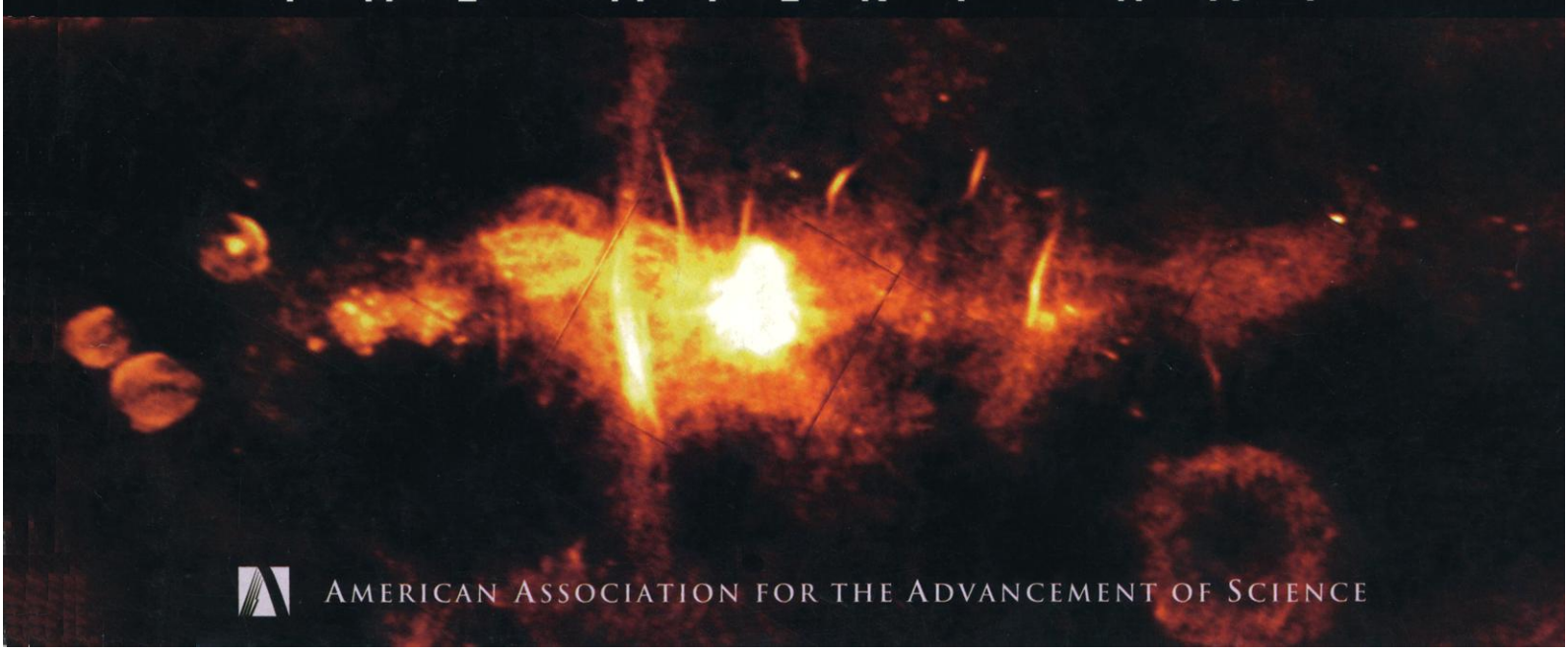
7 January 2000

Science

Vol. 287 No. 5450
Pages 1–180 $8

THE MILKY WAY



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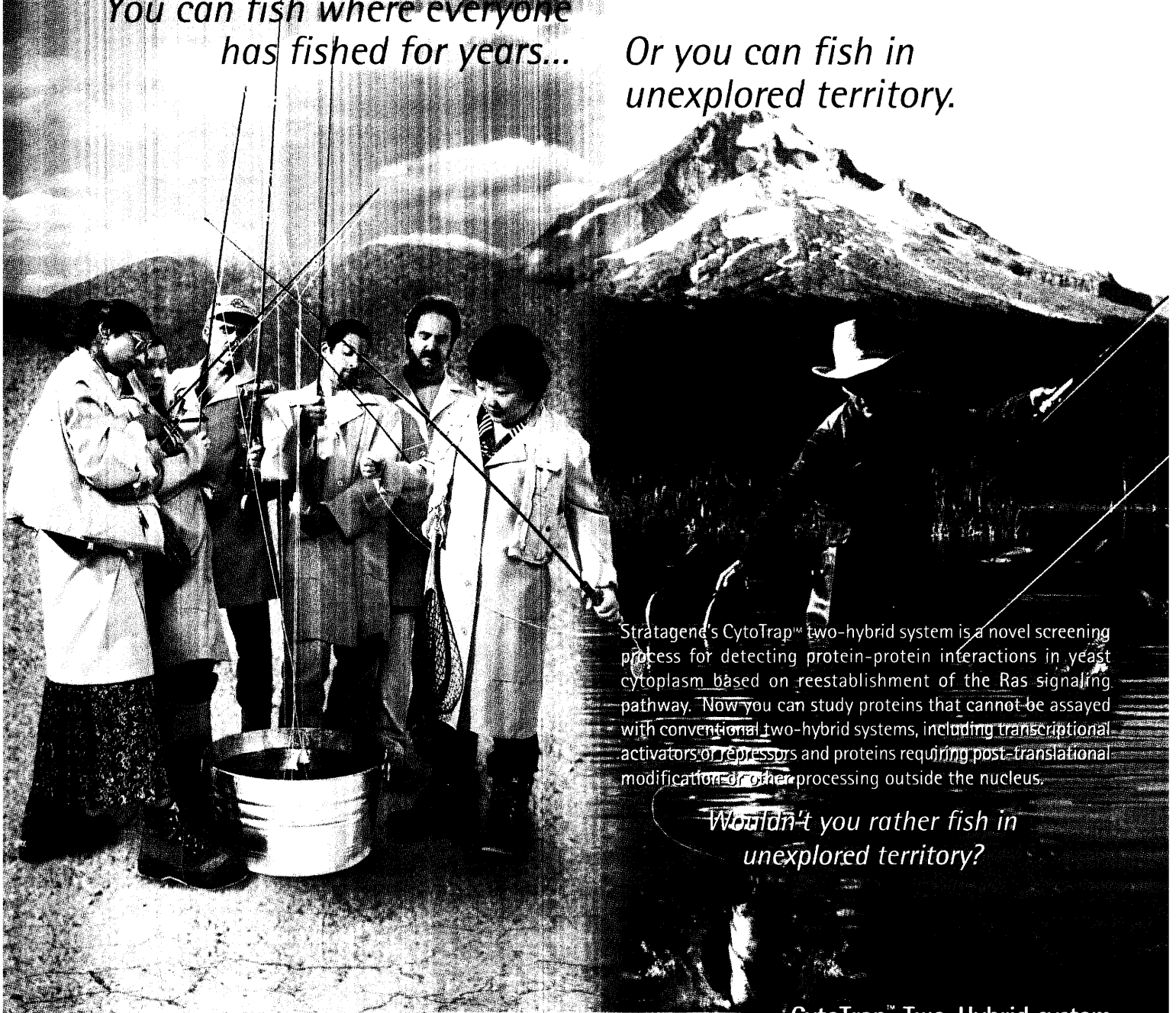

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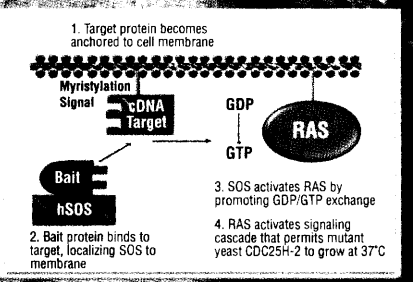

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THE MJ RESEARCH NOTEBOOK

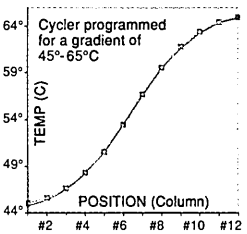
Volume IX...No. 3 *A Bulletin of Technological Advance in Molecular Biology* *Winter 2000*

Gradient Calculator Especially Useful

Easy to Transfer "Golden" Parameters to Actual Protocols

Most researchers would agree that gradient cyclers are great in concept—but their utility is significantly compromised if an optimized protocol does not transfer well to normal, non-gradient operation. This "Achilles heel" of gradient cyclers can often be traced to imprecise knowledge of either incubation time or incubation temperature during the gradient step. Whatever technology is used, there will always be lags—often not well known—before samples reach the new temperature.

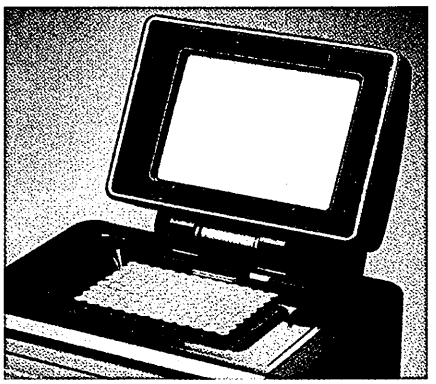
MJ has long had an excellent reputation for delivering time/temperature control with precision, so extra efforts were expended to address these issues. Thus time control includes "dynamic ramping" (see below), while temperature control incorporates a new software feature called the "gradient calculator".



Reported temps (dots) vs. independently acquired thermal data in 4 cyclers (lines).

This calculator is so precise and accurate that it reports the temperatures in individual columns to within ±0.4°C of the NIST standard, making transfer of values to normal operation *very* reproducible. Just look above how reported temperatures from the gradient calculator superpose *almost perfectly* with independent NIST-traceable data from 4 different cyclers.

NEW GRADIENT HELPS OPTIMIZE ANNEALING AND DENATURATION


DNA Engine™, with the thermal gradient shown in artificial colors from data collected by an IR camera.

Optimized Denaturations Surprisingly Important

It is well known in the biological community that DNA amplification reactions should have optimized annealing temperatures for best results. Denaturation is quite important as well—but only the savvy optimize this step.

Too bad. MJ's scientific staff finds that denaturation often leads to problems. Use of a lower denaturation temperature, such as 90°-92°C, is generally recommended whenever possible. Not only does it preserve enzymatic activity for later cycles, it also reduces breakdown of fluorescent dyes in cycle sequencing. On the other hand, higher temperatures, such as 95°-96°C, may be required for GC-rich templates from organisms such as Mycobacteria.

ALL EXISTING DNA ENGINES & TETRADS CAN BE UPGRADED

Standard Feature on New Thermal Cyclers

WALTHAM, Mass. — MJ RESEARCH is pleased to announce the introduction of an advanced gradient feature that is now standard on all DNA Engine & Tetrad thermal cyclers. This powerful new function allows precision thermal gradients as high as 24°C to be developed across 96-well blocks, at any temperature between 30° and 105°C. This greatly assists in developing robust protocols, for the optimal annealing and denaturation temperatures give strong results without lots of "ampli-schmutz" or other unwanted artifacts appearing in the gel.

Many reactions benefit from careful temperature optimization, especially sensitive ones, such as dye-terminator cycle sequencing. GC-content, length of molecule, concentration of magnesium—all these lead to differences in optimal "heat" for annealing and denaturation. This is why empirical experiments can almost always enhance even the *best* calculations for T_m.

But who wants to do a dozen runs of slightly variant protocols? Gradient cyclers make this chore much easier by allowing a dozen different incubation temperatures in a single run. The user simply selects a range of temperature, and the cycler does the rest. The optimal temperatures become obvious in the gel—with thick "meaty" bands unbracketed by artifact.

How to Get Upgrade

In a nutshell, visit the MJ website. For DNA Engines manufactured after 1/1/99, the gradient feature is a simple software upgrade that is provided free and can be installed by users. For older DNA Engines or Tetrads, a new logic board is also required, and this upgrade is available inexpensively from MJ or its distributors.

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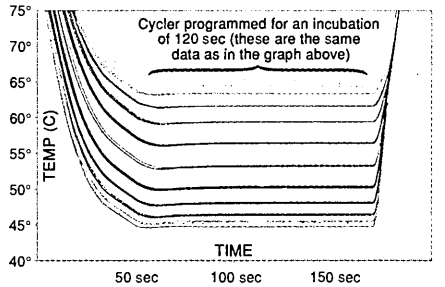
Precision Control of Time as well as Temp

"Dynamic Ramping" Incubates Each Sample for Same Period

In some gradient cyclers, the gradients develop gradually. When cooling to an annealing gradient, for example, the highest temperature stabilizes long before the lowest one does. This means that the time spent at incubation is different at each temperature—thus two critical parameters are being varied at the same time.

Not so with MJ cyclers. Careful engineering has led to "dynamic ramping" where each column of wells ramps at a different rate, for ramp rates are much less critical. The results are consistent incubation times column-to-column, with only temperature varying among samples.



Data from four cyclers are superposed in this graph, with each trace representing the average temperature measured in a column of wells. Note the consistency of incubation periods, the cycler-to-cycler reproducibility (each trace is made up of *four* separate lines), and the even spread of incubation temperatures between the programmed targets of 45° and 65°C.

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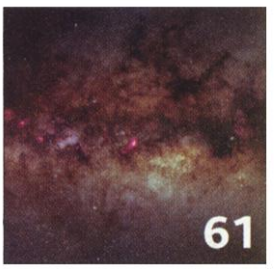
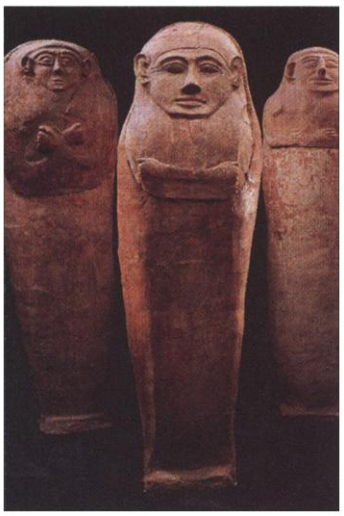


COVER Three views of the Milky Way, at different wavelengths and length scales: top, an inverted infrared image of the entire disk; middle, an optical image of the southern band of the disk with color enhancements; and bottom, a radio image of the Galactic center. These state-of-the-art snapshots of the structure of our Galaxy, and the evolution and future of our home spiral, are discussed in a special section starting on p. 61.

[IMAGES: TOP, NASA GODDARD SPACE FLIGHT CENTER AND COBE SCIENCE WORKING GROUP; MIDDLE, JOHN GLEASON/CELESTIAL IMAGES; BOTTOM, N. E. KASSIM AND COLLABORATORS, NAVAL RESEARCH LABORATORY]



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Archaeology in a caldron

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REVIEWS

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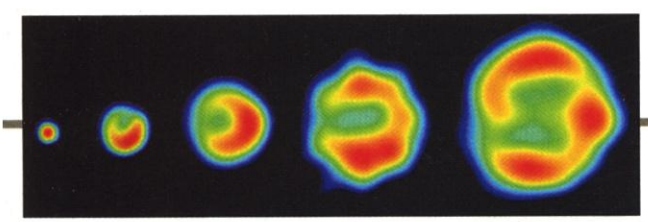

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Slowed and shifted remnants of a stellar explosion

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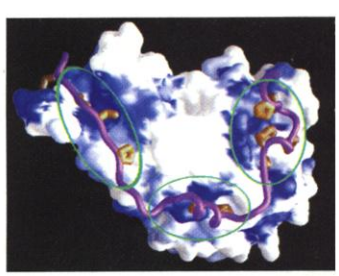

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Why Smad2 binds SARA

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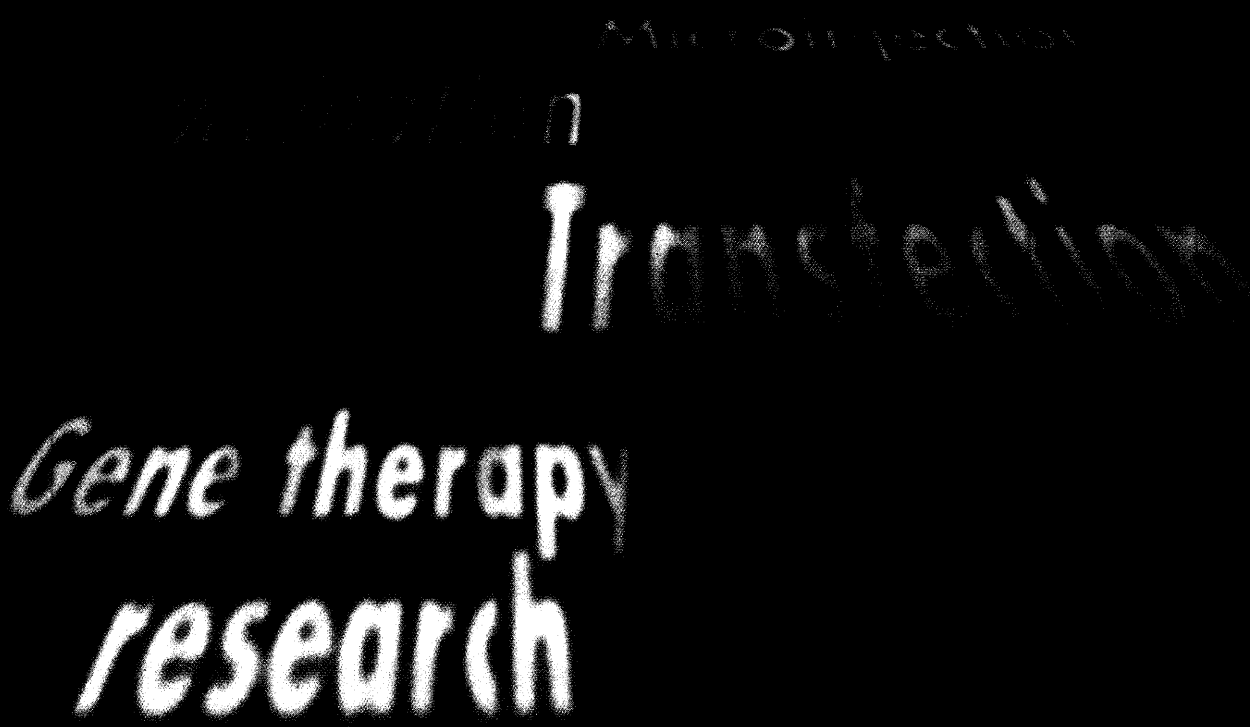

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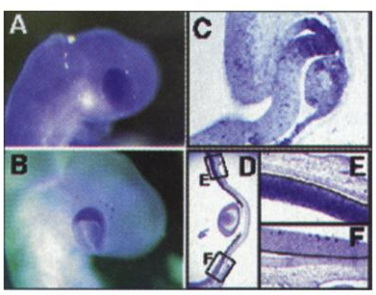
SOLITONS IN BOSE-EINSTEIN CONDENSATES

The atoms that constitute a Bose-Einstein condenstate all occupy the same quantum state. In other words, a single wave function can be used to describe the entire macroscopic pool of atoms. Denschlag *et al.* (p. 97) now demonstrate the ability to engineer and manipulate the quantum wave function of a sodium atom condensate. They use a patterned laser beam to stamp, or imprint, a region of the condensate with a specific phase pattern. In analogy to optical solitons, which propagate through a nonlinear medium without spreading out, they show that the modified region can propagate through the rest of the condensate while maintaining its imprinted phase pattern.

CONNECTING THE EYE

We see the world as a reasonable approximation of reality at least in part because axons extending from the retina search out specific regions of the optic tectum in the brain, thus mapping the visual world to the perceived world. Koshiba-Takeuchi *et al.*



(p. 134) show that the gene *Tbx5* is responsible in the chick for generating dorsal-ventral polarity in the eye and for directing the targeting of retinal axons. *Tbx5* seems to be a regulator of other genes previously implicated in the process.

WATCHING DIAMOND GROW

Diamond synthesis by chemical vapor deposition onto diamond or nondiamond substrates enables the use of relatively low pressures and temperatures. However, many details of the growth process are not well understood, especially for heteroepitaxial growth. Lee *et al.* (p. 104) have used high-resolution electron microscopy to image the interfaces between small diamond crystallites and the underlying silicon substrate. Ideal epitaxial alignment between the crystallites and the substrate was observed at steps on the silicon substrate. This identification of the diamond nucleation site may help in devising protocols for growing heteroepitaxial diamond films.

A LIGHT UNIVERSE

The density of non-relativistic particles in the universe (characterized by the parameter W) can be estimated from the Hubble parameter (the speed at which the universe is expanding) and the relative distances between galaxies. Unfortunately, neither of these parameters are well constrained or easily determined. Juszkiewicz *et al.* (p. 109) developed a method for determining the relative velocities between galaxies that does not require assumptions concerning mass distributions over specific volumes of space. They can derive W from the relative velocities of galaxies and have tested this method by estimating W from data gathered on thousands of galaxies in the Mark III survey. They find that W is about one-third, which is relatively low compared to the value of 1 for the standard cold dark matter model (the Einstein–de Sitter model). This approach could be used to refine independently the density of the universe by including other observations and ultimately to refine cosmological parameters that depend on W.

GROWING BIGGER AND SLOWER

The supernova SN1993J discovered in the nearby galaxy M81 in 1993 has been observed extensively to determine the nature of the stellar explosion and its interaction with the surrounding medium. Bartel *et al.* (p. 112) obtained 20 radio images of the expanding shell of shocked material that has been exiting from the explosion. After about 2 months, the shell was a uniform "bull's-eye" with a radius 13 times that of our solar system, but after 5 years it has expanded to a complex shell about 20 times larger. Two hot spots now form a rotating horseshoe that has moved from the east to the south. In addition, the expanding shell has been decelerating during the last 4 years. These observations suggest that the supernova is changing from an isotropic to an adiabatic expansion.

CHARON, A FOUNTAIN OF YOUTH

The small moon Charon orbits Pluto so closely that it was not discovered until 1978, and only recently has Charon's surface spectra been isolated from that of Pluto with ground-based observations. Brown and Calvin (p. 107; see the Perspective by Young) obtained a separate spectrum of Charon with the Keck telescope at infrared wavelengths and identified crystalline water ice and possible ammonia ices on the moon's surface. Neither of these ices have been identified on Pluto, but the authors suggest that Pluto is massive enough to retain a nitrogen-rich atmosphere and frost that may be covering a water-rich surface. Crystalline water ice suggests a young (renewed) surface on Charon that has not been rendered amorphous by solar radiation. The presence of ammonia would lower the melting temperature of water ice and allow it to flow.

SMADS ABOUT YOU

Smad proteins play a key role in transforming growth factor–β (TGF-β) signaling pathways, and structural studies can help unravel how related members of the Smad family can induce different signaling outcomes. The receptor-regulated Smads (R-Smads) are each involved in a specific signaling pathway, and the activation of specific TGF-β receptors mediates phosphorylation of specific R-Smads. Phosphorylated R-Smads heterodimerize with co-mediator Smads (co-Smads), and such complexes translocate into the nucleus and activate target genes. Smad2, an R-Smad that acts as a tumor suppressor in humans, is recruited to its TGF-β receptor by the protein SARA (Smad anchor for receptor activation). SARA does not interact with the R-Smads Smad1 or Smad5 despite an 80% sequence identity with Smad2. Wu *et al.* (p. 92) have determined a structure of the Smad2 MH2 domain, which is involved in receptor recognition, with the Smad binding domain of SARA that reveals the molecular basis for the specificity of the Smad2 interaction with SARA. Comparison of R-Smad and co-Smad structures provide insight into how R-Smads are recognized by receptors.

CATALYST OR SUBSTRATE?

Although heme complex may be the most familiar iron-containing proteins, carboxylate-bridged species can play key roles in respiration and the oxidation of organic species, as well as in iron storage. Hwang *et al.* (p. 122) have studied the peroxodiferric intermediates of ferritin, which appeared to be spectroscopically similar to those in enzymes. X-ray absorption and Mössbauer studies reveal that in ferritin, the iron-iron distance in the peroxodiferric complex is unusually short—2.53 angstroms, instead of the expected 3 to 4 angstroms. This short distance should

CONTINUED ON PAGE 11

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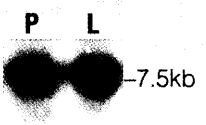

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THIS WEEK IN *SCIENCE*

CONTINUED FROM PAGE 9

favor release of hydrogen peroxide and the formation of biominerals over oxidation of organic species.

SEX RATIOS IN MALARIA

For the malaria parasite, a single haploid cell gives rise to a clone producing both females and males. The ratio of males to females is important in understanding and controlling disease because transmission of malaria in nature depends on sexual union of the parasites and because more males are formed in lethal infections. Paul *et al.* (p. 128) have found that the frequency of the sexes is affected by the host hematologic state. Treatments that induce erythropoiesis result in a shift to male parasites, which leads to decreased reproductive success. This finding may provide new approaches in malaria control as well as new considerations in therapy, as the antimalarial drug chloroquine inhibits erythropoiesis.

PULLING OUT PROTEINS

Genome sequencing is producing a huge number of putative gene sequences, many of unknown function. Walhout *et al.* (p. 116, see the Perspective by Kim) now report the feasibility of using large-scale yeast two-hybrid analysis to examine the proteins that interact during vulval development in the worm *Caenorhabditis elegans*. They selected 29 proteins known to be crucial for vulval development as "bait" and then scanned the entire *C. elegans* genome. They found 992 proteins that interacted with the bait proteins. The investigators also characterized an important interaction between one of the bait proteins LIN-37 and a worm homolog of LIN-35, a component of a tumor suppressor transcription complex.

DNA REPLICATION AND NEURONAL DEVELOPMENT

Topoisomerases, which allow DNA strands to cross one another, are critical for successful DNA replication, yet cells with defective topoisomerase II-b (IIb) proliferate normally. Yang *et al.* (p. 131) now show that mice with IIb mutations have very specific defects in the nervous system—motor neurons develop and differentiate but fail to extend axons that reach their normal targets. These results may indicate a particular sensitivity of nondividing cells to deficiencies in DNA repair systems, or, alternatively, a specialized function of IIb in sustaining transcriptional programs.

MIX-AND-MATCH PROTEIN FUNCTION?

Voltage-gated H^+ channels can be found in many different cell types throughout the body, but these channels have until now eluded all attempts at cloning. Banfi *et al.* (p. 138) report the identification of a gene that encodes a protein homologous to the enzyme that oxidizes the reduced form of nicotinamide adenine dinucleotide phosphate (NADPH oxidase). A proton channel is generated through alternative splicing of messenger RNA derived from this gene, which suggests that a gene product is converted from a putative enzyme to an ion channel.

LOSS OF APPETITE

Leptin is a hormone produced by fat cells that promotes weight loss by suppressing food intake and stimulating metabolism. The hypothalamus has been identified as the neuroanatomical target of leptin, and several molecular mediators of leptin action have been identified, but the neurobehavioral mechanisms underlying leptin's effects on food intake are unclear. In experiments with a rat model of intracranial self-stimulation, Fulton *et al.* (p. 125)show that leptin modulates brain reward circuitry by decreasing the appetitive value of food and increasing the value of other as yet unidentified behaviors that lead to increased energy expenditure. These opposing effects of leptin may help explain its role in energy balance.

TECHNICAL COMMENT SUMMARIES

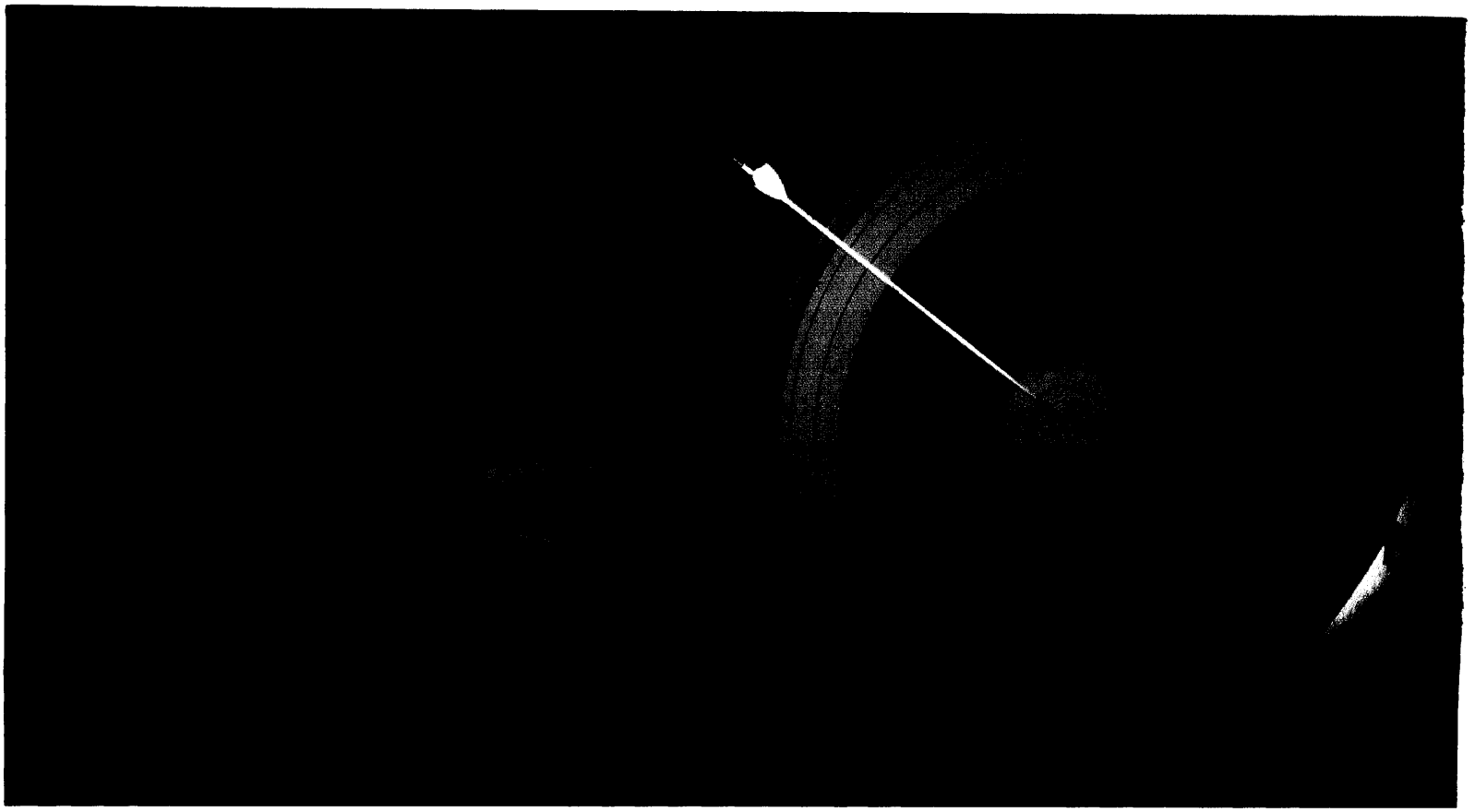
Non-Molecular Carbon Dioxide (CO_2) Solids

The full text of these comments can be seen at www.sciencemag.org/cgi/content/full/287/5450/11a

Iota *et al.* (Reports, 5 Mar., p. 1510) reported the high-pressure synthesis of a new quartzlike phase of CO_2, which suggested that non-molecular (polymeric) CO_2 phases could be produced at high pressure. Subsequently, Serra et al. (Reports, 30 Apr., p. 788) supported this result using molecular dynamics simulations.

Dong *et al.* comment that, on the basis of other molecular dynamic simulations, the high-pressure phase is not quartzlike, but cristobalite-like, and that this structure is also more consistent with the experimental data also.

In response, Yoo and Cavazzoni *et al.* indicate that because of the similarity in energies, other structures, including tridymite-like, may also be possible and should be considered.



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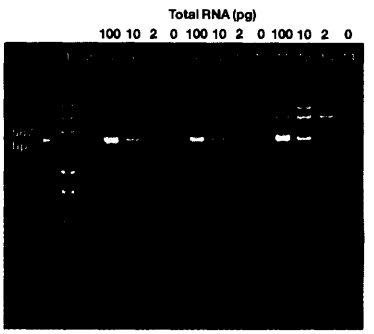

Amplification of β-actin from total human RNA

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Lanes 7, 8, 9, 10: RNA PCR; with MuLV and Taq DNA Polymerase, no Hot Start

Lanes 11, 12, 13, 14: RNA PCR; AMV and enzyme blend, no Hot Start

Lane 1: Size Standard

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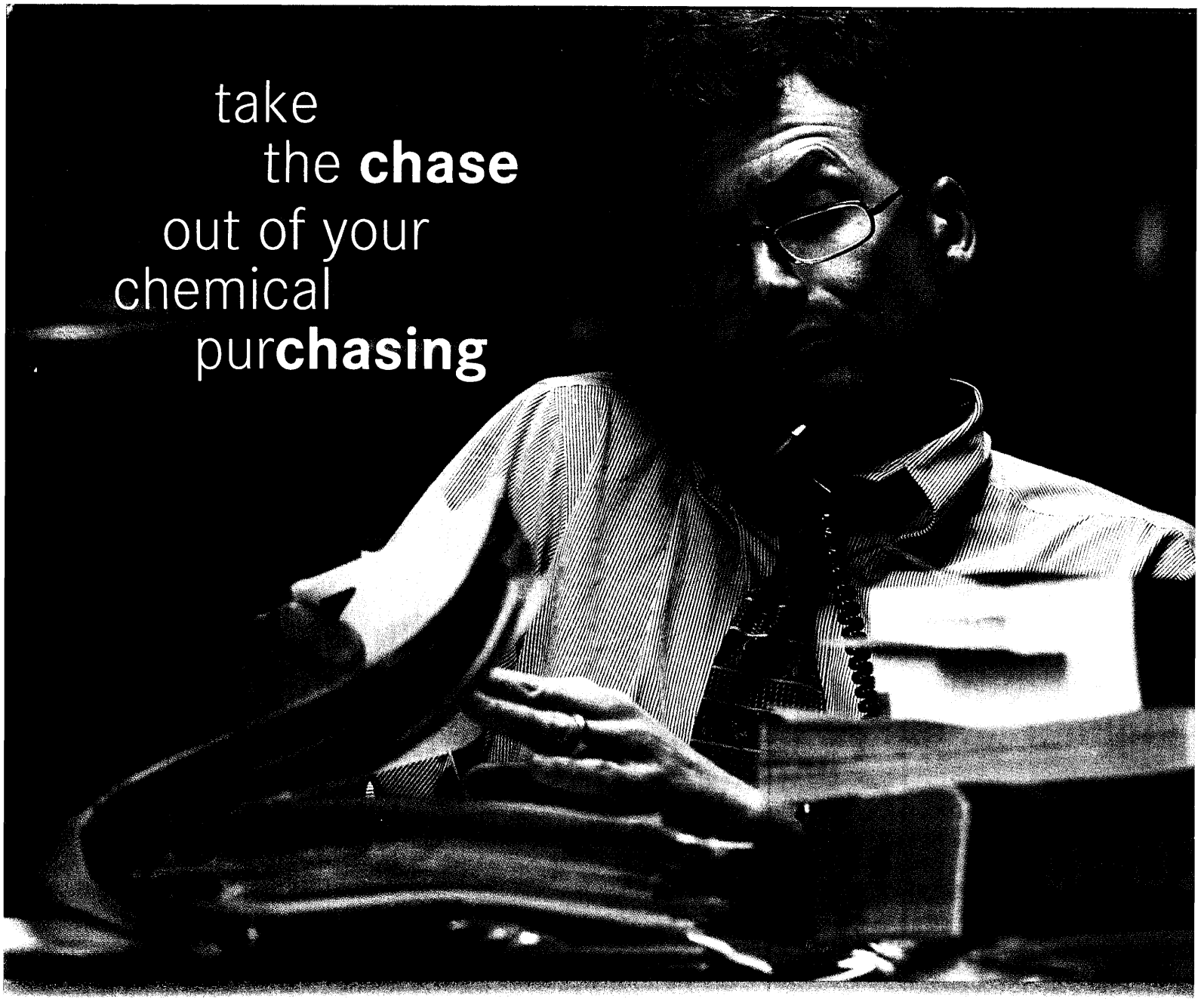

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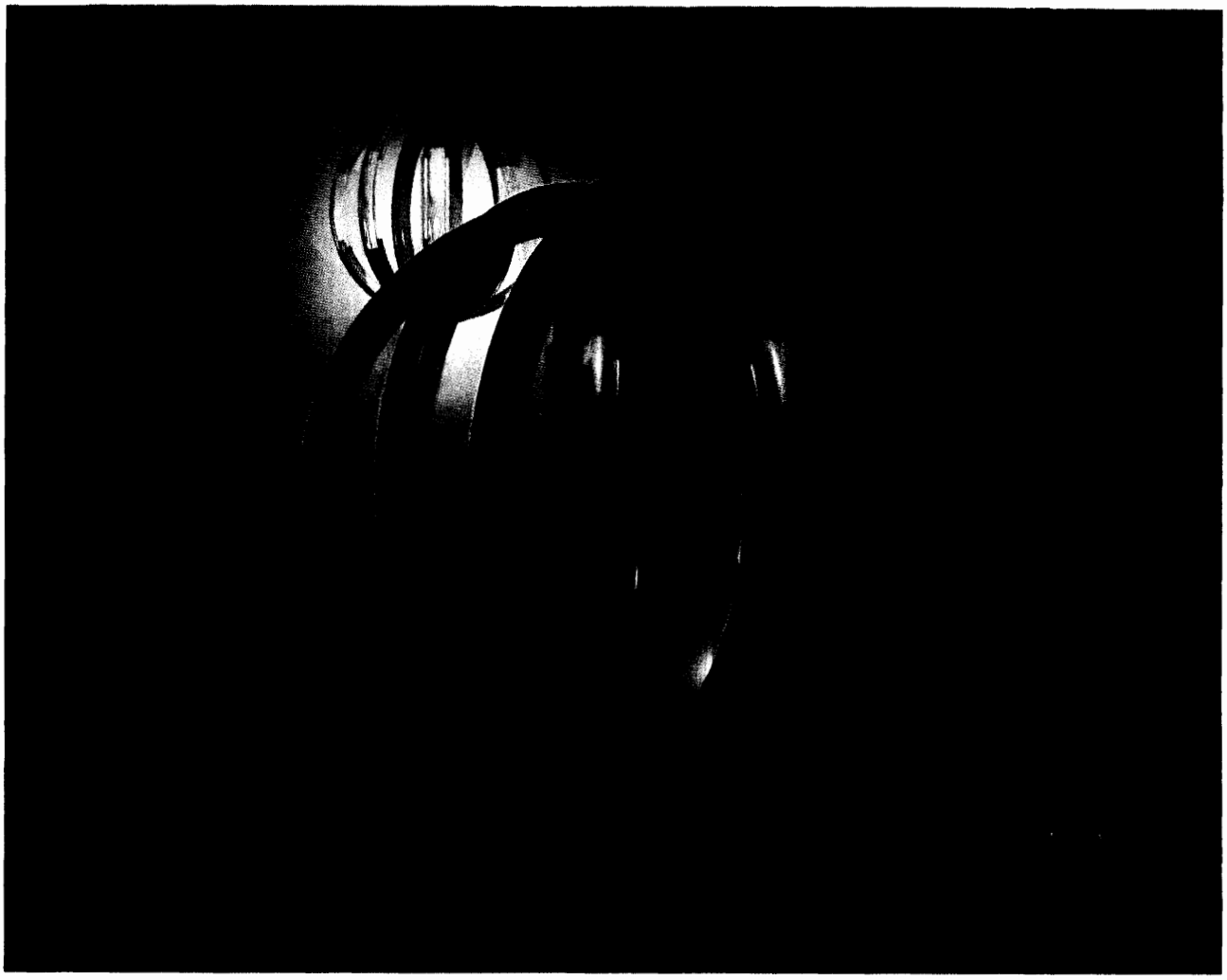

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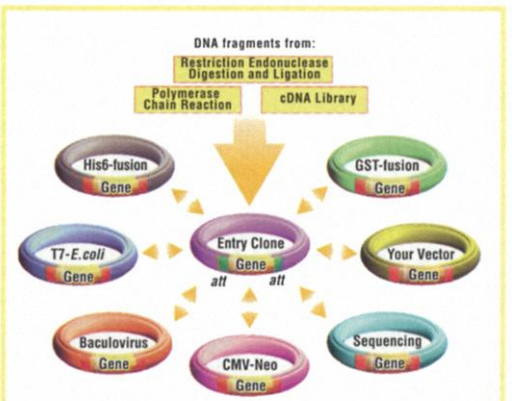

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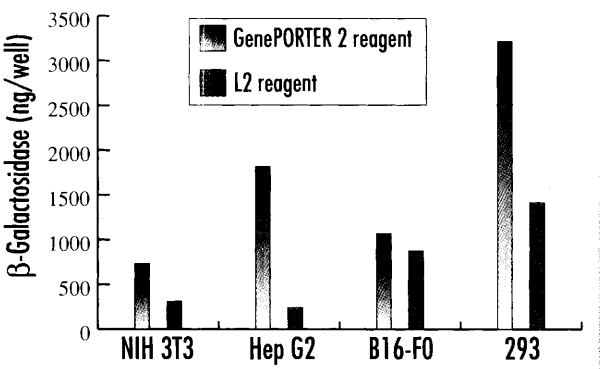

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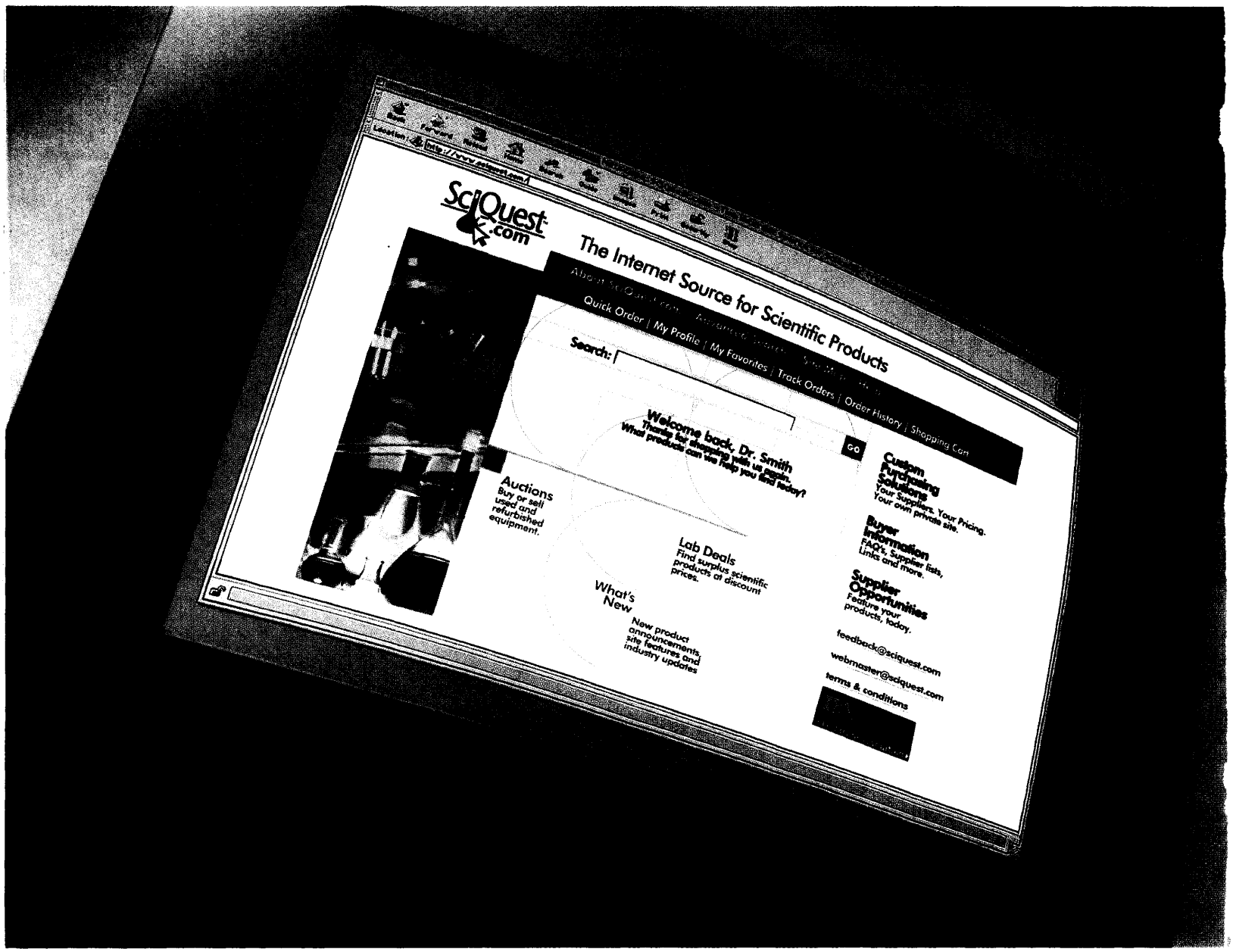

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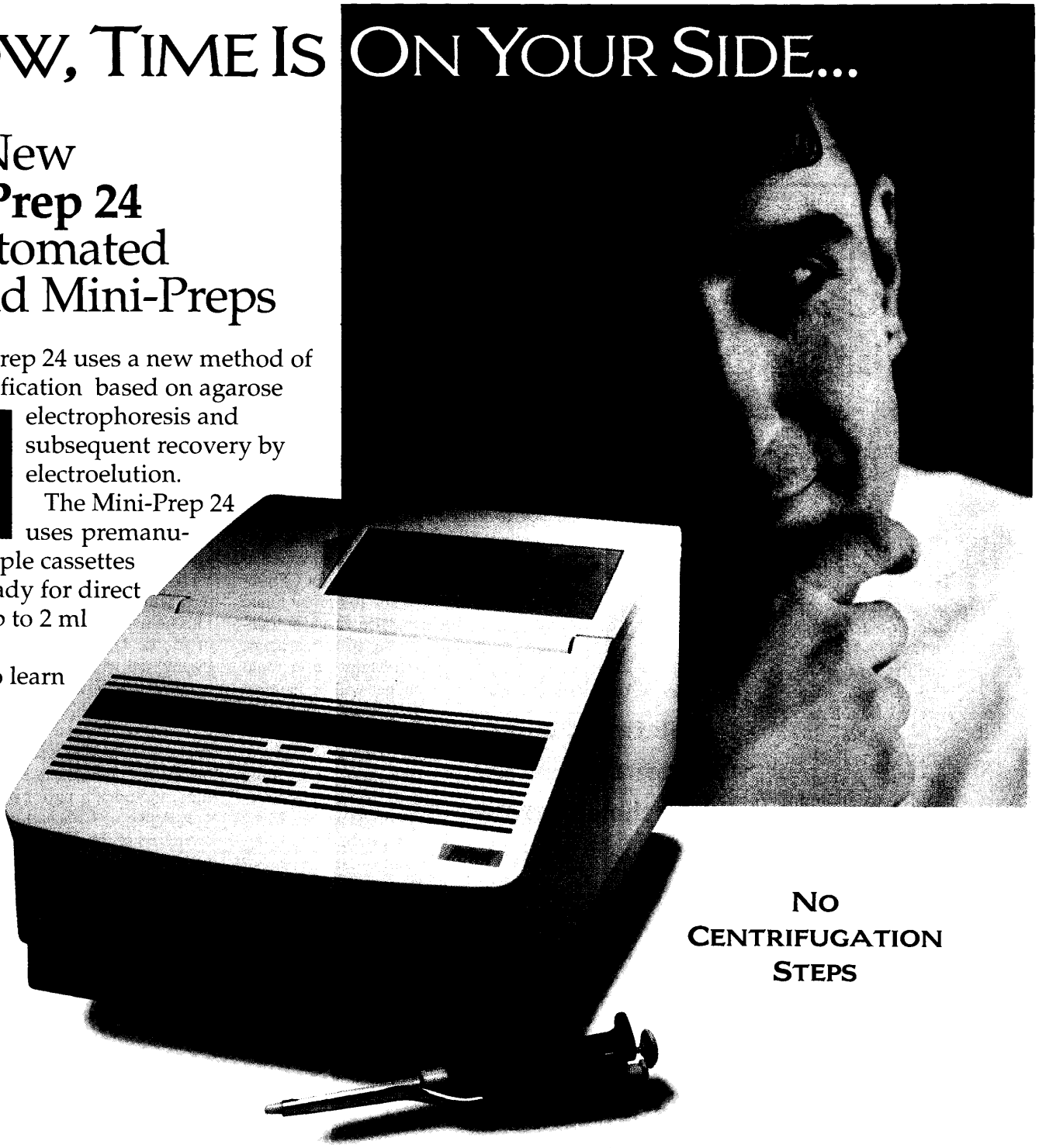

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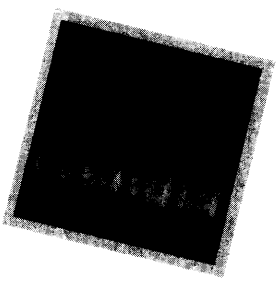

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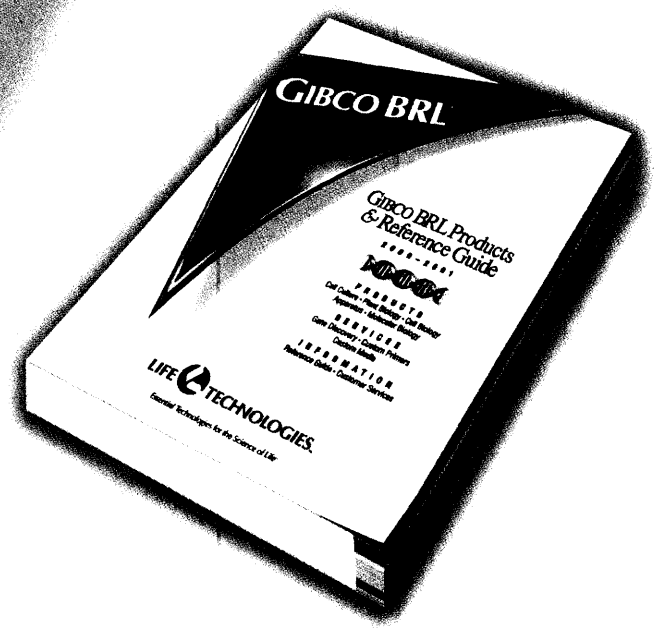

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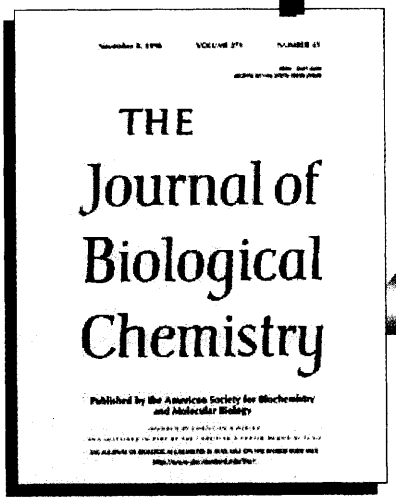

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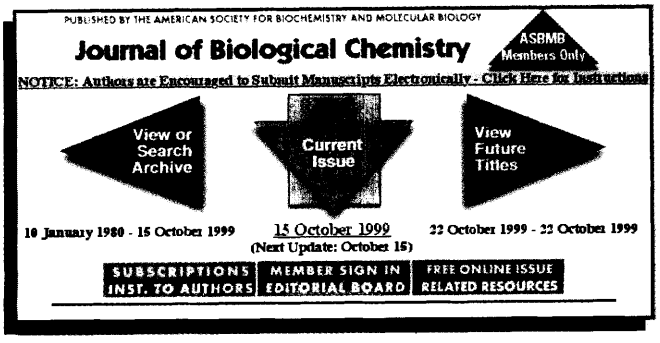

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2000 Genome Seminar
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2000 AAAS Forum for School Science
Reforming Science and Mathematics in Urban Schools: Finding the Road to Success

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January 2000

The forthcoming millennial transition may be entirely arbitrary in its failure to correspond with any natural cycle. (Indeed, we can't even settle the logically unresolvable debate of whether year 2000 or 2001 begins the new millennium!) Nonetheless, if only as a reflection of our psychological need to impose human order upon natural complexity, we regard such arbitrary passages as prime occasions for taking stock of our past and trying to chart our inherently uncertain future. We can be sure of at least one cardinal fact (predicated upon an assumption that we will be able to marshall our intelligence, and our moral sensibilities, both to survive and to prevail): life and social organization in the third millennium will require increasing understanding of science and its technological achievements.

In entitling this transitional meeting "Science in an Uncertain Millennium," we wish to emphasize both this centrality and the increasing need for incorporating science in partnership with all other facets of human understanding. We shall therefore attempt to make this 2000 meeting the most international and ecumenical in our history, featuring some of the world's leading scientists and young iconoclasts of course, but also presenting speakers drawn from a broad range of nations and disciplines, including Africa's foremost woman educator, and major figures in American public administration and in arts and humanities throughout the world.

May I also make a personal plea to my fellow scientists? The AAAS Annual Meeting had long functioned as the world's finest showcase, to journalists and to the general public, for the excitement and significance of scientific discovery—a role that we must continue to maintain and strengthen. But American science has lost the valuable concept of an ecumenical gathering for the personal growth and edification of scientists—to meet with colleagues in other disciplines and to increase our own learning and understanding in fields outside our immediate expertise. The AAAS meeting is too good to stage only for others, and not to reap the direct benefits for ourselves. These two goals—a showcase for the public and a renewal for ourselves—are entirely complementary and completely reinforcing. I therefore suggest to colleagues who have not attended a AAAS meeting for many years, and who may have grown a bit cynical about the meeting's potential value for their own professional growth—take another look!

We could not ask for a better symbol, or a better practical location, for this millennial meeting than Washington, DC. Katherine Lee Bates referred to our capital when she wrote, in "America the Beautiful"—"thine alabaster cities gleam, undimmed by human tears." A bit of overblown sentiment from the gilded age, perhaps, but not a bad—and not an inaccurate—image either. Do come!

Stephen Jay Gould
President, AAAS
Alexander Agassiz Professor of Zoology, Harvard University

Plenary Lectures

Thursday, February 17

Student Science Convocation

5:00 PM

American Junior Academy of Science Poster Displays

Opening Ceremony and Keynote Address

6:30 PM

David Satcher,
U.S. Surgeon General

Friday, February 18

Plenary Address

6:30 PM

Mamphela Ramphele,
Vice Chancellor, Univ of Cape Town

Saturday, February 19

AAAS President's Address

6:30 PM

Stephen Jay Gould,
Alexander Agassiz Professor of Zoology, Harvard Univ and AAAS

Sunday, February 20

Plenary Address

6:30 PM

Robert P. Kirshner,
Center for Astrophysics, Harvard Univ

Monday, February 21

Special Plenary

11:30 AM

The Honorable Madeleine K. Albright,*
U.S. Secretary of State

Plenary Address

6:30 PM

May Berenbaum,
Department of Entomology, Univ of Illinois

**Invited*

Lectures

Topical Lectures

Friday, February 18

- **AM Lectures (8:00AM–8:45AM)**

William E. Coyne, 3M Co
Innovation as a Growth Driver

Jaron Lanier, National Tele-Immersion Initiatives, Internet2 Central Laboratory
Information Technologies and the Future of Scientific Method

- **Special PM Lecture (12:30PM–1:15PM)**

Rita R. Colwell, NSF

- **PM Lectures (1:30PM–2:15PM)**

John P. McGovern Award Lecture:
George A. Miller, Princeton Univ
Ambiguous Language

Matthew Meselson, Harvard Univ
Averting the Hostile Exploitation of Biotechnology

G. Edward Schuh, Univ of MN
Competitiveness, Research, and Global Development: How Will the U.S. Cope?

Michael Hengartner, Cold Spg Hrbr Lab
Programmed Cell Death in the Nematode, C. elegans

Saturday, February 19

- **AM Lectures (8:00AM–8:45AM)**

Neil de Grasse Tyson, Hayden Planetarium
Bringing the Universe Down to Earth: Designing a Planetarium for the 21st Century

Jennifer Tour Chayes, Microsoft, Inc.
What Makes Hard Problems Hard? A Physicist's View of Algorithms and Intractability

Kari Stefánsson, de Code Genetics
Population, Genomics, and Complex Traits: The Case of Iceland

Science Innovation

- **PM Lectures (2:00PM–2:45PM)**

Carl Djerassi, Stanford Univ
Contraception vs. Conception—A Millennial Prognosis

Edelgard Bulmahn, Min of Sci and Ed, Germany

Esther Sternberg, NIMH, NIH
Does Stress Make You Sick and Believing Make You Well? The Science of Mind-Body Connections

Sunday, February 20

- **AM Lectures (8:00AM–8:45AM)**

John Cosgrove, Long Isl Jewish Med Cntr
Surgical History of the United States Presidents

Edward O. Wilson, Harvard Univ
The Relation Between Biology and the Humanities

Mary Lou Pardue, MIT
Drosophila Telomeres: Evolutionary Links Between Chromosome Ends and Retrotransposable Elements

- **Special PM Lecture (1:00PM–1:45PM)**

George Whitesides, Harvard Univ and Felice Frankel, MIT
Science as Art and Art as Science

- **PM Lectures (2:00PM–2:45PM)**

George Sarton Award Lecture:
Edward J. Larson, Univ of GA
75 Years Ago or Forever? The AAAS and the Scopes Trial

Felton Earls, Harvard Schl of Pub Hlth
Exposure to Violence in Childhood: Causes and Consequences

William A. Haseltine, Human Genome Sci, Inc.
Genes and Drugs: What to Do with All the Genes

Monday, February 21 PM

- **PM Lectures (2:00PM–2:45PM)**

Kenneth Prewitt, U.S. Census Bureau
The Science and Politics of the U.S. Census

Tim White, UC-Berkeley
Early Hominids

2000 Genome Seminar

Genomic Revolution in the Fields: Facing the Needs of the New Millennium

Saturday, February 19
9:00AM–6:00PM

Sunday, February 20
9:00AM–6:00PM

Organized by by J. Craig Venter, Celera Genomics, Inc., Barbara Jasny and Pamela J. Hines, AAAS and *Science* Magazine

Sponsored by Celera Genomics, Inc., National Corn Growers Association, and AAAS

In the new millennium, the needs of the world's population are sure to increase, and yet available natural resources are expected to decrease. Genomic technology will be an important part of the solution to bridge the gap. This third in a series of seminars co-sponsored by AAAS and TIGR, highlights exciting and late-breaking advances in application of genomic innovations to agriculture in such areas as plant responses to pathogens and environmental stresses, building more effective or non-traditional plant or animal 'factories', and improving the qualities of the produce. In considering how to use the advances of genomics in agriculture, speakers will also be discussing the sociopolitical complexities of delivering the results to the people who need them, and addressing issues of public acceptance of genetic engineering technology.

Saturday AM (9:00AM—12:00PM)

Richard C. J. Somerville, Carnegie Inst of Wash
Roger N. Beachy, Donald Danforth Plnt Sci entr
Brent D. Mishler, UC-Berkeley
Deep Green: Phylogeny of Green Plants, Comparative Genomics and Society
Scott V. Tingey D, DuPont Ag Biotech
Gene Discovery Programs for Ag Biotechnology
Charles M. Benbrook, Sci & Enviro Hlth Ntwrk
Who Controls and Will Benefit from Plant Genomics?

Saturday PM (3:00PM-6:00PM)

Patrice Laget, European Commission
Dean DellaPenna, Univ of NV-Reno
Michael Tomaschow, MSU
Genes Involved in Plant Freezing and Drought Tolerance
Peggy Lemaux, UC-Berkeley

Sunday AM (9:00AM-12:00PM)

Jeff Dangl, UNC-Chapel Hill
Expression Profiles of Plant Disease Resistance
Robert Martienssen, Cold Spring Harbor Lab
Daphne Preuss, Univ of Chicago
The Arabadopsis Centromeres: Genetic Mapping and Sequence Analysis
Xiaoying Lin, TIGR
Arabidopsis Chromosome 2: Sequencing and Analysis
Shauna Somerville, Carnegie Inst of Wash

Sunday PM (3:00PM-6:00PM)

Frederick J. Perlak, Monsanto Co
The Transformation of Modern Agriculture by Genetic Engineering of Plants
Virginia Walbot, Stanford Univ
Maize Gene Discovery
Stephen Bates, Celera Genomics, Inc.
The Impact of Drosophila Genomics on Insect Biology in Agriculture
Elizabeth Dennis, CSIRO

2000 AAAS Forum for School Science

Reforming Science and Mathematics in Urban Schools: Finding the Road to Success

Monday, February 21
8:00AM–6:30PM

Tuesday, February 22
8:00AM–1:00PM

Organized by Shirley M. Malcom, Betty Calinger, Mary Koppal, and George W. Nelson, AAAS

The Forum for School Science is co-sponsored by the AAAS Directorate for Education and Human Resources and AAAS Project 2061.

The Forum for School Science is a two-day seminar that mixes plenary and small group sessions featuring leading academic and policy authorities. In addition, there is a poster session and reception where Forum participants and presenters meet to network and gain more information.

The 2000 Forum will reflect on the progress of the movement to reform science and mathematics education in urban schools—much of it initiated by the National Science Foundation—and then engage participants in the discussion of unresolved issues that include: (1) how best to ensure that all students are taught science and mathematics by teachers very knowledgeable about content and pedagogy; (2) what strategies can promote learning and engagement for those students who have experienced difficulty learning mathematics and science; (3) how can school restructuring be implemented even in troubled systems; and (4) what is the "formula" for developing and maintaining supportive partnerships.

The meeting will begin with an overview of significant outcomes of urban reform efforts followed by panel presentations centered on the above issues. The panelists will have solid experience in areas that have a strong influence on the development and implementation of reform initiatives in urban schools, e.g., professional development, curriculum, research in teaching and learning, cognitive development, school/district restructuring, and the external community environment. Forum participants will engage in small group, facilitated discussion and analysis of the issues.

Invited Forum Speakers include:

Meir Ben-Hur, SkyLight Training & Publishing
Juanita Clay-Chambers,* Detroit Pub Schls
Manuel Gomez, Univ of Puerto Rico
Kati Haycock,* The Education Trust
David Hornbeck,* Schl District of Phil
Madeleine Long, The Implementation Grp
Maria Santos, San Francisco Unified Schl District
Carol Takemoto, Los Angeles Unified Schl District
Clara Tolbert,* Schl District of Philadelphia
And many others!

**= Invited, not yet confirmed*

Symposia at a Glance

Track	Friday	Saturday	Sunday	Monday	Tuesday
Changing Landscapes	**PM** Alien Species in Coastal Waters	**AM** Wetland Restoration **PM** China and Environmental Health	**AM** The Coevolution of Landscape and Culture **PM** Guinea Current Ecosystem	**AM** Human Impacts on Watersheds	
Communicating Science	**AM** Amateurs and Professionals **PM** Scientific Modeling of Complex Relationships	**AM** Cost of (Not) Sharing Data **PM** Legal Restrictions On Published Data		**AM** Engaging the Public in Science **PM** Science as an Error-Correcting	
Education and Public Understanding of Sci	**AM** Technology in Science Education	**AM** Teaching Mathematics to Children **PM** Teaching for Learning	**AM** Shaping Future Learning **PM** Science is Fun!		
Environment, Food, and Natural Resources	**AM** The 21st Century Food System **PM** Human Health and Climate Change Population and Environment in Coastal Areas	**AM** Who Will the World Feed? **PM** Antibiotics in Agriculture Hydrometeorological Frontiers	**AM** Sustainability Science **PM** Food and Ecological Resilience	**AM** Open Markets	**AM** Organic Agriculture Risky Microbes
Global Change/ Earth Systems Science	**AM** Climate Change and Values	**AM /PM** Hurricane Climate Research	**AM** Math Modeling in Earth Sciences **PM** Consequences of Climate Variability	**AM** Global Change: Uncertainty for Science and Democracy **PM** Human Dimensions of Global Change	**AM** Urban Sprawl from Space
Human Futures	**AM** Cyberterrorism **AM /PM** Human Resources for S&T	**AM** Critical Periods of Development: Hearing Loss **PM** Humans, Computers, and Speech	**AM** Sustainability through Science	**AM** Germline Intervention **PM** Stem Cell Controversy Production of Renewable Hydrogen	
Industry and Engineering	**AM** Can Universities Change? **PM** University Research and Industrial Performance?	**AM** Corporate Funding of Academics **PM** How Will Industry Manage Science and Technology?	**AM** R&D Performance Measurement Systems **PM** The Nutraceuticals Industry High-Tech Industry in the Region		
Interconnectivity and Life in Cyberspace		**AM** Found in Cyberspace **PM** Science and Health Information	**AM** Battling the Crypto Wars **PM** From Small-World Networks to the Web	**AM** Paperless Publishing **PM** Research, Education, and the Web	
Life Science and the Science of Life	**AM** Amphibian Declines	**AM** Understanding Ecosystems The Role of Water for Life **PM** Ecosystem Services	**AM** Sociality Among Primates **PM** Genes, Genomics, and Complex Ecosystems	**AM** Restoring Ecosystems Impacted by Fisheries **PM** Endangered Species Recovery	
Looking Back to Forecast the Future	**AM** Unearthing Climate Variability **PM** Peopling of the New World	**AM** Scientist's Workstations: 21st Century Expectations	**AM** Ecological Forecasting **PM** Anticipating S&T's Futures	**PM** Plants, Population and Welfare	

Track	Friday	Saturday	Sunday	Monday	Tuesday
Looking Beyond Earth	**AM** Space Access and Utilization **PM** Mars Exploration	**AM** First Light From CHANDRA Unpredictable Natural Events **PM** Space Weather	**AM** The Future of the Sun **PM** Supermassive Black Holes		
Mathematics and Physical Science	**AM** Mathematics in Hollywood and Life **PM** Paradigms for the 21st Century	**PM** Spintronics Predicting More Assuming Less	**AM** Cosmology **PM** Neutrino Experiments	**AM** Synthetics, Nanofabrication, and Mol Med **PM** Magic of Matter Waves	
Natural History in the New Millennium		**PM** Ethnobotany/Bioprospecting	**AM /PM** Sociobiology		
Public Health and Medicine	**AM** New Knowledge on Homocyst(e)ine **PM** About Faces Prophylaxis or Therapy	**AM** Chocolate Infections and Illicit Drug Abuse **PM** Eradication of Polio	**AM** Health Care, Economics, and Technology **PM** Genome Strategies in Evolution and Disease Pain 2000	**AM** Dietary Salt Improving Medical Decision Making **PM** Does Nicotine have Beneficial Effects? International Management of DDT.	**AM** Children and Chronic Diseases
Science and Society	**PM** The Science of Baseball Three Jobs–Two People	**AM** Analysis of Electronic Threats **PM** Technology and Inequality	**AM** Bio Music Violent Crime and Punishment **PM** Ethnic Restaurants in DC Criminal Punishment of Adolescents	**AM** Enviroshock Symmetry and Hierarchy **PM** Dynamics of Social Interactions Evolution, Science, and Society	**AM** Finding Landmines
Science, Engineering, and Public Policy	**AM** Geoscience and Geophilosophy Weapons of Mass Destruction **PM** The Mathematics of Politics	**AM** Sci Collaboration in Cuba **AM /PM** The Precautionary Principle	**AM** Scientists on Capitol Hill	**AM** Science at State **PM** "Science Savvy" at State	**AM** S&T Roadmaps
Science Innovation	**AM** Drosophila Genome Millennial Mind **PM** Development of the Brain	**AM** Neurogenesis **PM** Cognitive Memory	**AM** Drug Discovery Nanotechnology **PM** The New Era of Genomics The Thinking, Feeling Brain	**AM** Cancer Therapeutics	
Seminars		**AM /PM** Genome Seminar	**AM /PM** Genome Seminar	**AM /PM** Forum for School Science	**AM /PM** Forum for School Science

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