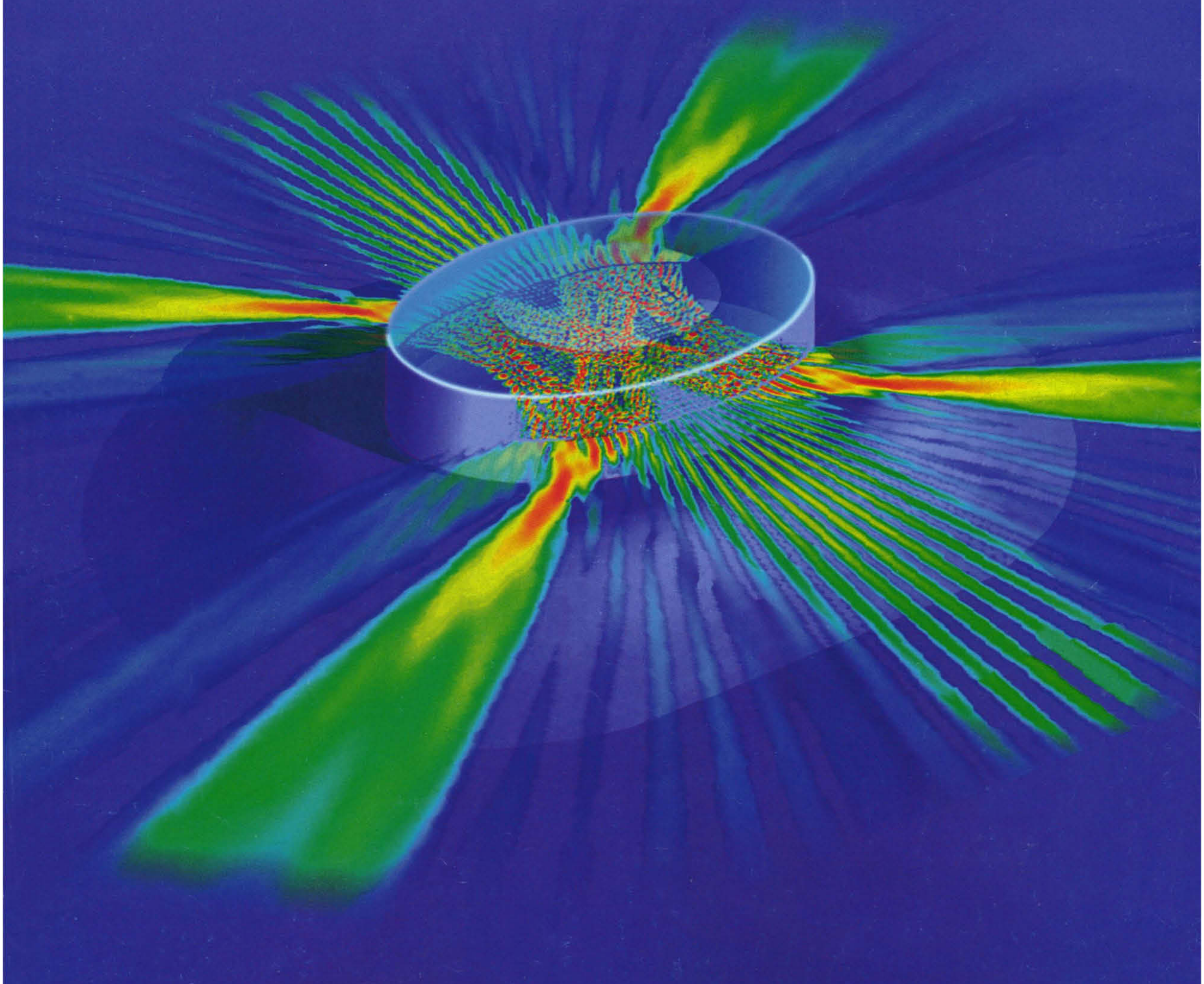


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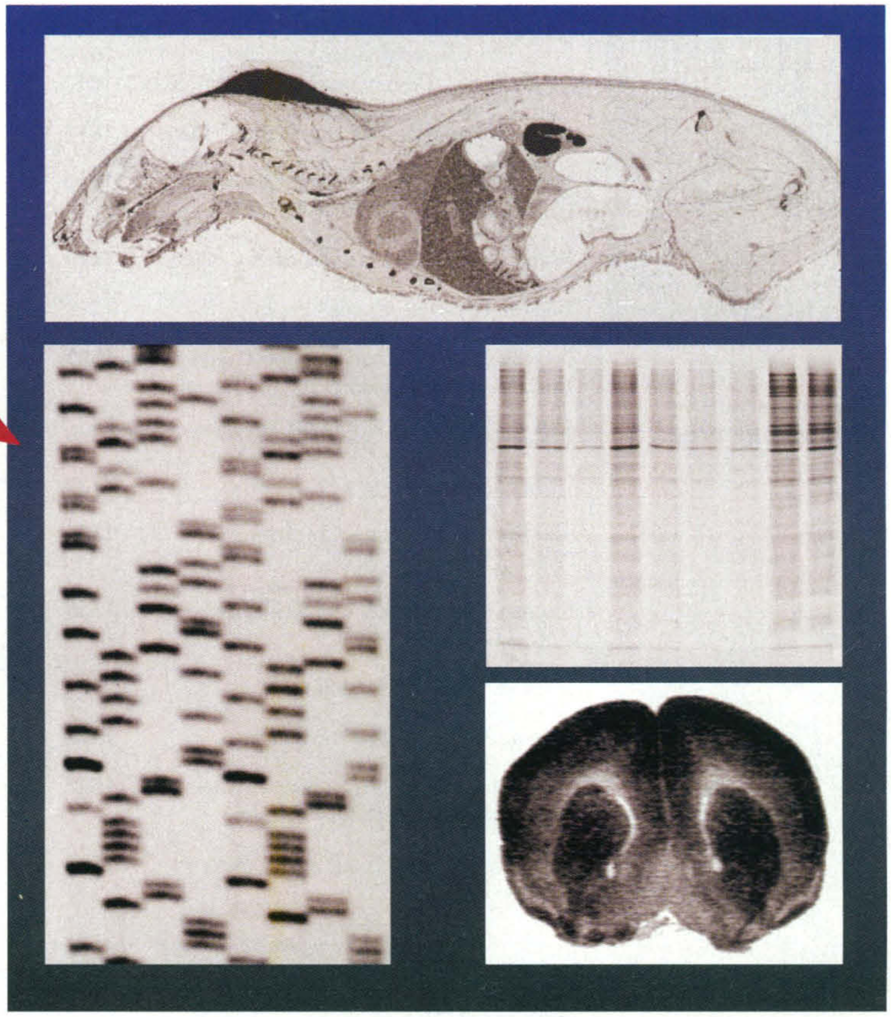

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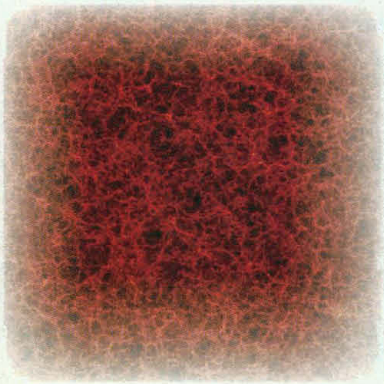
**1527**
**10 years after the Yellowstone fires**



**1522**
**Silicon universe**

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## RESEARCH NEWS



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### Policy



### Books and New Media



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### Review



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## COVER

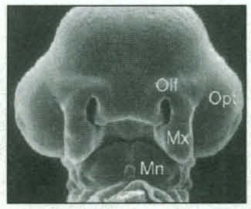
A cylindrical semiconductor microlaser has been deformed from circular symmetry. The deformation in general leads to a chaotic behavior of the light rays in the resonator. For the laser shown the deformation results in a "bow-tie"–shaped intensity pattern inside the microresonator, strongly directional light emission (yellow-green "beams"), and 1000 times the light output that would be achieved from the corresponding undeformed laser. See p. 1556 and the Commentary on p. 1544. [Illustration: K. D. Drake, Bell Labs, Lucent Technologies]

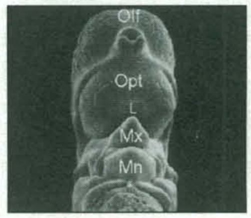

## RESEARCH ARTICLES



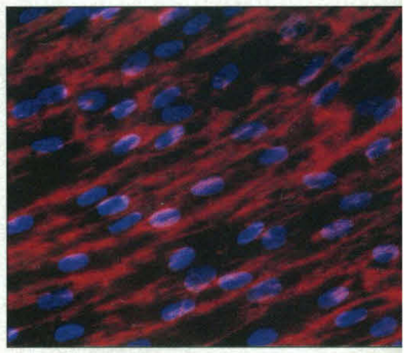
## REPORTS






**1528 & 1603**
**Teratogens and Sonic hedgehog**



**1614**
**PTEN tumor suppressor regulating adhesion**

Indicates accompanying feature

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## On the Web

**This week's Enhanced Research Commentary describes how lasers can benefit from chaos**
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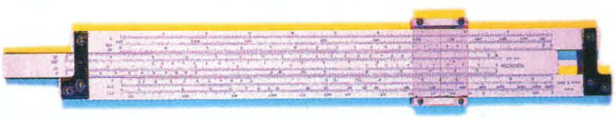

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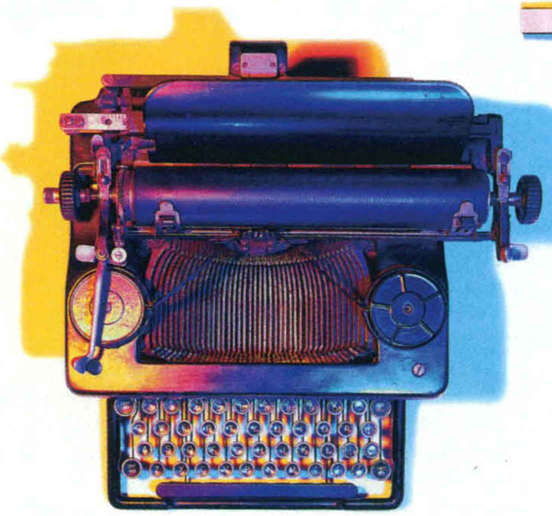

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# THIS WEEK IN SCIENCE

edited by BROOKS HANSON

## Glass dynamics

The dynamics of disordered systems differ inherently from those of crystalline materials, and many fundamental questions have remained unanswered because of experimental limitations. In a review, Sette *et al.* (p. 1550) examine recent progress at the European Synchrotron Radiation Facility, a third-generation radiation source, where inelastic x-ray scattering experiments with millielectron volt energy resolution have been performed on a range of glass-forming liquids, primarily glycerol. The data reveal how the microscopic dynamics of these materials, especially collective excitations at short wavelengths, are related to structural relaxation processes and other properties.

■

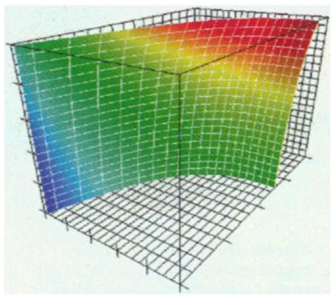
## Expanded superconductors

The layered high–transition temperature (high-$T_c$) superconductors are made up of $CuO_2$ planes separated by other cations. Choy *et al.* (p. 1589) show that the layers of the $Bi_2Sr_2CuO_y$ and $Bi_2Sr_2CaCu_2O_y$ can be exfoliated by intercalation, first with $HgI_2$ and followed by alkylpyridinium iodides. Even though this process separated the planes by distances of tens of angstroms, magnetization measurements indicate that there was little or no change in $T_c$. These results suggest that interlayer coupling effects are not critical for superconductivity. Such exfoliated superconducting layers may also have thin-film applications.

■

## High laser output from chaotic resonators

At the heart of a laser is its resonator, which allows light to pass back and forth through the active material and provides the feedback for stimulated emission. Recently, microdisk semiconductor lasers have been developed in which light, trapped by total internal reflection inside a circularly symmetric cavity, exhibits "whispering galley modes." Although their small size is attractive for device applications, their output is low. Gmachl *et al.* (p. 1556; see the cover and the commentary by Gornik, p. 1544) now demonstrate that devices with an asymmetric resonant cavity exhibit an increase in far-field power of up to three orders of magnitude because of the formation of "bow-tie" resonances. The effects of refraction at high deformations in these high-index semiconductors lead to chaotic behavior of the light rays as they circulate in the resonant cavity.



## Cored plumes

The origin and evolution of hot upwellings (hot spots) in Earth's mantle can only be remotely detected by chemical tracers in rocks sampled at or near the surface or by the behavior of seismic waves. One model is that the hot spots are produced by plumes rising from the core-mantle boundary. Brandon *et al.* (p. 1570) measured the osmium isotopic abundances in lavas from the classic hot spot, Hawaii. They found that the lavas were enriched in $^{186}Os$ and $^{187}Os$, which are produced by decay of rhenium and platinum isotopes that are now concentrated in Earth's core. The data suggest that the Hawaiian plume originated at the core mantle boundary. Thus, the coupled isotopic enrichments may be used to distinguish a deep plume from a shallow plume.

■

## Callisto's layers

Callisto is the outermost of the four Galilean satellites that orbit Jupiter. One close flyby of the Galileo spacecraft had yielded radio doppler data suggesting that Callisto was not differentiated (that is, a homogeneous mixture of ice, rock and metal from the surface to the center). Now, Anderson *et al.* (p. 1573) have refined this model based on more accurate radio doppler data from a third flyby. Callisto may be partially differentiated into an outer layer of ice, a middle layer of mixed rock and ice, and a rocky, metallic core.

■

## The Mars cycle

Mars probably had liquid water flowing on its surface soon after its formation. Measuring the hydrogen and oxygen isotopic abundances in martian materials provides one of the best methods for determining how much water Mars started with, how much has been lost, and how much remains frozen or trapped beneath the surface. Krasnopolsky *et al.* (p. 1576) have used the Hubble Space Telescope to estimate the fractionation of hydrogen and deuterium, which could be explained by a planetwide reservoir of water ice about 5 meters thick. Farquhar *et al.* (p. 1580) have measured the oxygen isotopic abundances of carbonate grains in martian meteorite ALH 84001 and found that the isotopes are fractionated in the carbonates independently of their mass, unlike previous measurements of other silicate minerals. This suggests that the oxygen may be exchanged between ozone and carbon dioxide, requiring two exchange reservoirs: ozone from the atmosphere and carbon dioxide from the crust. Where the oxygen is stored in the crust remains unresolved as discussed in the accompanying commentary by Yung and Kass (p. 1545).

■

## Rhythm mechanism

Circadian rhythms maintain organismal physiology through the daily light-dark cycle. Molecular details of the regulation of clock components are described in mammals by Gekakis *et al.* (p. 1564) and in *Drosophila* by Darlington *et al.* (p. 1599). Both reports describe how a clock component and a transcription factor subunit interact to regulate transcription of other clock components. A commentary by Dunlap (p. 1548) explains the importance of the findings in completing our picture of how rhythmic cycles are established and maintained.

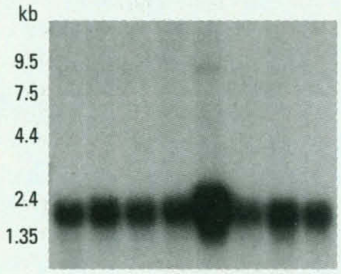
■

## Nanopatterns with infrared gratings

One approach to nanoscale lithographic patterning of surfaces is to use excited, metastable rare gas atoms, such as argon, or other compounds to chemically alter an overlayer; for example, adsorbed hydrocarbons can form a carbonaceous material that can be used to resist etching. Normally, the

*(Continued on page 1503)*


Illustration inspired by the art of René Magritte (1898–1967).

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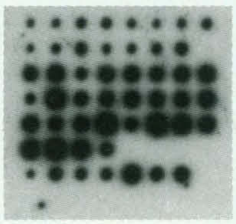

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(AD85419)

*(Continued from page 1501)*

patterning is achieved with physical masks to block the metastable atoms or with optical gratings that steer the atoms into lines. Johnson *et al.* (p. 1583) have taken a different approach by using an infrared optical grating to pump a de-excitation transition. Atoms are de-excited everywhere except at the nodes of the grating, thus forming lines of metastable atoms with nanometer-scale widths that impinge on the surface.

■

## Macrocyclic phosphorus ligands

Phosphorus is one of the main ligating atoms in transition metal chemistry. However, few macrocycles containing phosphorous are known; the ones that are known contain tricoordinate phosphorus and many consist of mixtures of conformational isomers. Avarvari *et al.* (p. 1587) have synthesized macrocycles containing three or four bicoordinate phosphorus atoms that coordinate transition metal ions. Such macrocyclic ligands may prove important in catalysis involving transition metals and because of their potential reducing properties.

■

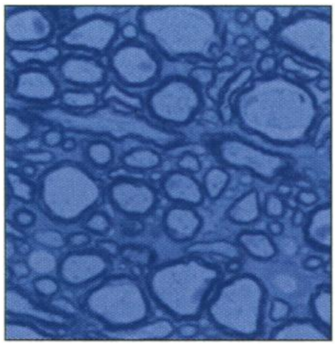
## The FAKs of tumor suppression

Alterations of the putative tumor suppressor gene PTEN occur in a wide range of human cancers, particularly endometrial cancer and glioblastoma. The PTEN protein shares sequence motifs with the cytoskeletal protein tensin and is a phosphatase, but its cellular function and substrates are unknown. In experiments with fibroblasts, Tamura *et al.* (p. 1614) show that wild-type PTEN inhibits cell migration, spreading, and adhesion, most likely through dephosphorylation of the focal adhesion kinase FAK. This cell surface role of PTEN distinguishes it from other tumor suppressors, which typically function in the nucleus.

■

## Axonal degeneration

Mutations in proteolipid protein (PLP) are responsible for neurological problems in humans and mice. The PLP is thought to help to stabilize myelin in the central nervous system but is not required for the production of the myelin sheath itself. Griffiths *et al.* (p. 1610) now



report that axon degenerate locally in aging mice lacking PLP. Their data point to a previously unsuspected role for the oligodendrocytes that wrap myelinated axons in maintaining axonal integrity.

■

## Therapeutic regulation

One of the problems of gene therapy is that the transferred gene needs to be brought under the same cellular regulation as the original one. This problem is especially severe in the regulation of globin gene expression needed to have successful gene therapy for sickle cell anemia. Lan *et al.* (p. 1593) circumvented this problem by targeting the β-globin transcripts themselves. They used a group I ribozyme to convert the mutant β-globins into γ-globins, which retard the development of sickling in red blood cells. These experiments were done in erythrocyte precursors isolated from people with the disease; future experiments will be needed to determine efficacy in actual patients.

■

## Receptor stoichiometry

Glutamate receptors are the most abundant neurotransmitter receptors in the brain. These receptors evidently malfunction in a large number of neurological diseases, including, for example, stroke and epilepsy. By drawing an analogy from other ligand gated receptors it was often assumed that glutamate receptors were made of five subunits. Rosenmund *et al.* (p. 1596; see the commentary by Miller, p. 1547) present evidence that they are made up of only four subunits-from single-channel recordings, kinetic analysis, electrophysiological recordings, and clever antagonist application experiments.

■

## Teratogen target

Certain steroidal alkaloids in plants are classified as mammalian teratogens because they induce cyclopia, a developmental defect characterized by the absence of median facial structures and an undivided forebrain. Cooper *et al.* (p. 1603; see news story by Strauss, p. 1528) show that these teratogens, which include cyclopamine and jervine, inhibit the response of target tissues to Sonic hedgehog (Shh), a secreted signaling protein that has a crucial role in the patterning of the head and brain. These compounds resemble cholesterol in structure and alter cholesterol biosynthesis, but notably they do not affect the autoproteolytic cleavage of Shh, a reaction that requires cholesterol and is essential for Shh's biological activity.

■

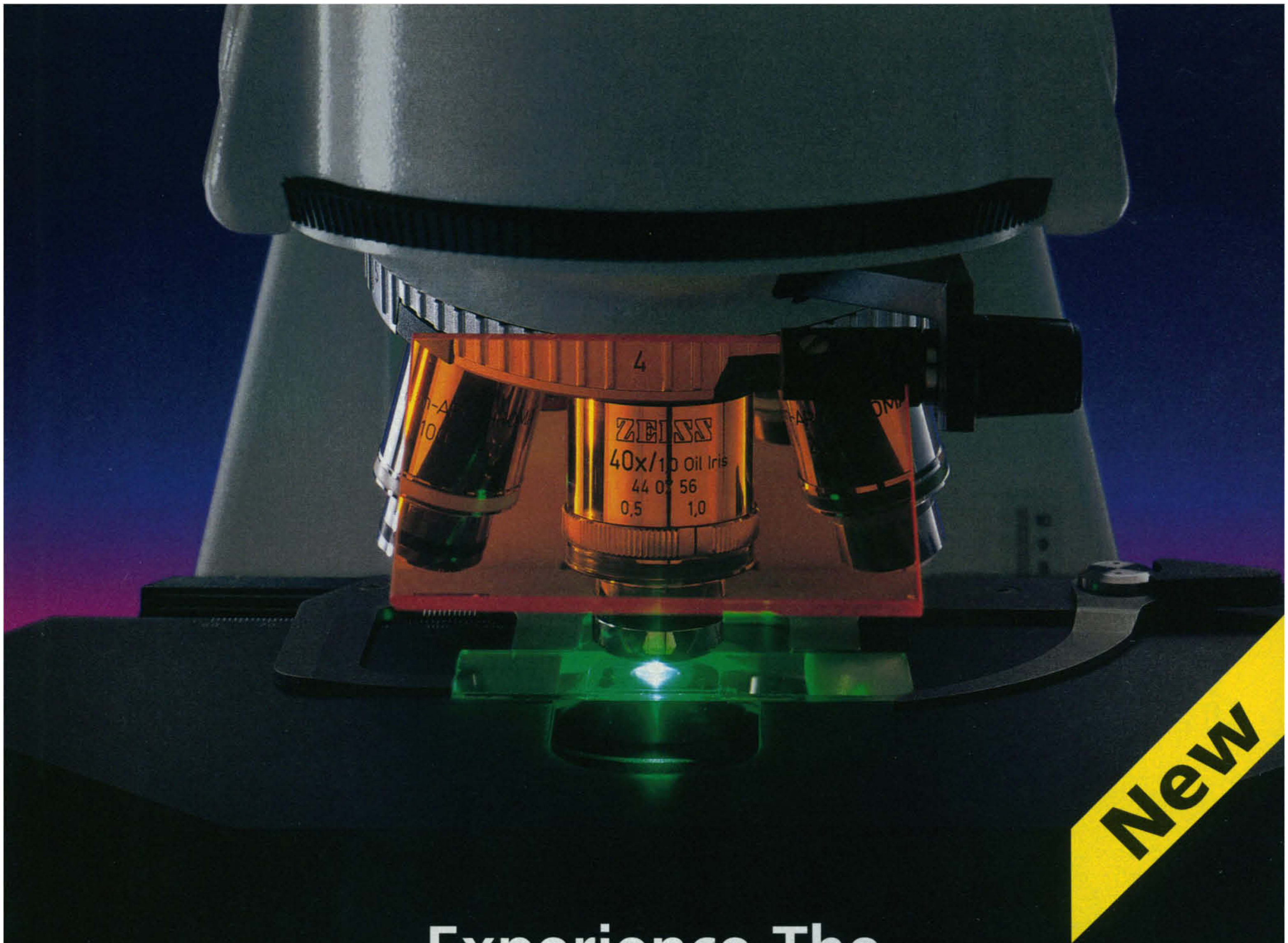
## Isoniazid-resistance in tuberculosis

Resistance to the tuberculosis drug isoniazid has become a significant problem. In some cases, resistance has been traced to mutations in two genes *katG* and *inhA*, but they cannot account for all clinical isolates or the accumulations of a saturated fatty acid that is associated with sensitivity. Mdluli *et al.* (p. 1607) found that an enzyme in the pathway of mycolic acid synthesis, β-ketoacyl ACP synthase (a product of the *kasA* gene), is inhibited by isoniazid. Mutations in this enzyme were found as isoniazid-resistant clinical isolates in the absence of changes in other genes.

■

## Common entry

Geraghty *et al.* (p. 1618) find that poliovirus receptor-related protein 1 (which they call Hve-C) is a general mediator of alphaherpesvirus entry into the host cell. Although other coreceptors have been found, this is the first to mediate entry of both herpes simplex virus types 1 and 2. Thus, two very different types of viruses (herpesviruses and picornaviruses) use the same receptors. This finding may help design therapies or vaccines that will prevent infection of mucosal surfaces and the spread of the virus to the nervous system.

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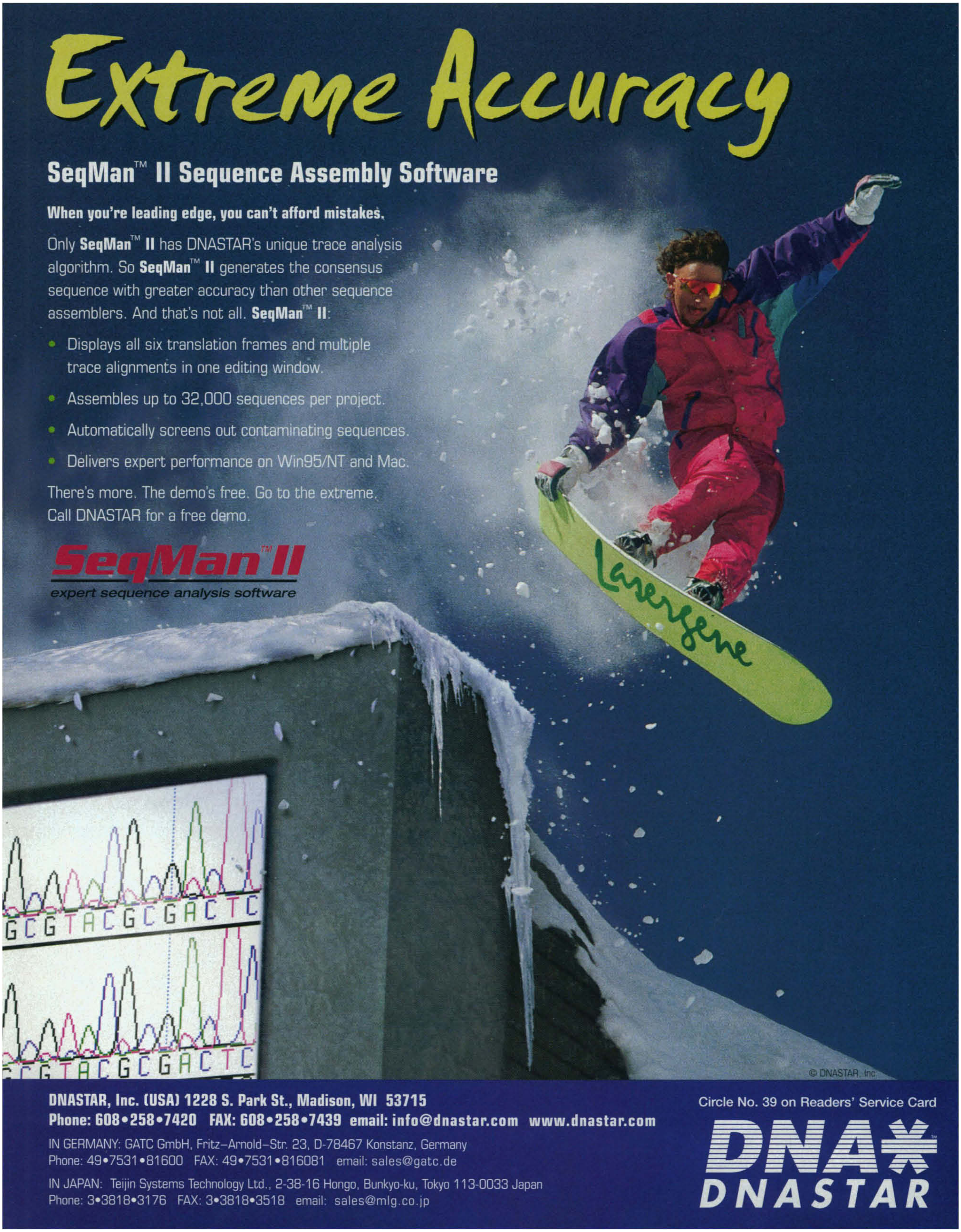
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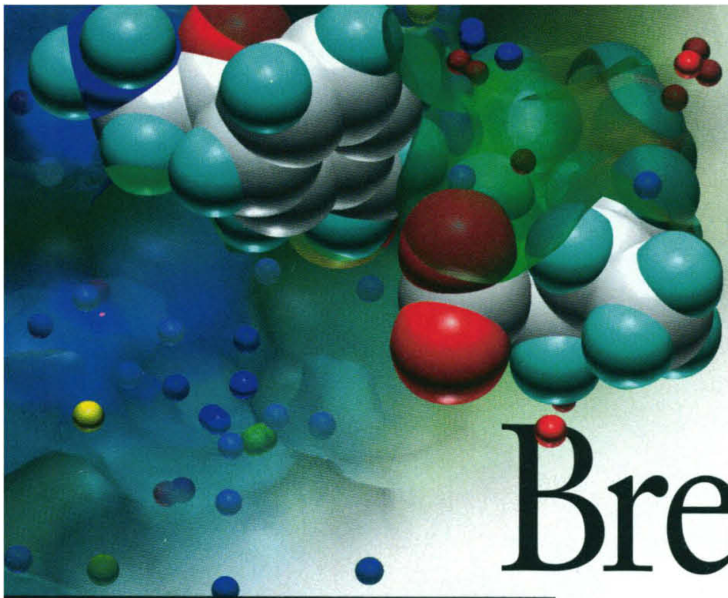

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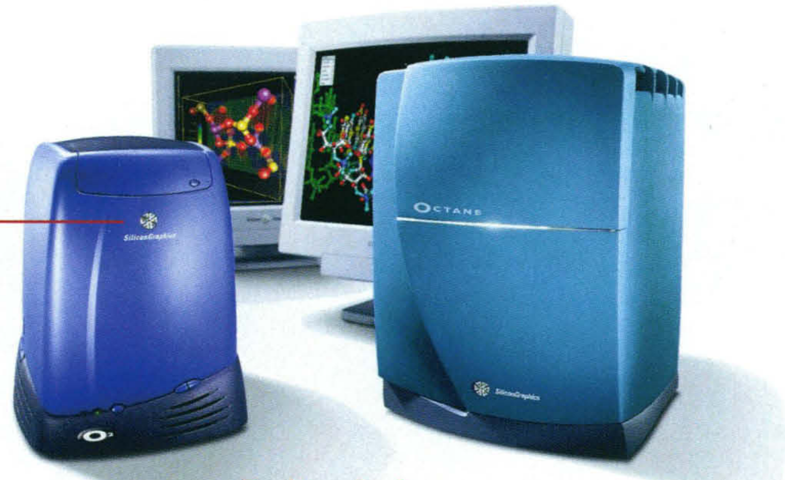


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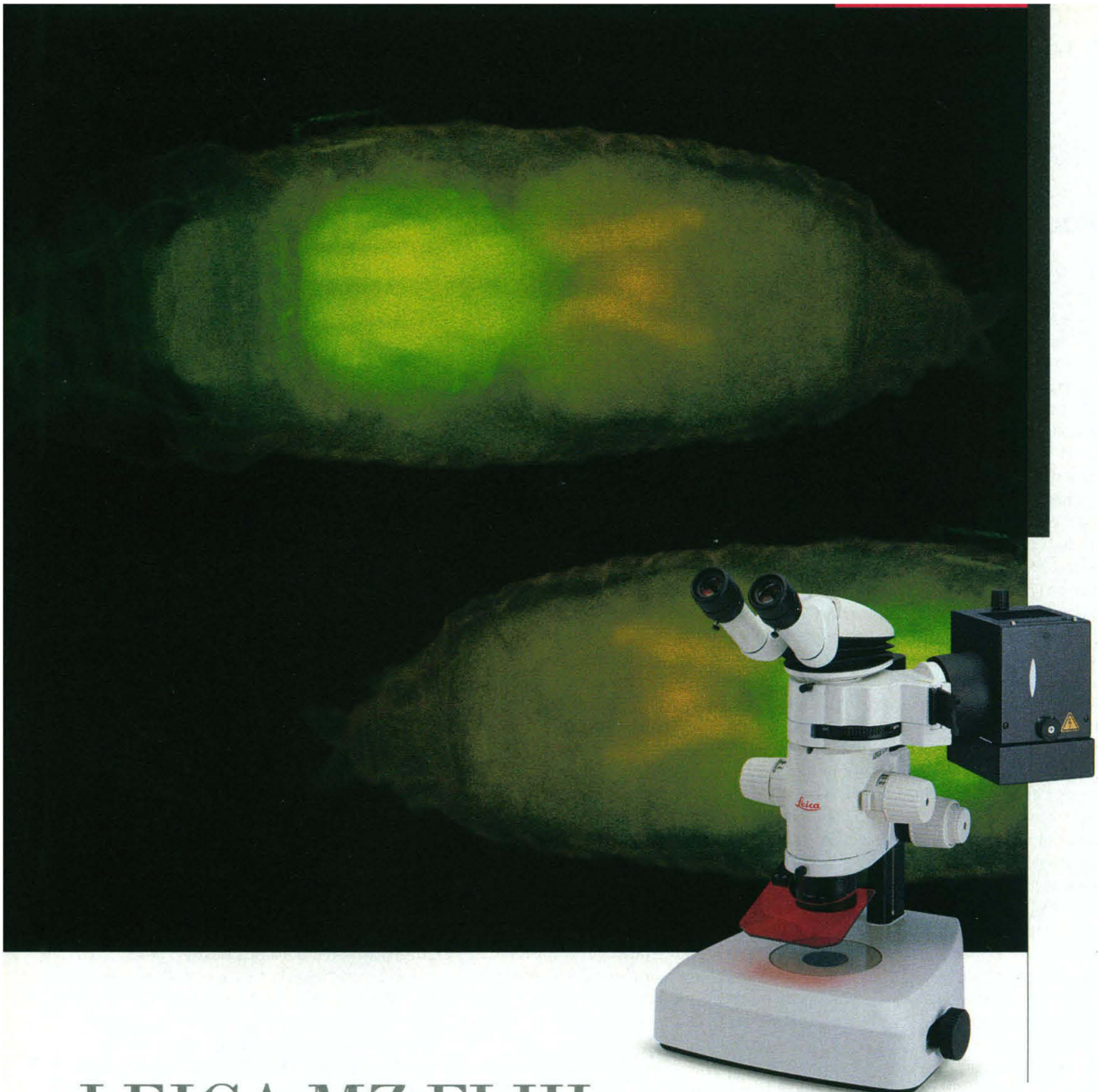


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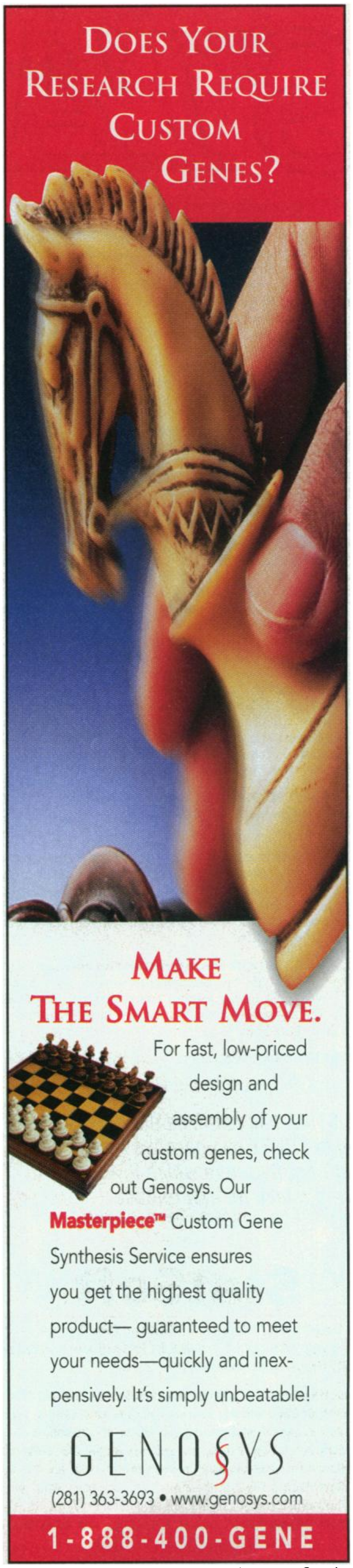

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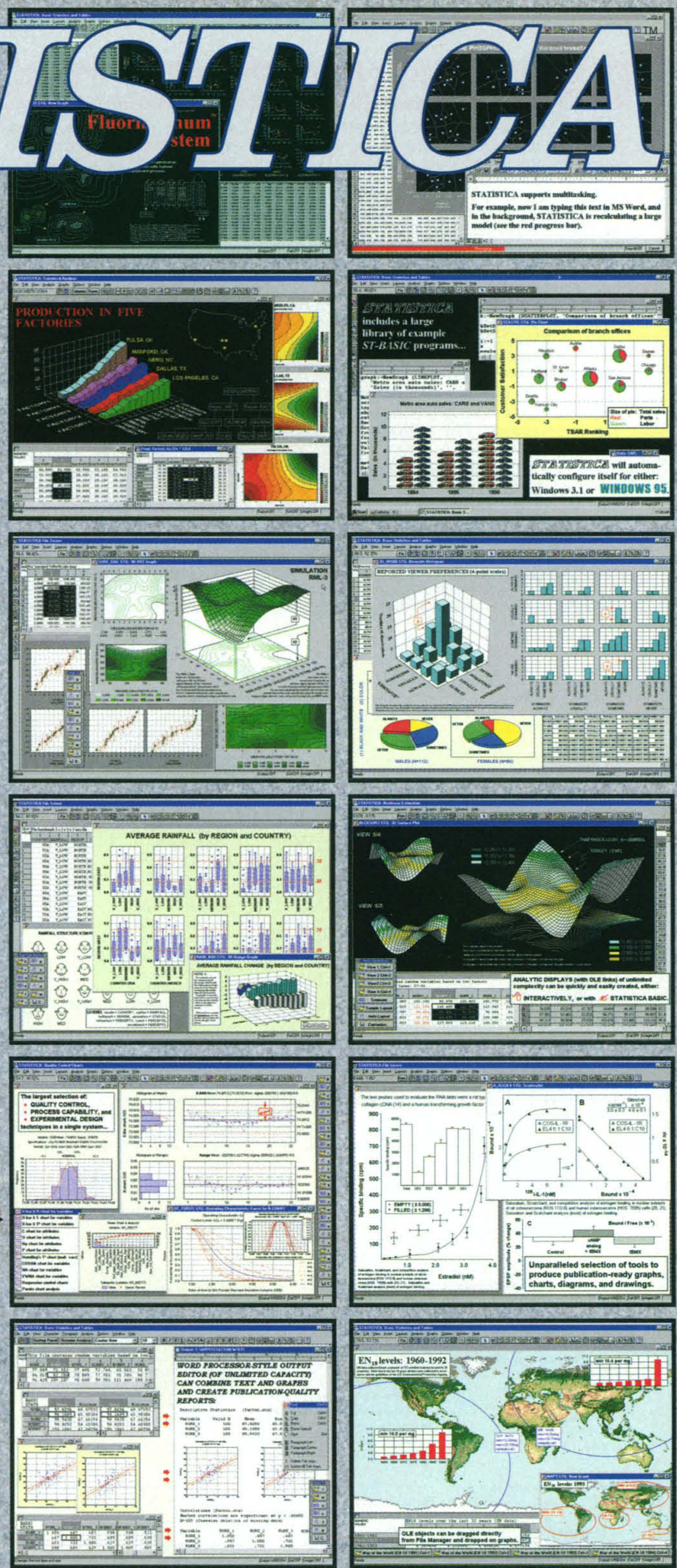


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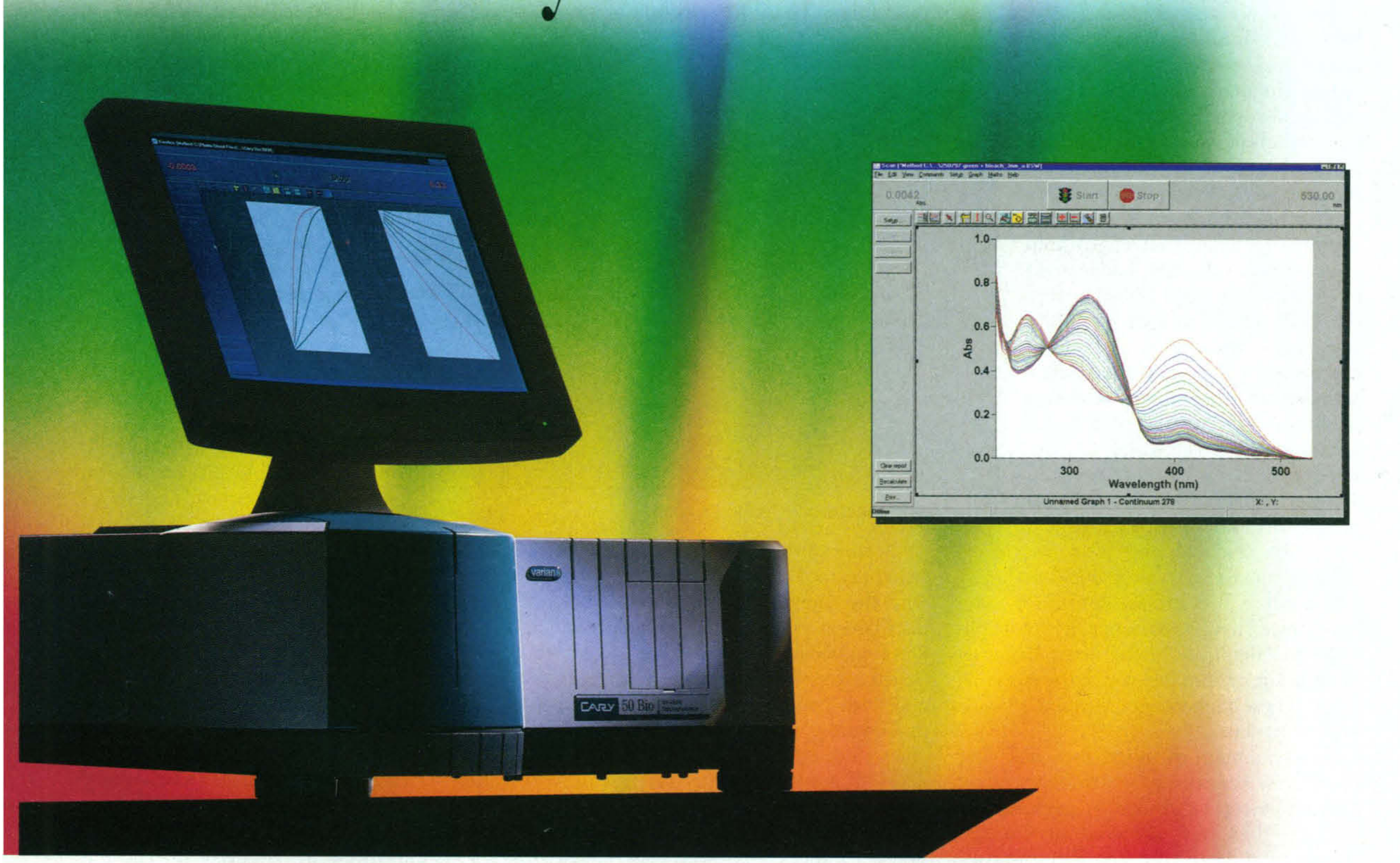


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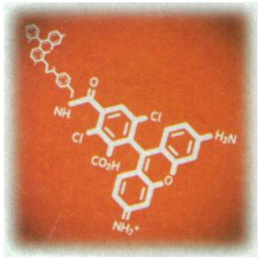

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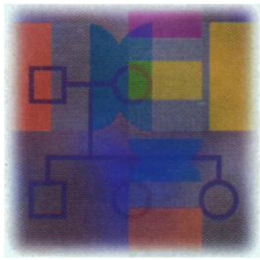

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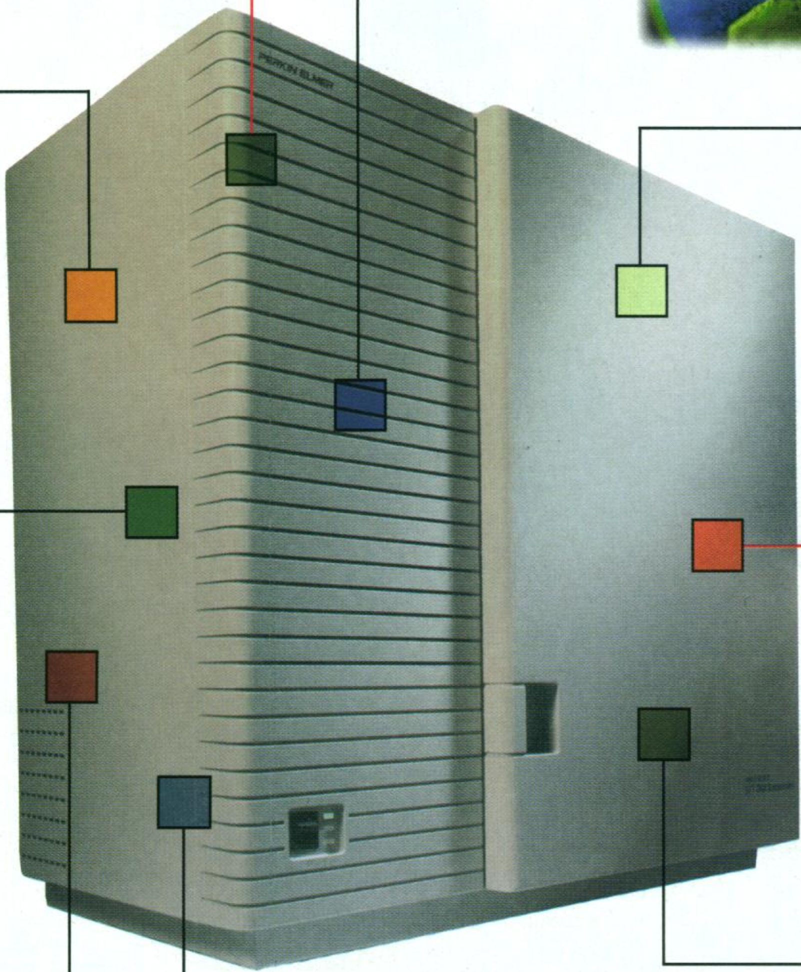

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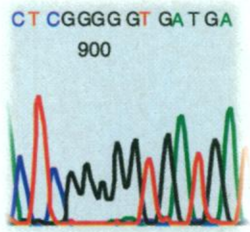


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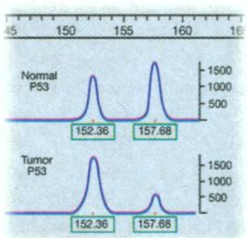

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Christine Jacobs discovered the mechanism that bacteria use to defend themselves against antibiotics.

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* from the *Science* homepage at http://www.aaas.org/science/prize.htm
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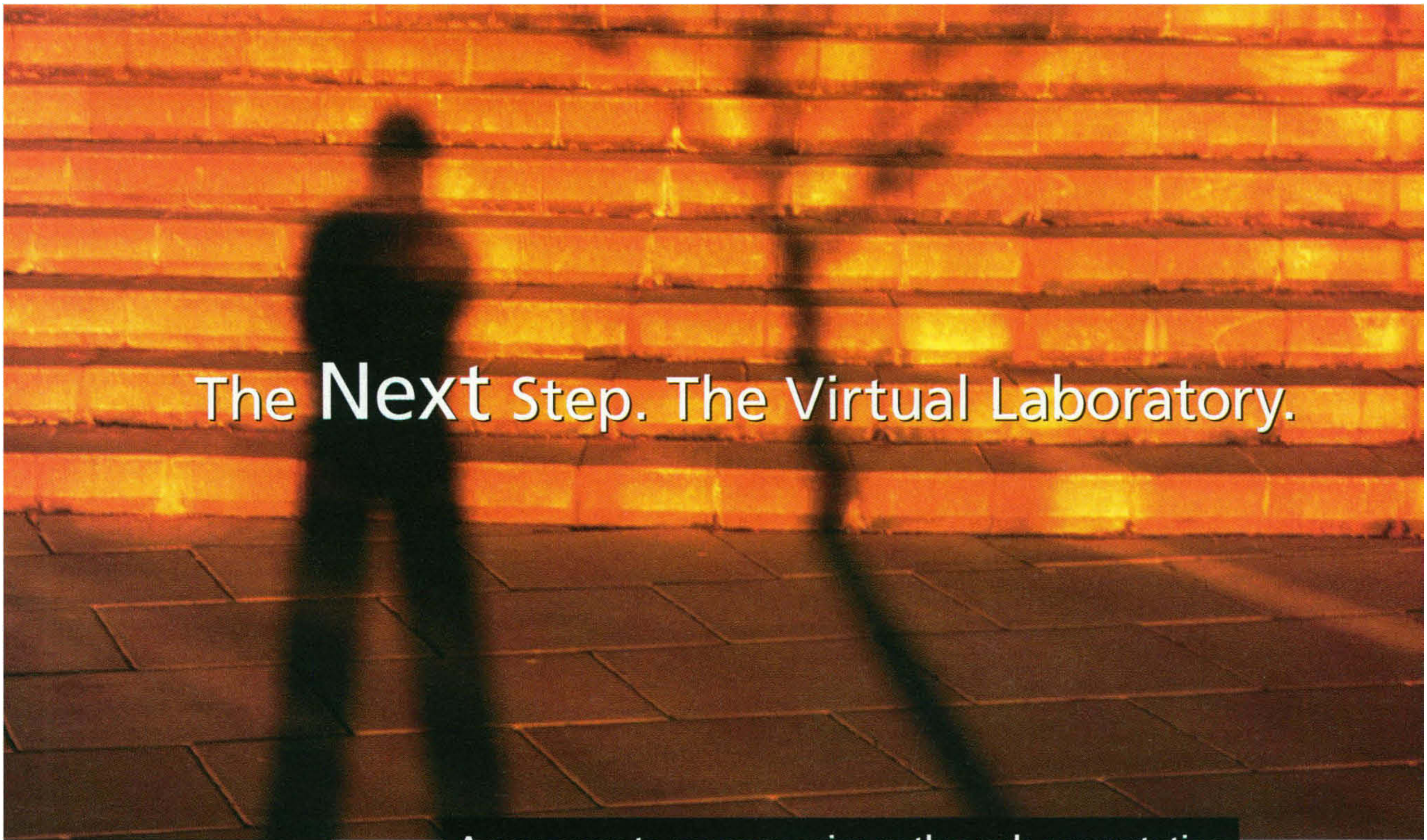


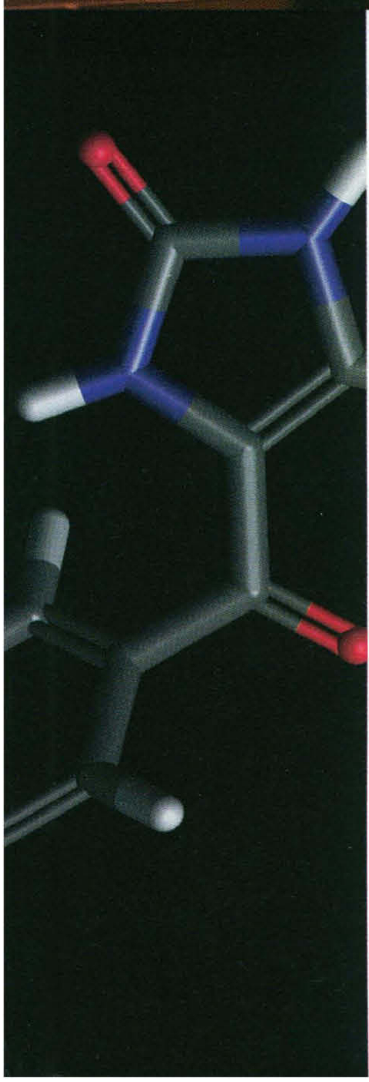

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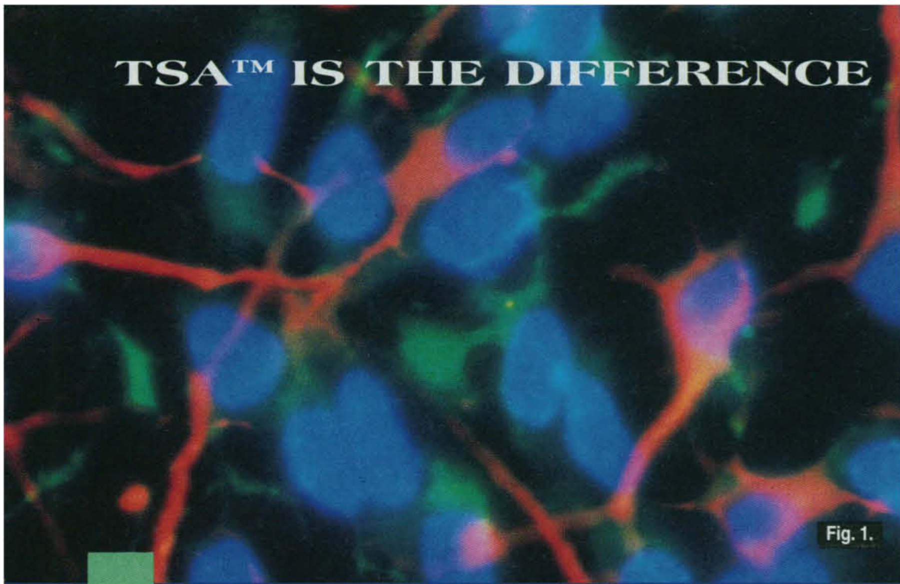


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**Fig. 1. Multicolor detection using TSA-Direct.**
*Courtesy of Kevin Roth, M.D., Washington University School of Medicine, St. Louis, Missouri.*

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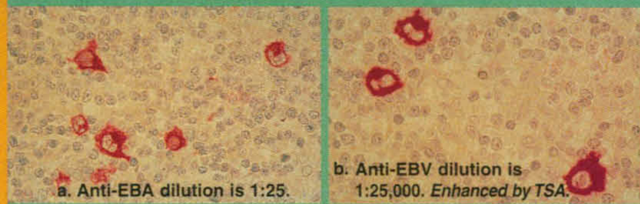
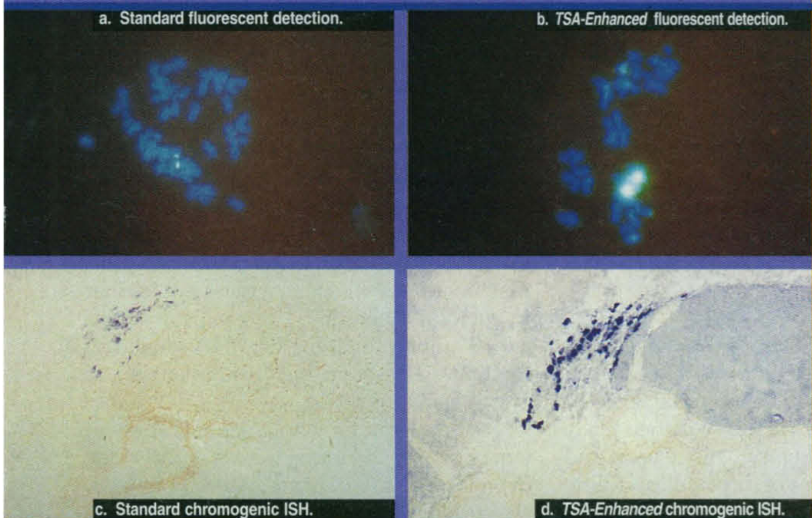
Fig. 3




**Figs. 3 a-b. IHC of EBV antigen in Hodgkin's Lymphoma of mixed cellularity.**
*Courtesy of R. Von Wasielewski and S. Gignac, Pathologisches Institut de Medizinischen Hochscule, Hannover, Germany.*

Fig. 2

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