



# Science

25 June 1999

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## Evolution



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**COVER** Fossils of the large (15 to 30 cm), soft-bodied organism *Pteridinium simplex* are locally abundant in sandstone beds of the terminal Proterozoic (~550-million-year-old) Nama Group in Namibia. New insights from paleontology, geochemistry, and molecular genetics are collectively illuminating the pattern, developmental basis, and environmental context of early animal evolution. These insights are part of the special section on evolution beginning on p. 2105. [Image: A. H. Knoll]



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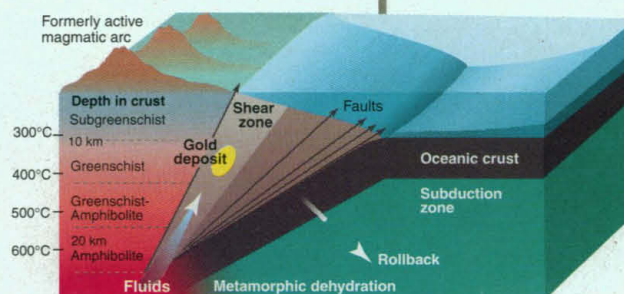
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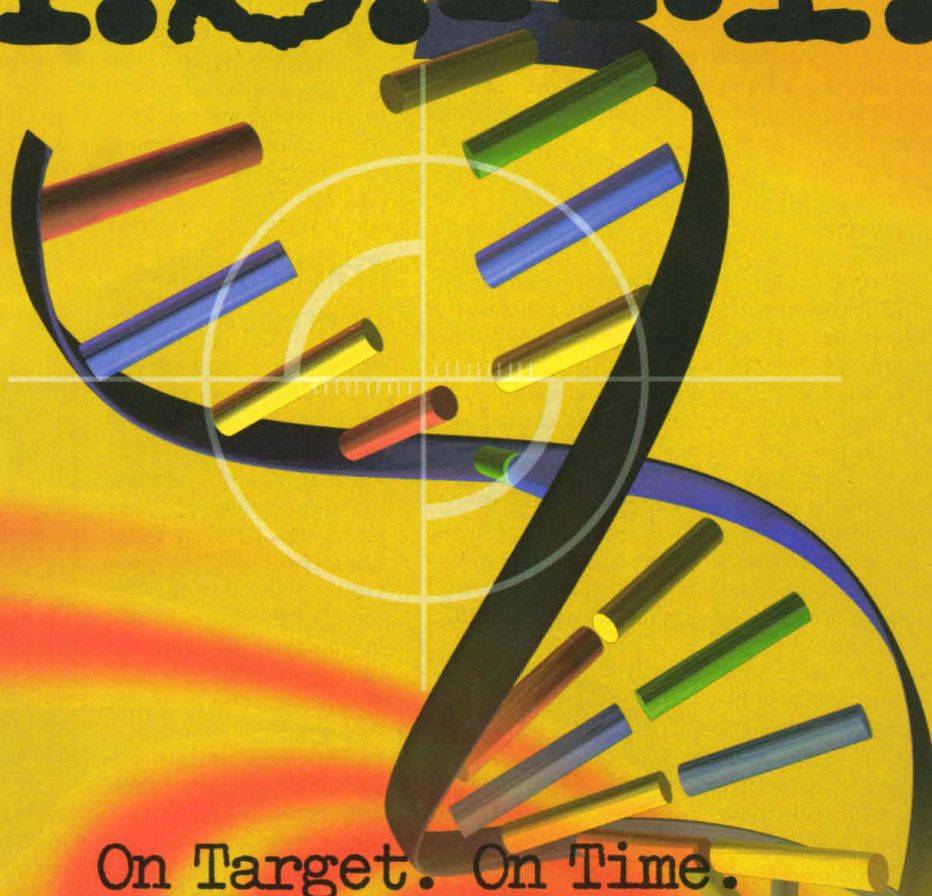
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## PLANTS UNDER ATTACK

One danger of an increase in global temperature is that it might increase predation of insects on plants. Wilf and Labandeira (p. 2153; see the Perspective by Coley) test this possibility by looking at the fossil record. They examined the predation of insects on plants during the Paleocene and Eocene, about 50 million years ago, a time when Earth's climate warmed considerably. Data from many plant fossils at comparable sites and latitudes in western North America show that predation was significantly greater during the warmer climates of the Eocene.

## GLOBAL CLIMATE LINKS

The historic climate record shows that the Indian summer monsoon and the El Niño–Southern Oscillation (ENSO) have been linked: A weak monsoon generally coincided with a warm El Niño event. Another factor influencing the Indian monsoon is Himalayan snow cover, which correlates with Eurasian temperatures. Kumar *et al.* (p. 2156) have analyzed the historic record and show that the ENSO–monsoon connection has weakened in the last couple of decades. One possible explanation may be recent increases in Eurasian temperatures, which may help sustain monsoon rainfall during warm ENSO events.

## THERE'S GOLD IN THOSE ROCKS

The origin of major regional gold deposits has been uncertain; much gold is found in quartz veins in metamorphic rocks, either in a magmatic arc or in oceanic crust accreted to the front of the arc. Knowledge of the solubility of gold with pressure and temperature is critical for inferring how the gold was concentrated in the vein-forming fluid and then deposited. Loucks and Mavrogenes (p. 2159; see the Perspective by Kerrich) measured gold solubility by creating gold-rich inclusions in quartz, which served as experimental pressure vessels. The data show that the solubility of gold species in fluids is quite high at high pressure and temperature but drops abruptly with cooling and depressurization. Sudden depressurization of a fluid containing gold could lead to an economically viable deposit.

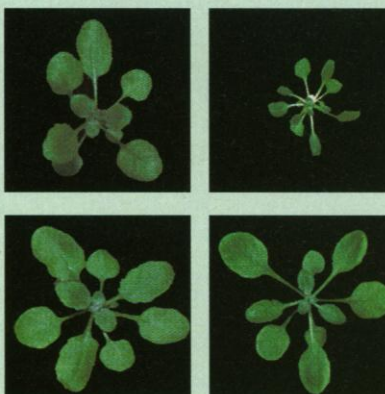
## RECONSTRUCTING THREE-DIMENSIONAL IMAGES

Many fields take advantage of two-dimensional optical imaging to record data, but in many cases it would be more useful to image the object in three dimensions. Most

methods with this capability require a point-by-point scanning of the object or illumination with coherent light (lasers) as in holography. Marks *et al.* (p. 2164; see the news story by Radov) describe a method that uses ordinary incoherent white light. The cones of light scattered from each point on the object contribute to the total intensity at each pixel, as measured on a two-dimensional sensor array. By analyzing this mutual intensity function using interferometry and algorithms developed for x-ray tomography, the authors were able to reconstruct accurately a three-dimensional image of an illuminated object.

## INTEGRATING ETHYLENE RESPONSES

An unusual protein anchors signal transduction for the ethylene hormone in plants and may as well coordinate responses to other volatile chemical signals. Alonso *et al.* (p. 2148) have now cloned and characterized the *EIN2* gene from *Arabidopsis*.



Analysis of the sequence predicts one domain with 12 transmembrane helices and a second hydrophilic domain that functions in ethylene signaling but shows little similarity to other known signaling proteins. Interactions of EIN2 with the rather distinct ethylene and jasmonate pathways suggest molecular explanations for the coordination of signaling responses.

## CLOSURE DOMAINS CLOSED

As electron spins undergo ordering in magnetic materials, energy minimization will cause the material to split into macroscopic regions where all of the individual magnetic moments have the same orientation. Between the domains and near the surface of the films are regions of in-plane magne-

tization called closure domains, which tend to elude imaging by normal magnetic scattering techniques. Dürr *et al.* (p. 2166; see the Perspective by Hillebrecht) describe a method for imaging based on scattering of circularly polarized x-rays. Magnetization profiles in thin iron-palladium films were obtained in which these in-plane closure domains could be seen.

## SMELL AND RESPONSE

Despite the enormous progress made in the molecular biology of olfactory receptors, our understanding of subsequent signal processing in the olfactory system is still rather limited. Duchamp-Viret *et al.* (p. 2171) examined the odor tuning of rat olfactory receptor neurons assayed by electrophysiological recordings from the nasal mucosa. Their results indicate that the responses of olfactory receptor neurons are only rarely specific to only one odor; the majority of cells respond to a broad range of substances. This finding challenges the hypotheses that one neuron expresses only a single olfactory receptor. Rather, it appears that arrays of neurons are activated in response to a specific odor.

## LIKE CLOCKWORK

Human circadian clocks have been thought to run with widely variable periods that average near 25 hours, which is considerably longer than that of other animals, and that the period decreases with age, which would account for the well-known early awakening of elderly people. Czeisler *et al.* (p. 2177; see the Perspective by Moore) now show that neither of these statements are true. They used an experimental protocol in which young and old subjects were exposed to environmental cues in a rhythm so far from that of the endogenous clock that these cues had no influence on the clock's period. Under these conditions, the free-running period of the human circadian clock was 24 hours and 11 minutes in both young and old subjects, similar to that of other animals.

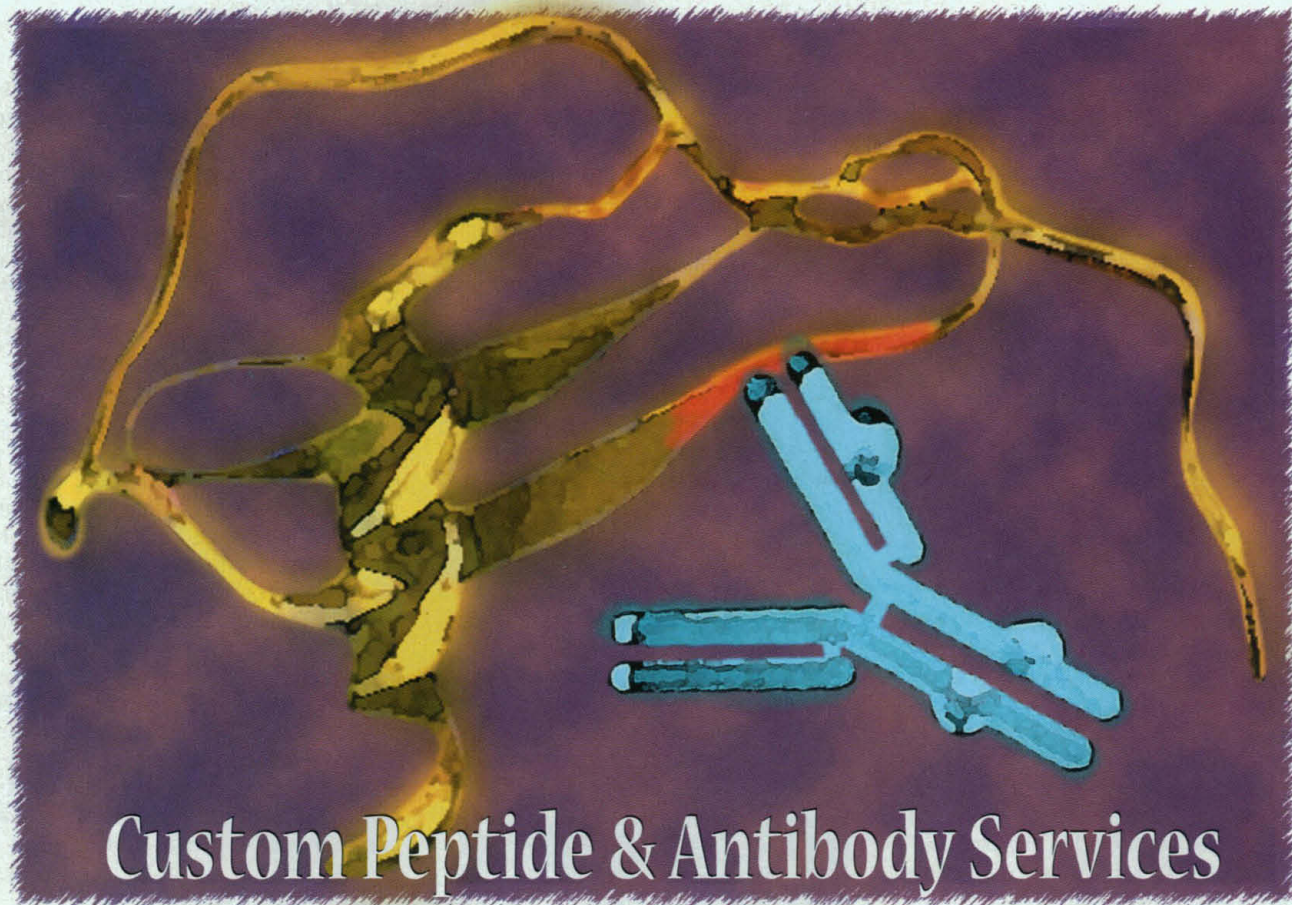
## ACCELERATING TRANSCRIPTION WITH A METHYLTRANSFERASE

The protein-DNA complex of chromatin presents a critical barrier to the transcription process; cells are able to deal with this structural barrier by utilizing chromatin-modifying factors such as histone acetyltransferases, or HATs. Several coactivators have been shown to have HAT activity. Chen *et al.* (p. 2174) now identify a so-called secondary coactivator that in-

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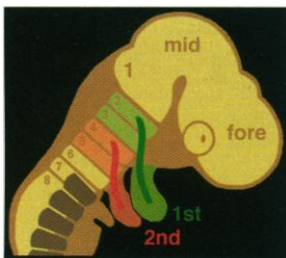
## THIS WEEK IN SCIENCE

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teracts with a nuclear hormone receptor coactivator to increase transcription activation. This secondary coactivator, CARM1, displays another enzyme activity—that of a methyltransferase. CARM1 may, like HATs, affect chromatin structure through histone modification. Alternatively, CARM1 may affect transcription by modulating the activities of other factors in the transcription complex.

### DIRECTING BRAIN DEVELOPMENT

Development of the vertebrate hindbrain and the surrounding branchial arches depends on an intricate interplay between the two types of tissue. By using an ingenious combination of ectopic expression



and orthotopic transplantation, Bell *et al.* (p. 2168) clarified how *Hox* genes specify positional identity in these tissues. The results of these studies in chick embryos show that the *Hox* genes regulate recognition cues that direct the interactions between different tissues.

### CALMING THE GI TRACT

Motilin is a peptide hormone long known to stimulate the transport of nutrients (motility) in the gastrointestinal (GI) tract. A human receptor for motilin has now been identified in a mass screening by Feighner *et al.* (p. 2184). The same receptor also binds to erythromycin and may explain the uncomfortable side effects of this antibiotic. The motilin receptor turns out to be a G protein-coupled receptor that is similar to that for human growth hormone secretagogues. With the motilin receptor now in hand, more effective agonists and antagonists may be designed to treat multiple disorders of GI motility.

### DESIGNER LIPIDS

The membranes that make up chloroplasts and house the photosynthetic apparatus have a distinctive lipid composition that is made up largely of galactolipids. Dörmann *et al.* (p. 2181) have now cloned one of the genes, *DGD1*, that affects galactolipid assembly in *Arabidopsis*. Genetic and biochemical studies indicate that the galactolipids are derived from two synthetic pathways, one in the plastid and one in the endoplasmic reticulum. Structure predictions from the cloned gene sequence suggest that the DGD1 protein is associated with the plastid envelope.

### TECHNICAL COMMENT SUMMARIES

#### Culture and Genetic Evolution in Whales

The full text of these comments can be seen at [www.sciencemag.org/cgi/content/full/284/5423/2055a](http://www.sciencemag.org/cgi/content/full/284/5423/2055a)

H. Whitehead (Reports, 27 Nov., p. 1708) suggested that, in four species of whale, "the selection of matrilineally transmitted cultural traits, upon which neutral mitochondrial DNA (mtDNA) alleles 'hitchhike,' has the potential to strongly reduce genetic variation. Thus, in contrast to other nonhuman mammals, culture may be an important evolutionary force for the matrilineal whales."

Four comments question whether the data, collected from several different studies, are sufficient to support Whitehead's suggestion. S. L. Mesnick *et al.* state, "it is difficult to imagine selective sweeps, cultural or otherwise, acting to maintain low inter-ocean diversity." C. Schlötterer states, "low mtDNA diversity could be a result of the effective population size of these species simply being smaller than that of the other species surveyed." R. Tiedemann and M. C. Milinkovitch state, "any stochastic heterogeneity in fecundity through space and time will cause a drastic reduction of mtDNA variability in matrilineal populations." W. Amos states that, in subpopulations where "dispersal from natal group is rare or absent," a hypothesis of "groups as life history units" may account for the data.

In response, Whitehead discusses each comment in turn, providing further details of his analysis and performing some new calculations. He notes that "scientists are currently collecting and analyzing long-term data on the social structure of a number of species of cetaceans" and states, "I presented one possible evolutionary scenario for this phenomenon, but the data are not conclusive, and I strongly support [the] call for an exploration of all feasible explanations."

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\* Patent pending

\*\* Cy5 is a trademark of Biological Detection Systems, Inc.

\* The PCR process is covered by patents owned by Hoffmann-La Roche.

\* Taggart, E.W., et al. (1998) *J. Clin. Micro* 36, 3408-3409



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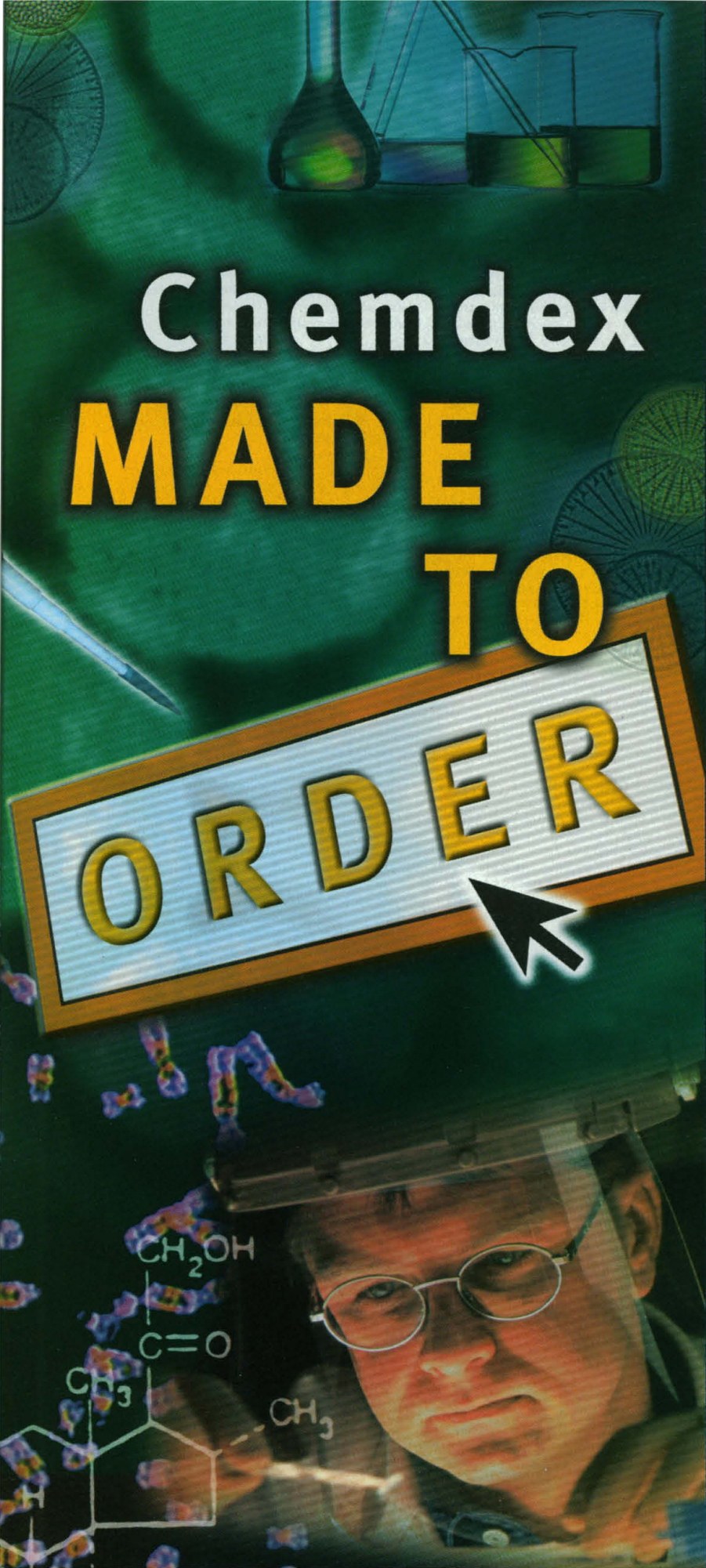
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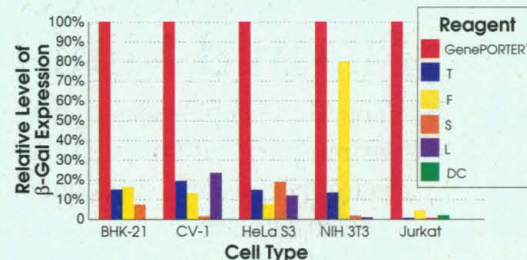
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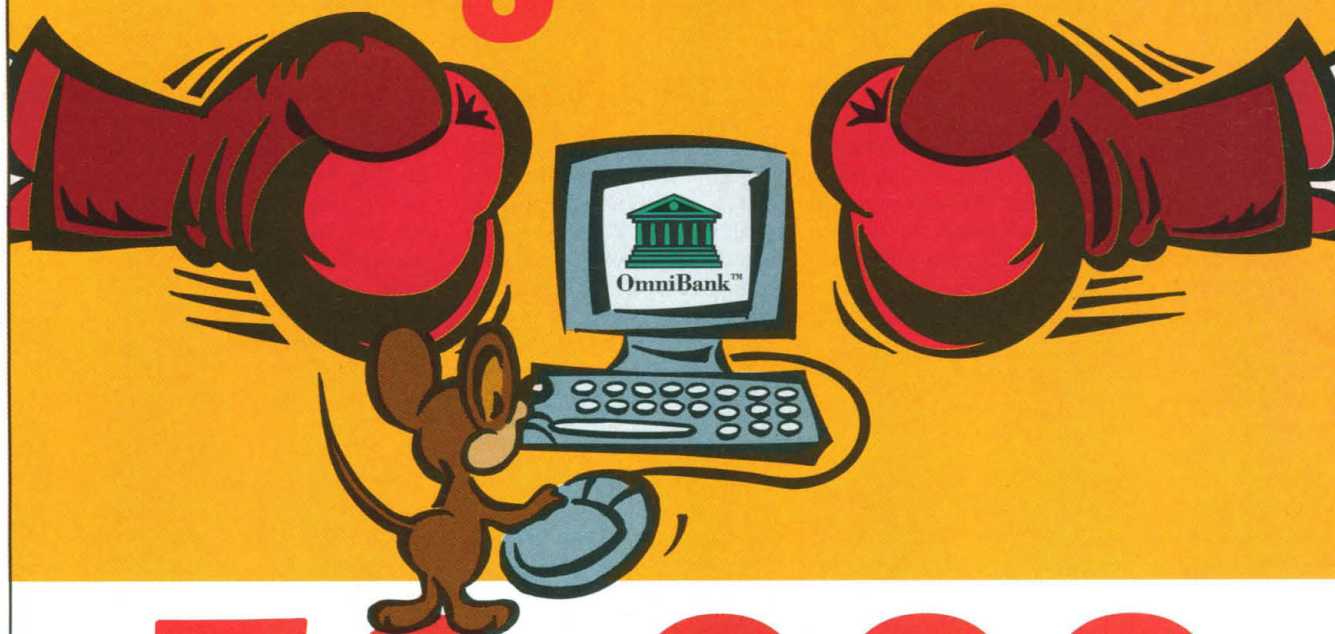
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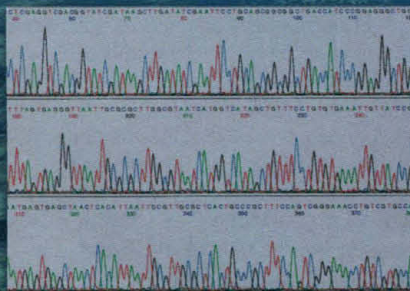
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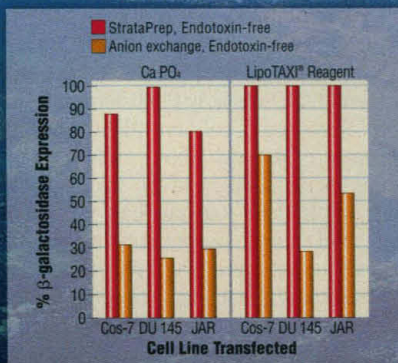
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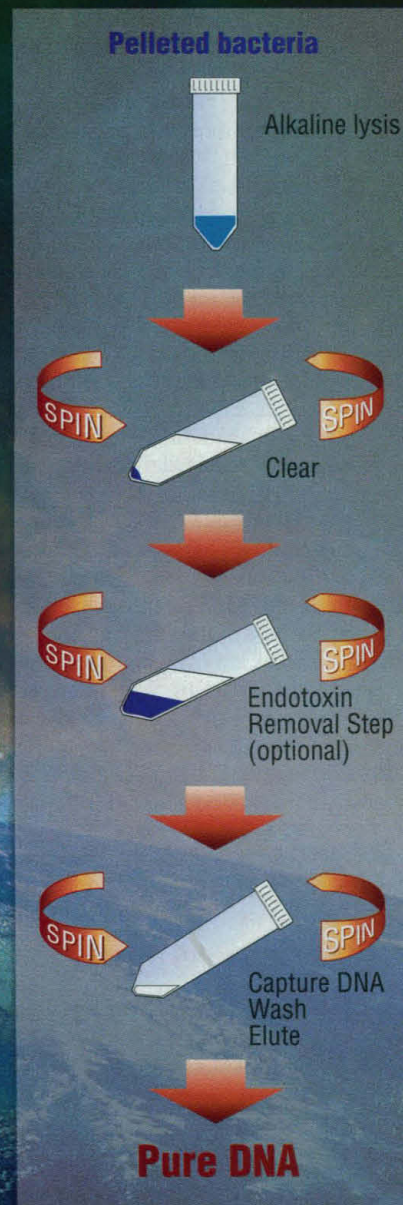
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**A NEW SECTION OF MCB: "MAMMALIAN GENETIC MODELS WITH MINIMAL OR COMPLEX PHENOTYPES"**

Many mouse knockouts have little or no obvious phenotype, or a very subtle phenotype, making it difficult to publish reports of mutant construction and analysis. Much of the publication problem may be due to a misconception: "no" phenotype is viewed as a "negative result," rather than as one more useful clue to the complex biology of mammals. This is unfortunate: the biomedical community is deprived of essential information, investigators are deprived of essential recognition, and arduous work may be needlessly duplicated in different laboratories. Moreover, as we learn more about redundant pathways, it may become routine to test new mutants in backgrounds containing other targeted deletions. This requires that the single mutants first be characterized, described in the scientific literature, and made available to the research community.

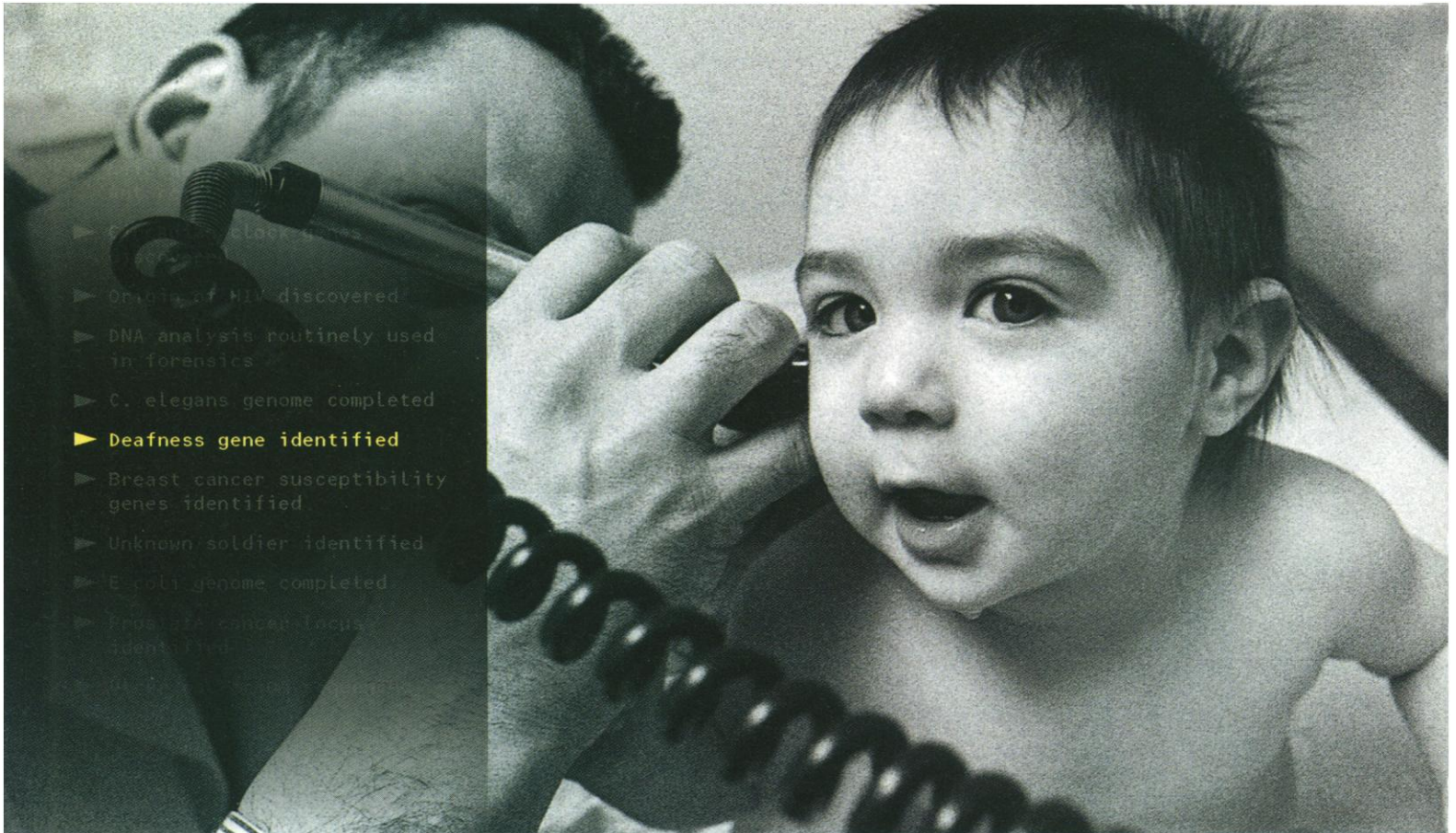
To address these issues, *Molecular and Cellular Biology* (MCB) is initiating a new section of the journal entitled "Mammalian Genetic Models with Minimal or Complex Phenotypes." The new section will be listed separately in the table of contents, and is intended only for knockouts that have no phenotype or unexpected phenotypes that are not easily reconciled with the suspected gene function. Knockouts providing additional information about known gene functions will be published in the section most appropriate for that function.

Manuscripts intended for the new section will be reviewed as are all other reports of original research. The manuscript should describe how the knockout was constructed, and should rigorously document the absence of gene expression. The manuscript should also explain how the phenotype of the mutant animals was characterized, but supporting data should not be shown unless absolutely necessary. Although manuscripts should be formatted as usual, publication will be strictly limited to five printed journal pages and a total of no more than five figures and tables. Manuscript length can be estimated by assuming that 1 printed page equals 5 double-spaced manuscript pages or 53 references; figure and table sizes can be estimated by eye.

Manuscripts for the new section may be submitted immediately. As one purpose of this new section is to make mutants available to the entire biomedical community, authors submitting to this section of the journal must agree to maintain the knockout line for at least 6 months following publication, or to generate cryoembryos.

Three copies of each manuscript should be submitted to: MCB, Journals Department, American Society for Microbiology, 1325 Massachusetts Ave., Washington, DC 20005-4171, U.S.A.





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Many things only change a little!

## Some things change the world!

**1789**

L. Galvani  
**Discovery of the electricity**

**1876**

G. Bell  
**The first telephone, that work efficient**

**1891**

O. Lilienthal  
**Invention of the first aeroplane**

**1969**

N. Armstrong  
**The first man on the moon**

**1999**

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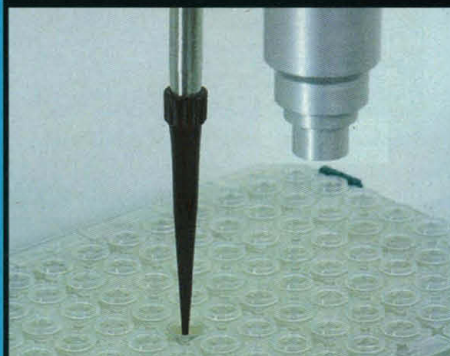
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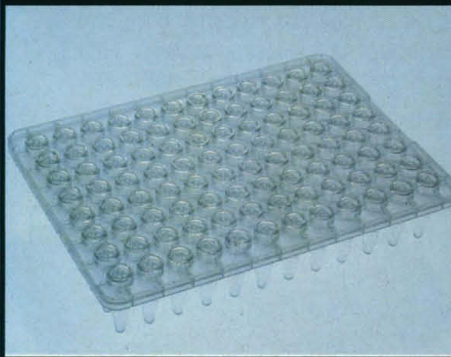
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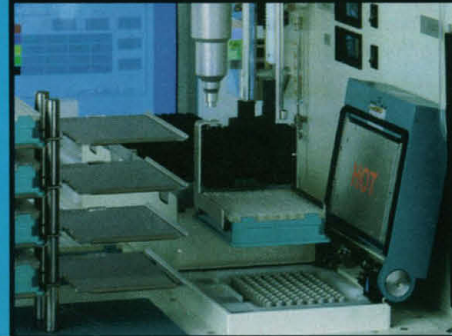
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Multi Temperature Gradient block



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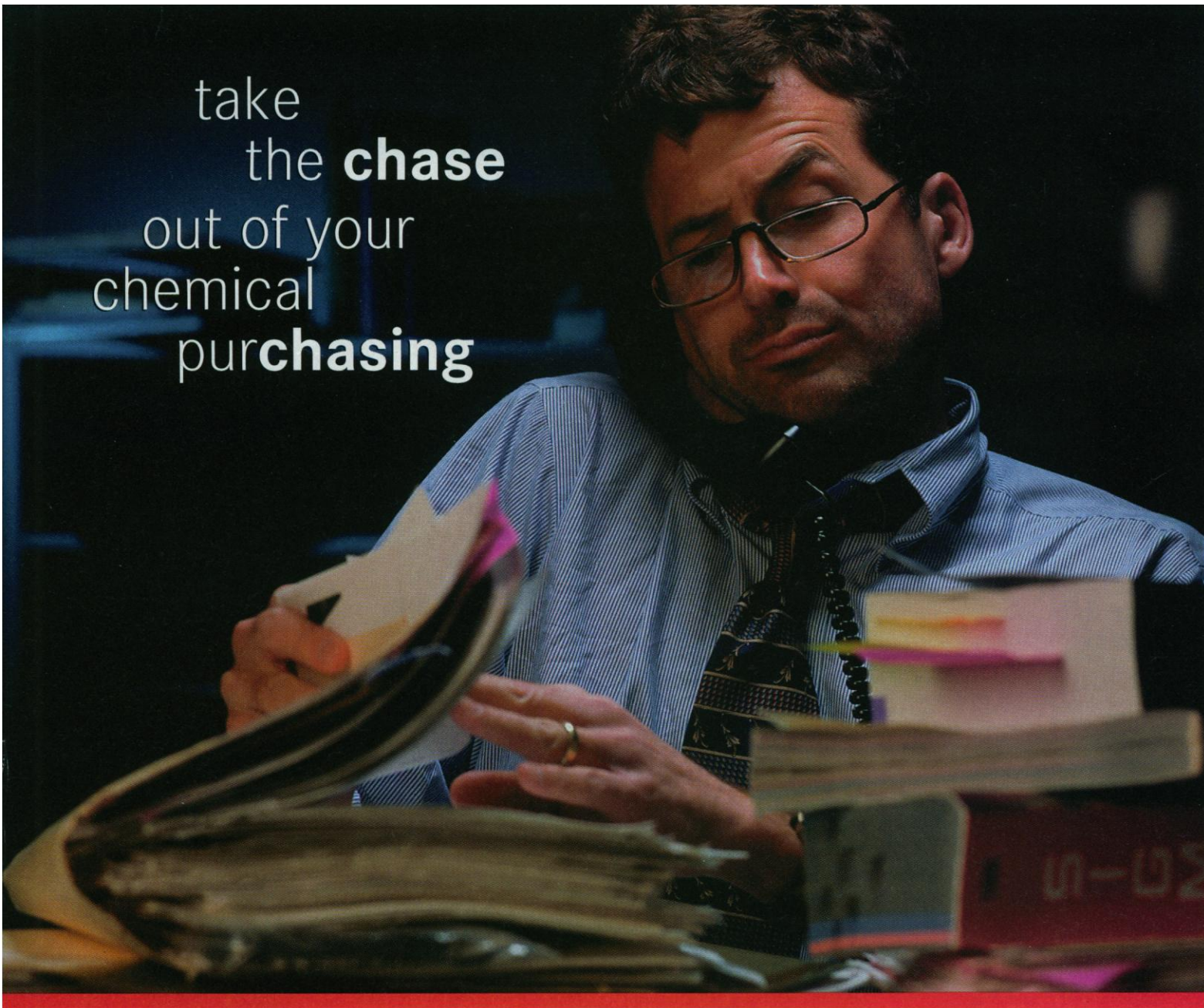
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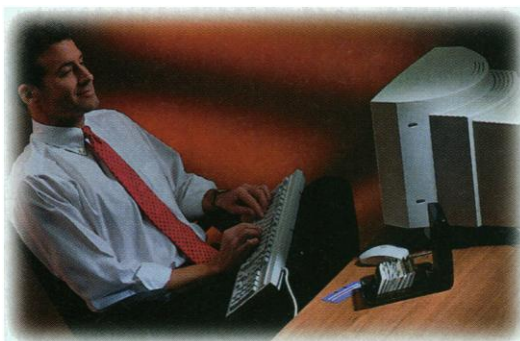
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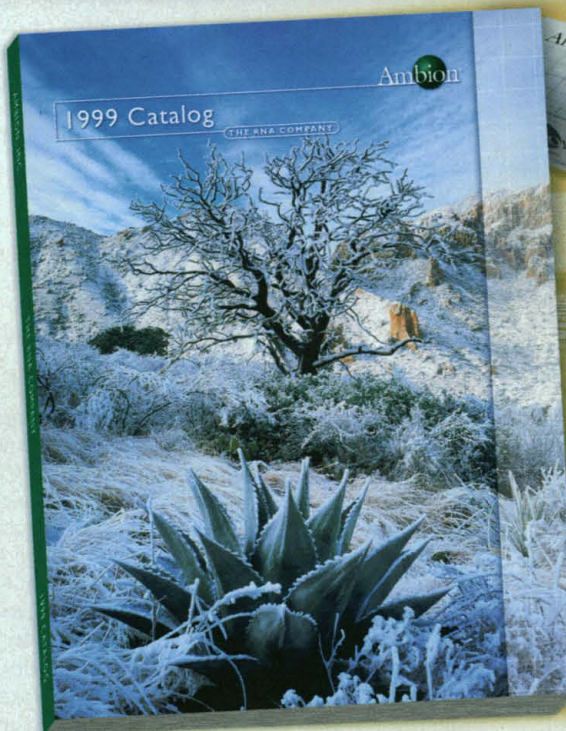
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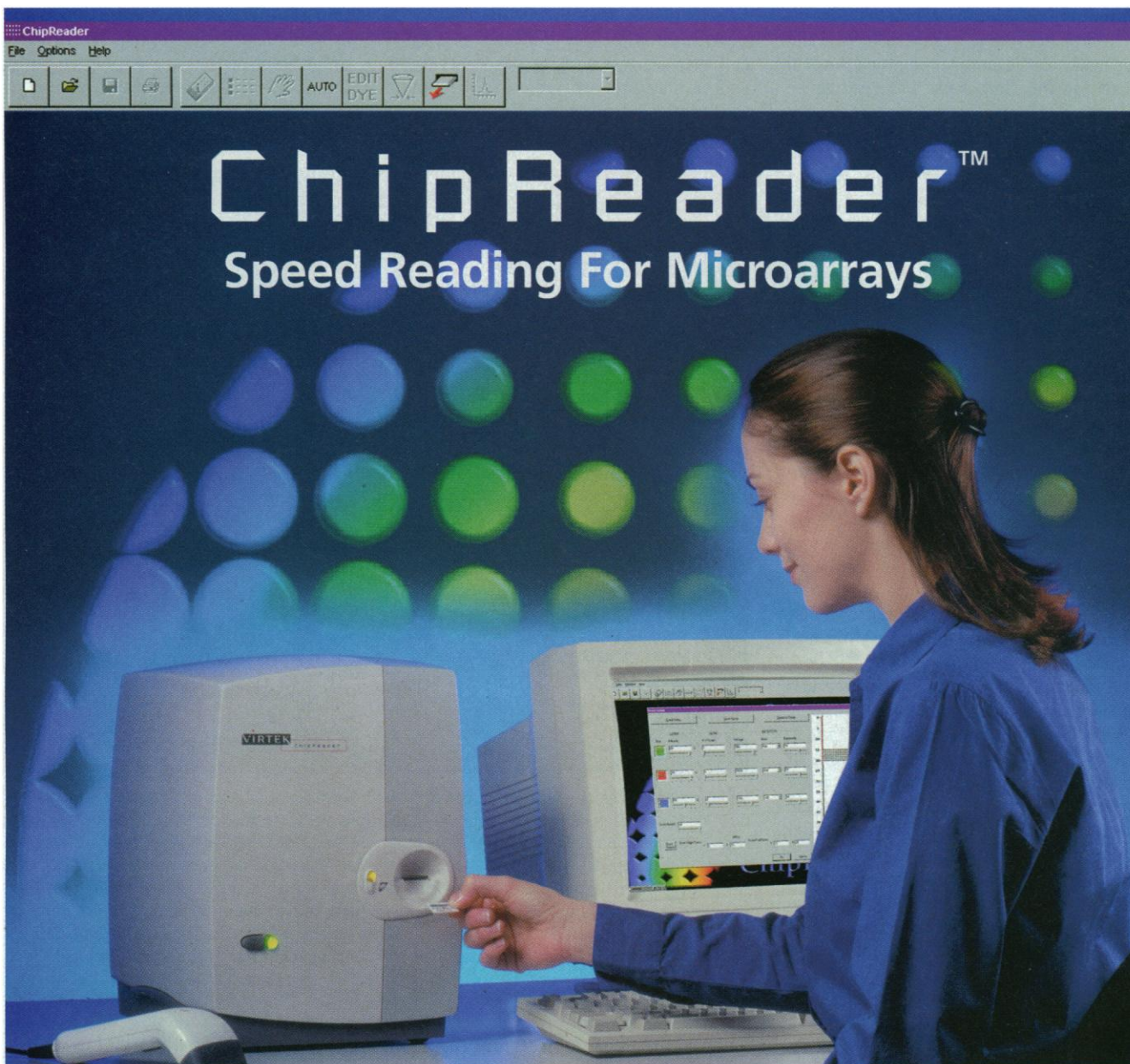


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