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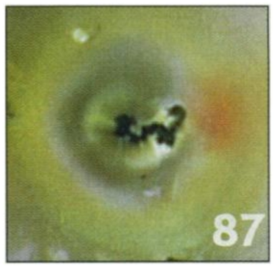
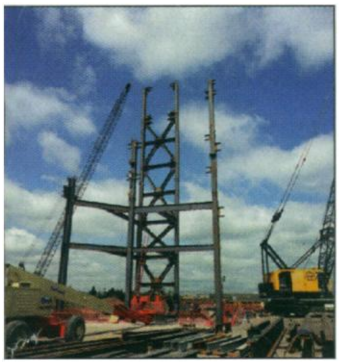
COVER A composite, false-color image of Jupiter's moon Io taken by the Galileo orbiter on 29 March 1998. Most of Io's brilliant colors are due to sulfur compounds, but the dark features are probably silicate lava flows, many of which are associated with deposits (red) from explosive volcanic eruptions. The circular plume deposit from the volcano Prometheus (right) is ~250 kilometers in diameter. [Image processing: P. Geissler]





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SPECIAL FOCUS CARDIOVASCULAR DISEASE

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RESEARCH

RESEARCH ARTICLE

REPORTS

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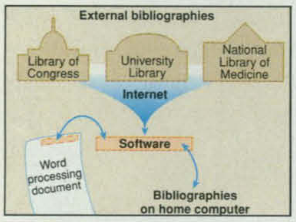

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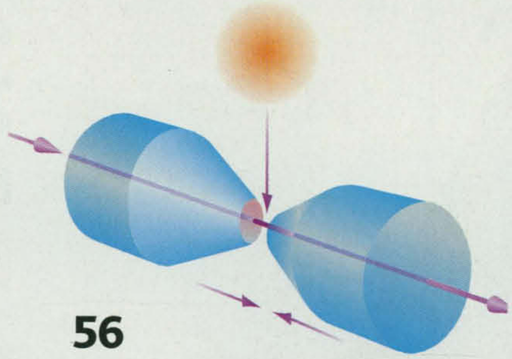
Software for scientists



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Setting the lightest atom trap

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Sandal design in prehistoric times

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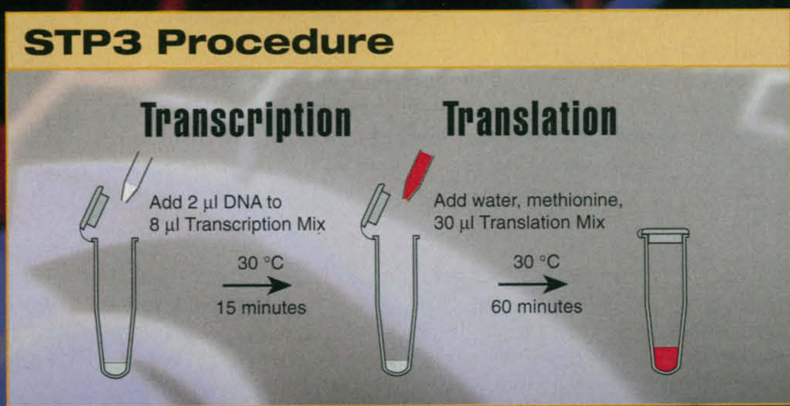

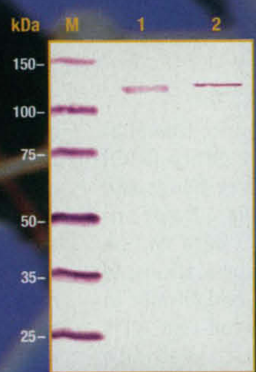

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OLD SOFT SHOES

Most of the evidence for early cultural evolution is from pottery or tools because these items are resistant to degradation and tend to be preserved, but records from more fragile items are important for providing a broader perspective. Kuttruff *et al.* (p. 72; see the news story by Pringle, p. 23) describe and have dated a remarkable collection of shoes preserved in deposits in Arnold Research Cave, Missouri. Eighteen shoes and sandals are complete or nearly complete and another 17 specimens are fragmentary. Together, the shoes provide a record of construction styles extending back to about 8000 years ago. Construction styles did not appear to become more complex with time; some earlier shoes were quite intricate, and all were made from grasses or woody fibers.

SELECTIVE VIBRATIONS

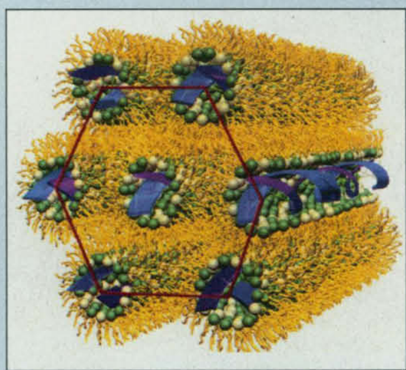
Dissociative recombination of ions with free electrons is an important reaction in astrophysics and the upper atmosphere as well as in plasma processing and combustion. Experimental investigation of such reactions in molecular beams is hampered by the difficulty in generating sufficiently strong beams of vibrationally relaxed ions. Ion storage rings overcome this problem and allow molecular ions to relax to their vibrational ground state. Amitay *et al.* (p. 75) have extended this technique to allow determination of the product distribution as a function of vibrational excitation of the reactant ion. They studied the dissociative recombination of HD^+ with an electron and show that rate coefficients generally increase for high vibrational excitations, where new dissociation routes become accessible. However, for isolated vibrational states, very low rate coefficients were observed that could not be reproduced by theoretical calculations, which suggests that the process is not fully understood.

SHIFTING ICE SHEET

Melting of the West Antarctic Ice Sheet would raise sea level by 5 to 6 meters. One clue to the stability of the ice sheet in response to current climate change is its past behavior during interglacial periods. To examine this question, Scherer *et al.* (p. 82; see the news story by Kerr, p. 17) drilled several holes through the ice sheet and collected glacial sediments from its bed. In several holes, the bed material contained Quaternary marine diatoms; these samples also had high concentrations of beryllium-10, a cosmogenic isotope with a half-life of 1.5 million years. Together, these data imply that the ice sheet receded greatly sometime during the last 1.3 million years and probably during the past 600,000 years. During that time, sediments containing the diatoms and ^{10}Be could be deposited upstream of the location of the drill holes.

GETTING LIPOSOMES TO GIVE UP DNA

Recent studies have shown that complexes of DNA with univalent cationic liposomes (CLs) used for gene delivery can adopt a well-defined structure in which DNA is aligned between lamellar liposome sheets. Koltover *et al.* (p. 78) used x-ray scattering to show that for DNA-CL ratios most favorable for gene transfer, a different structure forms in which the DNA molecules are encapsulated in liposome tubules. Optical microscopy revealed that this latter form rapidly fuses with anionic membranes to release DNA, while the lamellar complexes bind stably and retain DNA.



TO SOFTEN, ADD WATER

Many minerals in the mantle can contain some water; one of these minerals is wadsleyite, which is abundant in the lower part of Earth's upper mantle between depths of 440 and 660 kilometers. In experiments simulating mantle pressures and temperatures, Kubo *et al.* (p. 85) show that even the addition of a small amount of water to wadsleyite greatly reduces its strength. Thus, even if some water is present in the mantle at this depth, the mantle could be weak, and considerably weaker than the strengths indicated from experiments conducted under dry conditions.

SIZZLING SILICATES

The highest temperatures estimated for the surface of Io, a moon of Jupiter, by Voyager 1 in 1979 was about 650 kelvin (K). This temperature is not high enough to allow silicate volcanism as is observed on Earth but is within the temperature range for liquid sulfur; thus, sulfuric lava flows, lava lakes, and plumes were assumed to dominate the brilliant yellowish landscape of this volcanically active moon. The search for silicates on Io continued after Voyager with some observations of higher temperature "hot spots," but now McEwen *et al.* (p. 87) have used infrared wavelength observations from Galileo to estimate that at least a dozen hot spots have minimum temperatures exceeding 1700 K and the Pillan hot spot has a maximum temperature in excess of 2000 K (see the cover, which shows some of these hot spots colored in red). These high-temperature regions on Io indicate that silicate volcanism is prevalent on sulfur-covered Io and that some of these silicates are extremely hot compared to basaltic volcanism on Earth.

RELATIONSHIP FRAGMENTATION

What effect does forest fragmentation have on the relationship between trees and their pollinators? Aldrich and Hamrick (p. 103) have discovered dramatic changes in plant fecundity (the shade tree *Symphonia globulifera*) and pollinator (hummingbird) behavior in the rain forest that had been fragmented during the past 10 to 30 years. The study used genetic analysis to determine the parentage of a large number of saplings and seedlings. Certain trees isolated in pasture greatly increased in fecundity and dominated the production of seedlings in the remnant forest. Hummingbird behavior was altered, resulting from increased flower production in pasture trees and leading to increased self-fertilization of these trees. These changes have led to a genetic bottleneck that has markedly constricted the plant donor pool.

ELECTRIC PUMPS

Multisubunit enzyme complexes, the energy generators of the mitochondrion, use the downhill flow of electrons from NADH (the reduced form of nicotinamide adenine dinucleotide) to oxygen to pump protons across the mitochondrial membrane. Iwata *et al.* (p. 64; see the Perspective by Smith, p. 58) present the refined structure of the complete 11 subunit—complex III, also known as cytochrome

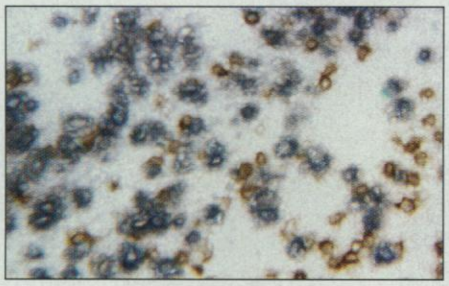
CONTINUED ON PAGE 11

CONTINUED FROM PAGE 9

bc_1, which reveals how the electrons initially deposited by ubiquinone are transported to the acceptor cytochrome c_1 by a 35° rotation of the "Rieske" subunit.

LYMPH NODE RENDEZVOUS

T cells and B cells that are specific for an antigen must somehow contact each other in the lymph nodes, where the antigens



are usually found. Garside *et al.* (p. 96) have developed a system in which cognate interactions between antigen-specific lymphocytes can be visualized in situ. This approach has clarified the role of the CD40 ligand (CD154) in clonal expansion.

METHANE METABOLISM

Anaerobic methanogenesis by Archaea and aerobic methane oxidation by methylotrophs were thought to be totally unrelated pathways. Chistoserdova *et al.* (p. 99) have found that these two pathways share some enzymes that are involved in processing single-carbon molecules, which is surprising because of the highly different ecological niches that these organisms occupy. The results are useful in understanding the evolution of oxidation/reduction pathways.

ACTIN TAIL NUCLEATION

The pathogenic bacterium *Listeria monocytogenes* invades cells and then acquires a tail of actin that moves the bacterium around the cell. A bacterial protein known as ActA is crucial for the formation of the actin tail. Welch *et al.* (p. 105) now describe in detail the role of a host cell protein complex that acts in concert with ActA to promote actin tail assembly. These findings shed light not only on the mechanism of *Listeria* invasion, but also suggest that endogenous host ActA-like proteins will be important in forming other polarized actin structures.

PATHWAY TO HEARTBREAK

The four-chambered human heart initially develops as a two-chambered tube consisting of one atrium and one ventricle. Partitioning (septation) of these primordial chambers is critical for normal heart function. Mistakes are common, however; atrial septal defects (ASDs) occur in about 1 in 1500 live births. Schott *et al.* (p. 108; see news story by Barinaga, p. 32) show that a subset of ASDs, conduction defects, and other heart abnormalities are caused by mutations in the gene encoding the heart-specific transcription factor NKX2-5. Homologs of this gene have been implicated in heart development in fruit flies and mice.

DETERMINING ENDODERM

Early in vertebrate embryonic development, the three germ layers are specified. These layers, ectoderm, mesoderm, and endoderm, each give rise to specific organs and tissues. Henry and Melton (p. 91) have identified a homeobox-containing gene, *Mixer*, that specifies the identity of the endodermal germ layer. The more specific anteroposterior pattern is specified by other downstream factors. These studies in *Xenopus* show that endoderm development follows a hierarchy of global definition followed by further specification that gives rise to endodermally derived organs.

TECHNICAL COMMENT SUMMARIES

Structure of β-Iron at High *T* and *P*

The full text of these comments can be seen at www.sciencemag.org/cgi/content/full/281/5373/11a

D. Andrault *et al.* studied (31 Oct., p. 831) the structure of iron under high temperature (*T*) and pressure (*P*) in a laser-heated, diamond-anvil cell. They found that iron underwent a phase transformation and exhibited "an orthorhombic lattice."

L. Dubrovinsky et al. see "two problems with this conclusion." They state that the "method of applying structural refinement for the purpose of 'quantitative assessment of a structural model' is invalid." They also "question whether phase analysis of collected x-ray patterns can be interpreted as a mixture of known iron phases ..., iron oxide, and pressure medium."

Andrault *et al.* respond that they "favor an orthorhombic-iron explanation of the experimental features, which seems ... the most parsimonious," and they discuss each of the criticisms in turn.

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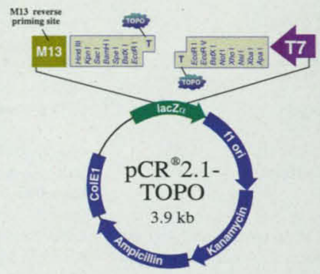

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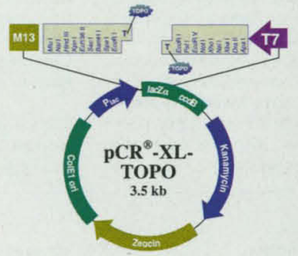

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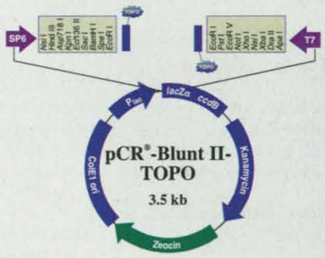

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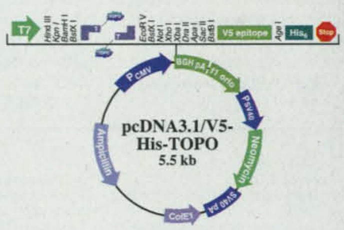

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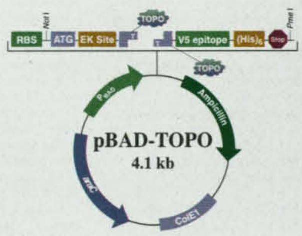

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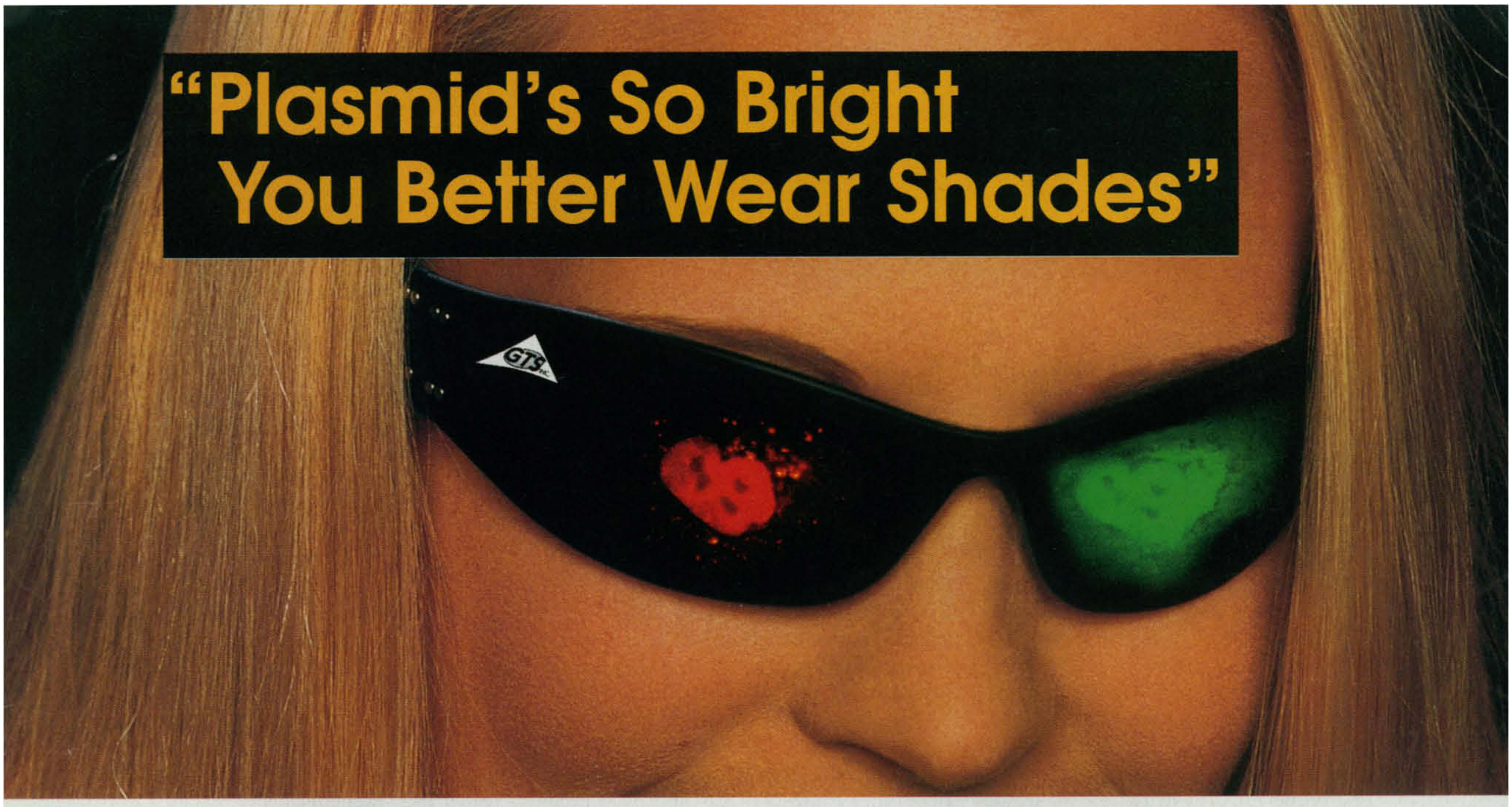

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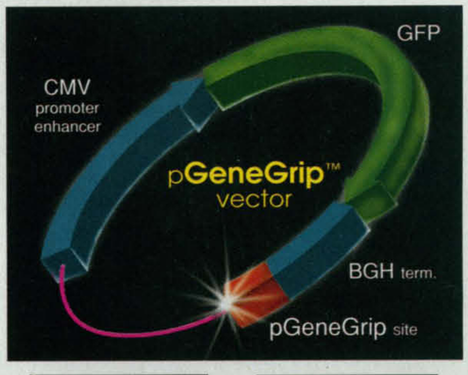

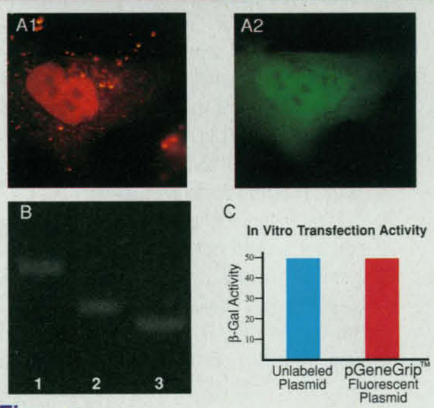

Figures:

A. Fibroblasts transfected with pGeneGrip™ Rhodamine/GFP vector:
1. Rhodamine labeled DNA
2. GFP expression

B. Electrophoresis of pGeneGrip™ Rhodamine labeled fluorescent vector
Lanes: 1. β-gal, 2. GFP, 3. Blank

C. Plasmid expression with and without fluorescent label.

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