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**Frontiers
in Optics**



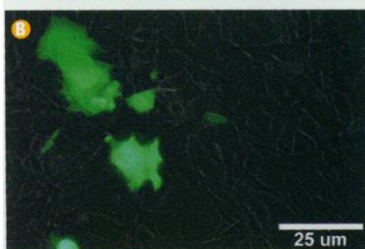
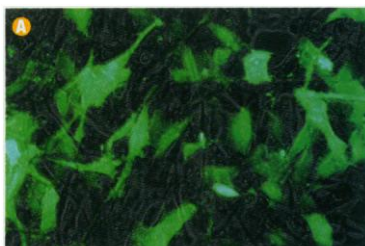
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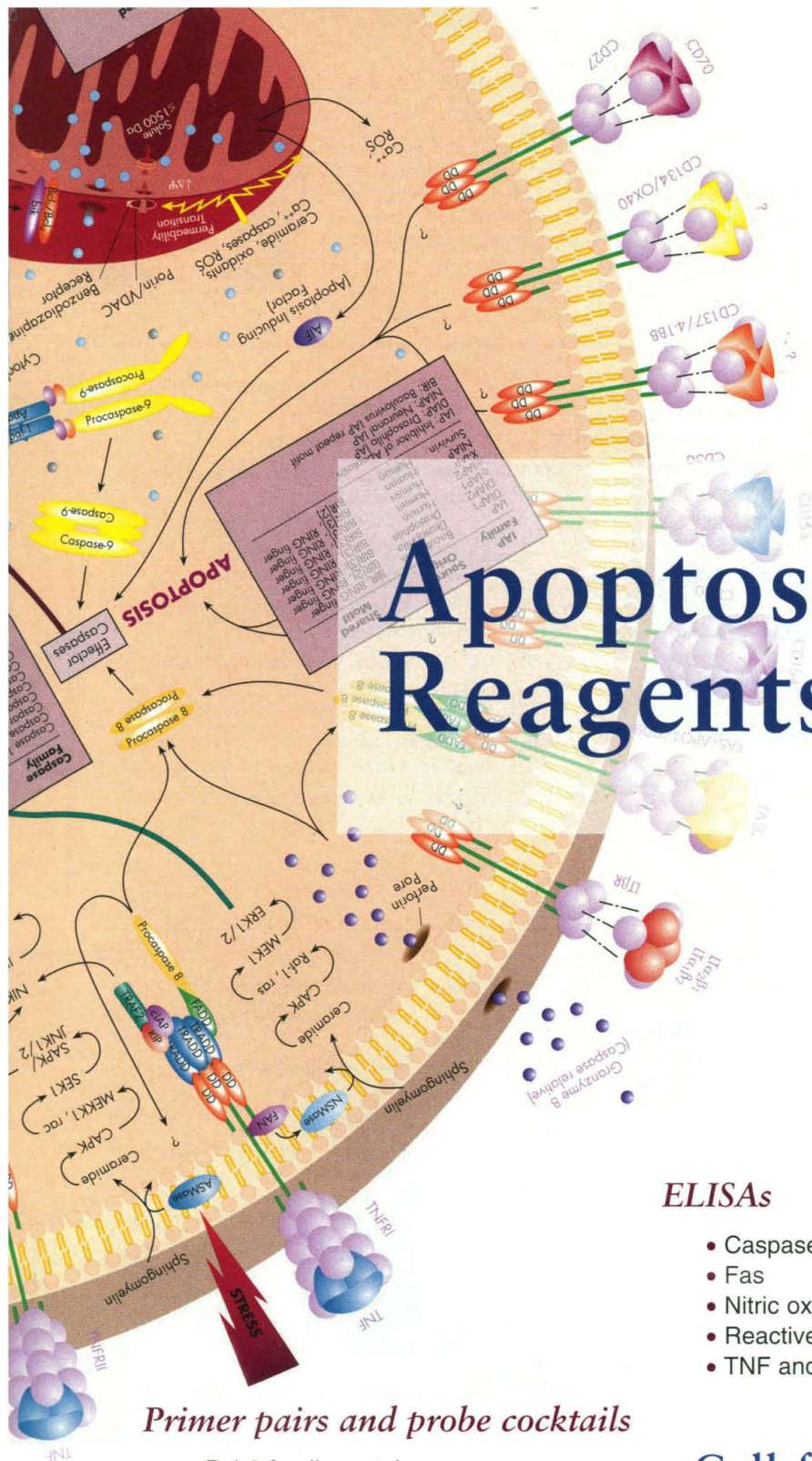
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The resurrection of Thomas Bayes

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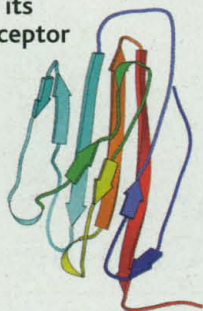
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Binding of adenovirus to its receptor



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COVER Output of a semiconductor nonlinear optical interferometer used in digital signal regeneration at very high speed (the trace shows signal probability as a function of time). Such devices are being developed to directly process the optical data signals carried in fiber-optic networks for the Internet and telecommunications, without needing conversion to electronic signals. This topic is part of the Frontiers in Optics special section beginning on p. 1499. [Image: D. Cotter *et al.*]



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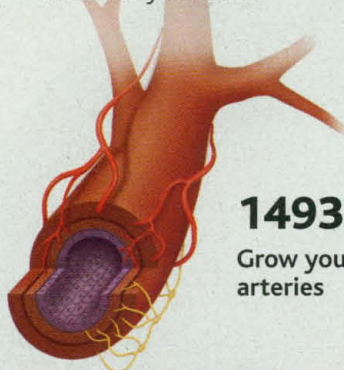
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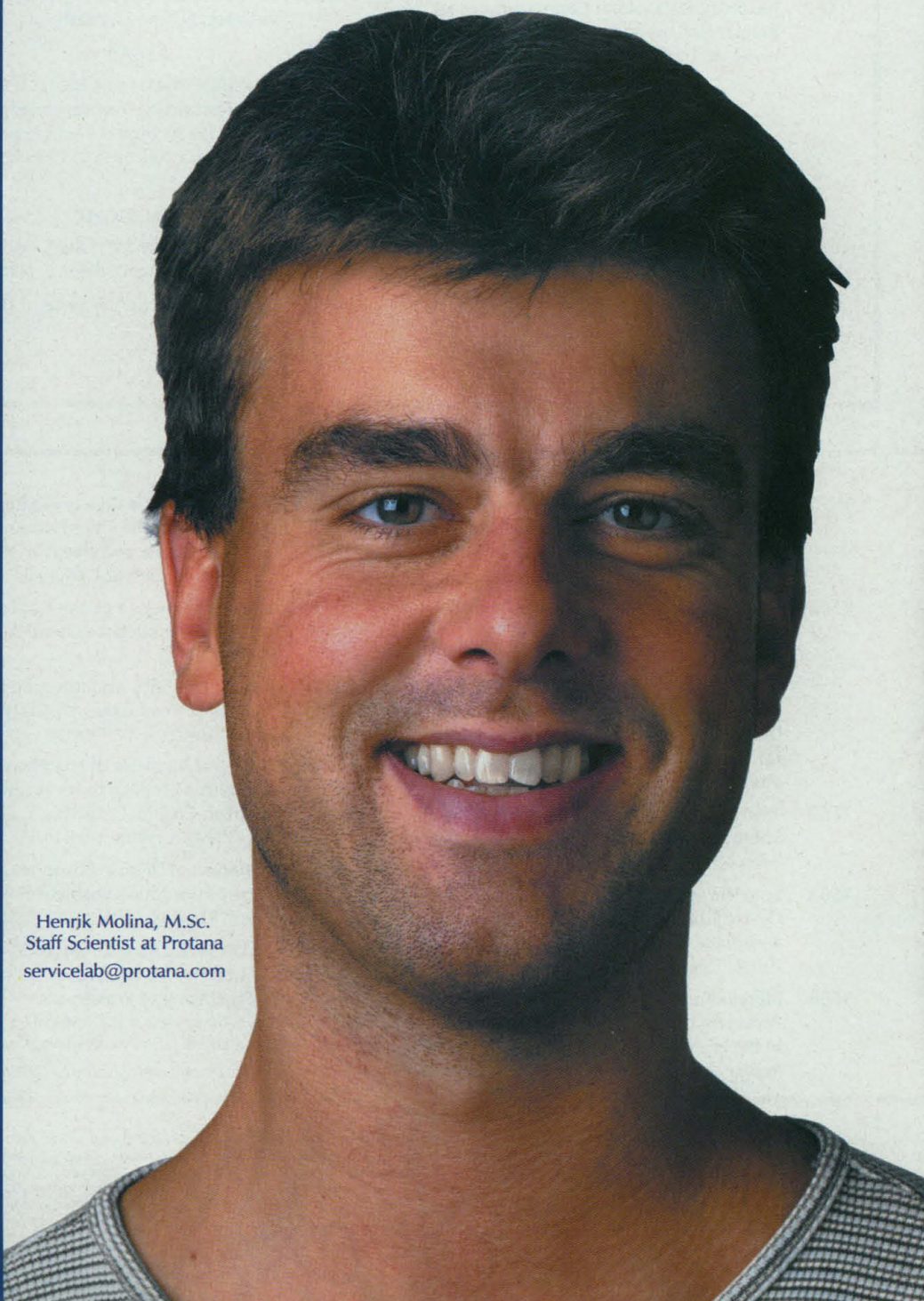
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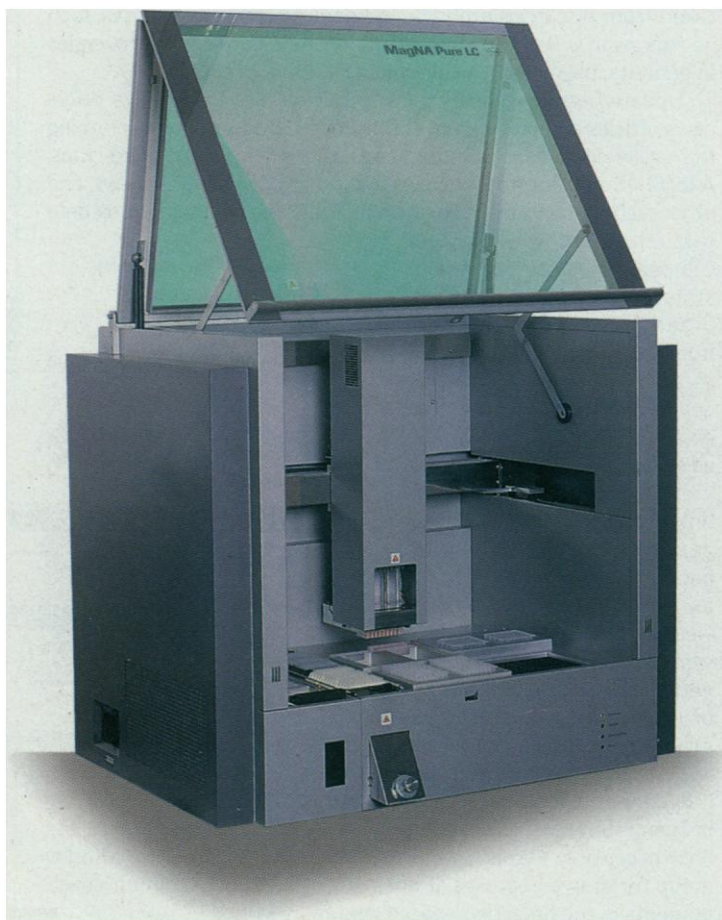
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BREAKING UP

Like the oceans, our atmosphere supports large-scale waves. Atmospheric waves in the troposphere, which are caused by air flow over mountains, have been studied for many years, but analogous structures in the stratosphere have been more difficult to observe. Eckermann and Preusse (p. 1534) used infrared emission measurements made from the space shuttle Atlantis to identify stratospheric mountain waves at altitudes between 15 and 30 kilometers above the Andes. They inferred that waves there were breaking above 30 kilometers. These results may be used to improve climate forecasts and atmospheric mixing models.

STATIONARY FRONTS IN THE OUTER CORE

Determining the detailed dynamic structure of the liquid outer core is important for understanding how the core evolved and how Earth's magnetic field is generated. Sumita and Olson (p. 1547) performed laboratory experiments to approximate the pattern of flow in the outer core when a large anomalous lateral heat flux from the mantle to the core is added to simulate heterogeneous mantle convection. In their model, a stationary spiral front in the "outer-core" liquid that separates warm liquid flowing "eastward" from cold liquid flowing "westward." Such a front in Earth's outer core could account for some variations in the geomagnetic field and for the anisotropy of the inner core.

SMALL FOAM CELLS WITH CO₂ GELS

The formation of foams with both low density and small cell size has been difficult to achieve. Shi *et al.* (p. 1540) have developed families of surfactants with high affinity for liquid carbon dioxide that increased its viscosity substantially and formed a gel even at a few weight percent. When the CO₂ was vented, low-density foams with submicrometer pores were formed. The use of CO₂ as a "blowing agent" could replace less environmentally benign compounds.

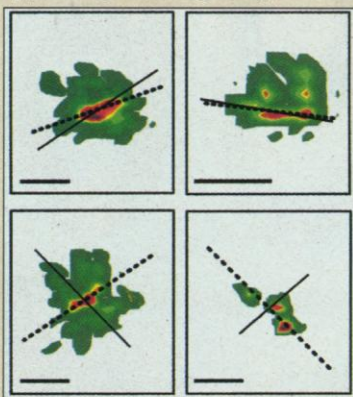
PINPOINT PERFORMANCE

Quantum-well resonant tunneling diodes can exhibit large increases in conductivity at particular voltages. Chen *et al.* (p. 1550) show that junctions formed from two gold electrodes separated by a monolayer of electroactive molecules can exhibit very large peaks in current at low temperatures; for one device at 60 kelvin, the "peak-to-valley" ratio of the currents exceeded

1000. Defects and pinholes in the monolayer, which can degrade performance, were minimized by confining the molecules to a region only tens of nanometers in diameter.

KEEPING TRACK THROUGH FEEDBACK

Information in the central nervous system is normally viewed as flowing from the periphery to the neocortex, but there is also massive feedback, such as from the cortex to the thalamus. Murphy *et al.* (p. 1552) provide evidence for a specific role of these cortico-thalamic connections in the visual system. They mapped regions of greatly increased



presynaptic terminal (bouton) density of corticogeniculate feedback axons that terminate in the dorsal lateral geniculate nucleus. The regions of maximum density are almost always elongate, and the axis of elongation depends on the visual orientation preference of the parent cells. These results are consistent with a model of spatiotemporal processing that would use such feedbacks to improve the ability of the visual system to track objects in space and time.

WARMING UP

The large, rapid warming that occurred 55.5 million years ago, the latest Paleocene thermal maximum, is one of the most dramatic episodes contained in the geological record of the past 100 million years. In only 10,000 to 20,000 years, the deep oceans warmed by 6°C, the oceans experienced a huge injection of isotopically light carbon, and benthic foraminifera suffered mass extinction. Many researchers attribute these events to a colossal release of methane

from clathrates on the sea floor. Katz *et al.* (p. 1531; see the news story by Kerr) present complementary stratigraphic, isotopic, and foraminiferal abundance records from a sediment core from the subtropical North-western Atlantic Ocean that document this event and provide strong evidence for the methane hypothesis. Their findings provide a specific example of what must have happened at numerous other locations on the sea floor near the end of the Paleocene.

DECIPHERING A DROUGHT

The drought conditions in the West African Sahel region that have persisted since the mid-1950s may have been caused by variations in sea surface temperature, changes in land use, or some combination of both effects. Zeng *et al.* (p. 1537) used a coupled atmosphere-land-vegetation model to explore dynamic interactions between the distribution of vegetation and the atmospheric budgets of water and energy. Their results suggest that the multidecade drying trend originated in oceanic forcing but that vegetation interactions may have amplified its magnitude.

PRESSURE EFFECTS IN HYDROGEN FRACTIONATION

A fundamental assumption of stable isotope geochemistry has been that isotopic fractionation is independent of pressure. Recently, however, theoretical calculations have suggested that this assumption should not hold true for hydrogen at pressures and temperatures commonly found in the Earth's mantle. Horita *et al.* (p. 1545) present experimental results that quantify the isotopic fractionation of hydrogen between the hydrous mineral brucite, Mg(OH)₂, and pure water between 15 and 800 megapascals at 380°C. These data may help resolve decades of questions about the hydrogen isotopic composition of high-temperature, high-pressure geological materials formed in the presence of water.

BACTERIAL ADAPTATION IN CYSTIC FIBROSIS

The major cause of death for patients with cystic fibrosis is the massive chronic infections with *Pseudomonas aeruginosa* that they acquire. Ernst *et al.* (p. 1561) have found that the bacteria adapt to the particular environment of the patients' lungs by synthesizing lipopolysaccharides with a specific

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THIS WEEK IN SCIENCE

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structure. This modification in lipid A is associated with an increased inflammatory response and resistance to antimicrobial agents.

EVERY BREATH YOU TAKE

Respiratory rhythms are generated by nerve cells in the brainstem. In an effort to identify the neurons and the mechanisms responsible for respiratory rhythmogenesis and frequency modulation, Gray *et al.* (p. 1566) analyzed the role of an area in the ventrolateral medulla, called the preBötzinger complex. They show that neurokinin-1 positive neurons anatomically define the preBötzinger complex and that a subpopulation of these neurons coexpressing opioid receptors can generate rhythms and modulate respiration frequency.

EXPERT AT REPAIRS

High levels of ultraviolet and ionizing radiation can cause extensive DNA damage and chromosomal breakage that can prove lethal to an organism. White *et al.* (p. 1571) determined the genome sequence of *Deinococcus radiodurans*, the most radiation-resistant bacterium known. The sequence analysis suggests that several factors contribute to radiation resistance: a large number of DNA repair genes, many of which are redundant; polyploidy, which can allow homologous recombination of double-strand DNA breaks; and the presence of a system that exports damaged nucleotides from the cell. The bacteria's natural resistance to radiation may prove useful in the bioremediation of contaminated radiation and toxic sites.

ADENOVIRUS ATTACHMENTS

Adenoviruses cause an array of diseases in animals and humans and are also used as vectors for gene therapy. They bind to their host cell receptors (the coxsackie and adenovirus receptor, or CAR) by means of a globular domain that extends from a fiber attached to the viral capsid. Two reports focus on the receptor-virus interaction. Bewley *et al.* (p. 1579) crystallized the complex of an adenovirus knob with CAR and determined that the receptor interacts at the interface between knob monomers, specifically in a region that is highly conserved among adenoviruses. Even areas where there were shape mismatches between the receptor and the viral knob contributed to high-affinity interactions. The identification of the receptor-binding region were confirmed in the mutational analysis of Roelvink *et al.* (p. 1568), who also were able to redirect an adenovirus to a new receptor.

ALLIED AGAINST INVASIONS

Introductions of exotic and invasive species are among the leading causes of biodiversity decline, but what makes an ecosystem susceptible to invasion? Stachowicz *et al.* (p. 1577) investigated this question experimentally by manipulating species richness in rocky intertidal communities and monitoring subsequent invasion by an introduced species. Increased species diversity enhanced the community's resistance to invasion. This result implies that loss of diversity and invasion might reinforce each other by a negative feedback cycle, thereby accelerating extinction rates among the world's threatened biota.

TECHNICAL COMMENT SUMMARIES

How Tangled Are Prokaryote Phylogenies?

The full text of these comments can be seen at www.sciencemag.org/cgi/content/full/286/5444/1443a

Doolittle (Reviews, 25 June, p. 2124) examined the problems, perhaps severe, posed by extensive lateral gene transfer (LGT) in constructing meaningful phylogenies, particularly for bacteria and archaea. Three comments debate other approaches for reconstructing phylogenies and the overall prevalence of LGT.

Huynen *et al.* argue that higher order approaches, for example, examining the total gene content, can be useful and should be taken into consideration. Stiller and Hall caution that it remains unclear whether LGT is as widespread as current phylogenies suggest. Gupta and Soltys propose instead that the presumed prevalence of LGT can be used instead to infer alternative relationships among archaea and bacteria.

Doolittle responds and notes that the "strongest evidence for the importance of LGT is not within-genome inhomogeneities...but the varying gene content of the collection of genomes now available....Each new prokaryote genome that appears contains dozens, if not hundreds, of genes not found in genomes of its nearest sequenced relatives, but found elsewhere...."

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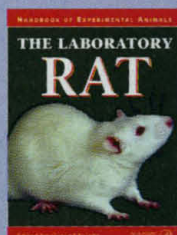
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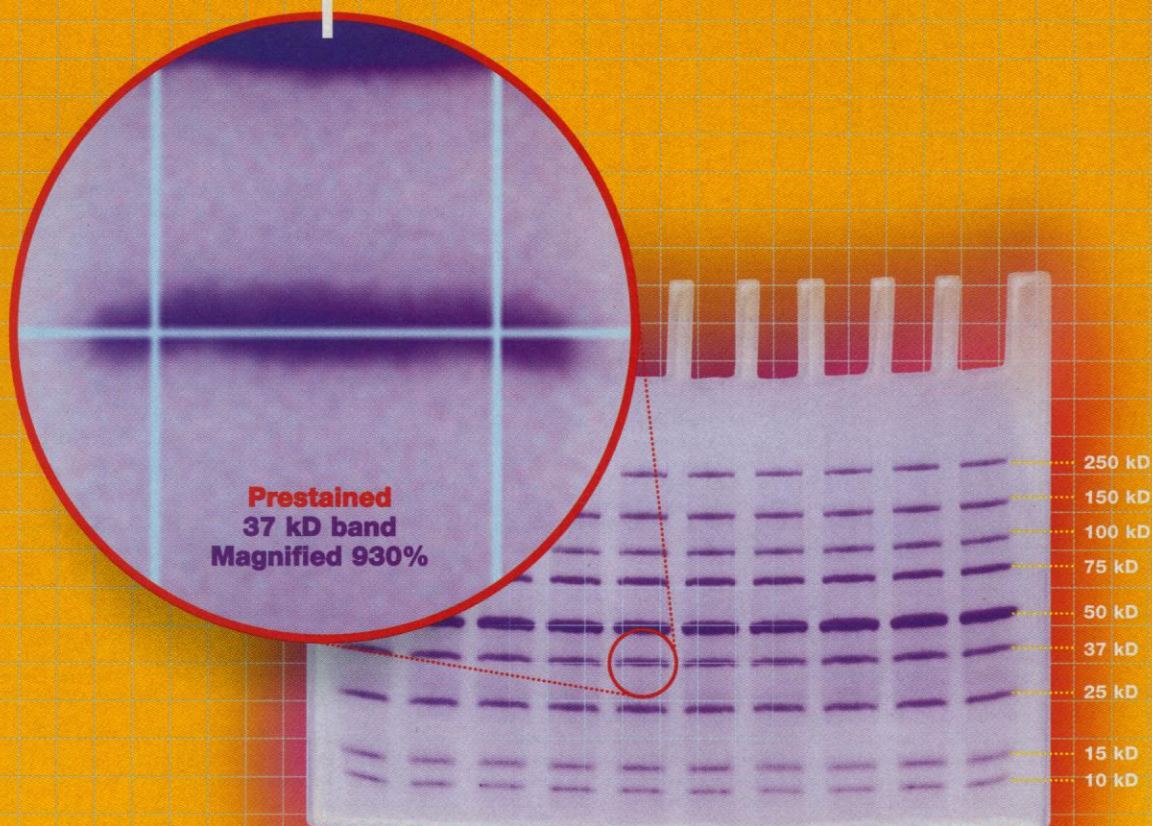
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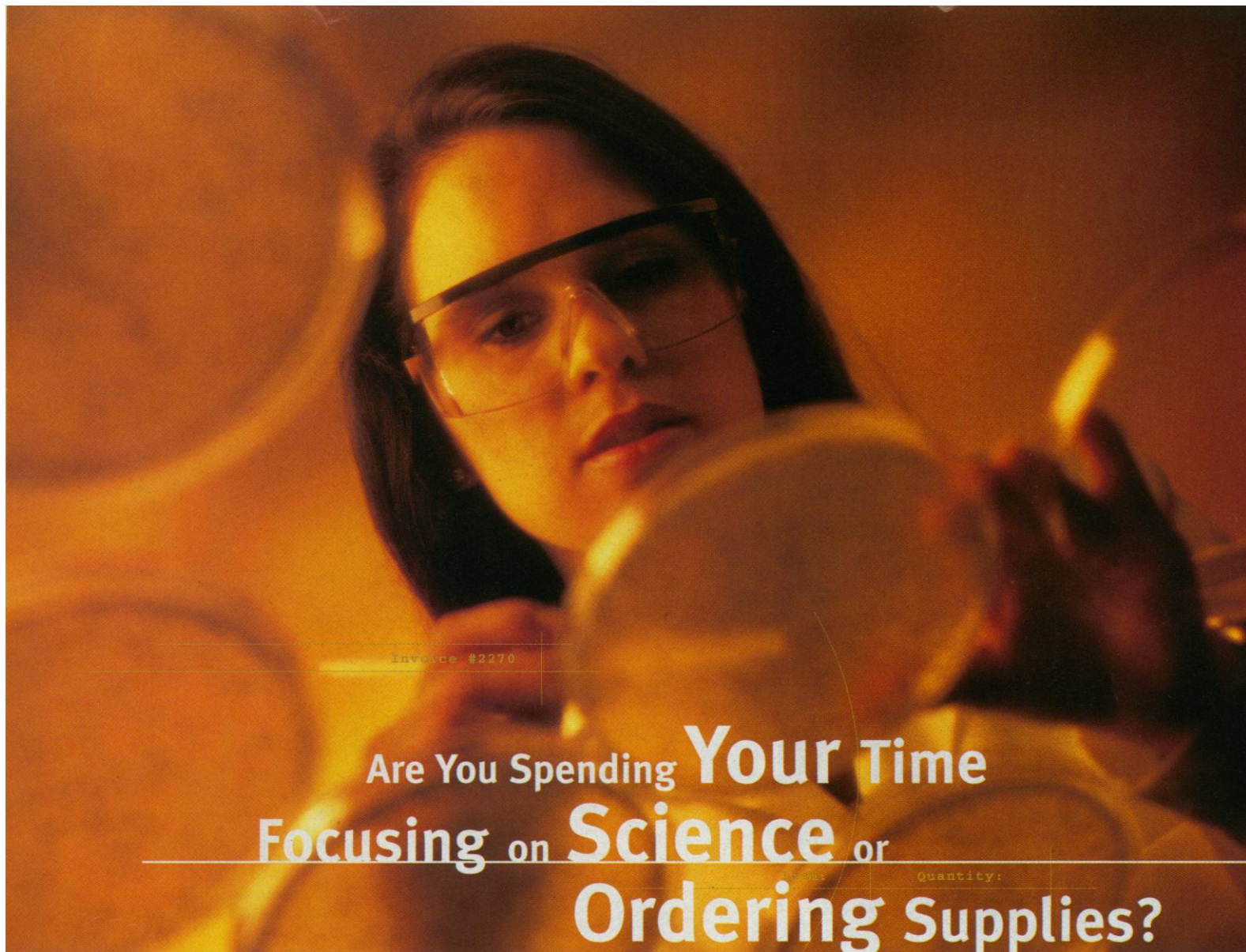
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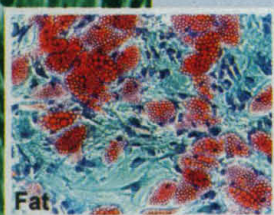


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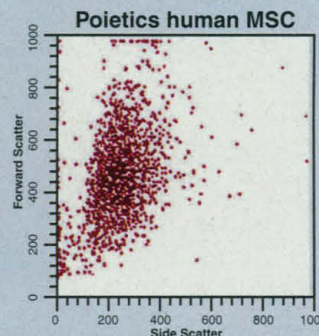
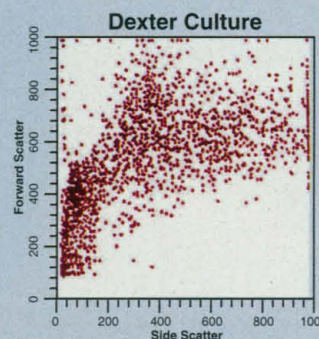


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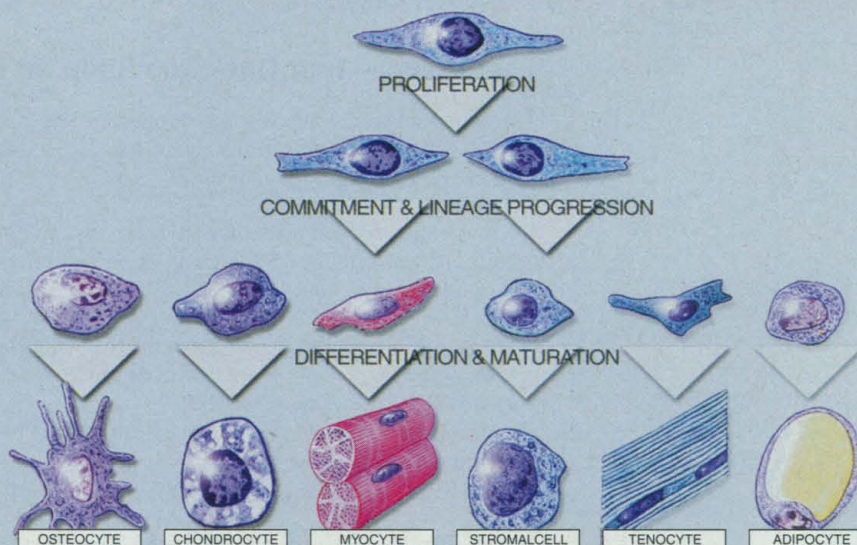


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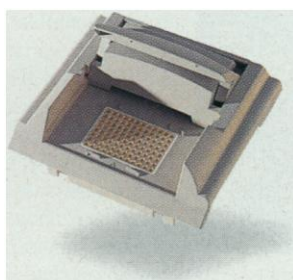
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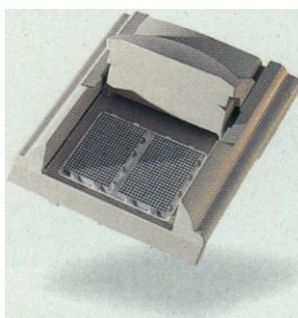
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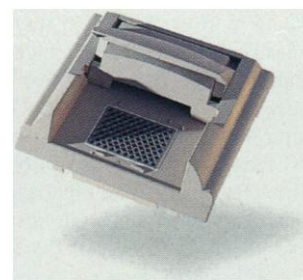
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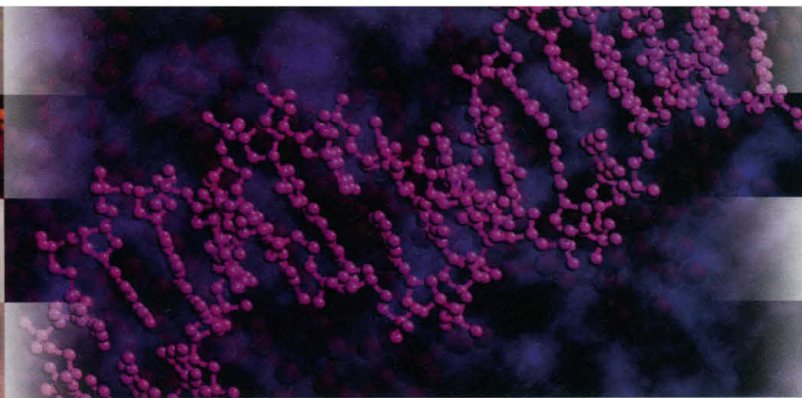
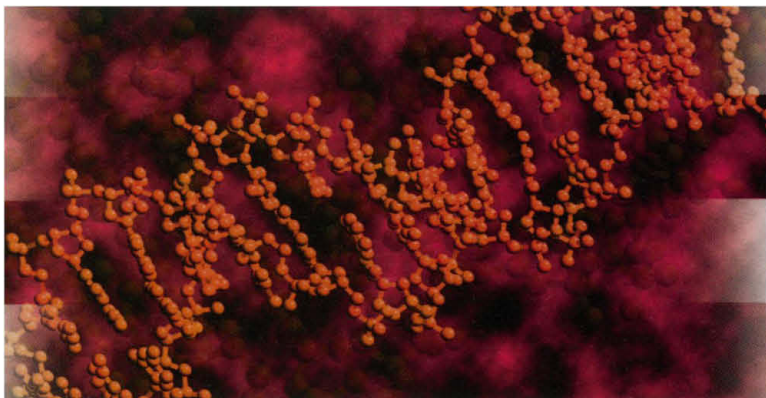


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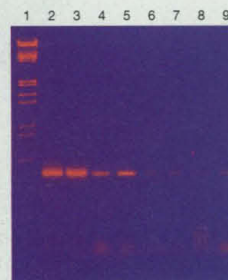
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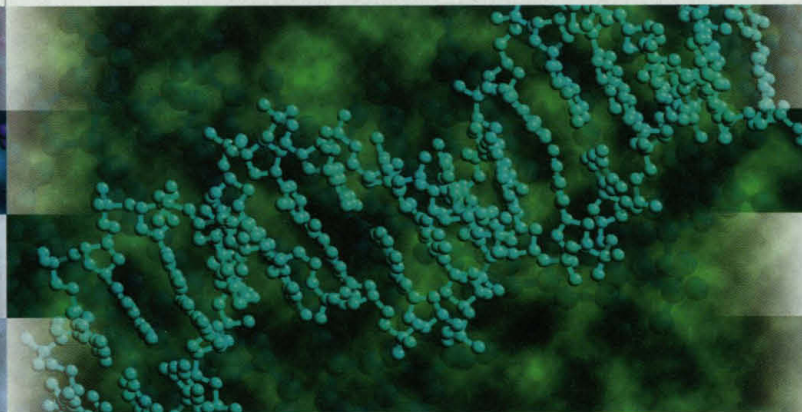
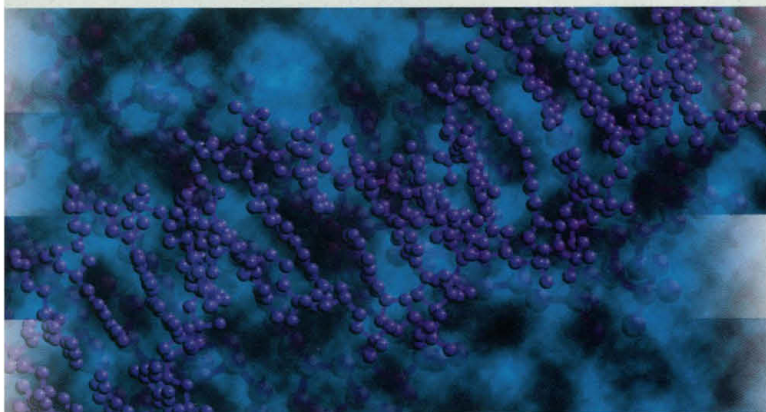
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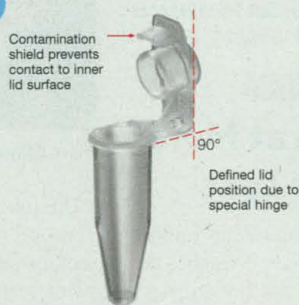
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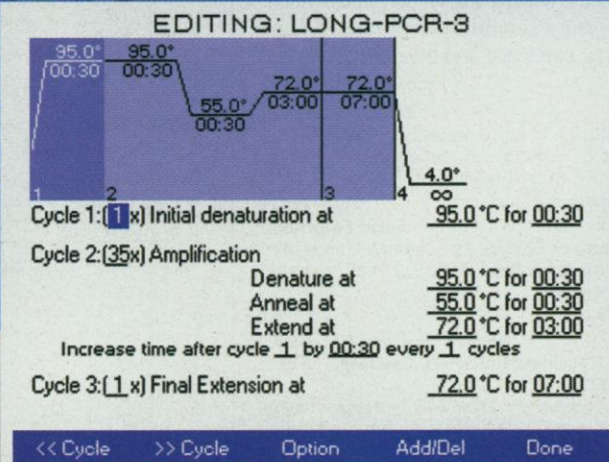
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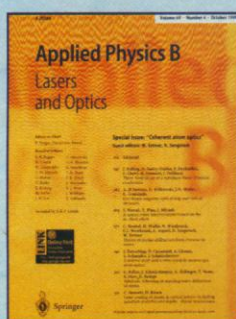
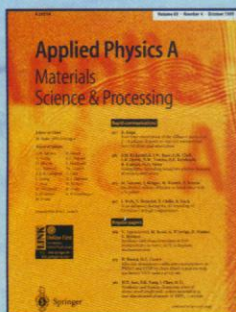
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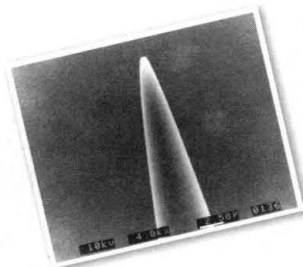
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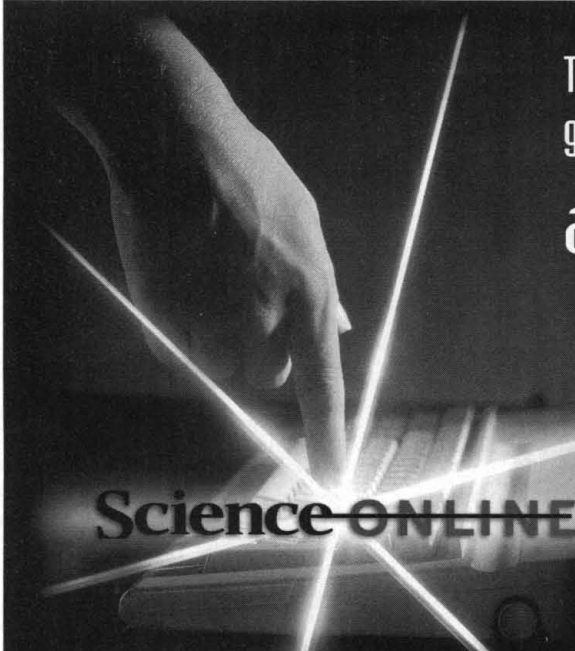
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