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Science

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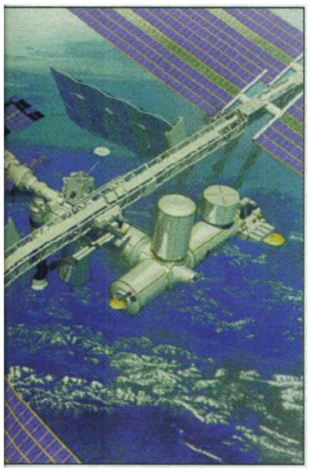
COVER The hippocampus has long fascinated scientists because of its involvement in learning and memory. Gene knockout studies now reveal an essential role of the LIM homeobox gene *Lhx5* in its formation. Hybridization of brain sections with a marker for hipppocampal cells showed that postmitotic cells in an *Lhx5*-deficient mutant (bottom) failed to form the structures typical of the hippocampus in normal mice (top) (image width ~880 μm). [Image: Yangu Zhao]



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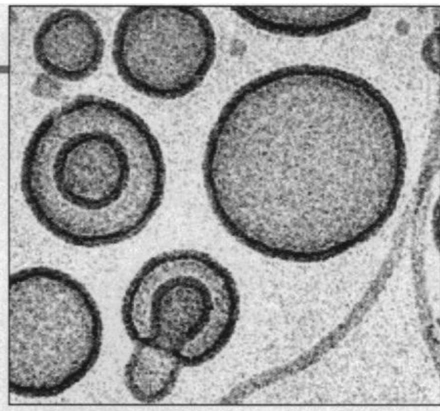

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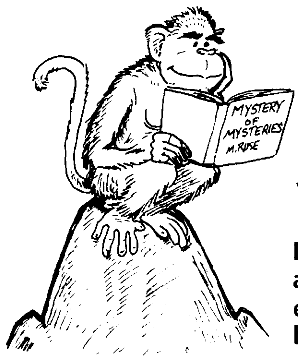

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Data, beliefs, and culture in evolutionary biology

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Plotting carbon uptake by forests

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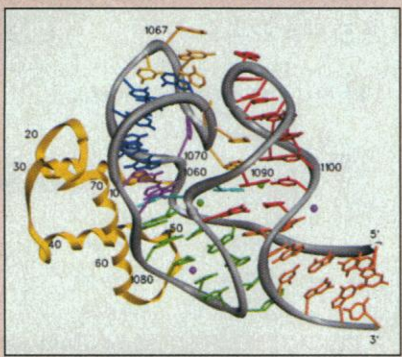
HOLDING A RIBOSOMAL RNA FOLD

Unlike most enzymes, the ribosome, which translates genetic information into peptide sequences, contains several RNA subunits in addition to many proteins. Although it might be expected that the RNAs would play a greater structural than catalytic role, a crystal structure determined by Conn *et al.* (p. 1171) shows how the protein L11 stabilizes an unusual fold of a piece of the large subunit ribosomal RNA and exposes highly conserved bases. This RNA piece contains the site where elongation factor G binds reversibly during peptide bond formation and where the antibiotic thiostrepton acts to inhibit protein synthesis. Helical portions of the RNA are brought together through base stacking and hydrogen bonds between three base triplets, and the protein helps to stabilize the intertwined helices through precise interactions with extrahelical bases.



SCULPTING FAINT JOVIAN RINGS

Jupiter has three faint rings (the gossamer ring, the main ring, and the inner halo) composed mainly of micrometer-sized particles that have been difficult to observe. Burns *et al.* (p. 1146) have analyzed and modeled data from the Galileo spacecraft and the Keck telescope in Hawaii and determined that the gossamer ring is actually two rings, and the roughly rectangular cross sections that these rings present when viewed edge on (as opposed to a lens-shaped cross section) are controlled mainly by the production of ejecta from the small satellites Amalthea and Thebe. Absorption of solar radiation causes a subsequent inward reduction of the particles' orbit through momentum loss. The main ring of the Jupiter system is probably also derived from ejecta from the satellite Adrastea. These observations and models suggest that the Jovian planets and possibly Mars have faint rings associated with their small satellites.

SWITCHING SUPERCONDUCTIVITY

The electronic properties of a high-temperature superconductor are sensitive to the amount of doping of positive charge carriers (holes) in the material. The ability to control this dopant density in a reversible manner is crucial for developing useful devices. Ahn *et al.* (p. 1152) describe how they switch a thin-film cuprate between a superconducting state and insulating state by biasing a ferroelectric layer located adjacent to the cuprate layer. The electric field provided by the ferroelectric is sufficient to modify the dopant density in the cuprate layer by pulling in or repelling holes from the layer, depending on its polarization state. The ability to program the polarization state of the ferroelectric allows nonvolatile switching of the cuprate layer.

TOUGHER VESICLES FROM POLYMERS

The combination of hydrophilic and hydrophobic interactions that allow lipids to form membranes and vesicles can be built into synthetic polymers. Discher *et al.* (p. 1143) found that they could replicate the flexibility of lipid vesicles in short polyethyleneoxide (PEG)–polyethylethylene copolymers but achieve almost an order of magnitude improvement in toughness (rupture strength) and at least a 10-fold decrease in water permeability. Such tunability may prove useful in designing vesicles for delivery applications.

FAMINE OF THE DEEP

A 7-year comparison of sinking particulate organic carbon and oxygen consumption by a sediment community at a site in the eastern North Pacific by Smith and Kaufmann (p. 1174; see the Perspective by Druffel and Robison) indicates that the demand for food by this deep-sea community currently outstrips its supply from the ocean surface. The discrepancy results from a decrease in plankton biomass at the surface that may be caused by increases in sea-surface temperature. Such trends could impact deep-sea communities and geochemical cycling.

CAPTURING CO_2

Concentrations of carbon dioxide (CO_2) are not increasing as fast as they should based on known inputs. The world's forests may be consuming this excess CO_2, but detection has been difficult because the forests have several carbon pools (including wood, foliage, litter, and soils) that also rapidly exchange carbon with each other. Delucia *et al.* (p. 1177) present results from an experiment in an intact ecosystem designed to evaluate these pools and fluxes. The experiment has run for 2 years and involves forest plots exposed to ambient or to high CO_2 concentrations. During this time, total net primary production increased by 25% in the CO_2-enriched plots. Such an increase globally would extract about one-half of the anthropogenic CO_2 emissions in 2050.

REPLENISHING EPITHELIAL LINES

The oval cells of the liver are thought to be precursors (stem cells) for the major cell types that comprise the liver, including hepatocytes and bile ductal epithelium. These cells are a potential source for regeneration of the organ after acute liver failure. Their origin has been obscure, however. Petersen *et al.* (p. 1168) report that such cells can be found in the bone marrow. Thus, the bone marrow, source of stem cells for blood and mesenchymal cells, may also be a source of stem cells of an epithelial lineage.

MOVING PICTURES

How do we decide which bits and pieces of a visual scene go with which other bits and pieces? The usual suspects would be common features, such as color, brightness, or direction of motion. Lee and Blake (p. 1165; see the news story by Barinaga) have created a new kind of visual display in which patches containing contours of a particular orientation (called Gabor elements) change orientation unpredictably. Observers perceived a figure distinct from the background if the changes of direction within a small area were synchronized under conditions where the usual cues for figure-ground segmentation do not contribute. These results raise the question of how the visual system detects fine temporal correlations and identifies boundaries where these local correlations differ.

DISRUPTING SPERM FOR GENE TRANSFER

Current methods of transferring foreign genes into embryos all have different drawbacks. One approach, the use of sperm to carry DNA on their external surfaces into eggs, had fallen into disrepute because of irreproducibility. Perry *et al.* (p.

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1180) found that they could get a high frequency of transfer of two different plasmids into mouse oocytes by disrupting the membranes of sperm heads. A transgene for green fluorescent protein was expressed in live offspring, which were then capable of passing the transgene to their progeny. This procedure has the potential to be applicable to species in which micronuclear injection has not been easy and for the transfer of larger pieces of DNA.

HIPPOCAMPAL DEVELOPMENT

In the mammalian brain, higher cognitive functions such as learning and memory depend upon the circuits that run through the hippocampus. Zhao *et al.* (p. 1155; see the cover) have identified a LIM homeobox gene, *Lhx5*, that is required for normal hippocampal development. In mice carrying a deletion in the *Lhx5* gene, development of the hippocampus began relatively normally as the precursor cells proliferated. However, in the mutant mice, the cells destined to form the hippocampus migrated aberrantly and failed to differentiate. Comparison with phenotypes generated by other mutations affecting the hippocampus now delineates an intermediate phase in hippocampal development, after proliferation but before final placement and differentiation of the critical cells, for which *Lhx5* function is critical.

GAD AND TYPE I DIABETES

In type I diabetes, the immune system destroys the insulin-producing β cells of the pancreas. T cells to specific antigens develop—those recognizing glutamic acid decarboxylase (GAD) appear early in disease. Transfer of these T cells to nondiabetic animals can initiate disease. Yoon *et al.* (p. 1183; see the Perspective by Boehmer and Sarukhan) report that expression of GAD in β cells is required for the development of diabetes in NOD mice, the mouse model of type I diabetes. A series of mice were developed that expressed increasing amounts of an antisense gene to GAD messenger RNA. When expression was high, little GAD was detected on the β cells, and the NOD mice did not develop diabetes. Transfer of β cells from these mice into diabetic NOD mice cured NOD diabetes. Thus, not only was GAD necessary for the development of diabetogenic T cells, but the β cells were not destroyed in mice with ongoing disease unless they expressed GAD.

HITTING THE IMMUNE SYSTEM TWICE

Although it is accepted that CD8 T cells need continued engagement of their T cell receptor (TCR) for survival, it is not clear what role CD8 actually plays. Pestano *et al.* (p. 1187) report that if CD8 cells do not simultaneously engage both their TCR and CD8 proteins, the CD8 gene is remethylated and the cells eventually die through the Fas-FasL pathway. It seems that blockade of this default death pathway, rather than being provided with an external signal, may be most important for survival. Thus, if CD8 T cells bind to targets that do not express enough of the ligand for CD8 (major histocompatibility complex class I proteins), such as some virally infected cells and many tumor cells, not only may the targets live, but the CD8 T cells may die as well.

TECHNICAL COMMENT SUMMARIES

Considering a Neoproterozoic Snowball Earth

The full text of these comments can be seen at www.sciencemag.org/cgi/content/full/284/5417/1087a

P. F. Hoffman *et al.* (Reports, 28 Aug., p. 1342) found "carbon isotope anomalies in carbonate rocks bracketing Neoproterozoic glacial deposits in Nambia" and calculated "estimates of thermal subsidence history." Their results support the proposal that a "global glaciation (that is, a snowball Earth)" occurred about 700 million years ago (Ma), stifling life in the oceans. They concluded that "volcanic outgassing" created "extreme greenhouse conditions," which finally melted the ice.

N. Christie-Blick *et al.* comment that evidence of "gradual retreat of the ice front is recorded in many areas" of Australia and North America, contrary to the "catastrophic" melting posited in the report. They also state that isotopic depletion data indicate that the maximum point of "collapse of primary productivity" in the oceans likely happened after the time at which the ocean would have been frozen.

In response, Hoffman and Schrag describe a "complex interplay" of forces, stating that "conventional glaciation" probably preceded—and that "a limited hydrologic cycle" would still have existed during—a snowball Earth. They interpret the isotopic values as reflecting the "*relative* amounts of carbonate carbon and organic carbon burial in sediments," which thus supports the snowball Earth scenario.

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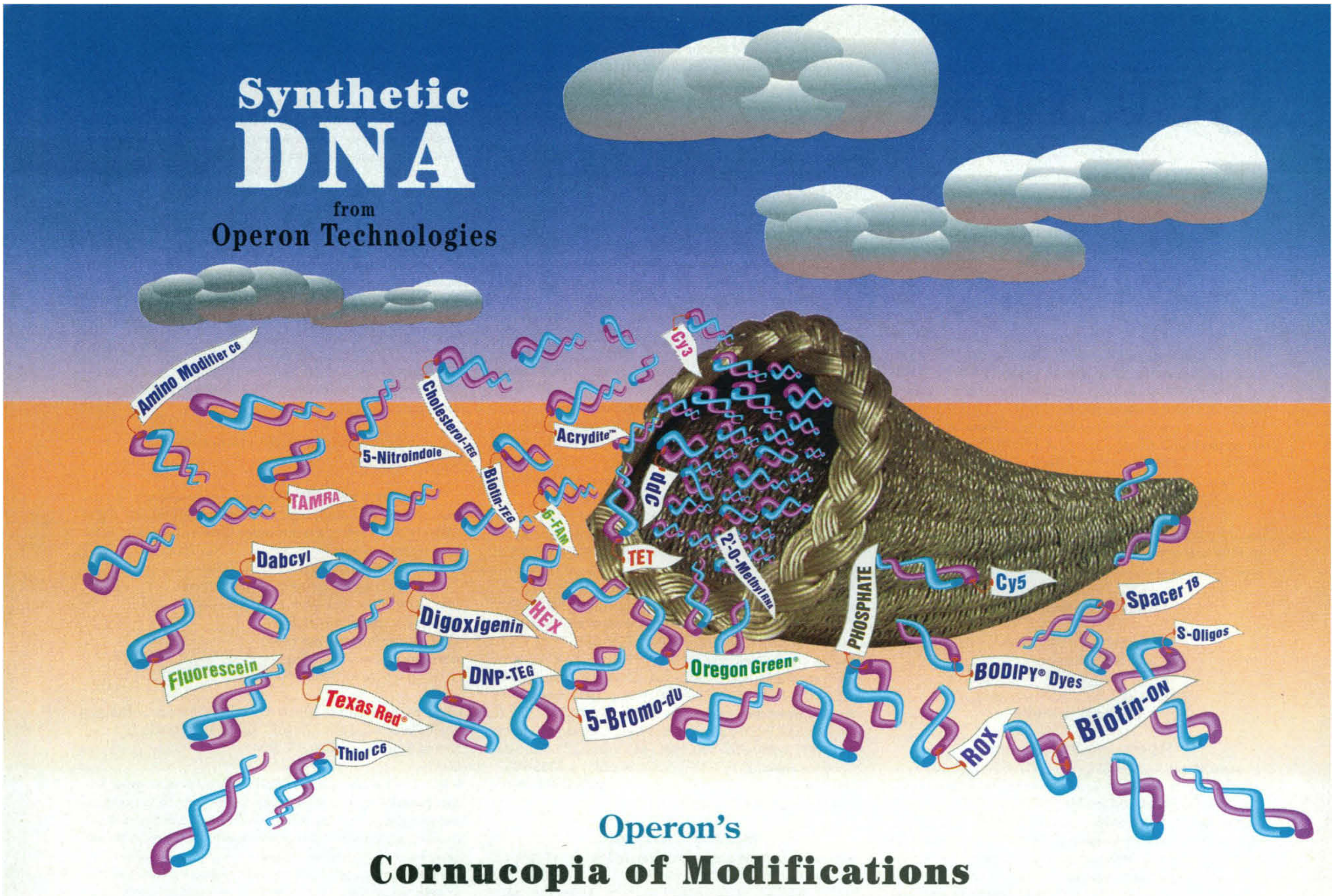

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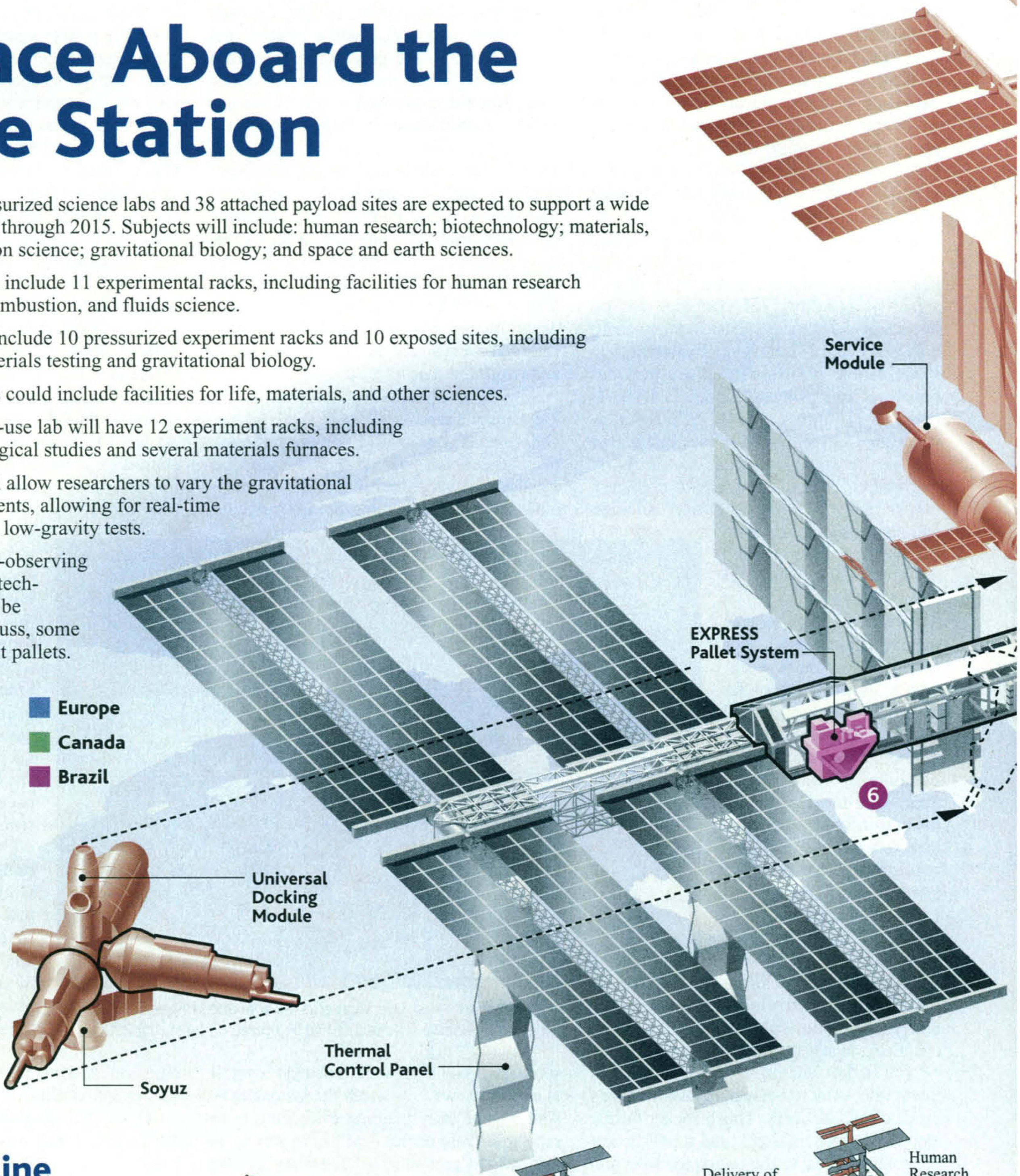
Science Aboard the Space Station

The station's six pressurized science labs and 38 attached payload sites are expected to support a wide range of experiments through 2015. Subjects will include: human research; biotechnology; materials, fluids, and combustion science; gravitational biology; and space and earth sciences.

1. The U.S. lab will include 11 experimental racks, including facilities for human research and materials, combustion, and fluids science.
2. Japan's lab will include 10 pressurized experiment racks and 10 exposed sites, including facilities for materials testing and gravitational biology.
3. Russia's two labs could include facilities for life, materials, and other sciences.
4. Europe's general-use lab will have 12 experiment racks, including BioLab for biological studies and several materials furnaces.
5. A centrifuge will allow researchers to vary the gravitational force in experiments, allowing for real-time comparison with low-gravity tests.
6. Earth- and space-observing instruments and technology tests will be attached to the truss, some on Brazilian-built pallets.



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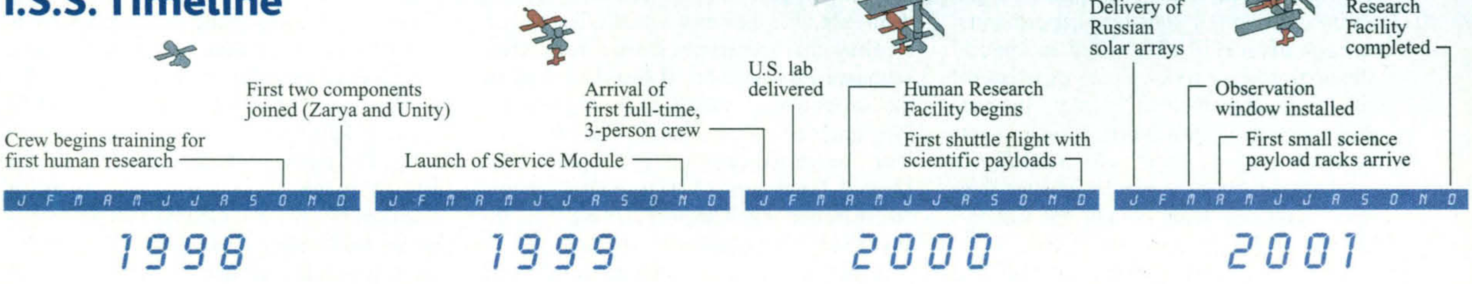

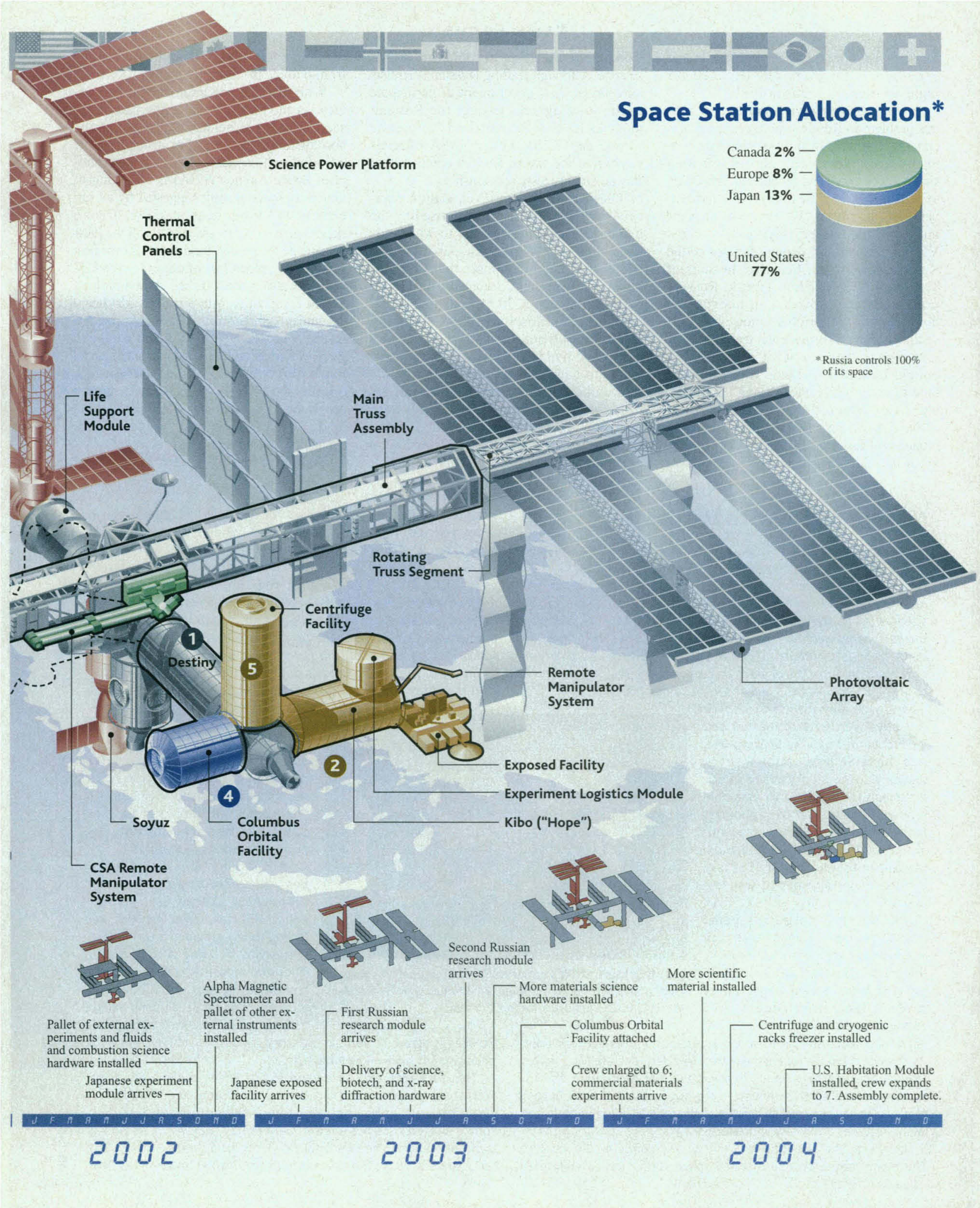
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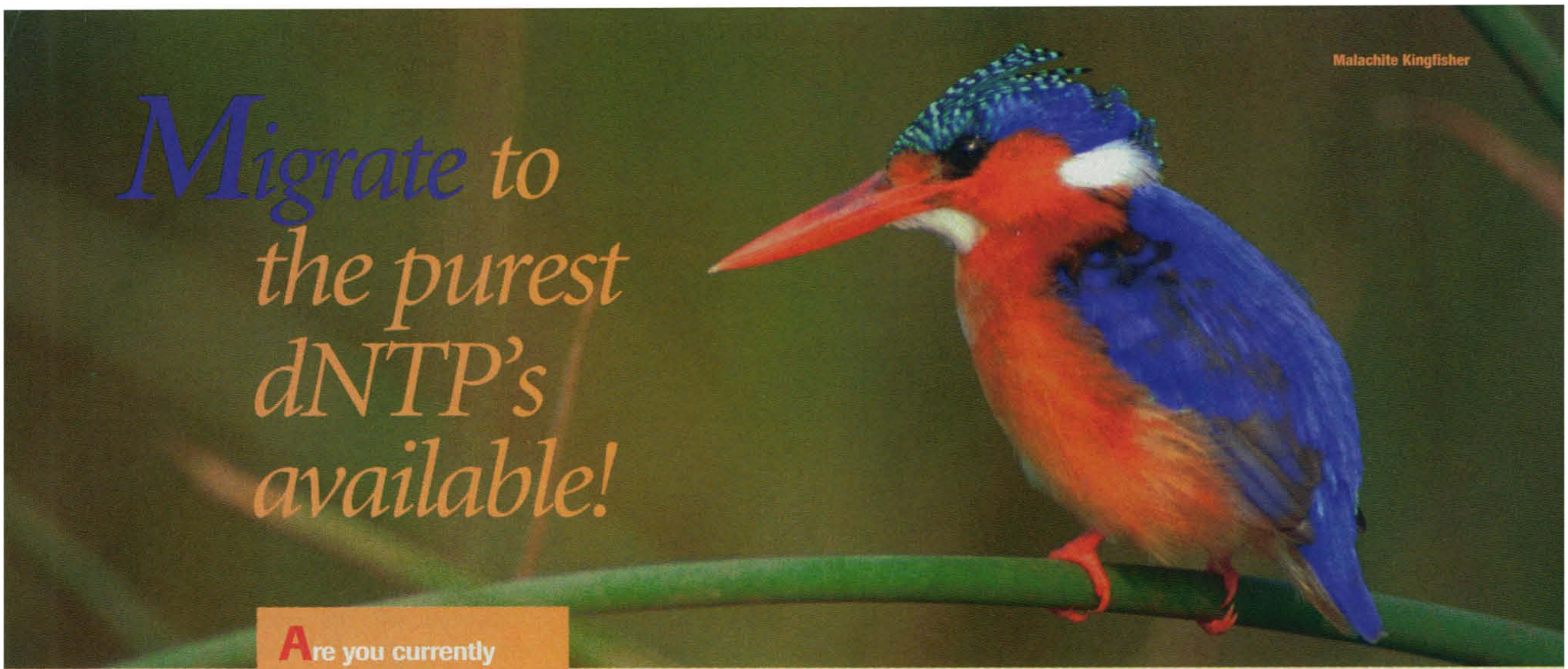

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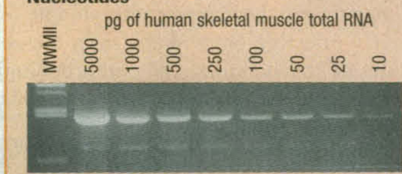

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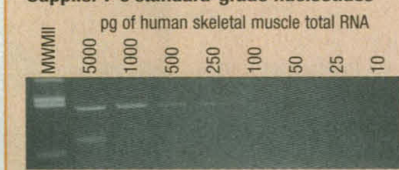

RT-PCR amplification of an 1849 bp fragment of the human dystrophin gene.

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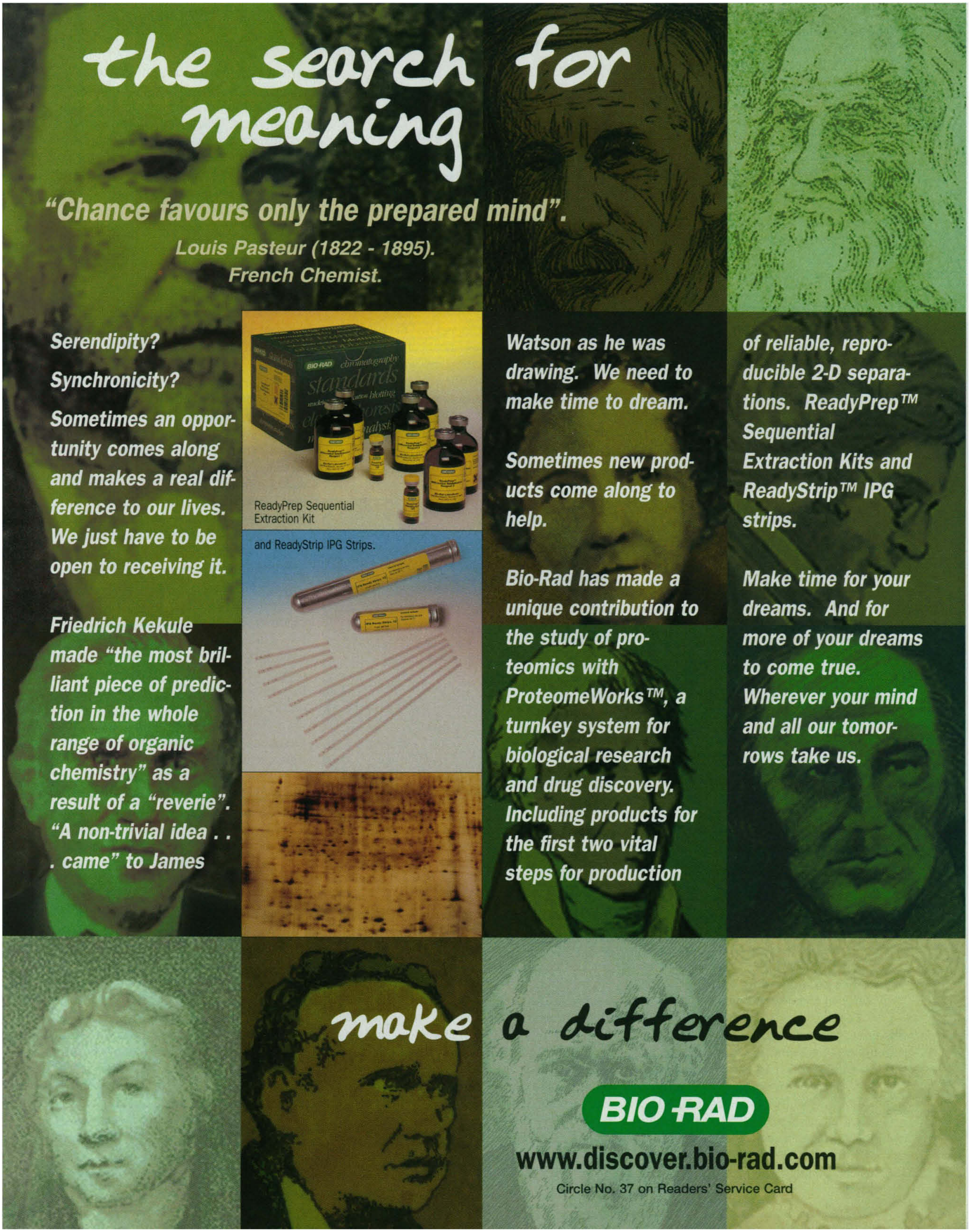
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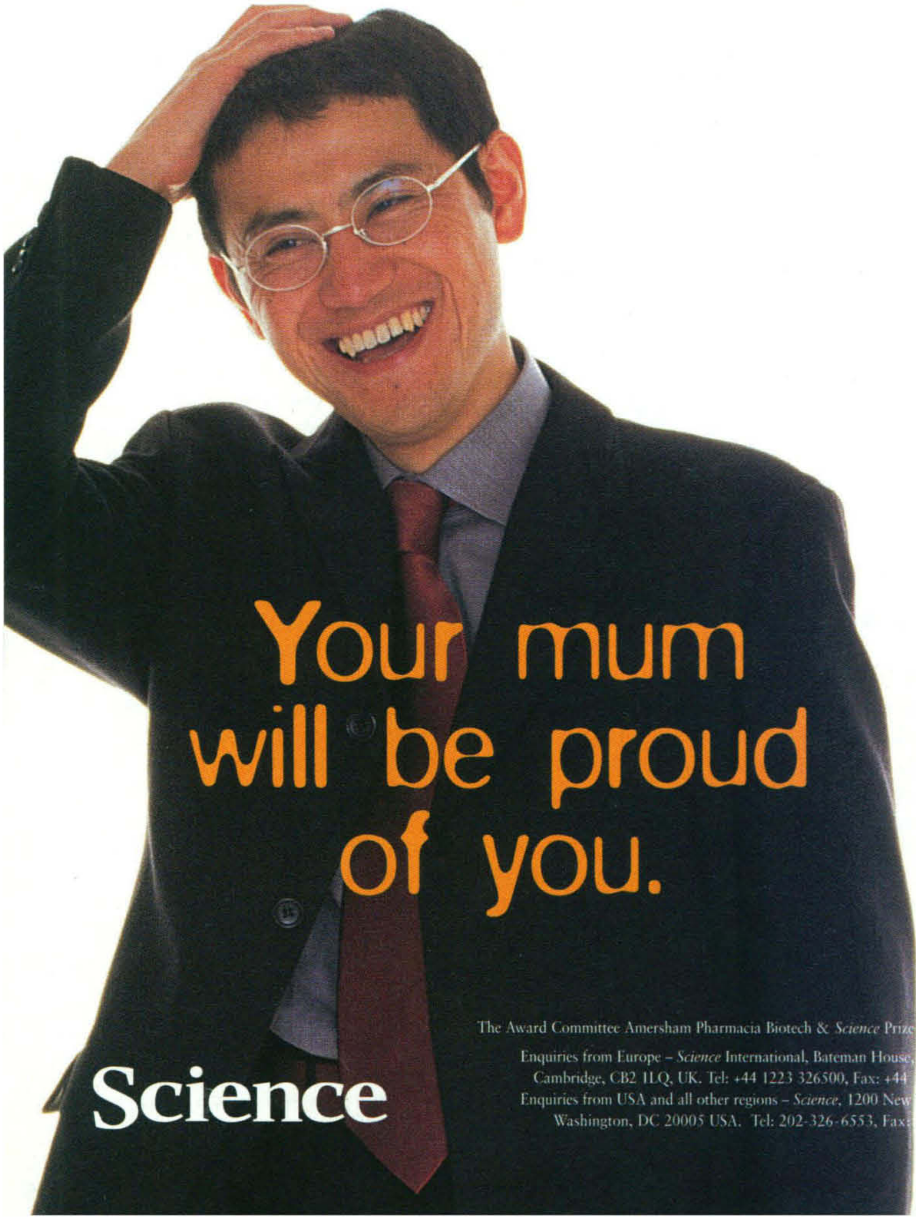

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Hiroyuki Noji
(Ph.D. awarded by Tokyo Institute of Technology), winner of the 1998 Amersham Pharmacia Biotech & *Science* Prize for Young Scientists.

The Award Committee Amersham Pharmacia Biotech & *Science* Prize for Young Scientists

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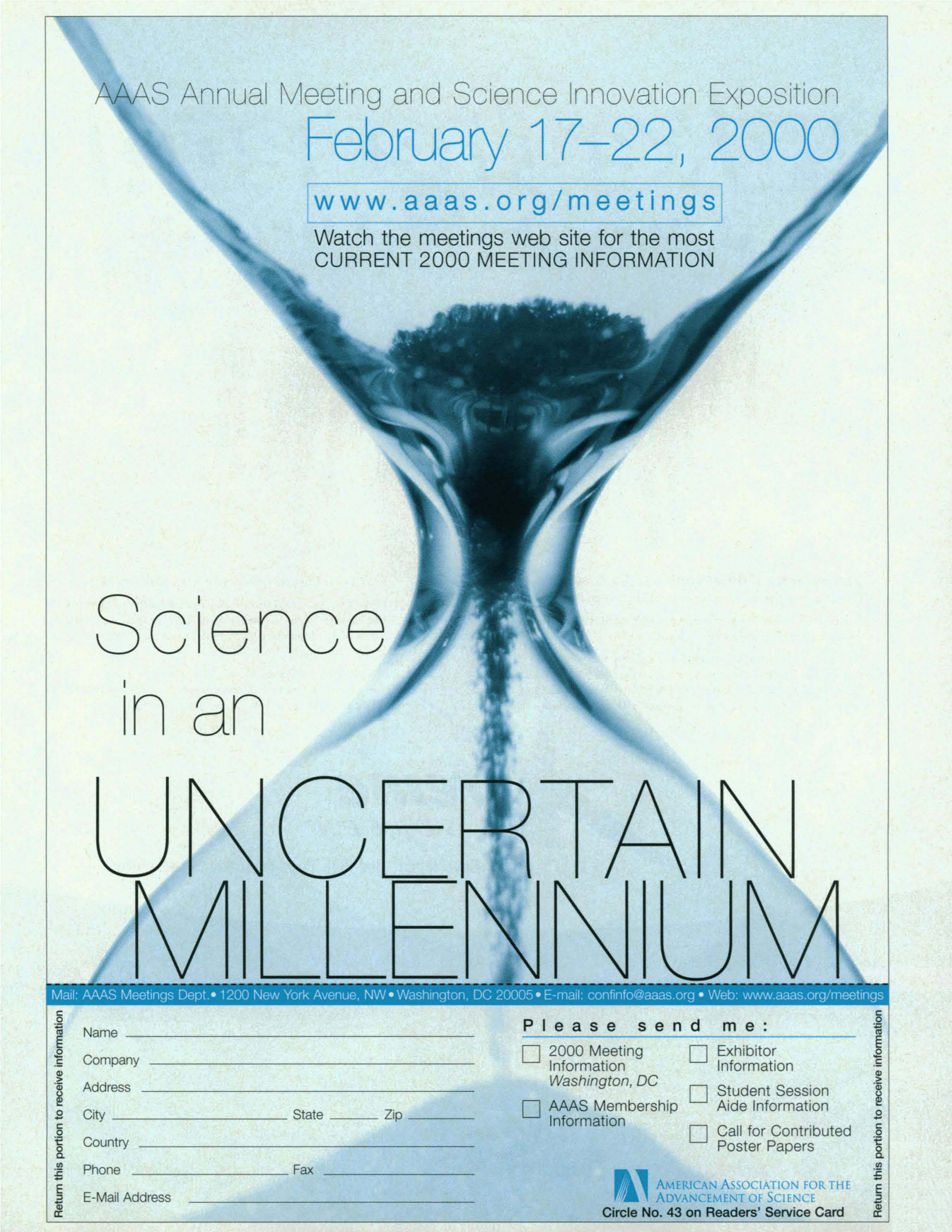
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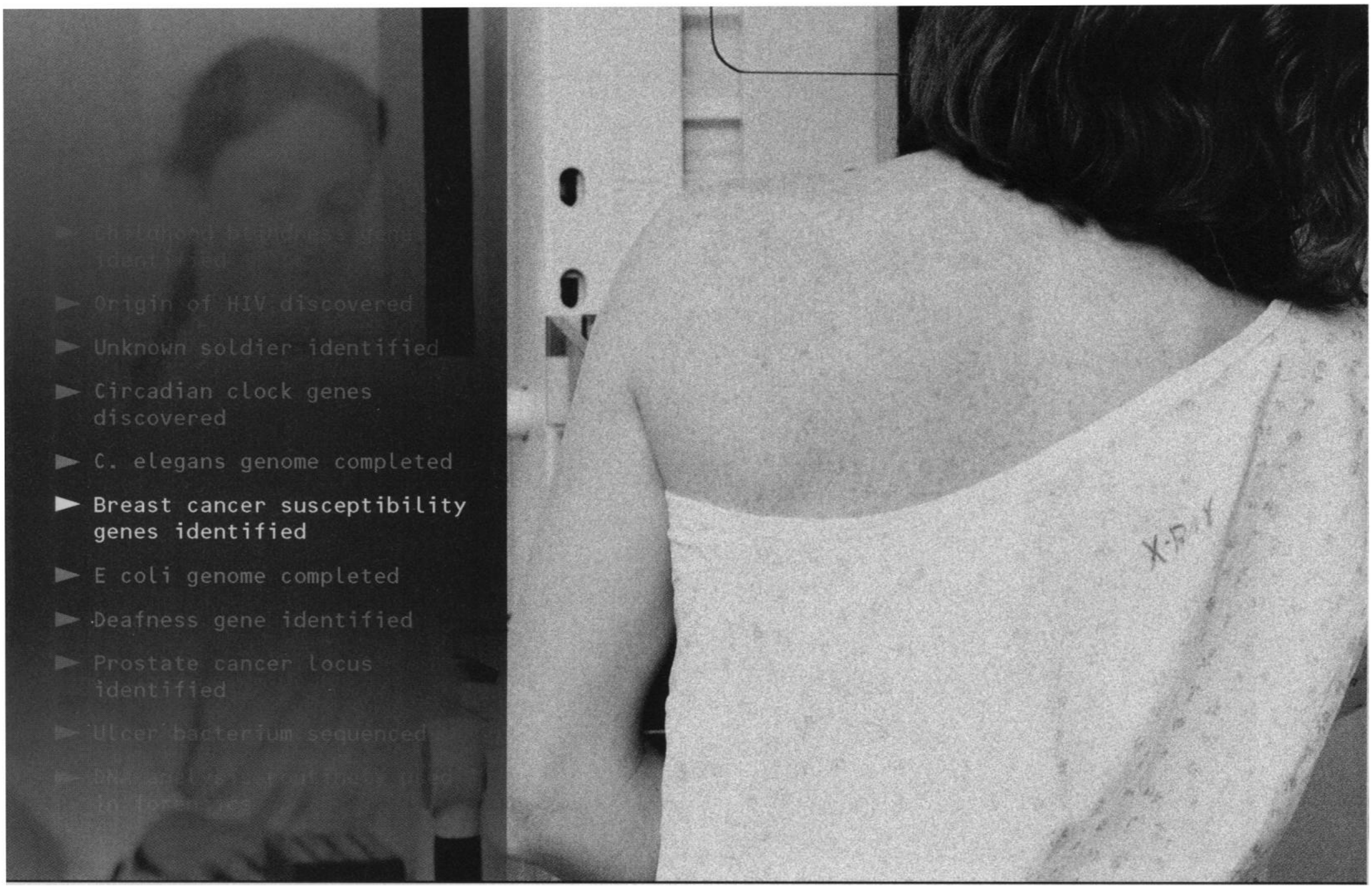

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