
American Association for the Advancement of Science
150 Years • 1848-1998
SCIENCE
17 April 1998
Vol. 280 • Pages 345–484
$7.00

The Yeast Genome.
First the sequence. Now Expression-Ready Clones.

Introducing GeneStorm™ Expression Vectors. Already Cloned. Already Tested. All Ready to Go.

GeneStorm™ Expression Vectors. Functional tools for functional genomics. Each GeneStorm™ vector contains a recombinant yeast Open Reading Frame (yORF) properly cloned and expression tested. With thousands of clones available and more coming every day, GeneStorm™ vectors are precisely the tools you need. The vectors are ideal for dozens of applications including functional studies and antigen generation. Each yORF is cloned

into a state-of-the-art yeast or mammalian expression vector. Each vector has convenient features including a polyhistidine sequence for purification and an epitope tag for expression verification. GeneStorm™ vectors eliminate unpredictable cloning and save you weeks of labwork. To learn more about these indispensable research tools, contact Invitrogen or visit our continually -updated GeneStorm™ web site at **www.invitrogen.com/genestorm/**

European Headquarters:
Invitrogen BV
De Schelp 12, 9351 NV Leek
The Netherlands
Tel: +31 (0) 594 515 175
Fax: +31 (0) 594 515 312
email: tech_service@invitrogen.nl

Toll Free Phone Numbers:
Belgium 0800 111 73
Denmark 800 188 67
Finland 990 31 800 5345
France 00 31 800 5345
Germany 0130 8100 43
The Netherlands 0800 022 88 48
Norway 800 113 70
Sweden 020 795 369
Switzerland 0800 551 966
United Kingdom 0800 96 61 93

Distributors:
Australia 1 800 882 555
China 010 6255 3477
Hungary 01 280 3728
India 91 80 839 1453
Israel 02 652 2102
Italy 02 38 19 51
Japan 03 5684 1616
Korea 82 2 569 6902
Malaysia 03 432 1357
Poland 058 41 42 26
Portugal 01 453 7085
Singapore 65 779 1919
Slovak Republic 07 3707 368
Spain 03 450 2601
Taiwan 080 231 530
Thailand 246 7243

From all other countries, contact our European headquarters at +31 (0) 594 515 175.

United States Headquarters:
Invitrogen
1600 Faraday Avenue
Carlsbad, California 92008
Tel: 1-800-955-6288
Fax: 760-603-7201
Email: tech_service@invitrogen.com
http://www.invitrogen.com

Circle No. 18 on Readers' Service Card

QuikChange™

SITE-DIRECTED MUTAGENESIS KIT*

The fast, easy and efficient non-PCR site-directed mutagenesis method.

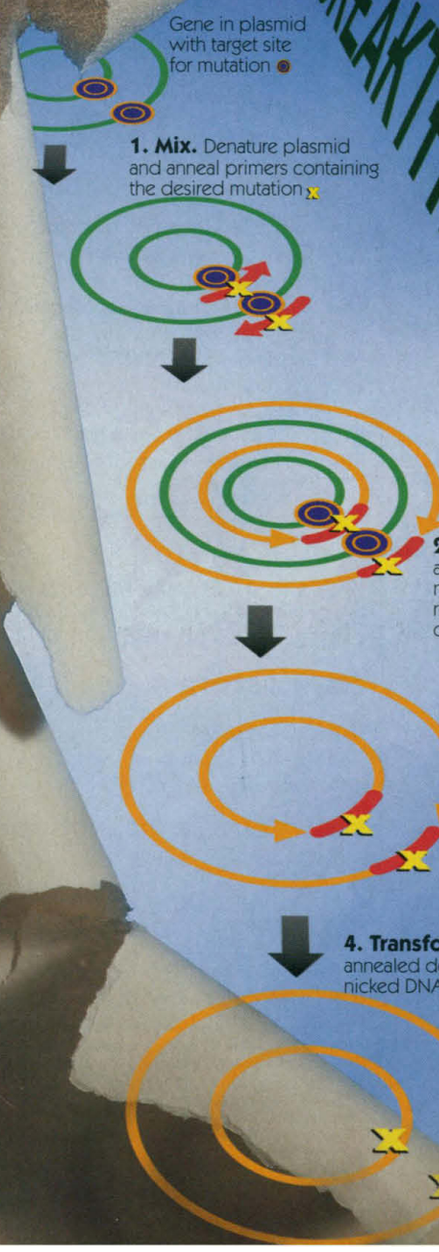
Near 100% Efficiency
- Highest efficiency method
- Eliminates background
- Mutations in virtually all transformants

150 Times More Accurate
- Extends without PCR
- Uses high-fidelity *Pfu* DNA polymerase
- Replicates only parental DNA
- Reduces second-site mutations 150-fold

Simple One-Day Procedure
- Eliminates single-stranded DNA templates, subcloning into specialized vectors, unique restriction sites and multiple transformations
- Cuts screening time in half

MUTAGENESIS BREAKTHROUGH

1-DAY METHOD



Change the Way You Do Mutagenesis!

UNITED STATES:
Stratagene Cloning Systems
(800) 424-5444
INTERNET MAIL:
techservices@stratagene.com

AUSTRALIA: (02) 9417 7866
AUSTRIA: (0222) 3 68 99 51
BRAZIL: 11 5561-1771
CANADA: 905-713-1201
DENMARK: 86 10 10 55
FRANCE: (01) 34 60 24 24
GERMANY: (0130) 84 09 11
HONG KONG: 578-5839
ISRAEL: 03-5761520
ITALY: 02-58.01.34.09
JAPAN: (Funakoshi) (03)5684-1622
(Toyobo) (03)3660-4819
KOREA: (02)-556-0311
MALAYSIA: 3-7031888
NETHERLANDS: 033 495 00 94
NEW ZEALAND: 9 443-5867
NORWAY: 22 20 01 37
PORTUGAL: 01-441 06 84
SINGAPORE: 2730898
SPAIN: 1 729 03 33
SWEDEN: (8) 6800845
SWITZERLAND: (061) 6 93 05 40
THAILAND: (662) 308-0611
UNITED KINGDOM: 0800 585370

OTHER COUNTRIES CALL:
STRATAGENE USA: (619) 535-5400

*Patent pending

QuikChange™ Site-Directed Mutagenesis Kit catalog #200518

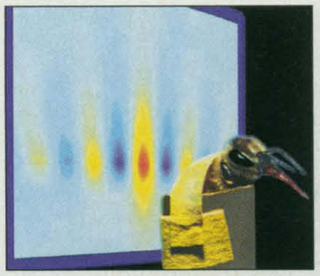
STRATAGENE®

Circle No. 28 on Readers' Service Card

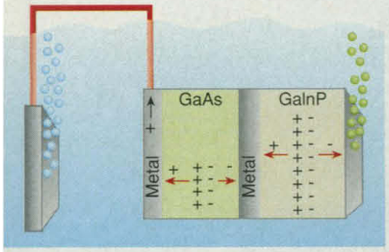
ISSN 0036-8075
17 APRIL 1998
VOLUME 280
NUMBER 5362

SCIENCE

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
150 YEARS • 1848-1998



376
Recording neural symphonies



382 & 425
A solar device for getting hydrogen from water

446
Maternal-effect mutation

NEWS & COMMENT

RESEARCH NEWS

SCIENCE'S COMPASS

Policy

Books and New Media

Research

Review

DEPARTMENTS

■ **SCIENCE (ISSN 0036-8075) is published weekly on Friday, except the last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005.** Periodicals Mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Domestic individual membership and subscription (51 issues): $108 ($60 allocated to subscription). Domestic institutional subscription (51 issues): $295. Foreign postage extra: Mexico, Caribbean (surface mail) $55; other countries (air assist delivery) $90. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request, GST #1254 88122. IPM #1069624. **Printed in the U.S.A.**

COVER

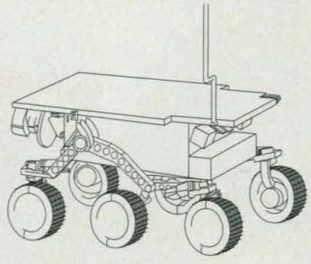
The large-scale structure of the universe is believed to be weblike, as revealed in this supercomputer simulation. The image shows a three-dimensional isosurface of the baryonic material (gas) in a volume that is 175 by 130 by 175 million light years on a side. A rich cluster of galaxies has formed at the center of the volume. Material continually accretes onto the cluster along the filamentary structures, giving rise to the stormy infracluster conditions discussed in the Review beginning on p. 400. [Image: Chris Loken, University of Missouri-Columbia]

REPORTS

TECHNICAL COMMENTS

www.sciencemag.org/cgi/content/full/280/5362/355a

434
Straightening out a knotty problem



454
Tech.Sight: Robots on Mars

◩ **Indicates accompanying feature**

Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. **Postmaster:** Send change of address to *Science*, P.O. Box 1811, Danbury, CT 06813–1811. **Single copy sales:** $7.00 per issue prepaid includes surface postage; bulk rates on request.

On the Web

Apply now for the Young Investigators Award!
www.aaas.org/science/prize.htm

The new standard in protein purification.

ÄKTA*FPLC*.

For years, FPLC® has been making history as the standard in lab-scale protein purification.

Now, we are set to make history all over again. ÄKTA*FPLC*® makes it easier than ever for you to achieve the most accurate, reliable results in lab-scale protein purification.

For a start, the ergonomic, compact design of ÄKTA*FPLC* makes it more versatile and easy to work with. Its unique, integral rack is fully adjustable to accommodate a wide variety of configurations for different purposes.

ÄKTA*FPLC* features the same proven pump technology that you'll find in its famous sister system. But now it has twice the throughput.

And with the pre-programmed templates of UNICORN® 3.0 for Windows NT control software, you'll spend even less time setting up your experiment. Just select your options from the graphical interface, and do it.

What could be simpler or more efficient? ÄKTA*FPLC* means fast, reliable results, time after time after time (there again, some things never change).

For more information about ÄKTA*FPLC* and other systems within the ÄKTA*design* platform please call us at: +1 (800) 526-3593 in the USA; +81 (0)3 3492 6949 in Japan; +46 18 16 50 11 in Europe and the rest of the world. Or visit us on the Web: www.apbiotech.com/akta

FPLC makes history. It is the world's most widely-used and cited purification system. It is the only system of its kind to be selected for display in The Science Museum, London.

FPLC is making history. Again.

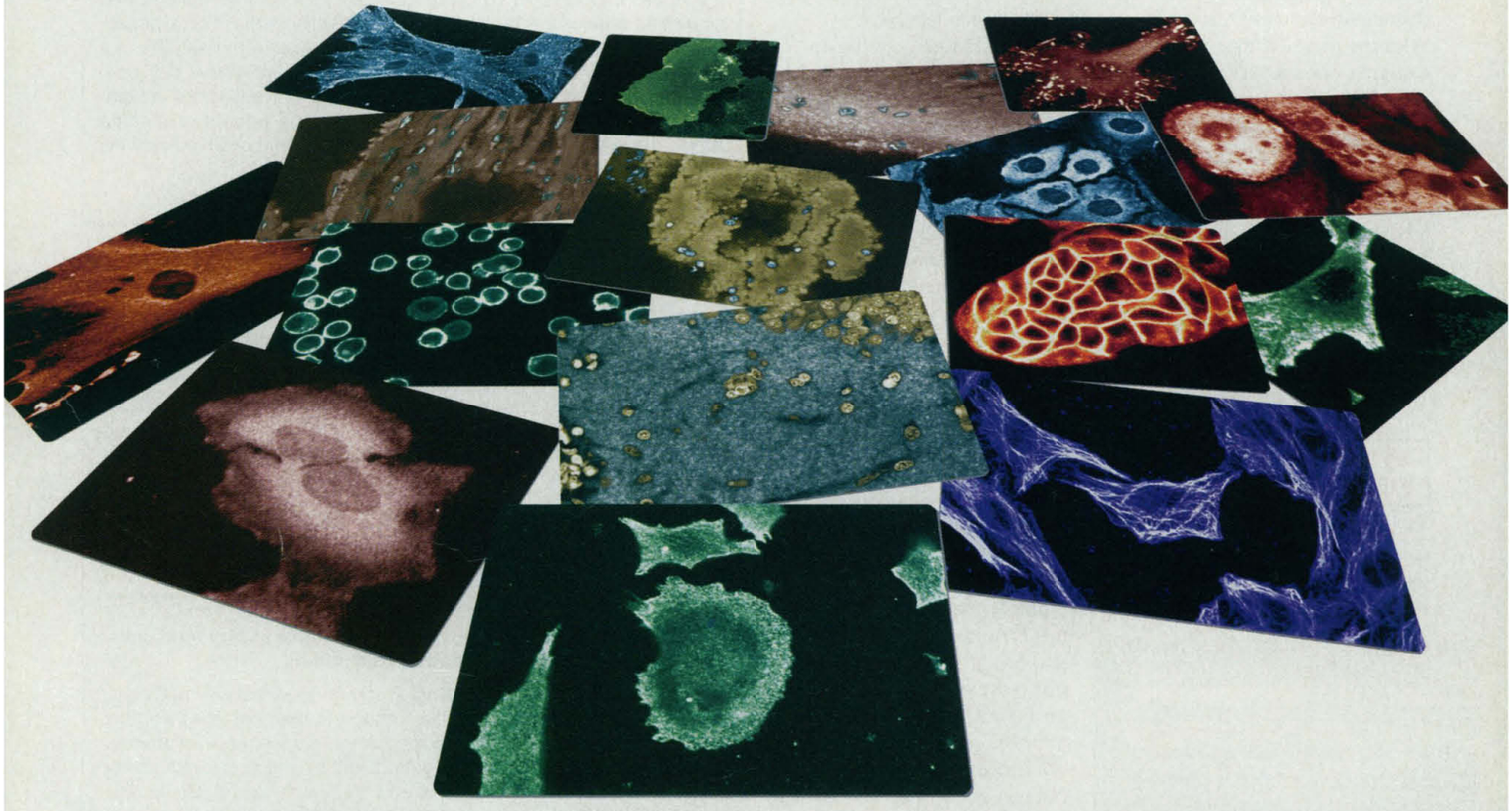
Windows NT is a registered trademark of Microsoft Corp.

amersham pharmacia biotech

Circle No. 23 on Readers' Service Card

6-98 MMC

Powerful Antibodies



You will be *amazed* at how powerful an antibody can be.

Transduction Laboratories

Toll-free 800-227-4063 *Fax* 606-259-1413
Voice 606-259-1550 *Website* translab.com

A list of current distributors of Transduction Laboratories products can be found on the Web at **translab.com/Distributors.html**

Circle No. 89 on Readers' Service Card

THIS WEEK IN SCIENCE

edited by PHIL SZUROMI

Stormy clusters

Clusters of galaxies are huge, gravitationally bound systems composed of about 1 percent visible galaxies, 15 percent intracluster gas, and 84 percent unseen matter (some form of dark matter that holds the entire cluster together). Burns (p. 400) reviews observations and modeling of these clusters which indicate that clusters have structure; complicated clumps of galaxies are woven together by irregular filaments, sheets, or walls into a weblike pattern with huge, empty void spaces (see cover). High, nonequilibrium temperatures and high relative velocities between galaxies indicate that clusters have collided, increasing the stormy conditions within the clusters. Many more collisions will occur until clusters will settle down into spherical balls of galaxies and gas in equilibrium with their dark matter.

■

Strange matter

Strange matter can be described as a soup of quarks, which are the elementary particles that make up protons and neutrons. Cheng *et al.* (p. 407) have developed a model for the unusual hard x-ray burster GRO J1744-28 (discovered by the Compton Gamma-Ray Observatory) that includes the formation of some strange matter. In their model, a star that accretes too much mass can cause the "crust" of the star to crack, and the released mass is converted to strange matter that subsequently produces a fireball that expands outward. The relativistically expanding fireball interacts with the surrounding interstellar medium, which then creates shock waves that produce a burst of x-ray radiation. The intensity, duration, and spectrum of the modeled x-ray burst is consistent with recent observations of GRO J1744-28, which indicate that the x-ray burster may be associated with a strange star.

■

T cell specificity and cathepsins

The repertoire of $CD4^+$ T cells that eventually circulate through the body are a result of careful culling to prevent autoreactivity or immunodeficiency. This selection process is initiated by major histocompatibility complex class II–expressing antigen presenting cells (APCs) in the thymus: The cortical epitheliuim initiates maturation of those T cells with helpful specificities, and the hematopoietically derived APCs identify autoreactive T cells that will ultimately die. Nakagawa *et al.* (p. 450; see the commentary by Creswell p. 394) have found that the cysteine protease cathepsin L is critical for the degradation of the invariant chain (Ii) of class II—but only in thymic cortical epithelium. Because Ii occupies the peptide binding site of class II molecules, the cathepsin L–deficient cortical epithelium was apparently unable to present the appropriate peptides to developing T cells. The lack of a positive selection signal led to a reduction in the number of mature $CD4^+$ T cells. The activity of the various cathepsin family proteases was different in different tissues, so this result may offer some explanation for how stimulation of T cells by different types of APCs can have different consequences: The array of peptides that ultimately are presented may depend on the activity of the particular cathepsin active in that particular APC.

Refractory inclusions: All together then

Calcium and aluminum-rich inclusions (CAIs) found in carbonaceous chondrites and more rarely in ordinary chondrites have been inferred to represent some of the first solid particles formed in the solar nebula. The abundances of oxygen isotopes in CAIs from carbonaceous chondrites have been used to determine their spatial and temporal origin in the solar nebula. Now, McKeegan *et al.* (p. 414) measured the oxygen isotopic abundances of three CAIs from ordinary chondrites. They found a similar enrichment of oxygen-16 in the ordinary chondrite CAIs as had been found in the carbonaceous chondrite CAIs. This result suggests that the CAIs in all chondrites formed in a similar and restricted region of the solar nebula. Because ordinary chondrites are assumed to have been formed in a different region of the solar nebula than the carbonaceous chondrites, these CAIs must be distributed unevenly into different parts of the solar nebula.

■

Carbonates tainting meteorites

The Tatahouine meteorite fell in southern Tunisia on a limestone hill slope covered with a sandy soil on 27 June 1931. Samples were recovered that day and again in 1994. Barrat *et al.* (p. 412) compared the samples and found that the 1994 fragments contained carbonate within the fractures, whereas the 1931 fragments did not. They measured the carbon isotopes of the carbonates and found the isotopic data consistent with contamination from the sandy soil in which the samples were recovered.

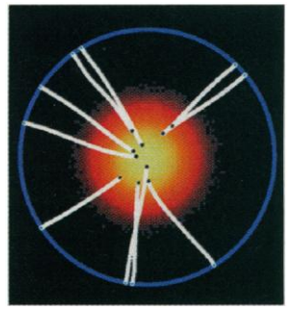
Stranded crust

The Kerguelen Plateau, one of Earth's largest oceanic plateaus, formed during the opening of the Indian Ocean when India and Australia rifted away from Antarctica. Hassler and Shimuzu (p. 418) used osmium isotope data to show that the plateau is underlain by pieces of Precambrian continental lithosphere. One possibility is that a piece of Gondwanaland was delaminated and stranded in the Indian Ocean during rifting.

■

Optimizing operators

In many coherent spectroscopic methods, such as nuclear magnetic resonance (NMR), the experimentalist wants to maximize the observed signal to shorten the data collection process. Such measurements are made on ensembles of quantum states rather than pure states, and the observables have imaginary parts that correspond to the action of non–real-valued,



or non-Hermitian, operators. Thus the methods that would optimize Hermitian operators will in general not lead to the best solution. Glaser *et al.* (p. 421; see the commentary by Warren, p. 398) describe a gradient-based procedure for optimizing these transformations that also has applications in applied mathematics and control theory.

(Continued on page 355)

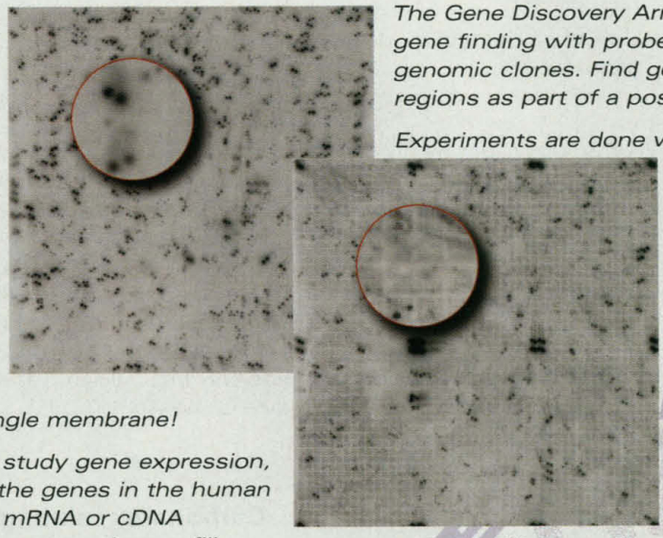
get discovered!

call for our latest catalogue
800. 430. 0030

with Genome Systems' Gene Discovery Array

New! **Genome Systems now offers its gene expression array as the newest resource for genetic research.**

- Discover active and inactive genes in a specific RNA sample
- Quickly identify new gene targets for future analysis



*We have arrayed **18,394** unique human genes from the I.M.A.G.E Consortium (llnl)[1] cDNA Libraries on a single membrane!*

These filters can be used to study gene expression, in parallel, for up to 20% of the genes in the human genome. Probes made from mRNA or cDNA libraries can be hybridized for expression profiling.

The Gene Discovery Array can also be used for gene finding with probes made from large genomic clones. Find genes in large genomic regions as part of a positional cloning program.

Experiments are done with simple $^{32}P/^{33}P$ labeling and hybridization techniques. Detection and analysis using phosphorimaging will allow for easy identification of the genes.

Researchers can purchase filters for their own high throughput analysis. Two filters are provided for the assessment of quantifiable differences between the expression of genes from two different RNA sources. All clones are linked to sequence information in dbEST.

Genome Systems can perform custom screening of the Gene Discovery Array. In just days we will provide complete data via confidential web access.

1. "The I.M.A.G.E Consortium: An Integrated Molecular Analysis of Genomes and their Expression", Lennon, G.G., Auffray, C., Polymeropoulos, M., and Soares, M.B. [1995] Genomics.

Genome Systems is an equal opportunity employer.

GenomeSystems Inc™
4633 World Parkway Circle
St. Louis, Missouri 63134-3115
Voice: 800. 430. 0030 or 314. 427. 3222
FAX: 314. 427. 3324
email: gda@genomesystems.com
World Wide Web:
http://www.genomesystems.com
France: Appel gratuit, 0590. 2104
Germany: Rufen sie uns an zum ortstarif, 0130. 81. 9081
UK: Call us free on, 0800. 89. 3733

(Continued from page 353)

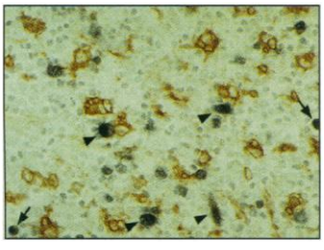
Hydrogen from solar cells

Splitting water into hydrogen and oxygen with sunlight is one of the most important goals of photoelectrochemistry. However, the *p*-type semiconductors most suitable for hydrogen generation often cannot produce sufficient voltage bias to actually perform the reaction. Khaselev and Turner (p. 425; see the news story by Service, p. 382) have made the sunlight do double duty—a *p*-type $GaInP_2$ layer adsorbs visible light to perform the electrochemistry that generates hydrogen, and it is sandwiched to a GaAs junction that adsorbs near-infrared light to generate an electrical potential that gives the *p*-$GaInP_2$ electrode sufficient bias. The authors report an efficiency greater than 12 percent.

■

Tracked in the GI tract

Understanding the events that occur immediately (within days or weeks) after infection with the human immunodeficiency virus (HIV) could be important in understanding and preventing the cascade of events that follow and lead to disease. Veazey *et al.*

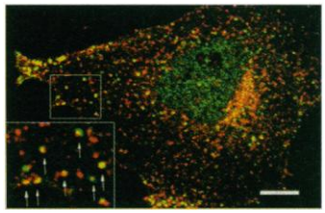


(p. 427) studied SIV (simian immunodeficiency virus) infection of macaques and found that before changes are apparent in peripheral lymphoid tissues (which are the most extensively studied tissues in HIV infection), the lymphoid tissues of the gastrointestinal tract are the major site of SIV replication and $CD4^+$ T cell loss.

■

Clathrin and AP3 adaptor complex

Different classes of clathrin-coated vesicles are used in receptor-mediated endocytosis at the cell surface and to sort secretory and lysosomal proteins



upon export from the Golgi complex. Adaptor proteins appear to mediate the sorting of membrane proteins into clathrin coats. Two types of adaptor (AP-1 and AP-2) are well known at the two sites. A third class of adaptors (AP-3) was identified recently with a role in signal-mediated protein sorting to endocytic compartments but was not thought to interact with clathrin. Dell'Angelica *et al.* (p. 431) now show that the AP-3 complex does in fact interact with clathrin on Golgi and endosome-associated coats.

■

Stress and potassium channels

Stress causes many changes in organismal physiology. Xie *et al.* (p. 443) examined the effects of stress hormones on the expression of a class of potassium channels in rat adrenal chromaffin tissue. Reductions in the level of the stress-related hormone adrenocorticotrophic hormone led to changes in the levels of alternatively splice variants of the messenger RNA that encoded a calcium and voltage-activated potassium channel. This process would be expected to alter the excitability properties of the chromaffin cells and thus how they secrete catecholamines—which would have further effects on many other organs, including the heart.

■

Soil and CO_2

The effects of elevated CO_2 on below-ground ecosystem processes and biota is reported by Jones *et al.* (p. 441). Using model ecosystems created in the Ecotron facility, they identified alterations in community composition, exemplified by changes in fungi and Collembola species, and in biogeochemistry, as indicated by enhanced cellulose decomposition. The work suggests that that rising atmospheric CO_2 concentrations may significantly impact long-term feedback in soil processes.

■

Back and forth

Development in higher plants alternates between diploid and haploid generations. Grossniklaus *et al.* (p. 446) have identified in *Arabidopsis* a genetic mutant that particularly affects the haploid gametophyte generation. The gene, *medea*, resembles genes encoding members of the Polycomb group of proteins, some of which regulate expression of homeotic genes in *Drosophila*.

Technical Comment Summaries

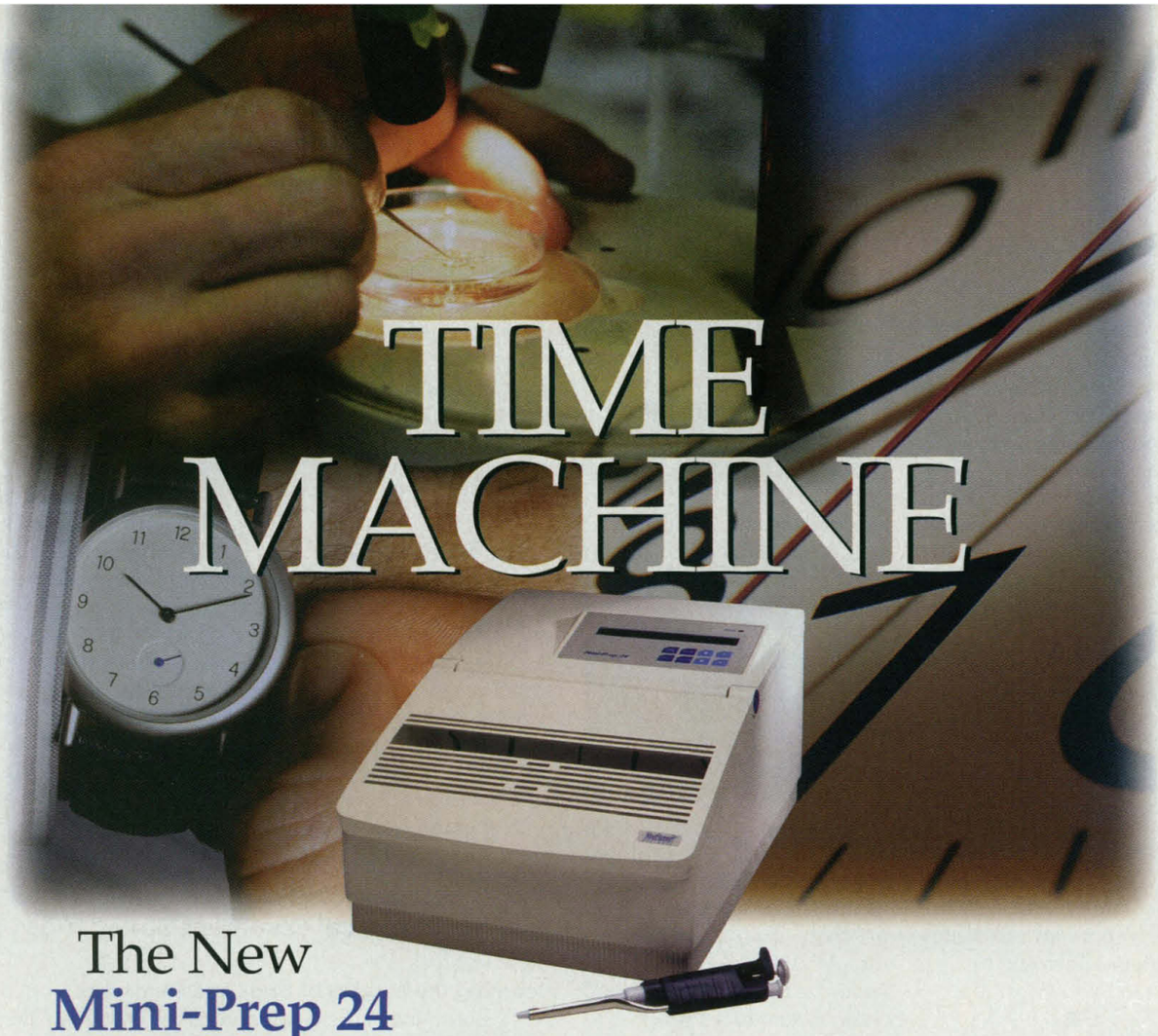
Counting the Fingers of Birds and Dinosaurs

A. C. Burke and A. Feduccia studied the embryonic development of fingers and wrists in extant amniotes (egg-laying animals) (Reports, 24 Oct., p. 666) and concluded that the three digits seen in birds are not homologous to the three digits seen in theropod dinosaurs. In an accompanying Perspective (p. 597), R. Hinchliffe wrote in favor of "[evolutionary] convergence (rather than common origin) as an explanation of the similarities between the structure of the forelimb of theropods and the wing of [the ancient bird] *Archaeopteryx*."

S. Chatterjee defends the birds-from-dinosaurs idea by reviewing work in several disciplines. He describes the "topographic position" of the digits in embryos as they develop and discusses ways that "digital reduction" could have occurred through evolution (in many species, fingers were reduced from five to two or three). He concludes that a "synthesis of both neontological and paleontological data" supports the theropod origin of birds. J. P. Garner and A. L. R. Thomas question "assumptions" made in the report and describe how the developmental data therein are actually "entirely consistent with a theropod origin of birds."

In response, Burke, Feduccia, and Hinchliffe discuss each point of criticism and describe how the theropod hand most likely developed (in the embryo) in a fashion consistent with the highly conserved pattern of development among amniotes. They maintain that the birds-from-dinosaurs idea is "inconsistent with the observations and current evidence of comparative embryology."

The full text of these comments can be seen at www.sciencemag.org/cgi/content/full/280/5362/355a



The New **Mini-Prep 24** for Automated Plasmid Mini-Preps

The Mini-Prep 24 is a fully automated bench-top instrument designed for purification of plasmid DNA directly from bacterial culture.

The instrument uses a revolutionary new method of nucleic acid purification based on modified agarose gel electrophoresis and subsequent recovery by electroelution.

The process utilizes premanufactured sample cassettes which allow for direct loading of up to 2 ml of culture.

Call now to learn how the New and Improved Mini-Prep 24 can provide you with great, high-quality DNA...while saving you a lot of time.

High Purity - sufficient for automated fluorescent and manual sequencing.

Easy Operation - begin prep with direct loading of bacteria culture - no centrifugation step saves you time.

Consistent Results - up to 6 µg of plasmid per ml.

Fast - up to 24 preps per hour, saving you time.

Quality - time and time again.

MacConnell RESEARCH

1-800-466-7949

11339 SorrentoValley Rd • San Diego, CA 92121 Phone: (619) 452-2603 Fax (619) 452-6753

www.macconnell.com

Circle No. 22 on Readers' Service Card

Biotechnology Software & Internet Journal

AWARDs

BEST COMPREHENSIVE & OVERALL PRODUCT OF 1997

September/October 1997

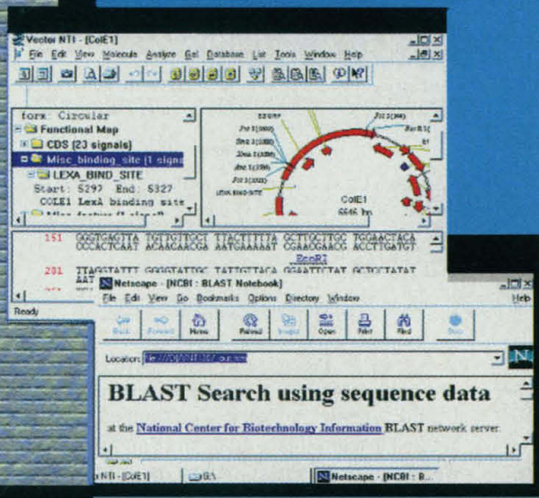
New Version 5.0

VECTOR NTI™

THE BEST SOFTWARE FOR MOLECULAR BIOLOGY

Proteins & Protein Analysis

- PCR
- Molecule Construction & Design
- Cloning
- Electrophoresis
- Oligos, ORFs, Motifs
- Excellent Graphics
- Internet Connectivity
- ✔ Protein Analysis



- InforMax Vector NTI communicates with your Oracle and Sybase databases via the web
- InforMax WWW - based technology integrates your databases and programs

BIO-INFORMATICS SYSTEM INTEGRATION

InforMax, Inc.
6110 Executive Blvd, Suite 400
North Bethesda, MD 20852 USA
(800) 357-3114 or (301) 984-2206
Fax (301) 216-0087
informax@informaxinc.com

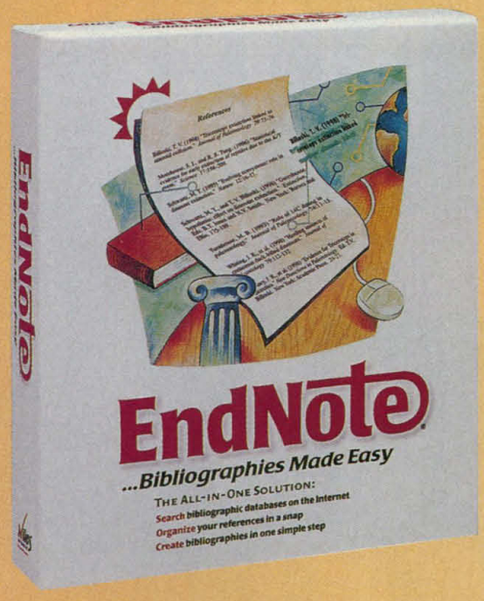
InforMax®

分子生物学

細胞生物学

Download Vector NTI Demo - http://www.informaxinc.com

Circle No. 36 on Readers' Service Card



from the company that invented 1-Step Bibliographies™–

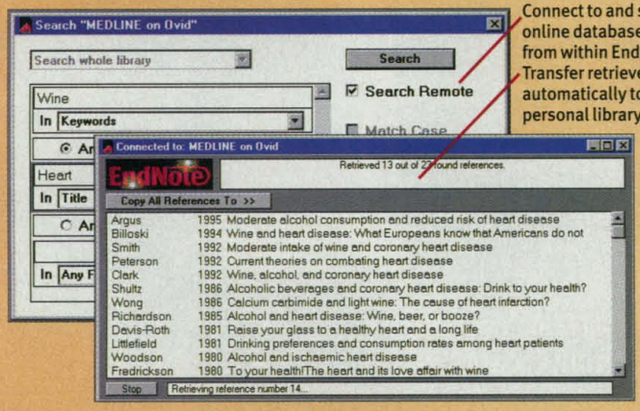
Introducing

EndNote® 3

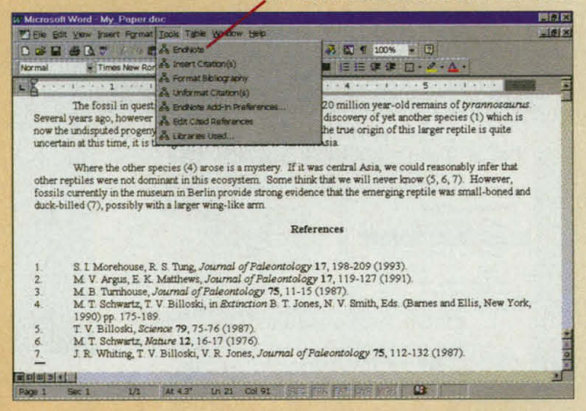
THE ALL-IN-ONE SOLUTION:

- ✓**1-Step Internet Research** *New!*
- ✓**1-Step Reference Organization**
- ✓**1-Step Bibliographies**

Connect to and search online databases from within EndNote. Transfer retrieved references automatically to your personal library.



Access EndNote commands and create ONE-STEP BIBLIOGRAPHIES™ from within Microsoft Word & WordPerfect.



Online Search Tool *New!*

EndNote includes more than 100 connection files, enabling you to seamlessly access remote bibliographic databases such as MEDLINE, PsycINFO, and many university library catalogs from within EndNote. Search these and other databases using EndNote's simple search window-then transfer your results directly into your EndNote database. No additional importing steps!

Reference Database

EndNote makes organizing references easy. Create your own EndNote databases (as many as you wish) and store up to 32,000 records in each. Store abstracts, keywords, and notes, and link records to full-text articles or other material on the World Wide Web. At the click of a button, EndNote launches your web browser (e.g. Netscape, Microsoft Internet Explorer) directly from EndNote records.

1-Step Bibliography Maker

EndNote creates 1-Step Bibliographies™ from within Microsoft Word (Macintosh and Windows) and WordPerfect (Windows), allowing you to insert citations and format bibliographies without leaving your word processing documents. For journal article submissions, grant proposals, thesis preparation and a wide variety of academic writing projects, EndNote is an invaluable time-saving tool. You can choose from over 300 pre-defined bibliographic styles (e.g., APA, Science, Nature), or create a style to suit your needs. You can revise your document as many times as needed—EndNote will update the in-text citations and bibliography quickly and easily. And EndNote will also generate bibliographies in HTML for publication on the Internet!

More than 150,000 users prefer EndNote.

Compatible with Windows 95, Windows NT, Windows 3.1 and Mac OS. To use EndNote as an online search tool: Remote databases must be z39.50 compliant; System must have Internet access and ability to run standard Internet applications.

Visit our website at www.niles.com to download a free 30-day trial version of EndNote.

Niles SOFTWARE INC.
The EndNote Company

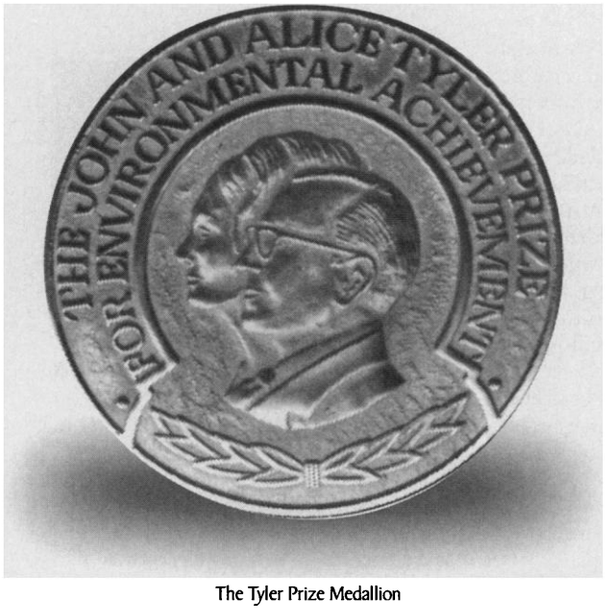
800 Jones Street Berkeley California 94710 USA
PHONE 510.559.8592 FAX 510.559.8683
EMAIL info@niles.com http://www.niles.com

Circle No. 35 on Readers' Service Card

1998 Tyler Prize

for Environmental Achievement

25th ANNIVERSARY 1973 - 1998



The Tyler Prize Medallion

Anne H. Ehrlich

Senior Research Associate
Department of Biological Sciences and
Associate Director, Center for Conservation Biology
Stanford University

Paul R. Ehrlich

Bing Professor of Population Studies and
Professor of Biological Sciences
Stanford University

Tyler Prize

The Tyler Prize was established in 1973 by the late Alice and John Tyler as an international award honoring outstanding scientific and policy achievements in environmental research and environmental protection. The Tyler Prize is in the sum of $200,000, divided equally between the 1998 Tyler Prize Laureates.

World renowned scientists in the fields of population biology, ecology and evolution, the Ehrlichs have made exemplary contributions to understanding environmental conditions worldwide. For more than three decades, they have raised public awareness of human impacts and shaped public opinion on the problems of population, resource depletion, and environmental degradation. Through their efforts, they have influenced more than a generation of scientists and policymakers worldwide.

Call For Nominations

Nominations for the 1999 Tyler Prize will be accepted until September 15, 1998
Visit the Tyler Prize Home Page to download a nomination form at: www.usc.edu/go//TylerPrize

For additional information contact Dr. Jerome Walker, Executive Director, The Tyler Prize
Phone: 213-740-6559, Fax: 213-740-1313, Email: tylerprz@usc.edu

Selection of the Tyler Prize is made by the Tyler Prize Executive Committee
The Tyler Prize is administered by the University of Southern California

Circle No. 37 on Readers' Service Card

www.sciencemag.org

SCIENCE

Editor-in-Chief: Floyd E. Bloom
Editor: Ellis Rubinstein
Managing Editor: Monica M. Bradford
Deputy Editors: Philip H. Abelson (*Engineering and Applied Sciences*); John I. Brauman (*Physical Sciences*); Thomas R. Cech (*Biological Sciences*)

Editorial

Assistant Managing Editor: Dawn McCoy; **Senior Editors**: Gilbert J. Chin, R. Brooks Hanson, Pamela J. Hines, Barbara Jasny, Paula A. Kiberstis, Linda J. Miller, L. Bryan Ray, Phillip D. Szuromi; **Associate Editors:** Beverly A. Purnell, Linda R. Rowan; **Letters and Technical Comments:** Christine Gilbert, *Editor*; Steven S. Lapham, *Associate Letters Editor*; Charlene King, *Assistant*; ***Science*'s Compass:** Katrina L. Kelner, David F. Voss, *Senior Editors*; Sherman J. Suter, *Associate Book Review Editor*, Brent Gendleman, Jeffrey Hearn, *Assistants*; Janet Kegg, *Information Specialist*; **Tech.Sight:** Richard Peters, Robert Sikorski, *Contributing Editors*; **Editing:** Cara Tate, *Supervisor*; Harry Jach, Christine M. Pearce, *Senior Copy Editors*; Jeffrey E. Cook, Etta Kavanagh, Joshua Marcy; **Copy Desk:** Ellen E. Murphy, *Supervisor*; Joi S. Granger, Abigail Hollister, Monique Martineau, Beverly Shields; Jessica Moshell, *Assistant*; **Editorial Support:** Carolyn Kyle, *Editorial Assistant*; Candace Gallery, Amy Herda, Josh Lipicky, Patricia M. Moore, Anita Wynn, *Manuscript Assistants*; **Administrative Support:** Sylvia Kihara; **Computer Specialist:** Roman Frillarte

News

News Editor: Colin Norman; **Features Editor:** Tim Appenzeller; **Deputy News Editors:** Elizabeth Culotta (contributing editor), Jean Marx, Jeffrey Mervis, Richard Stone; **News & Comment/Research News Writers:** Constance Holden, Jocelyn Kaiser, Richard A. Kerr, David Kestenbaum, Andrew Lawler, Eliot Marshall, Elizabeth Pennisi, Robert F. Service, Gretchen Vogel; **Bureaus:** Berkeley, CA: Marcia Barinaga (contributing correspondent); San Diego, CA: Jon Cohen; Chicago, IL: James Glanz; **Copy Editors:** Linda B. Felaco, Daniel T. Helgerman; **Contributing Correspondents:** Barry A. Cipra, Ann Gibbons, Patricia Kahn, Charles C. Mann, Wade Roush, Anne Simon Moffat, Virginia Morell, Gary Taubes, Ingrid Wickelgren; **Administrative Support:** Scherraine Mack, Fannie Groom

Production & Art

Production: James Landry, *Director*; Wendy K. Shank, *Manager*; Lizabeth A. Harman, *Assistant Manager*; Clarence A. Foules, Vicki J. Jorgensen, Cynthia M. Penny, Kameaka Williams, *Associates*
Art: Amy Decker Henry, *Design Director*; C. Faber Smith, *Art Director*; Elizabeth Carroll, *Associate Art Director*; Katharine Sutliff, *Scientific Illustrator*; Holly Bishop, Preston Morrighan, Darcel Pugh, *Graphics Associates*; Patricia M. Riehn, *Graphics Assistant*; Leslie Blizard, *Photo Researcher*; **Technology Manager:** Christopher J. Feldmeier

Science International: Europe Office

Editorial: Richard B. Gallagher, *Office Head and Senior Editor*; Stella M. Hurtley, Peter Stern, Julia Uppenbrink, *Associate Editors*; Belinda Holden, *Editorial Associate*; **News:** Daniel Clery, *Editor*; Nigel Williams, *Correspondent*; Michael Balter (Paris), *Contributing Correspondent*; **UK Editor, *Science*'s Next Wave:** John MacFarlane; **Administrative Support:** Janet Mumford, Liz Ellis; **Asia Office:** Japan News Bureau: Dennis Normile, *Contributing Correspondent*; China Representative: Hao Xin

ScienceNOW: www.sciencenow.org
Editor: Erik Stokstad

***Science*'s Next Wave: www.nextwave.org**
Managing Editor: Wendy Yee; **Associate Editor:** Nicole Ruediger; **Writer:** Melissa Mertl; **Canada Editor:** Charles Boulakia

Richard S. Nicholson
Publisher

Beth Rosner
Associate Publisher

Michael Spinella
Membership/Circulation Director

Membership/Circulation

Deputy Director: Marlene Zendell
Member Services: Michael Lung, *Manager;* Mary Curry, *Supervisor;* Pat Butler, Laurie Baker, Jonathan Keeler, Jantell Smith, *Representatives*
Marketing: Dee Valencia, *Manager;* Hilary Baar, *Assistant Manager;* Lauri Sirois, *Coordinator;* Jane Pennington, *Europe Manager;* Ben Holland, *Representative*
Research: Renuka Chander, *Manager*
Business and Finance: Robert Smariga, *Manager;* Susan Maxim, *Assistant*
Computer Specialist: Charles Munson

Finance and Advertising

Business and Finance: Deborah Rivera-Wienhold, *Business Manager;* Randy Yi, *Senior Analyst;* Connie Dang, *Financial Analyst*
Permissions: Lincoln Richman, *Administrator;* Emilie David, *Assistant*
Marketing: John Meyers, *Director;* Chris Harbaugh, Allison Pritchard, *Associates*
Electronic Media: David Gillikin, *Manager;* Wendy Green, *Computer Specialist;* Mark Croatti, Crystal Young, *Production Associates*

Product Advertising: Carol Maddox, *Traffic Manager*; Sheila Myers, Sandra Walls, *Associates*
Assistant to Associate Publisher: Jessica Tierney

Sales

Product Advertising: Richard Teeling, *Acting National Sales Manager/E. Coast and E. Canada*: 973-904-9774, FAX 973-904-9701 • **Midwest/Southeast:** Elizabeth Mosko: 773-665-1150, FAX 773-665-2129 • **West Coast/W. Canada:** Neil Boylan: 415-673-9265, FAX 415-673-9267 • **U.S. Inside Sales:** Chris Breslin: 202-326-6544, FAX 202-682-0816 • **UK/Scandinavia/France/Italy/ Belgium/Netherlands:** Andrew Davies: (44) 1-457-871-073, FAX (44) 1-457-877-344 • **Germany/Switzerland/Austria:** Tracey Peers: (44) 1-260-297-530, FAX (44) 1-260-271-022 • **Japan:** Mashy Yoshikawa: (81) 3-3235-5961, FAX (81) 3-3235-5852
Recruitment Advertising: Terri Seiter Azie, *Sales and Production Operations Manager* • **U.S. Sales:** Gabrielle Boguslawski, *Sales Manager*: 718-491-1607, FAX 202-289-6742; Daryl Anderson, *Sales Supervisor*; Beth Dwyer, Bren Peters-Minnis, Eric Banks, Troy Benitez, *Sales Representatives*; Erika Bryant, Kathleen Clark, Angela Panton, *Assistants* • Ellen McGuire, Jennifer Rankin, *Production Associates*; Chris Filiatreau, *Copy Editor/Proofreader* • **U.K./Europe:** Debbie Cummings, *Sales Manager*; Sabine Lenud, *Sales Executive*; Michaela Heigl, *Assistant*: (44) 1-223-302-067, FAX (44) 1-223-576-208 • **Australia/New Zealand:** Keith Sandell: (61) 02-922-2977, FAX (61) 02-922-1100 • **Japan:** Mashy Yoshikawa: (81) 3-3235-5961, FAX (81) 3-3235-5852

■ Published by the **American Association for the Advancement of Science (AAAS),** *Science* serves its readers as a forum for the presentation and discussion of important issues related to the advancement of science, including the presentation of minority or conflicting points of view, rather than by publishing only material on which a consensus has been reached. Accordingly, all articles published in *Science*—including editorials, news and comment, and book reviews—are signed and reflect the individual views of the authors and not official points of view adopted by the AAAS or the institutions with which the authors are affiliated.

■ The American Association for the Advancement of Science was founded in 1848 and incorporated in 1874. Its objectives are to further the work of scientists, to facilitate cooperation among them, to foster scientific freedom and responsibility, to improve the effectiveness of science in the promotion of human welfare, to advance education in science, and to increase public understanding and appreciation of the importance and promise of the methods of science in human progress.

INFORMATION RESOURCES

SUBSCRIPTION SERVICES

For change of address, missing issues, new orders and renewals, and payment questions, please contact AAAS at Danbury, CT: 800-731-4939 or Washington, DC: 202-326-6417, FAX 202-842-1065. Mailing addresses: AAAS, P.O. Box 1811, Danbury, CT 06813 or AAAS Member Services, 1200 New York Avenue, NW, Washington, DC 20005 • **Other AAAS Programs:** 202-326-6400

MEMBER BENEFIT CONTACTS

Credit Card: MBNA 1-800-847-7378; Car Rentals: Hertz 1-800-654-2200 CDP#343457, Dollar 1-800-800-4000 #AA1115; AAAS Travels: Betchart Expeditions 1-800-252-4910; Life Insurance: Seabury & Smith 1-800-424-9883; Other Benefits: AAAS Member Services 1-202-326-6417.

REPRINTS & PERMISSION

Reprints: Ordering/Billing/Status, 800-407-9190; Corrections, 202-326-6501 • **Permissions:** 202-326-7074, FAX 202-682-0816

INTERNET ADDRESSES

science_editors@aaas.org (for general editorial queries); science_news@aaas.org (for news queries); science_letters@aaas.org (for letters to the editor); science_reviews@aaas.org (for returning manuscript reviews); science_bookrevs@aaas.org (for book review queries); science@science-int.co.uk (for the Europe Office); membership@aaas.org (for member services); science_classifieds@aaas.org (for submitting classified advertisements); science_advertising@aaas.org (for product advertising)

INFORMATION FOR CONTRIBUTORS

See pages 108 and 109 of the 2 January 1998 issue or access www.sciencemag.org/misc/con-info.shtml.

EDITORIAL & NEWS CONTACTS

North America

Address: 1200 New York Avenue, NW, Washington, DC 20005
Editorial: 202-326-6501, FAX 202-289-7562
News: 202-326-6500, FAX 202-371-9227 • **Bureaus:** **Berkeley, CA:** 510-841-1154, FAX 510- 841-6339, **San Diego, CA:** 619-942-3252, FAX 619-942-4979, **Chicago, IL:** 312-360-1227, FAX 312-360-0537

Europe

Headquarters: 14 George IV Street, Cambridge, UK CB2 1HH; (44) 1223-302067, FAX (44) 1223-302068
Paris Correspondent: (33) 1-49-29-09-01, FAX (33) 1-49-29-09-00

Asia

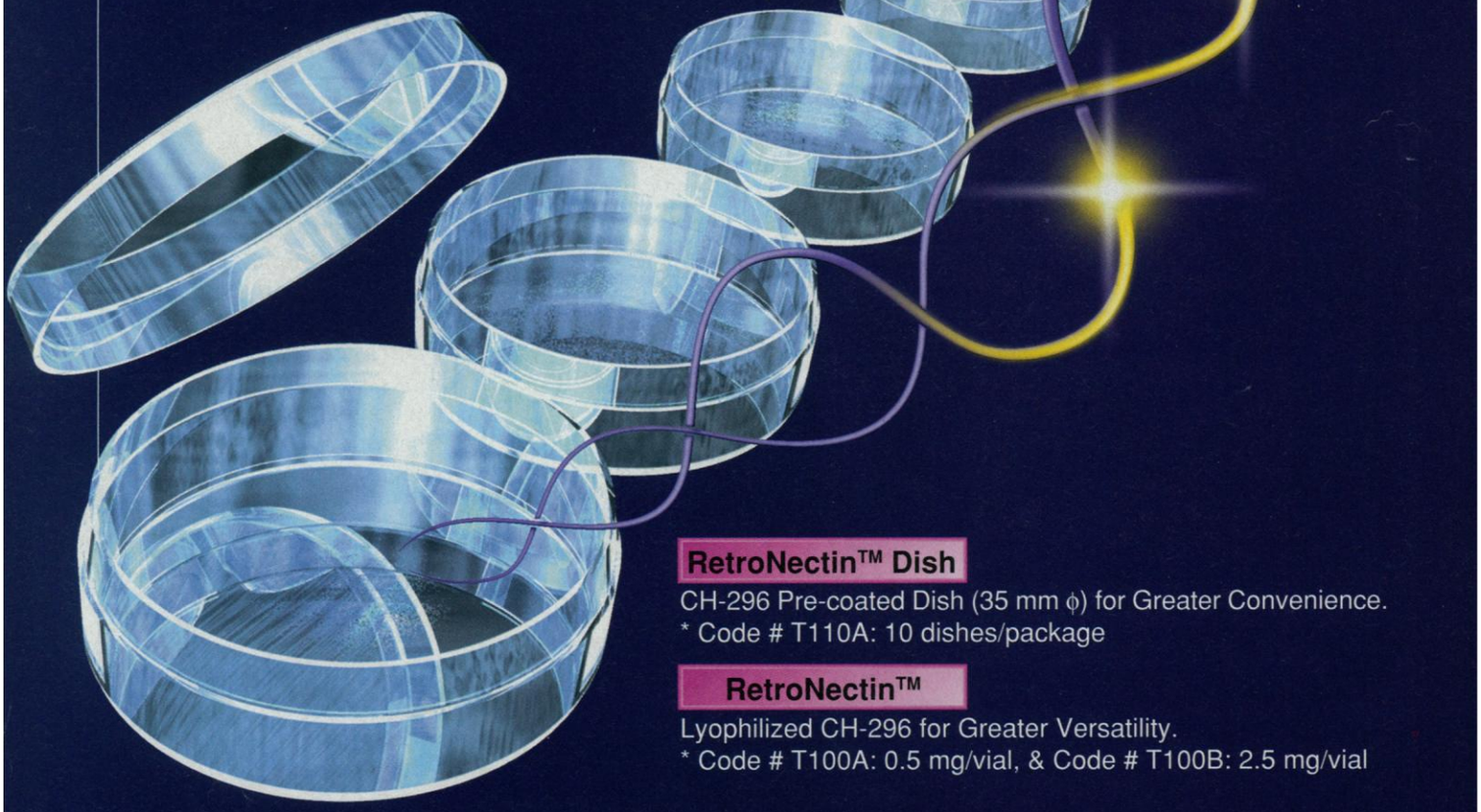
News Bureau: Dennis Normile, (81) 3-3335-9925, FAX (81) 3-3335-4898; dnormile@twics.com
• **Japan Office:** Carl Kay, Esaka 1-chome 16-10-305, Suita-shi, Osaka-fu 564 Japan; (81) 6-387-5483, FAX (81) 6-337-6809; science@japanese.co.jp
• **China Office:** Hao Xin, science@public3.bta.net.cn

RetroNectin™ Dish

Today's Research for Tomorrow's Revolution

Retrovirus-Mediated Gene Transfer Becomes Routine With Pre-Coated Dish! Easy, Quick and Highly Efficient!

Recombinant Human Fibronectin Fragment CH-296 Significantly Enhances Retrovirus Mediated Gene Transfer into Mammalian Cells Including Established Cell Lines.



RetroNectin™ Dish

CH-296 Pre-coated Dish (35 mm ϕ) for Greater Convenience.
* Code # T110A: 10 dishes/package

RetroNectin™

Lyophilized CH-296 for Greater Versatility.
* Code # T100A: 0.5 mg/vial, & Code # T100B: 2.5 mg/vial

Notes:
Any commercialization of products resulting from the use of material and/or technology requires a license from Takara Shuzo Co., Ltd. .
#1 RetroNectin™ is covered by Patents issued to Takara Shuzo Co., Ltd. (US Patent No. 5,198,423 and equivalents in other countries)
#2 A method to increase the efficiency of retrovirus mediated gene transfer (WO 95/26200) is licensed to Takara exclusively and worldwide.

RetroNectin™ IS INTENDED FOR RESEARCH USE ONLY. NOT FOR USE IN DIAGNOSTIC OR THERAPEUTIC PROCEDURES.

TaKaRa
TAKARA SHUZO CO.,LTD.
BIOMEDICAL GROUP
Otsu, Shiga, Japan
Phone:+81 77-543-7247 Fax:+81 77-543-9254

Korea
BOHAN (TaKaRa-Korea) Biomedical Inc.
Phone: (02) 577-2002 Fax: (02) 577-3691
Europe
TaKaRa Biomedical Europe S.A.
Phone: +33 1 41 47 01 14 Fax: +33 1 47 92 18 80

DISTRIBUTORS

Europe
Boehringer Ingelheim Bioproducts Partnership
Phone: +49 6221 59 83 00
Fax: +49 6221 59 83 13

North & South Americas
PanVera Corporation
Toll Free: 800-791-1400
Fax: 608-233-3007
E-mail : info@panvera.com

U.S.A.
BioWhittaker, Inc.
Toll Free: 800-638-8174
Fax: 301-845-8338

Taiwan
Cold Spring Biotechnology Co.,Ltd.
Phone: +886 2-695-9990
Fax: +886 2-695-9963

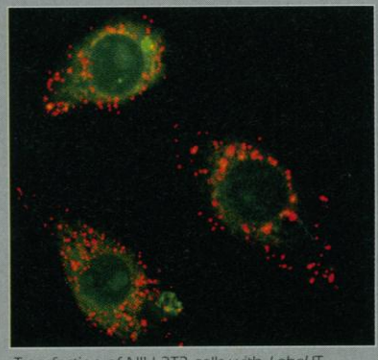
Taiwan
Cheng Chin Trading Co.,Ltd.
Phone: +886 2-331-3111
Fax: +886 2-382-2197

Homepage: http://www.takara.co.jp/english/bio_e/ E-mail: bio-sm@takara.co.jp

Circle No. 3 on Readers' Service Card

At last, One Step DNA Labeling.

Identical linear ds DNA fragments, either unlabeled (A), or labeled with the *Label* IT™ Rhodamine* Labeling Kit (B), were analyzed by gel electrophoresis and visualized under UV illumination. Gel A was stained with EtBr; the labeled fragments on Gel B were visualized WITHOUT EtBr staining. This demonstrates the high labeling efficiency and non-destructiveness of the *Label* IT method.



Transfection of NIH 3T3 cells with *Label* IT rhodamine labeled DNA. Red spots indicate internalization of labeled DNA.

**Label* IT Kits are available for rhodamine, fluorescein, biotin and digoxin labeling.

Mirus' *Label* IT™ Non-Radioactive Labeling Kits offer:

Versatility: Label any DNA or RNA with a single reagent. Labeled products can be used in any molecular biology application, FISH, or DNA or RNA transport studies.

Simplicity: Just mix *Label* IT reagent with DNA or RNA to covalently label.

Reproducibility: The proprietary, non-enzymatic *Label* IT method yields extremely reproducible results.

High Efficiency: *Label* IT reagents can add ≥1 label per 10 base pairs of DNA.

Quantitative recoveries and "scalability": The original substrate nucleic acid is covalently and non-destructively labeled, and the reaction can be scaled up in a single tube with no loss of efficiency.

From now on *Label* IT.™

800-791-1400

(In the USA and Canada)

PANVERA

PanVera Corporation, 545 Science Drive, Madison, WI 53711 USA 608-233-5050 Fax: 608-233-3007 E-mail: info@panvera.com www.panvera.com

In Japan contact TaKaRa Shuzo Co., Ltd. Phone: +81 775-43-7247 Fax: +81 775-43-9254 In the UK contact Cambridge Bioscience Phone: +44 1223-316855 Fax: +44 1223-360732 E-mail: cbio@cix.compulink.co.uk In Switzerland contact JURO Supply AG Phone: +41(041)226-20-60 Fax: +41(041)226-20-66 E-mail: juro_lucerne@mail.tic.ch In Germany contact MoBiTec Phone: +49 551-371062 Fax: +49 551-34987 E-mail: info@mobitec.com

The Merrill Lynch forum

THE MERRILL LYNCH FORUM ANNOUNCES THE INNOVATION GRANTS COMPETITION

The Merrill Lynch Forum will award $150,000 in grants to recent Ph.D. recipients from universities worldwide. Top prize is $50,000.

In the 21st-century global economy, we believe that universities will be more important incubators of innovation and creators of intellectual capital than ever before. The Innovation Grants Competition seeks to encourage Ph.D. candidates to explore the marketplace potential of their dissertation ideas. In addition to cash awards, winners will meet with leading entrepreneurs and venture capitalists to discuss their work. The winning candidates' university departments will also receive $5,000 Innovation Grants.

All Ph.D. candidates in the sciences, liberal arts and engineering who successfully defend a dissertation between January 1, 1996 and July 1, 1998 are eligible to enter the competition. Awards will be announced in September, 1998. Applications and entry information can be obtained from the Forum Web site at www.ml.com/innovation or via e-mail to InnovationGrants@ml.com. Or call 1-888-33-FORUM.

An independent panel of distinguished scientists and entrepreneurs, under the direction of **Michael Schrage,** Research Associate of the MIT Media Lab, will judge the competition:

John Seely Brown, Ph.D., Chief Scientist, Xerox Corp., Director, Xerox Palo Alto Research Center (PARC)

Edgar W.K. Cheng, M.D., Chairman, World-Wide Investment Company Limited and Former Chairman, The Stock Exchange of Hong Kong

John Doerr, Partner, Kleiner Perkins Caufield & Byers

Esther Dyson, EDventure Holdings, Inc.

Peter Goldmark Jr., President, The Rockefeller Foundation

William Haseltine, Ph.D., Chairman & CEO, Human Genome Sciences, Inc.

John Markoff, Technology Correspondent, *The New York Times*

Edward McKinley, President, E.M. Warburg, Pincus & Company, International, Ltd.

Arati Prabhakar, Ph.D., Chief Technology Officer, Raychem Corp.

The Merrill Lynch Forum seeks to create a more vibrant marketplace of ideas, bringing together leading experts to consider and explore issues of worldwide importance in technology, economics, geopolitics and beyond.

NATO Science Programme

Programme Changes -1998

Overview

Following a wide-ranging review of the NATO Science Programme, the NATO Science Committee has decided that the Programme will in future provide assistance primarily for scientific collaboration between NATO-country scientists and scientists in NATO's Partner countries, including those participating in the Mediterranean Dialogue. 1998 will be a year of transition, when support will initially be available for both NATO and NATO-Partner collaboration, but will progressively move during the year towards support for exclusively NATO-Partner collaboration. Applications for support in 1999 will only be considered if they involve collaboration between NATO-country scientists and Partner-country scientists. NATO countries and Partner countries eligible for support under the Programme are listed below.

The New Programme

The NATO Science Programme now offers support for scientific collaboration in general science, and in a number of Priority Areas, between NATO-country scientists and scientists in NATO's Partner countries. The following types of collaborative activity are supported: **Advanced Study Institutes (ASIs), Advanced Research Workshops (ARWs), Collaborative Research Grants (CRGs), Linkage Grants (LGs), Expert Visits (EVs) and Networking Infrastructure Grants (NIGs)**. Support for applied industrial and environmental R&D projects in Partner countries, in collaboration with NATO country counterparts, is also available under the **Science for Peace (SfP)** Programme. Notes for Applicants and specific application forms for these activities are available from the Scientific Affairs Division, or at the NATO science web site.

The Priority Areas in 1998 are Environmental Security, High Technology, Disarmament Technologies, Science and Technology Policy, and Computer Networking.

NATO **Science Fellowships** are also supported. While precise eligibility criteria vary from country to country, fellowships are generally available to both Partner scientists and NATO scientists. Science Fellowships are administered in NATO countries, and contact information for National Fellowships Administrators is available from the Scientific Affairs Division or at the NATO science web site.

Application Deadlines

- The annual deadlines for receipt of applications in areas of **General Science** for the different types of activity are:
  Advanced Study Institutes & Advanced Research Workshops: 1 February & 1 July
  Collaborative Research Grants, Linkage Grants & Expert Visits: 31 March, 15 August & 30 November
- The annual deadlines for receipt of applications in **Priority Areas**, for all types of activity, are 15 January, 15 May and 15 September.
- The remaining 1998 deadline for receipt of proposals under the **Science for Peace** Programme is 15 May.

Spotlight on Changes

Applications for Intra-Alliance **Collaborative Research Grants** will no longer be accepted for support after the published deadline of 31 March 1998. For the subsequent published deadlines of 15 August and 30 November 1998 for General Science CRGs, only applications for collaboration between scientists in NATO and Partner countries will be considered for support. Further support criteria are specified in current Notes for Applicants.

Applications for Intra-Alliance **Advanced Study Institutes** will no longer be accepted for support after the published deadline of 1 July 1998. For the subsequent published deadlines of 1 February 1999 and 1 July 1999 for General Science ASIs, only applications for ASIs having two co-directors, one from a NATO country and one from a Partner country, will be considered for support. Further support criteria are specified in current Notes for Applicants.

As regards ASI applications submitted for the deadline of 1 July 1998, preference will be given to those with a more balanced participation of ASI students between NATO and Partner countries, that is with 40-50% coming from Partner countries. The ASI may be held in either a NATO country or a Partner country.

Scientific Affairs Division
NATO
1110 Brussels, Belgium
NATO Science Web Site - http://www.nato.int/science

NATO countries: Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Turkey, United Kingdom, United States.

Partner countries eligible for support: Albania, Armenia, Azerbaijan, Belarus, Bulgaria, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Poland, Romania, Russian Federation, Slovak Republic, Slovenia, Tajikistan, the former Yugoslav Republic of Macedonia[1], Turkmenistan, Ukraine, Uzbekistan

Mediterranean Dialogue countries eligible for support on a case-by-case basis: Egypt, Israel, Jordan, Mauritania, Morocco, Tunisia

[1] *Turkey recognises the Republic of Macedonia with its constitutional name.*