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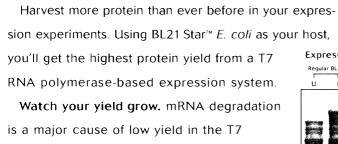
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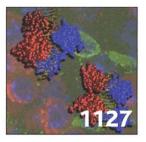
Expression of B-gal BL21 Star Regular BL21

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COVER The transcription factor Pit-1 binds recognition sites in cell type-specific target genes in distinct configurations. X-ray cocrystal structures of Pit-1 bound to prolactin (left) and growth hormone (right) promoter elements are superimposed on a background of immunostained adult mouse pituitary tissue showing growth hormone (red), prolactin (green), and nuclei (blue).



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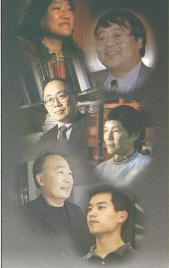
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In this month's essay, Eric R. Kandel and Larry R. Squire chronicle how brain research has migrated from the peripheries of biology and psychology to assume a central position within those disciplines. The multidiscipline of neuroscience that emerged from this process now ranges from genes to cognition, from molecules to minds.

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THIS WEEK IN SCIENCE

edited by PHIL SZUROMI

MAGNESIUM MATTERS

The most abundant minerals precipitated from the oceans are forms of $CaCO_3$, either as aragonite or calcite. The incorporation of some Mg²⁺ ions into these minerals seems to control the biomineralization process and has been used empirically to infer past ocean temperatures, but the physical basis for incorporation of Mg²⁺ into the growing crystal has been obscure. Davis *et al.* (p. 1134) used atomic force microscopy to describe how incorporation of Mg²⁺ along steps controls calcite crystal growth by modifying calcite solubility.

A GREENER ROUTE TO ESTERS

One goal of green chemistry is to avoid the use of excess reagents. For example, the condensation of alcohols and carboxylic acids into esters normally requires an excess of one reagent to avoid side reactions such as transesterification. Ishihara *et al.* (p. 1140) now report that hafnium(IV) salts can be used as catalysts for the direct condensation of esters from equimolar amounts of alcohols and acids in yields typically greater than 95%. These catalysts can also be used for polyesterifications of dicarboxylic acids and diols.

DANCING TO A TROPICAL TUNE?

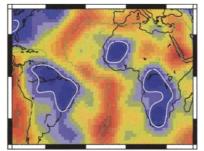
Sea surface temperatures (SSTs) in the tropical and subtropical Pacific Ocean vary on decadal and interdecadal time scales, but records long enough to evaluate the periodicity, strength, and distribution of these variations are scarce. Linsley et al. (p. 1145; see the Perspective by Cane and Evans) have constructed a 271-year-long record of Sr/Ca in coral, a proxy for temperature, from the Cook Islands in the South Pacific gyre. Decadal SST changes of greater than 0.75°C have occurred nine times since the beginning of the 18th century. These shifts are related to similar variations in the North Pacific, which suggests a tropical control of both hemispheres.

A FILLING SINK

The causes of a terrestrial carbon sink in northern mid-latitudes (especially North America) are still controversial. Caspersen *et al.* (p. 1148) have used data from forest inventories in five U.S. states to show that rates of biomass accumulation in forests have not increased during the past 15 years. Enhanced growth, which can be attributed to fertilization by increasing atmospheric CO_2 , accounts for only 2% of the observed accumulation; the rest is the result of accumulation by forest regrowth after earlier disturbances. Thus, land-use history is the dominant factor governing carbon accumulation in these forests. Carbon accumulation in unmanaged forests may be expected to attenuate as a result of demographic factors, and further increases in atmospheric CO_2 will not result in greater carbon sequestration.

SHORT HOT SPOTS

Many hot spot plumes, such as Hawaii and Iceland, are thought to originate as thermal anomalies at the coremantle boundary. King and Ritsema (p. 1137) suggest that hot spots in South America and Africa may originate in the upper mantle through



small-scale convection at the edges of continental cratons. Their models show plumes forming in the upper mantle that lead to volcanism on the edges of cratons. Thus, some hot spots may be short and only extend from the crust to the upper mantle.

LUNAR AND SOLAR NITROGEN ABUNDANCES

Nitrogen, the most abundant element in Earth's atmosphere, is also a ubiquitous component of the solar system. However, the use of ¹⁵N/¹⁴N isotopic ratios to understand the timing of formation and mixing of various components in the solar nebula has been limited, in part because the ¹⁵N/¹⁴N ratio for the sun has been unknown. Hashizume et al. (p. 1142; see the Perspective by Becker) measured the ¹⁵N/¹⁴N in lunar soils as a function of depth and determined that the nitrogen component in the uppermost layers of soil grains (the first tens of nanometers) is produced by the solar wind. Thus, these data provide a measure of the solar ¹⁵N/¹⁴N value. The authors also measured a different isotopic nitrogen ratio associated with a deuterium- and silicon-rich layer on some ilmenite grains that may represent an interstellar nitrogen component.

EUROPEAN ORIGINS

The nonrecombining portion of the Y chromosome (NRY) is a particularly informative locus to evaluate migratory, geneflow, and admixture episodes during human history and prehistory. In a survey of polymorphisms associated with the NRY, Semino et al. (p. 1155; see the news story by Gibbons) find that >95% of the contemporary European male gene pool can be allotted to just 10 unique predecessor patrilineages. Their data provide a detailed picture of the multiple migrations creating the modern diversity in the European gene pool and indicate that about 80% of the European gene pool originated in two Paleolithic migrations, and the remainder in a Neolithic migration.

SPACING MAKES THE DIFFERENCE

During development, specific cell types differentiate from common progenitor cells to produce various tissues and organs. Each cell type results from a precise plan that specifies what genes are turned on or off. Several cell types in the pituitary gland express Pit-1, a POU domain transcription factor. Scully et al. (p. 1127; see the news story by Marx) have examined two of these cell types, somatotropes and lactotropes, for the regulatory role of Pit-1 in the activation of the growth hormone and prolactin genes, respectively. Whether Pit-1 represses or activates growth-hormone gene expression depends on the presence or absence of a two-base pair spacer between the bipartite POU domains. Further mechanistic analyses revealed that Pit-1 interacts with the corepressor N-CoR to repress growth hormone in lactotropes. The allosteric effect observed with Pit-1 in the pituitary gland may be representative of other regulatory mechanisms for celltype specification.

BIRTH AND DEATH OF GENES

How are gene duplications preserved, lost, or changed during evolution? Lynch and Conery (p. 1151; see the news story by Pennisi), using comparative analyses of nucleotide sequences for different eukaryotic species, found that the birthrate of new duplicates is high enough that every gene in a typical eukaryotic genome can be expected to duplicate at least once in 500 million years. However, the half-life of a duplicate gene is comparatively short—only a few million years. Selective constraints on duplicate genes increase CONTINUED ON PAGE 1051



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THIS WEEK IN SCIENCE

CONTINUED FROM PAGE 1049

with time. The authors speculate that gene duplications may be important in the generation of new species.

A HELICASE FOR RNA DEGRADATION

In nearly all eukaryotes, the misexpression of transgenes or the introduction of double-stranded RNA into cells can result in sequence-specific gene silencing, known respectively as posttranslational gene silencing (PTGS) and RNA-mediated interference (RNAi). Relatively little has been known about the molecular mechanism underlying the phenomenon, but many of the models proposed for PTGS and RNAi action include the involvement of an RNA helicase. Wu-Scharf et al. (p. 1159; see the Perspective by Baulcombe) have conducted a genetic screen for the loss of silencing of a transgene in the unicellular green alga Chlamydomonas and have isolated a putative RNA helicase. The putative RNA helicase is either part of the machinery of PTGS or possibly involved in the surveillance of aberrant RNA molecules.

NO IMMUNITY TO COSTS

The cost and benefits of activating an immune response are the subject of two reports (see the Perspective by Read and Allen). Moret and Schmid-Hempel (p. 1166) have manipulated a model to measure the costs of innate immune responses in insects. Starved bumblebees stimulated to generate a response to soluble lipopolysaccharide and to sterile particles soon died because they diverted all of their remaining resources to the immune response. In well-fed field populations, most bumblebees carried an infection but showed normal behaviors and activities, which indicates that compensatory mechanisms effectively countered any costs to mounting an immune response. Promiscuous sexual behavior presents an obvious risk to the individual because of the increased likelihood of contracting a sexually transmitted disease. Although behaviors may adapt to avoid this hazard, a study by Nunn et al. (p. 1168) suggest that in some primate species, it is the immune system that has adapted to cope with the problem. Several species of captive primates were tested for numbers of white blood cells (WBC)---the mediators of immune defense. The authors found that while there was no correlation of WBC counts with social factors such as group size, frequencies of these cells were significantly elevated in the females of species that had multiple mating partners. The WBC counts of (noncaptive) humans were low on this scale.

FIRMING UP MEMORIES

Much evidence links the N-methyl-D-aspartate (NMDA) receptor to memory formation, but its role in memory consolidation, a process that can take days or weeks after initial learning, has not been clear. Shimizu et al. (p. 1170) generated animals in which they could selectively eliminate NMDA receptor function in hippocampal CA1 neurons at any time. The learning of two well-established memory tasks required intact NMDA receptors for the consolidation of memories. By changing the time after learning at which NMDA receptors were turned on or off, they could rule out an effect on memory retrieval. Memory consolidation appears to require activation of NMDA receptors after the initial learning has taken place.

TECHNICAL COMMENT SUMMARIES

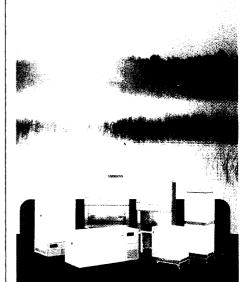
Flash-Lag Effect: Differential Latency, Not Postdiction

The full text of these comments can be seen at www.sciencemag.org/cgi/content/full/290/5494/1051a

Eagleman and Sejnowski (Reports, 17 March, p. 2036), in a study of the visual illusion known as the flash-lag effect, suggested that their experimental results supported a postdictive hypothesis for the phenomenon, and that the same data were not consistent with another explanation of the flash-lag effect, the differential-latency hypothesis. Patel *et al.*, in a comment, argue that those experiments did not actually test that hypothesis and that the data of Eagleman and Sejnowski are indeed fully consistent with differential latency. They also maintain that the postdictive model of Eagleman and Sejnowski cannot explain the results of other experiments that "have shown

... that the perceived misalignment between an object in continuous motion ... and a flashed object changes from a flash lag to a flash lead" under certain circumstances. Eagleman and Sejnowski respond that "the results of Patel *et al.* are consistent with an expanded postdiction framework" that they presented in a previous Technical Comment (www.sciencemag.org/cgi/content/full/289/5482/1107a), and offer additional data that they argue are inconsistent with the key assumptions of differential latency.





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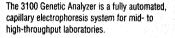
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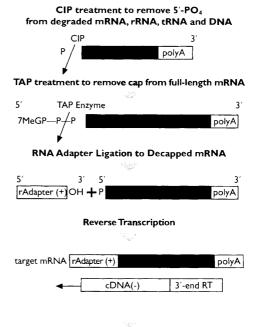
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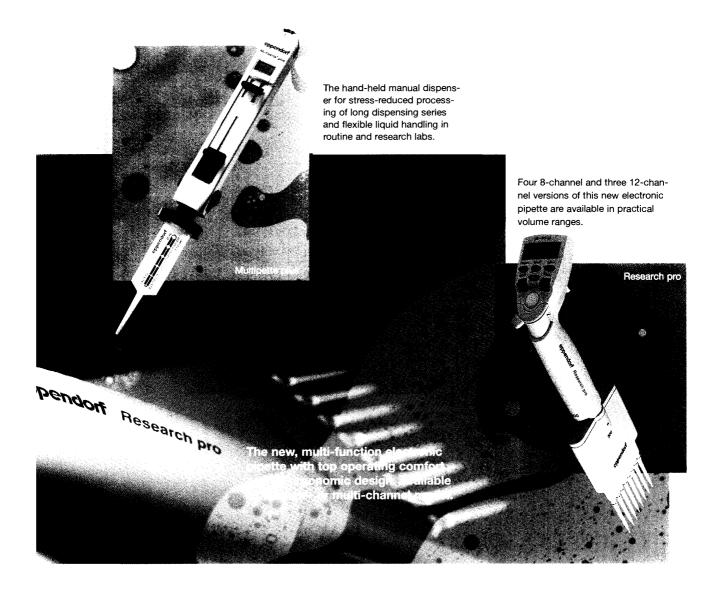
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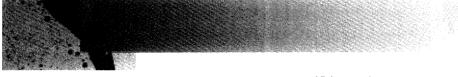
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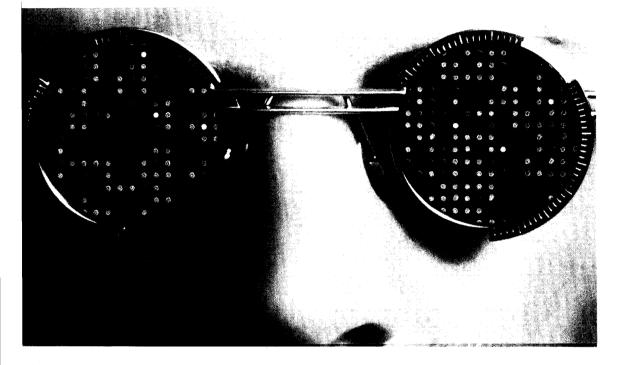
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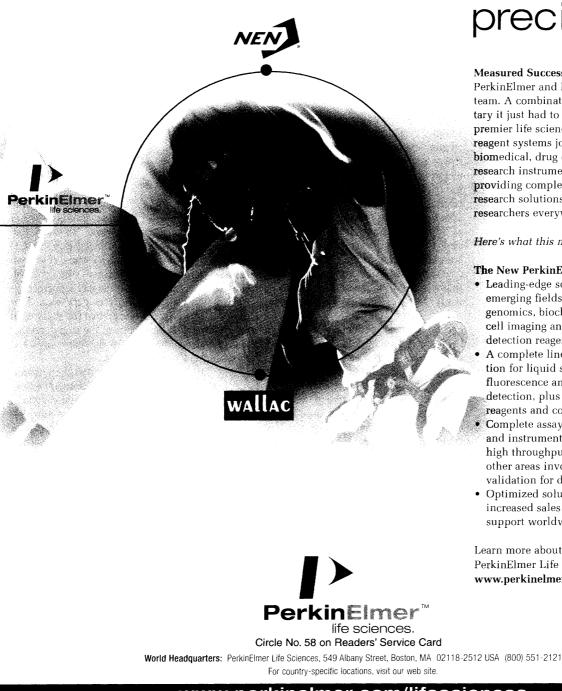
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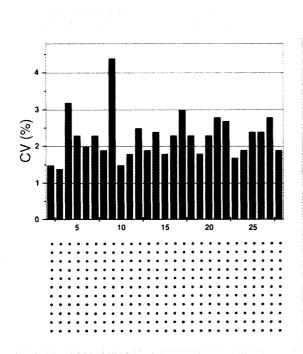
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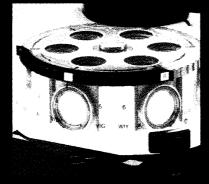
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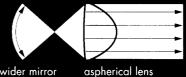


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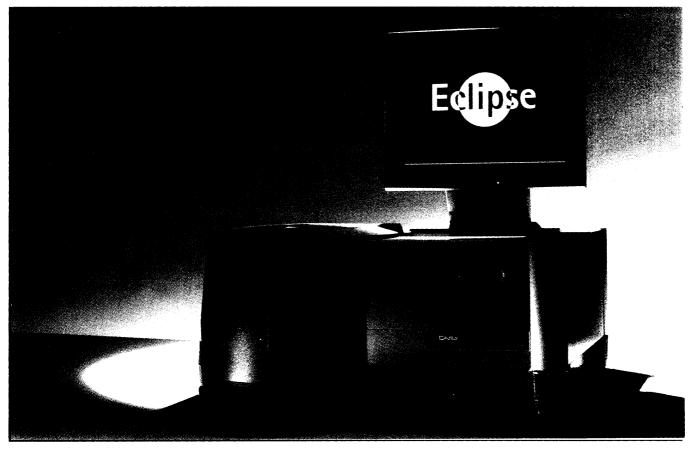
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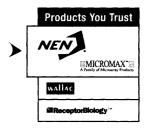
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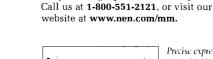


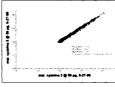
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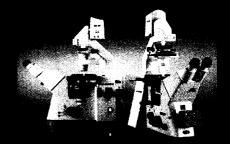
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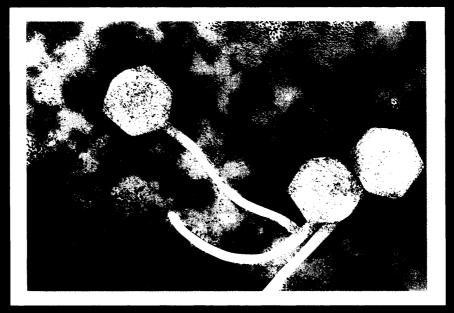
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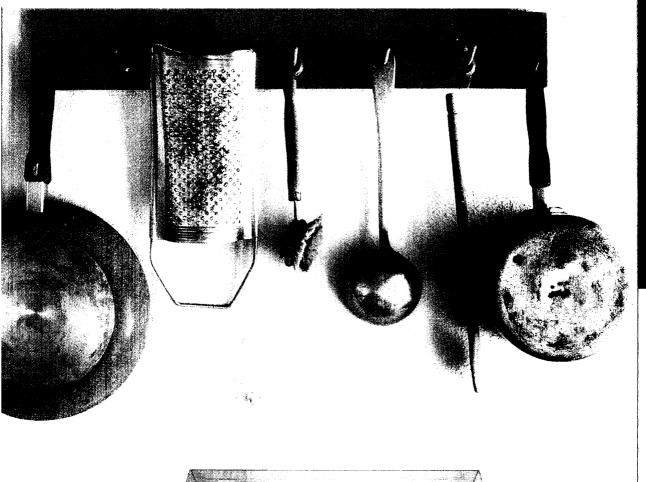
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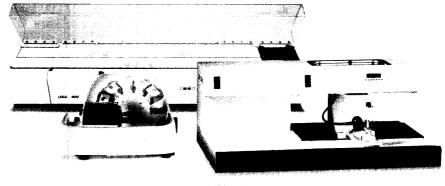
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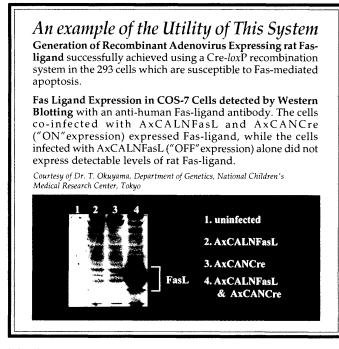
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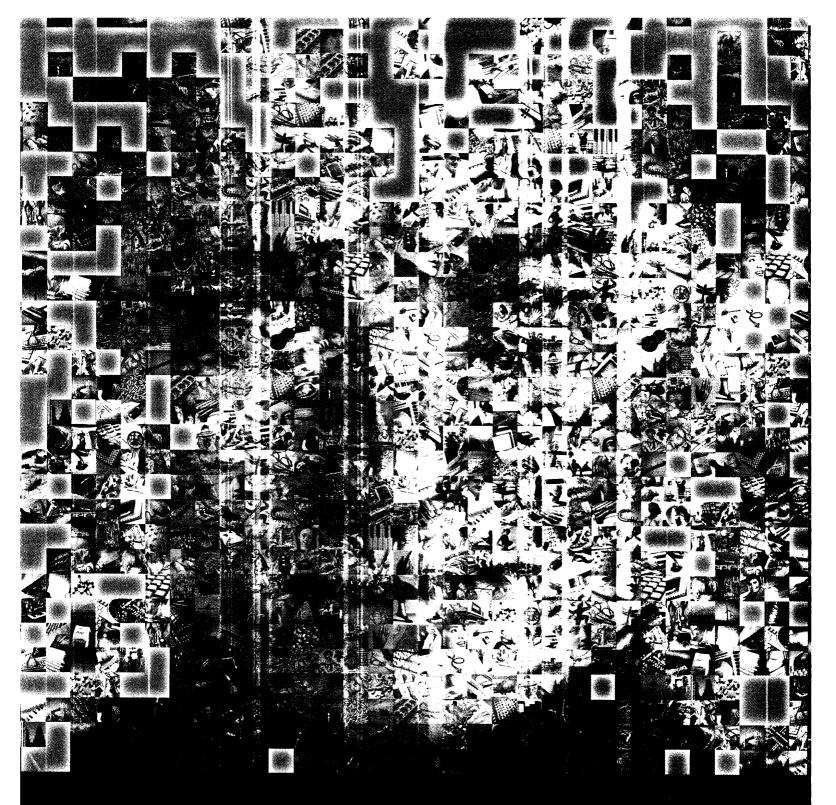
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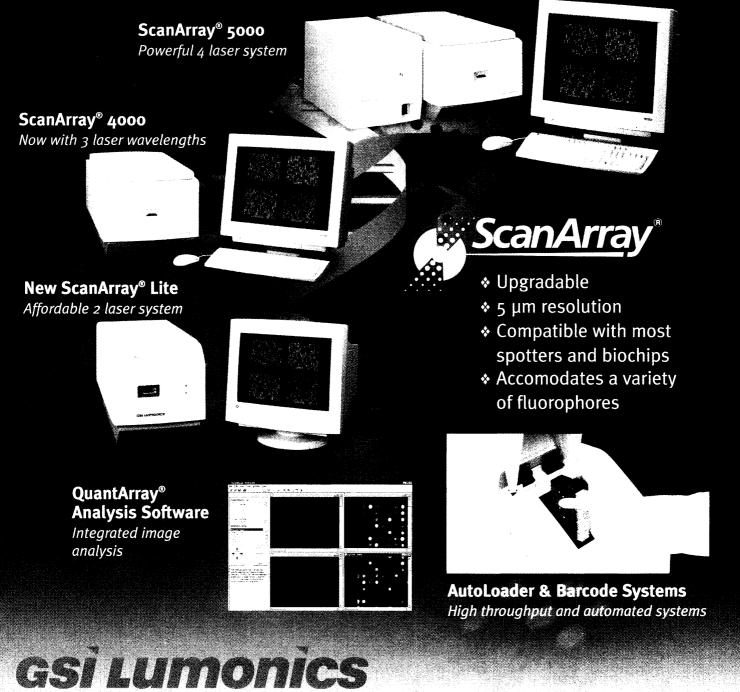
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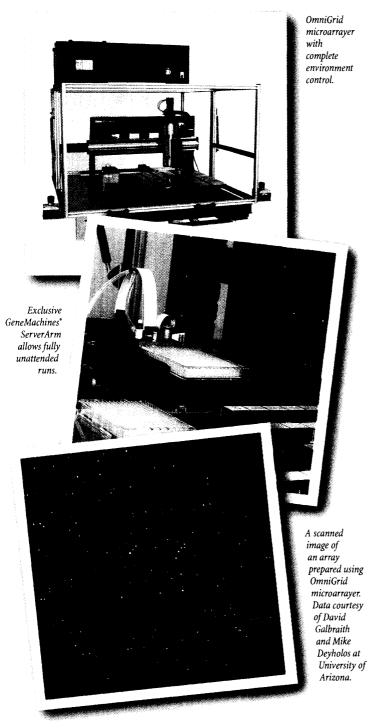


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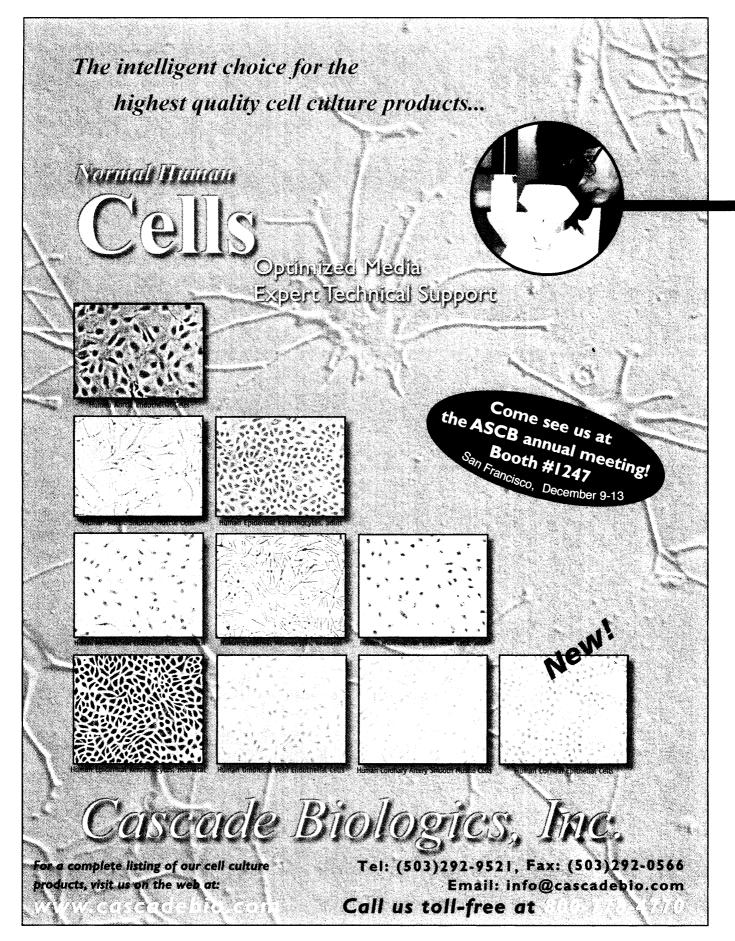
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