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Science

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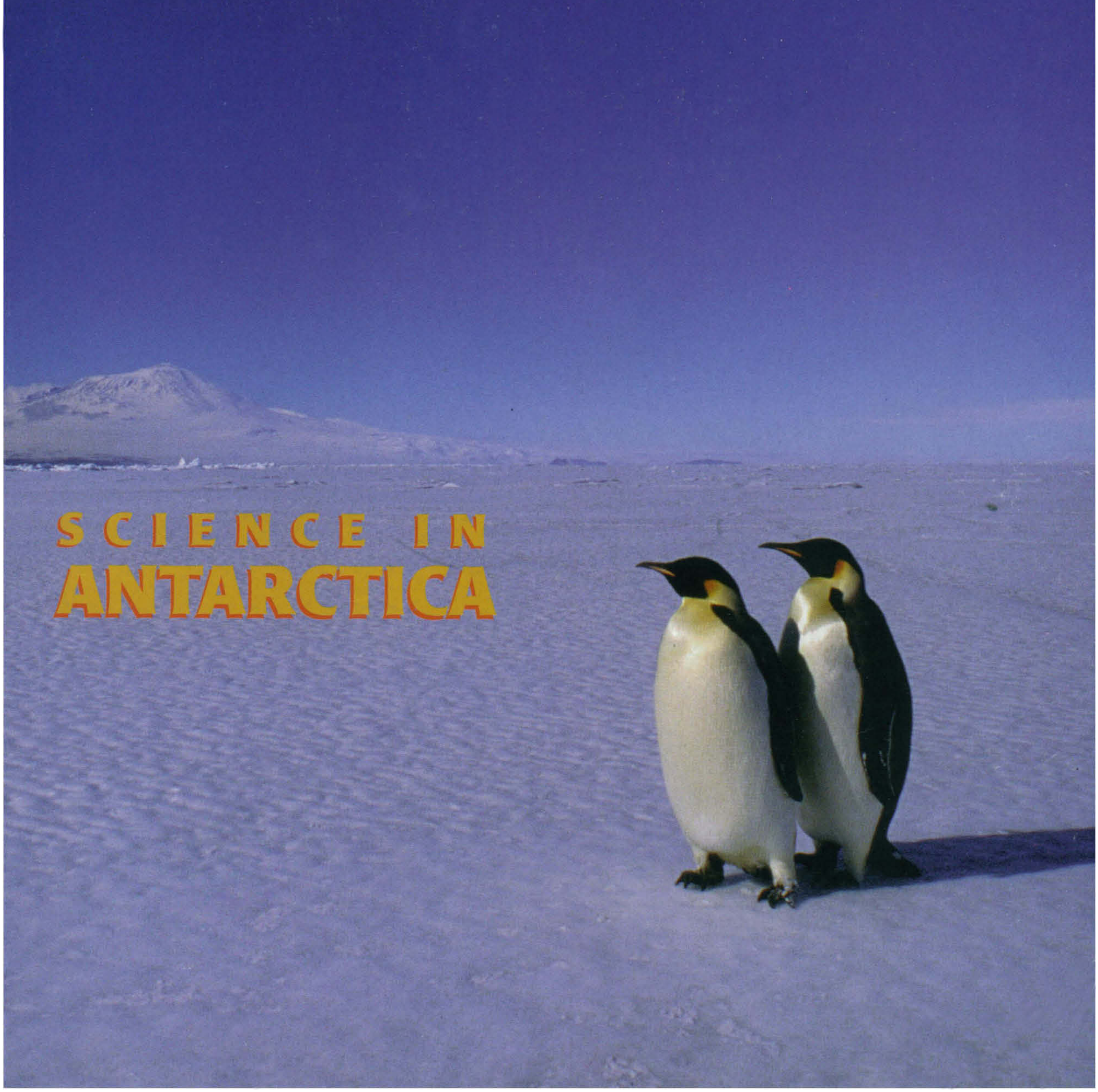

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SCIENCE

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150 YEARS • 1848-1998

653
The first Southwestern style

671
Not a flying disc

NEWS

SPECIAL NEWS REPORT

SCIENCE'S COMPASS

REPORTS

DEPARTMENTS

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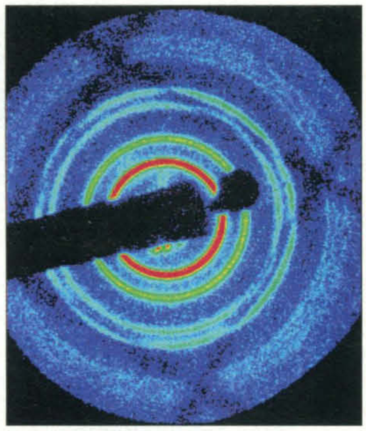
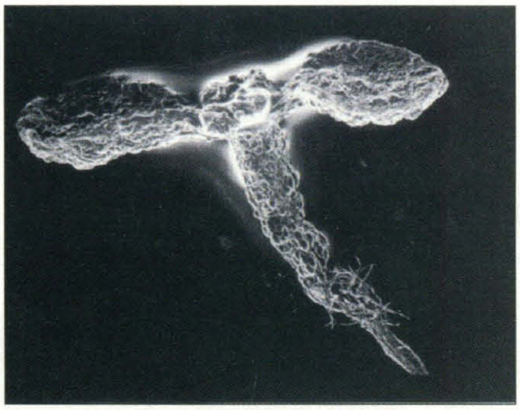
COVER

Many research projects in Antarctica are reaching critical turning points. Astrophysicists, for example, are gearing up to turn a South Pole test-bed into a major observatory. The cover photo, a pair of emperor penguins on the transitional ice between the sea and Mount Erebus, whimsically captures the increasingly international partnerships that drive antarctic science. A Special News Report beginning on page 655 and a Report on page 689 highlight antarctic research in its time of transition. [Photo: Eric Baker]



675 & 686
Crystalline plasma



672 & 717
Building cell walls

◩ **Indicates accompanying feature**

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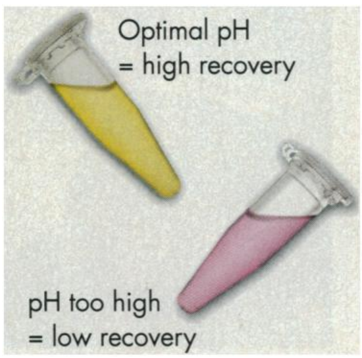
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edited by PHIL SZUROMI

Fast protons in faraway galaxies

High-energy photons are emitted from galaxies such as Markarian (Mrk) 501 and Mrk 421 that are difficult to explain as gamma rays produced by the acceleration of electrons in plasma jets. Mannheim (p. 684; see the commentary by Buckley, p. 676) proposes that these high-energy photons are instead produced by the acceleration of protons. Assuming this scenario is the correct one, he then estimated the number of galaxies in the universe from the amount of energy that is attributed to the observed extragalactic diffuse isotropic infrared background (DIRB). The contribution of energy produced by proton acceleration from the number of galaxies estimated from observations equals the amount of DIRB, indicating that the observational estimate may be quite accurate. Mannheim's model would support the idea that the rate of star formation has been decreasing over the history of the universe.

■

Jovian origin of chondrules?

The most common meteorites collected on Earth, the chondrites, consist of varying proportions of chondrules, which are rounded centimeter- to millimeter-sized clumps of silicate minerals with igneous textures. Within chondrules there are some refractory inclusions called calcium-aluminum–rich inclusions (CAIs); these are assumed to represent the earliest condensation products formed in the solar nebula. For decades, meteoriticists and astrophysicists have struggled to explain the evolution of the chondrules. The CAIs are millions of years older than the chondrules, indicating that the CAIs had to survive in the primitive solar nebula for a long time before becoming "protected" within the chondrules. Also, some chondrules show a complex thermal history in which some experienced multiple heating events, but others were only heated and melted into chondrules once. Finally, the exact heating mechanism is unknown, although it has been assumed that they were formed early in the solar nebula by shock waves from jetting from the sun or swirling dust in the nebula. Weidenschilling *et al.* (p. 681) propose a different model to explain these major discrepancies. They suggest that the CAIs formed early in the solar nebula and were insulated by being accreted to planetesimals. Then Jupiter formed before all of the nebular gas was dissipated. The gravitational force of Jupiter plus the gas drag from the remaining nebular dust allowed resonances to develop within the present asteroid belt region, which destabilized the orbits of planetesimals to produce additional collisions. The increased frequency of collisions produced the shock waves needed to melt particles into chondrules, while the nebular dust and the particles produced from planetesimal collisions produced the particles needed to create chondrites as well as isolating CAIs from the planetesimals by breakup for re-accretion into chondrules. This scenario can explain the age difference between CAIs and chondrules, the heating mechanism, and the multiple heating events experienced by some chondrules. In addition, if this scenario is correct it may provide an age of formation for Jupiter in the solar nebula.

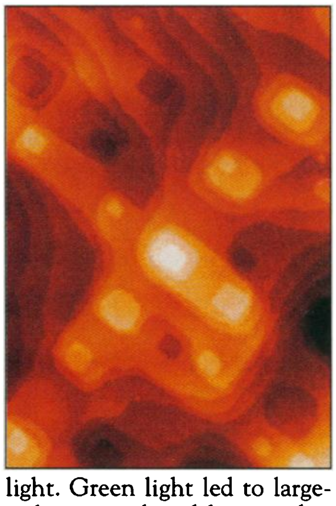
■

Creating crystals with plasmas

One-component plasmas, which consist of a single charged species embedded in a uniform, neutralizing background charge, are believed to be of relevance for astrophysical plasmas such as those found in neutron stars. Structural characterization of "frozen" plasmas has been difficult because of the need to combine stabilization of a plasma of sufficient size with structure detection. Itano *et al.* (p. 686; see the commentary by Schiffer, p. 675) report the characterization of one-component plasma crystals. They confine from 10^5 to 10^6 beryllium-9 cations at a density of 10^8 to 10^9 atoms per cubic centimeter, which is much less dense than normal crystals because there are no anions to screen the Coulomb repulsion. Under appropriate conditions, single crystals with a body-centered cubic (bcc) structure are formed and observed by resonant light scattering, confirming theoretical predictions. In other cases, two bcc crystals form, or a mixture of bcc and face-centered cubic ordering is observed.

■

How lighting can change a face



Light absorbed by metals is usually transformed into heat within a few picoseconds because electronic excitations are short-lived and delocalized. Structural changes in metals induced by light have been linked to temperature-induced melting or thermally induced strain. Ernst *et al.* (p. 679) have irradiated copper surfaces with green and infrared light. Green light led to large-scale structural modifications that terraced the surface, despite the low-temperature rise associated with the total energy put into the system. For the same total energy input, infrared light did not induce structural change. The green light must therefore excite a long-lived, spatially localized electronic state that couples with nuclear motion, whereas this state is not accessible for the infrared light.

■

Antarctic ice streams seen anew

The West Antarctic Ice Sheet is drained by several ice streams; the stability of the ice sheet has been

PATRICIA VORNBERGER

debated but is key for evaluating potential sea-level changes. Bindschadler and Vornberger (p. 689) analyzed recently declassified satellite images to evaluate long-term changes in the ice streams since 1963. Comparison with more recent images and data imply that ice stream B has widened at a rate much faster than expected and also slowed. Thus, the pattern of discharge from the ice sheet has changed significantly during this century.

■

Connecting ice sheets to bedrock

The Laurentide Ice Sheet covered most of eastern and central North America. One key question is whether its base was hard and more fixed to the bedrock or was soft. The nature of the base is reflected in the height and topography of the ice sheet and may help explain the origin of Heinrich events—episodes of ice discharge from the ice sheet that

(Continued on page 631)

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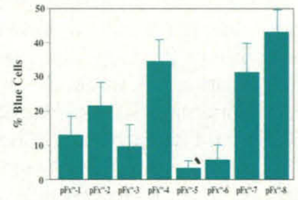

Figure 1: Percent blue cells produced by transfection of CHO cells with a lacZ control vector using PerFect Lipids™ (pFx™1 - pFx™8).

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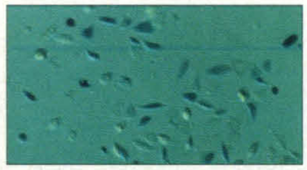

Figure 2: Transfected CHO cells expressing β-galactosidase, stained with X-gal.

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(Continued from page 629)

may reflect its temporary collapse. Fisher *et al.* (p. 692) describe results from two ice cores on Baffin Island through what is shown to be the remnant of the Laurentide Ice Sheet. The oxygen isotope data imply that ice preserved in the base of the cores originated at a high elevation. The data thus imply that the ice sheet had a hard bed.

Some preassembly before transport

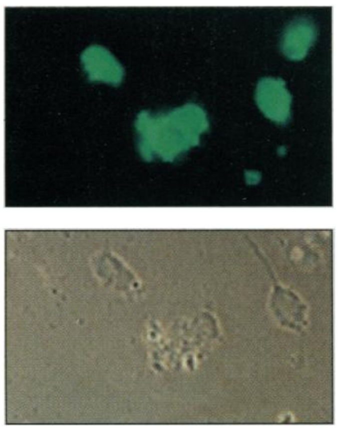
The SNARE hypothesis postulated the presence of receptors on vesicles (v-SNAREs) and target membranes (t-SNAREs) that would define the specificity of membrane fusion events during intracellular membrane traffic. Rowe *et al.* (p. 696) now show that a t-SNARE involved in endoplasmic reticulum (ER) to Golgi transport, syntaxin-5, actually performs its function while on a transport vesicle, rather than when at the target membrane. Previous studies in yeast have suggested that transport from the ER to the Golgi was mediated directly by the COPII vesicle coat complex. Syntaxin-5 appeared to be required for the fusion of COPII into the vesicle-tubular pre-Golgi intermediates and for delivery to the Golgi.

Getting the right amount of iron

Iron is a key element in multiple enzyme pathways, but its transport and homeostasis in the body must be carefully regulated to avoid toxic consequences of too much iron in the tissues. Ceruloplasmin (Cp), a copper oxidase, plays a role in iron metabolism (oxidizing Fe^{2+} to Fe^{3+}), and individuals lacking Cp accumulate damaging levels of iron in their tissue. Mukhopadhyay *et al.* (p. 714) describes how Cp surprisingly does not stimulate iron release from cells as previously assumed, but instead stimulates iron uptake by cells. Unlike most other iron controllers, Cp is not posttranscriptionally regulated, but is regulated at the transcriptional level (low iron concentrations stabilize its messenger RNA). One possibility for understanding the clinical implications is that poor iron accumulation in the liver leads to high plasma concentrations of iron, which stimulates Cp transcription and that of iron contollers.

Coactivators and transcription factors

Viral proteins such as the adenovirus E1A oncoprotein can inhibit normal cell differentiation and growth, and their study has led to the identification of proteins termed coactivators that interact with transcription factors. Several transcription factors involved in multiple cellular pro-



cesses specifically interact with the coactivators CBP (CREB binding protein) and p300. Kurokawa *et al.* (p. 700) use in vitro and in vivo analyses to demonstrate that various domains within the coactivators function with different classes of transcription factors. In comparing CBP-stimulated transcription, STAT-1 (signal inducer and activator of transcription–1) requires the cysteine-histidine–rich (C/H3) domain in CBP, which is also the site through which E1A inhibits STAT-1, but RAR (retinoic acid receptor) does not require the C/H3 domain, and its inhibition by E1A occurs through inhibition of assembly of the CBP-nuclear receptor coactivator complex. Korzus *et al.* (p. 703) show that various transcription factors display specificity in their interactions with factors containing histone acetyltransferase (HAT) activities. These studies help explain many of the interactions between transcription factors and coactivators and the need for various HAT activities.

PKB-kinase signaling

Many cell surface receptors activate phosphoinositide-3 kinases that phosphorylate phosphatidylinositol (4,5)-bisphosphate [PtdIns(4,5)P_2] to yield PtdIns(3,4,5)P_3. But until recently, it was unclear how the generation of PtdIns(3,4,5) contributed to cellular signaling. Two reports help clarify this signaling pathway and its regulation of the activity of insulin and growth factors (see the commentary by Downward, p. 673). The protein kinase PKB is now recognized as a target of complex regulation by inositol phospholipids. Binding of PtdIns(3,4,5)P_3 to PKB is required for phosphorylation and activation of PKB by another protein kinase. Stephens *et al.* (p. 710) have isolated and characterized a family of such PKB kinases. They find that PKB kinases also bind to and are activated by PtdIns(3,4,5)P_3. Generation of PtdIns(3,4,5)P_3 thus appears to promote activation of PKB by causing translocation of PKB and its activating kinase to membranes. Binding of insulin or growth factors to their receptors cause activation of the p70 ribosomal protein S6 kinase ($p70^{s6k}$), which enhances translation of messenger RNA transcripts that encode essential components of the protein synthetic machinery. This regulation and other effects of insulin are brought about through activation of a complicated array of phospholipid and protein kinases. The $p70^{s6k}$ protein is itself regulated by phosphorylation at multiple sites. Pullen *et al.* (p. 707) show that the PKB kinase known as phosphoinositide-dependent protein kinase 1 (PDK1) is also a key participant in control of $p70^{s6k}$ activity. Activation of PDK-1 appears to be required for insulin-induced activation of $p70^{s6k}$.

Cellulose synthesis

Despite its abundant and numerous uses, the synthesis of cellulose is still poorly understood. Through analysis of a mutation in *Arabidopsis* that fails in cellulose synthesis at high temperature, Arioli *et al.* (p. 717; see the commentary by Carpita, p. 672) have cloned the RSW1 protein, which functions as a catalytic subunit of cellulose synthase. At the restrictive temperature, the mutant plants fail to synthesize cellulose, and the multisubunit rosettes in the plasma membrane, thought to be sites of cellulose synthesis, disassemble.

Genes and human baldness

Although stages in the development of hair have been described, very little is known about the genes regulating that process or the factors that result in baldness. Ahmad *et al.* (p. 720) have studied a rare, inherited form of baldness called alopecia universalis, which results in a complete loss of hair on the scalp and other parts of the body. A missense mutation in the human homolog of the mouse gene *hairless* was associated with this disease in a human family. Understanding the effects of this gene may illuminate pathways leading to hair growth and indicate points for therapeutic intervention in more common forms of baldness.

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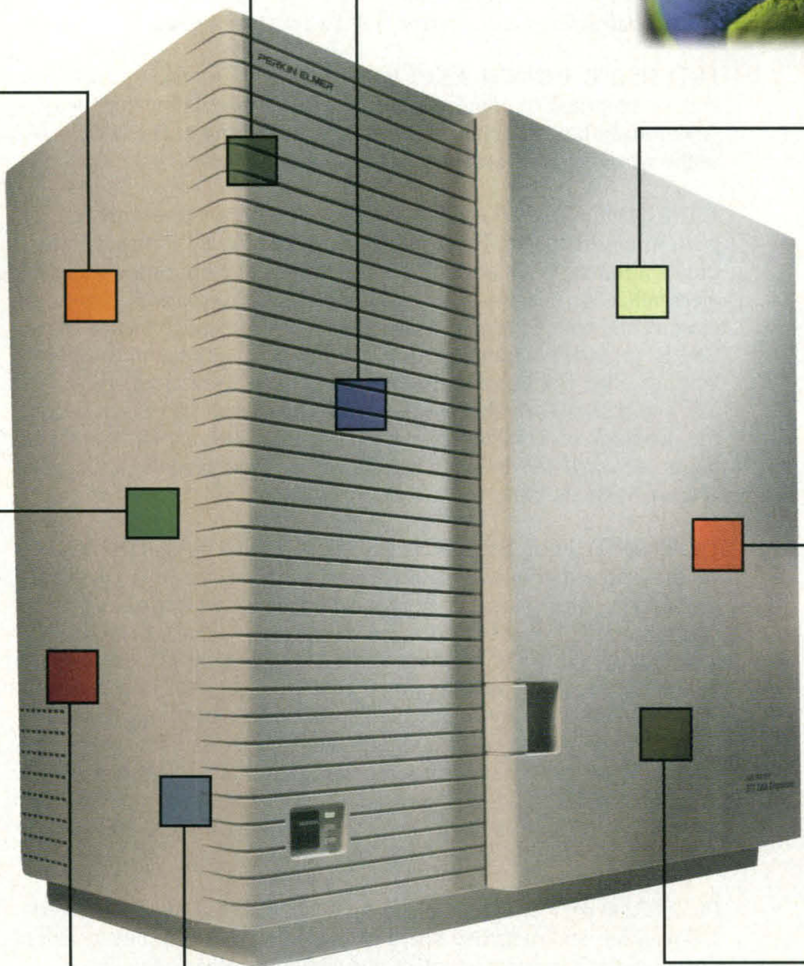

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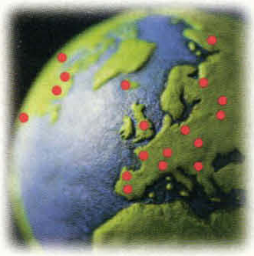

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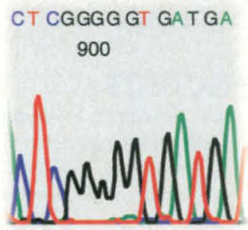

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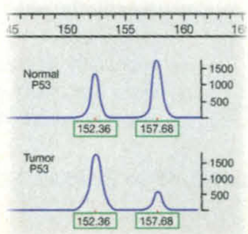

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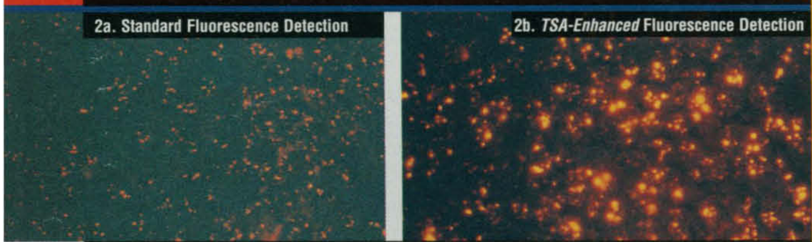
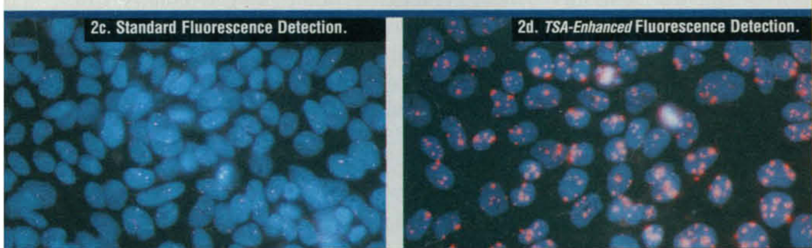


Tetramethylrhodamine filter



Multiband pass filter

Figs. 2a-d. Comparison of HPV fluorescence detection using Cy™3-conjugated Streptavidin versus TSA-Direct (Cyanine 3 FISH). Biotinylated HPV-16 E6 DNA probe hybridized to cultured CaSki cells.

2a-b. Standard fluorescence detection carried out with Cy™3-conjugated Streptavidin (Jackson ImmunoResearch Laboratories, Inc.). TSA-enhanced fluorescence used Streptavidin-HRP followed by Cyanine 3 Tyramide. Slides counterstained with Hoechst 33342 (Molecular Probes, Inc.) and evaluated using a tetramethylrhodamine filter. Photos taken using KODAK 1000 speed film with a 1 second exposure using a 40X objective.

2c-d. Protocol same as above but counterstained slides evaluated using a multiband pass filter. Photos taken using KODAK 1000 speed film with a 1 second exposure using a 40X objective.

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Fig. 3a-b. Comparison of standard fluorescence detection using Cy™3-conjugated Streptavidin versus TSA-Direct (Cyanine 3). Courtesy of *Kevin Roth, M.D., Ph.D., Washington University School of Medicine, St. Louis, MO.* Bouin's fixed, paraffin embedded mouse intestinal tissue, deparaffinized and incubated with biotinylated wheat germ agglutinin. Sections incubated with Cy3-conjugated Streptavidin (3a) or with Streptavidin-HRP followed by Cyanine 3 Tyramide (3b). Wheat Germ Agglutinin labels intestinal epithelial cells at the base of the crypts.

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Protein Characterization and Proteomics:

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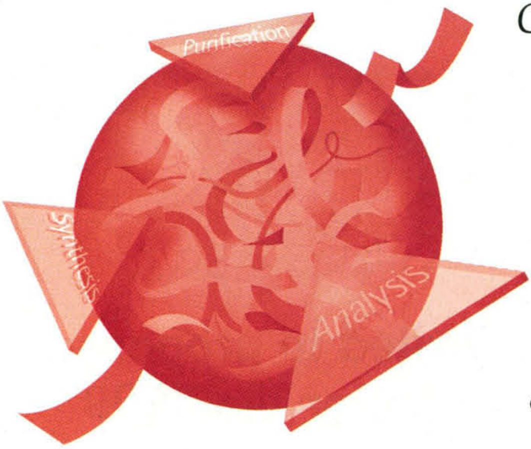

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