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Delivery of Na<sup>+</sup>,K<sup>+</sup>-ATPase in Polarized Epithelial Cells

Indicates accompanying feature

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Currents in bioremediation

[Image: A close-up of a small insect with a detailed view of its legs and wings.]

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Science and Technology in Government

Science and technology (S&T) have had profound effects in modifying human existence. Their influence will continue in a new era marked by global economic competition, cessation of the Cold War, potential terrorism, and U.S. budget deficits. In the future, it is highly desirable that governments seek to optimize processes of decision-making in the host of circumstances in which research and development (R&D) has an important role.

Components of governance can benefit from careful consideration of 400 recommendations issued by a high-level Carnegie Commission on Science, Technology, and Government. The 22 members of the commission consisted of distinguished scientists, engineers, industrialists, and other notables including U.S. senators, governors, and President Carter. The 31 members of a related advisory council included President Ford and a broad spectrum of eminent persons. Another 150 experts participated in various task forces of the commission.

Initiative to create the commission was taken by David Hamburg, president of the Carnegie Corporation of New York (a private foundation). The work of the commission began in April 1988 and its major activities ended on 1 April of this year. A series of 18 reports have been issued during the 5-year interval, the first in October 1988 entitled Science and Technology and the President. Recommendations in that report urging enhancement of the status of the president’s science adviser and his role in coordinating R&D activities of the executive branch were implemented by President Bush. A majority of the reports have dealt with S&T in the executive branch. However, matters relating to the Congress, states, judiciary, education, and international affairs were also treated.

In the past, reports of distinguished commissions have produced a brief flurry of publicity followed by a collection of a thick layer of dust. The current crop is likely to have continuing impact. One reason is that they are timely and address new, current needs. Perhaps more important is that some of the people who were participants in preparing the reports now are government officials. William J. Perry, who is now Deputy Secretary of Defense, was a principal author of a report entitled National Security/New Thinking and American Defense Technology. The document recommended a drastic change in defense R&D and procurement to reflect the present realities including termination of the Cold War. At one time, defense spending dominated U.S. R&D, and accounted for one-third of funding of R&D in the first world nations. It now funds less than one-ninth of the total first-world R&D. Commercial products are now often equivalent or superior to those meeting costly rigid, complex military specifications. Huge sums could be saved if the military’s outdated system of procurement from defense contractors were modified. Deputy Secretary Perry is in a position to implement recommendations he made earlier in the Carnegie Commission report.

In preparation of the reports, potentially affected entities, such as Congress, were usually consulted and ideas from them incorporated. Members of the judiciary seemed particularly eager to improve their handling of litigation involving S&T. There has been an increase in S&T cases such as toxicology and epidemiology. Too often decisions have hinged on biased testimony provided by mercenaries. Judges cannot be magically transformed into expert scientists but they can be provided with tools that enable them to deal more effectively with complex cases. Under the sponsorship of the Carnegie Commission, a comprehensive reference manual is being prepared that will provide suggested questions for judges, helping them to make quicker and more effective rulings.

In a government highly focused on emotionally charged issues of the moment, there is little attention and inadequate investment for means of dealing with future contingencies. One of the reports entitled Long Term Goals—Linking Science and Technology to Societal Goals grapples with this governmental deficiency. A major recommendation is the creation of a nongovernmental national forum on S&T goals. The forum would facilitate the process of defining S&T goals and monitor the effect of policies to achieve them.

More than 150,000 copies of the reports have been distributed and more of them have gone to second printing. A synopsis of each of the reports and the names of commissioners and associates are contained in Science, Technology, and Government for a Changing World.*

Richard S. Nicholson and Philip H. Abelson

*Copies may be obtained from the Carnegie Commission on Science, Technology, and Government, 10 Waverley Place, New York, NY 10003.
DNA Fingerprinting Report

In the News & Comment article "Geneticists attack NRC report as scientifically flawed" (5 Feb., p. 755), Peter Aldhous describes some of the criticisms being leveled at the National Research Council (NRC) report on the forensic use of DNA. The article ends with a quote from David Kaye that "nobody's disputing that some number should be presented" when evidence of a matching profile is entered into court. Kaye is being overly optimistic. On 26 January 1993 District Court Judge Edward Lynch in Minnesota did indeed refuse to allow numbers to be presented (1).

Judge Lynch was told that one locus in each of two databases compiled by the Minnesota Bureau of Criminal Apprehension showed some evidence of departures from Hardy-Weinberg equilibrium. He was then misinformed that the NRC report would require the entire databases not to be used. The lack of logic in that chain of reasoning becomes clear when it is realized that it will always be possible to find a human locus out of Hardy-Weinberg equilibrium. This should not prevent use being made of all those loci that are in equilibrium. Judge Lynch's decision follows from a lack of guidance in the NRC report as to the appropriate course of action when some disequilibrium is found, and this finding will be very common when as many as 20 databases are tested for equilibrium at each locus, as required by the report (multiple-test corrections are not called for, as the separate tests are not true replicates).

There is a simple solution. The profile frequency could be calculated in each database separately, using only the independent alleles. A conservative profile frequency estimate is then the maximum of the estimates from each database.

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References


The critique that B. Devlin et al. (Policy Forum, 5 Feb., p. 748) aim at the NRC report on DNA typing (1) is itself open to some criticism. Devlin et al. assert a "consensus" favoring the multiplication rule for estimating genotype probability, but provide no supporting evidence or documentation. As it happens, an informal telephone survey by the population geneticist Charles Taylor (2) of 33 population geneticists, including four members of the National Academy of Sciences and 16 persons cited in textbooks of population genetics, found only 11 (33%) supportive of the method used by the Federal Bureau of Investigation to calculate match probability, 19 (58%) critical of the method, and the remaining three (9%) uncommitted. It seems that on the basis of this survey there is, indeed, a consensus in the sense of Devlin et al., but not in the direction they say.

Devlin et al. also assert that deciding whether or not the multiplication rule should be used as evidence in court "remains the province of legal scholars, not population geneticists or statisticians." Fortunately for the citizens of the United States, four superior courts (3) disagree and say that issues of population genetics should be resolved by population geneticists. Finding no evidence of consensus among population geneticists, the justices have ruled that convictions based on faulty statistics should be set aside.

Scientifically, the critique of Devlin et al. is a rehash of old arguments and inadequate data discussed at length in previous issues of Science (4, 5). They attempt to refute the statement of one of us (R.C.L.) (6) that there is approximately as much genetic variation between ethnic groups as between major races by citing a number of authors who are characterized as having "failed to replicate his finding" or having reached "a conclusion very different from Lewontin's," but without providing any actual numbers. An examination of the works cited, however, leads to a different conclusion. Mitton (7) does not, in fact, use a measure of genetic variation and, in any event, gives no data on ethnic group differences. Nei and Roychoudhury (8) give no total values for the components, but these can be calculated from their paper by averaging. The resulting values are 0.03 and 0.02 for between-race and between-ethnic group distances. Smouse et al. (9) give values of 4.40 and 2.36 for between-race and between-ethnic group average distances. Latter (10) uses three different methods of estimating the variation between races and between ethnic groups, one of which is the same as Lewontin's (6). Latter's three sets of values are 0.104:0.056, 0.075:0.055, and 0.096:0.066. These values...
should be compared with Lewontin’s values of 0.063:0.083 (6). We leave it to the reader to judge whether the differences represent biologically significant discrepancies. Averaging all of the estimates, after normalization of the values of Smouse et al. to percentages, yields 0.076:0.057, or a ratio of 1.3:1 of genetic variation among major races to genetic variation among ethnic groups. We reiterate the conclusion that there is approximately as much genetic variation among ethnic groups within major races as there is among the races.

Devlin et al. also say they are against additional research to obtain data relevant to population substructure for DNA-typing genes because they believe that new data will not resolve the population genetics debate. But new data have already been obtained (11) that categorically support our original conclusions (4), as well as those of the NRC report (1), and refute the arguments of Devlin et al. The data are from populations of ethnic Finns and Ethnic Italians as well as an ethnically heterogeneous Caucasian population whose DNA was typed using several highly polymorphic markers (11, 12). The principal findings were as follows. (i) The ethnic groups often have significant differences in allele frequency distributions. (ii) Genetic differences between the ethnic groups could not be detected by conventional tests of Hardy-Weinberg equilibrium or linkage disequilibrium—the tests are virtually useless for detecting substructure in human populations. (iii) When probabilities of DNA profiles were estimated using the product rule with frequencies from the “wrong” ethnic database (Italian database for Finns, Finnish database for Italians), 77% of the estimated probabilities were artificially small—34% by a factor of more than 10 and 4% by a factor of more than 100. (iv) When probabilities of DNA profiles were estimated using the product rule with frequencies from the mixed Caucasian database, 80% of the estimates were artificially small. Points (iii) and (iv) contradict the assertions that “even when there is substantial substructure, the multiplication rule still yields adequate approximations” and that “the methods used in court are already conservative.” On the contrary, the new data demonstrate that the methods currently used in court are not conservative—they are systematically prejudiced against the defendant—and no amount of argument will make them conservative.

As for the interim ceiling principle recommended by the NRC (1), we agree that the lower bound of 10% used for allele frequencies is arbitrary. Everyone agrees that it is conservative, and some believe that it is too conservative. Whether or not it is excessively conservative is a matter that can be resolved empirically by ethnic group studies of the kind abjured by Devlin et al. In the Finnish and Italian data, the interim ceiling principle was not excessively conservative for genotype probabilities greater than 5 × 10⁻⁵. Only additional data will reveal the general robustness and degree of conservatism of the interim ceiling principle. The call for “no new data” will only guarantee more contentiousness and controversy.

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References and Notes


12. These data have been provided to the Federal Bureau of Investigation and to the Forensic Branch of the British Home Office for independent analysis.

Extraterrestrial Intelligence

Ernst Mayr (Letters, 12 Mar., p. 1522) argues against the NASA search for extraterrestrial intelligence (SETI) on the basis that “only one of the approximately 50 billion species that have lived on Earth was able to generate civilizations. Among these approximately 20 civilizations, only one developed electronic technology.” The implication is that Earth history suggests that the evolution of intelligence and technology is rare, and so it would be futile to search. The quoted facts actually tell us something different and trivial: The first species to develop intelligent civilizations will discover that it is the only such species. Should it be surprised? Someone must be first, and being first says
nothing about how many other species had or have the potential to evolve into intelligent civilizations, or may do so in the future. Indeed, that so many species evolved in the terrestrial biota demonstrates its flexibility and its ability to exploit any characteristic, such as intelligence, that would enhance the fitness of a species. We might worry that intelligence is rare only if a few species evolved in biotas.

Similarly, among many civilizations, one will be the first, and temporarily the only one, to develop electronic technology. How else could it be? The evidence does suggest that planetary systems need to exist in sufficiently benign circumstances for a few billion years for a technology-using species to evolve. This guides us in selecting the classes of star in which to search for signs of technological activity. Such guidance is used in the NASA SETI program, which is well justified and merits the some $10 million per year, or 5 cents per person, that is assigned to it. Those who contemplate the possibilities of life, civilizations, and technology in space should never underestimate the opportunistic nature of biological systems or the enormity of cosmic time.

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Mayr is always at his best when speaking ex cathedra, but in his letter of 12 March he makes some pronouncements that are clearly at variance with the facts. At the same time, he seems to argue that no search for extraterrestrial intelligence should be attempted because he has already decided on the outcome. Would that all scientific experiments could be done so cheaply.

A search for extraterrestrial life has indeed been recommended by the last three National Academy of Sciences (NAS) Astronomy and Astrophysics Survey committees; but it has also been recommended by other groups in the NAS and elsewhere that included noted biologists and paleontologists, many of whom disagreed with Mayr about this issue.

In fact, it is the general and not the particular circumstances of Earth’s evolutionary history that motivate a search for life elsewhere. What happened here could, in the broadest outlines, have happened elsewhere—conservatively estimated at approximately 60 billion "elsewheres" (planets) in the Milky Way galaxy alone. The question is, "Did it?" By using available technology, we can determine the existence of life elsewhere in the universe now by detecting artificially generated radio signals coming from other solar systems. In the final analysis, I believe it is better to perform such experiments than to be walled off from the real world by the opinions of experts.

John D. Rummel
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Washington, DC 20546

I agree with Mayr that evolution elsewhere in space has a vanishingly small probability of replicating our own history, but I am much more optimistic about the general issue. Evolution on Earth is replete with examples of adaptive convergence which, were they not so well documented, would most probably be deemed impossible. The striking similarity of certain marsupial and placental mammals is the common classroom example, and other cases abound.

Powered flight evolved independently many times and, although the wings of bats, birds, pterosaurs, and insects are structurally very different, their functions are the same. SETI does not depend on finding a perfect replica of human intelligence, but only something functionally close enough to be recognizable in a listening, as opposed to a communicating, mode. And evolutionary biologists do not know enough yet about the phenomenon of convergence to rule out the independent evolution of intelligence. Research on convergence has not gotten beyond description of cases and some pallid plausibility arguments based on unconstrained natural selection.

The prognosis for SETI is further enhanced if one considers the possibility that seemingly intelligent behavior need not be of the conscious, humanoid type (1). A surprising variety of living organisms generate relatively strong electrical pulses, and some can detect radio signals; this suggests that interspecies electronic communication could be the hard-wired product of ordinary Darwinian evolution.

I am optimistic about SETI because it constitutes a bold experiment in exobiology, a field where we have little to go on but where the past few decades have witnessed many surprises—phenomena that were shown a generation ago to be impossible on the basis of "first principles." Even in this time of fiscal austerity, I do not think we should eliminate one of the few federal science projects that has not been promoted as a sure thing. After all, if SETI succeeds, the returns will be incalculably large.

David M. Raup
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Scanning electron micrographs of primary rat mammary epithelial cells at 24 hours (top) and 36 hours (background) on MATRIGEL® Basement Membrane Matrix.
Photo courtesy of Dr. Margaret Neville.

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The Conference on New Techniques and Instruments in Biomedical Research

BOSTON, MASSACHUSETTS
6-10 AUGUST 1993
HYNES CONVENTION CENTER

PRELIMINARY PROGRAM
Concurrent discussion sessions
Industry-sponsored workshops
Plus plenary lectures featuring some of the greatest minds in biomedical research

REGISTER NOW AND SAVE UP TO $100
Deadline for early-bird registration fees has been extended to 16 July 1993.
(See inside for details.)

SPONSORED BY
The American Association for the Advancement of Science and Science Magazine
DEAR COLLEAGUE:

Here is the preliminary program for SCIENCE INNOVATION '93, a refreshingly different presentation of new technologies and instruments in biomedical research and developments.

As we all know, novel technology developments have played a pivotal role to propel research and generate new knowledge. A most vivid example is the recent discovery of PCR, which has revolutionized the concept and practice of molecular biology and genetics.

Thus, this meeting uniquely focuses on the process of research rather than on its findings. It showcases new technologies and instruments that scientists can use to conduct their own research more effectively. It also enables investigators to learn not only about new technologies but also about new applications of existing technologies.

The meeting program is constantly being expanded and refined to ensure that the presentation will represent the very cutting edge of biotechnology. It has been carefully structured to provide both a broad understanding of available new technologies and the detailed information you need to adapt specific techniques and applications to solve problems in your own area of research.

The organization of the conference is such that overviews of new technologies will be presented as plenary lectures in the mornings and evenings. In the afternoons, there will be multiple workshops running concurrently and you can participate in specific ones of your choice. Furthermore, you can exchange ideas with your colleagues at the poster sessions and experience the new technologies up close in daily exhibits, as well as in the industry workshops.

Finally, you will also have the opportunity to preview the emerging technologies at a unique, last-day session highlighting the next frontiers of science.

Register now by completing and returning the registration form on the inside back cover. I look forward to seeing you in Boston.

Savio L.C. Woo, Ph.D.
Science Innovation '93 Program Chair
Friday, 8/6

12:00–7:00pm
Registration

12:00pm–6:00pm
Employment Exchange

5:00–7:00pm
Exhibition Opening and Reception

7:00pm
INTRODUCTION
Savio L.C. Woo*
Baylor Coll of Med

7:15pm
THOMAS ALVA EDISON LECTURE
DNA AMPLIFICATION
Kary Mullis*
Atomic Tags

8:15pm
KEYNOTE ADDRESS—SCIENCE AND TECHNOLOGY IN AMERICA
A View from the New Administration
Speaker TBA

Saturday-Monday, 8/7-9

7:30am–6:00pm
Employment Exchange

8:00am–12:30pm
Plenary

8:30am–12:45pm/5:00pm–6:00pm
Career Development Seminars

10:00–10:30am
Coffee Break

10:00am–3:00pm
Exhibits

12:30–2:30pm
Lunch

1:00–2:15pm
Exhibitor Workshops

2:30–5:00pm
Concurrent Discussions

5:00–7:00pm
Poster Session/Exhibits

8:00–10:30pm
Evening Concurrent Plenaries

Tuesday, 8/10

8:00am–12:30pm
Plenary

9:00am–1:00pm
Employment Exchange

10:00–10:30am
Coffee Break

12:30–2:00pm
Lunch

12:30–2:00pm
Program Committee Meeting

2:00–5:00pm
Emerging Technologies

Plenary Lectures
(Saturday-Tuesday)

RNA CATALYSIS
Sidney Altman
Yale Univ

HUMAN GENOME
Francis Collins*
National Ctr for Human Genome Rsch

GENE MAPPING
Eric Lander*
Whitehead Inst

GENE THERAPY AND TRANSFER
Kenneth Culver*
NIH

ONCOGENES AND CANCER
David Housman*
MIT

PLANT MOLECULAR BIOLOGY
Robert Goldberg*
Univ of California-Los Angeles

PROTEIN CRYSTALLOGRAPHIC STRUCTURE
Doug Rees
California Inst of Technology

PROTEIN-DNA INTERACTIONS
Tom Steitz
Yale Univ

PREDICTING FUNCTION BASED ON SEQUENCE
Russell F. Doolittle*
Univ of California-San Diego

CATALYTIC ANTIBODIES
Peter Schultz
Univ of California-Berkeley

ANTIBIOTIC RESISTANCE
Barry Bloom
Albert Einstein Coll of Med

DRUG DELIVERY AND TISSUE ENGINEERING
Robert Langer*
MIT

NEUROIMAGING
Jack Belliveau*
Harvard Univ

NANOTECHNOLOGY
Stephen Fodor
Affymax

NOVEL CHEMISTRY
George Whitesides
Harvard Univ

Exhibitor Workshops
(Saturday-Monday)

AMERSHAM CORP

AMICON, INC

IMMUNOCHEMICAL STAINING TECHNIQUES
Dako Corp

RAPID DNA SEQUENCING WITH THE GENESPRINTER SYSTEM
Fotodyne

PREPARATIVE ELECTROPHORESIS TECHNIQUES
Hoefer Scientific Instruments
Evening Concurrent Plenaries

GENOMIC LIBRARIES
- David Page, Whitehead Inst
- Nat Sternberg, Du Pont Merck Pharmaceutical
- Jean-Michel H. Vos*, Univ of North Carolina-Chapel Hill
- Melvin Simon and Hiroaki Shizuya*, California Inst of Technology

RNA AND IN VITRO GENETIC SELECTION
- Harry Noller, Univ of California-Santa Cruz
- Jack Szostak, Massachusetts General Hosp
- Julius Rebek, MIT

ENGINEERING PROTEINS
- David Tirrell, Univ of Massachusetts
  Self-assembly
- Charles Craik*, UC San Francisco
  Redesigning Proteases
- Cori Gorman, Genentech
  Dibasic Site Cleavage
- Jim Wells, Genentech
  Improving Protein Function

SOLID PHASE SYNTHESIS
- Marvin Caruthers, Univ of Colorado
  RNA and DNA
- Stephen Kent*, Scripps Clinic & Rsch Inst
  Total Chemical Synthesis of Enzymes
- Samuel Danishefsky, Yale Univ
  Polysaccharides

VECTOR DEVELOPMENT FOR GENE THERAPY
- Richard Samulski, Univ of Pittsburgh
  Adenovirus
- Joseph Glorioso, Univ of Pittsburgh
  HSV
- Ron Crystal, NIH
  John Mekalanos, Harvard Univ Med Sch
  In Vivo Induction

GENE TRANSFER
- Oliver Smithies, Univ of North Carolina
  Knockout Mice
- Alan Colman, Pharmaceutical Proteins, Ltd
  Transgenic Animals
Emerging Technologies

- THE FUTURE OF BIOREMEDIATION: BIODEGRADATION OF CHLORINATED ORGANICS
  - Daniel Abramowicz* General Electric

- PREIMPLANTATION GENETIC DIAGNOSIS: MOLECULAR ANALYSIS OF SINGLE HUMAN BLASTOMERES
  - Mark R. Hughes* Baylor Coll of Med

- CHAOS AND CARDIAC ARRHYTHMIA
  - Alan Garfinkel* Univ of California-Los Angeles

- 3-D AND VIRTUAL REALITY IN MEDICINE
  - Julian Rosenman, Univ of North Carolina Med Sch

- NO AND BRAIN MESSENGERS
  - David Bredt* Johns Hopkins Univ

- COMPUTATIONAL ANALYSIS OF GENOME DATABASES
  - David States
  - Washington Univ

---

**Call for Papers**

See inside back cover or call 202-326-6450 or fax 202-289-4021 for more information.

**Boston Area Tours**

AAAS is exploring the possibility of conducting field trips to areas of scientific interest (Woods Hole institutions, MIT robot labs, among others) as well as guest tours (Boston, Salem, art tours are possibilities).

Most trips would range from $20-30.

Fax your interests to Jackie Wester by 1 June 1993. Fax: 202-289-4021.

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**SCIENCE INNOVATION ‘93 EXHIBITORS**

(at press time)

- ACADEMIC PRESS, INC.
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- HITACHI SOFTWARE ENGINEERING AMERICA
- HOEFER SCIENTIFIC INSTRUMENTS
- INTELLIGENETICS/BETAGEN
- INTERNATIONAL BIOTECHNOLOGY SUPPLIERS ASSOCIATION
- J.T. BAKER, INC.
- JOLLEY CONSULTING & RESEARCH, INC.
- LI-COR
- MICROCAL SOFTWARE, INC.
- MICROPAK
- MILLIPORE
- MJ RESEARCH
- MOLECULAR DYNAMICS
- NASA STI PROGRAM
- NATIONAL BIOSCIENCES
- NATIONAL INSTRUMENTS
- NEW ENGLAND BIORABS
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- OWL SCIENTIFIC, INC.
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- PHARMACIA BIOTEC, INC.
- PROTEIN & DNA IMAGING SYSTEMS
- RESEARCH INFORMATION SYSTEMS
- SCIENCE MAGAZINE
- SEIKAGAKU AMERICA
- STOVALL LIFE SCIENCE
- TECAN/SLT LAB INSTRUMENTS
- TROPIX
- WOLFRAM RESEARCH
- WALLAC
- YAMATO SCIENTIFIC AMERICA

---

**General Meeting Information**

**LOCATION**

Sessions and exhibits will be in the Hynes Convention Center, 900 Boylston Street, Boston, MA.

**HOUSING**

Reduced rate guest rooms are available at a number of Boston hotels if you make your reservations using the AAAS housing form on the following page. Reservations must be made through the housing bureau and must be postmarked by 9 July 1993.

**ON-SITE REGISTRATION HOURS**

Friday 6 August, noon-8:00pm
Saturday-Monday 7-9 August, 7:00am-9:00pm
Tuesday 10 August, 7:00am-3:00pm

**FOR MORE INFORMATION CONTACT**

AAAS Meetings
1333 H Street, NW
Washington, DC 20005
Tel: 202-326-6450
Fax: 202-289-4021

---

**Airline Ticket**

Get discounted airfare to Science Innovation ’93 and your next flight may be free!

Make your reservations through Gil Travel to save money on discounted air fares for travel to and from Boston on selected major airlines from 30 July - 13 August 1993.

- Save 10% on most unrestricted coach fares.
- No minimum stay required. 7-day advance reservation and ticketing required. No one-way discounts.
- Save 5% off the lowest applicable roundtrip fare, subject to availability.

Plus, you may win a free ticket: All Science Innovation ’93 registrants who make their reservations through Gil Travel will be entered into a drawing for a round trip ticket to and from any location in the continental United States.

This promotional offer is available only through the Gil Travel convention reservation desk. Certain standard restrictions apply.

For details and reservations, call or fax Gil Travel at the number below. Be sure to tell them that you are attending Science Innovation ’93.

Toll-free number: 1-800-223-3855
Outside the U.S.: 1-215-568-6655
Fax number: 1-215-568-0696
REGISTRANT INFORMATION (Please type or print, or peel off label from cover and place here)

First Name (as you would like it to appear on your badge)

Family Name (as you would like it to appear on your badge)

Institution/Company (will appear on badge, subject to abbreviation)

Mailing Address

City

State

Country

Zip Code

AAAS membership number (if member) (appears on AAAS membership card and above your name on Science subscription label)

If registering at the student rate, check here and attach a copy of your student ID card.

Concurrent session preferences (check three): Indicate the three sessions you’re most interested in attending:

- DNA Amplification
- Gene Sequencing Tools
- Fluorescent In Situ Hybridization and Nonisotopic Detection
- Screening
- Peptides and Combinatorial Libraries
- NMR Determination of Protein Structure
- Antibody Catalysis
- Non-invasive Diagnostics
- Imaging
- DNA Diagnostics
- Oligonucleotide Synthesis and Antisense Pharmaceuticals
- Drug Design
- Drug Targeting and Liposomes
- Clinical Immunology, Immunosuppression and Vaccines
- Cytokines Growth Factors and their Receptors
- Tumor Immunogenicity and Markers
- Blood Substitutes
- AIDS Research and Animal Models
- Chemical Communication
- Plant Development
- New Microscopy
- Sensors
- Thinking Machines and Neural Networks

Meeting Registration Fees¹ (Check one box only)

<table>
<thead>
<tr>
<th>Category</th>
<th>Advance by 16 July '93</th>
<th>On Site</th>
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<tr>
<td>Regular AAAS member</td>
<td>$295</td>
<td>$395</td>
</tr>
<tr>
<td>Regular nonmember</td>
<td>$395</td>
<td>$495</td>
</tr>
<tr>
<td>Student² AAAS member</td>
<td>$125</td>
<td>$200</td>
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<tr>
<td>Student² nonmember</td>
<td>$175</td>
<td>$250</td>
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Lunch Fees (Check all that apply)

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<tr>
<td>Lunch, Sunday 8 August</td>
<td>$21</td>
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<tr>
<td>Lunch, Monday 9 August</td>
<td>$21</td>
</tr>
<tr>
<td>Lunch, Tuesday 10 August</td>
<td>$21</td>
</tr>
</tbody>
</table>

Payment

Meeting registration fee

Luncheon fee total

Membership dues (if joining now)

Total amount

- Check enclosed³
- VISA
- MasterCard

Original institutional purchase order attached

Credit card number

Expiration date

Signature

Mailing Instructions (16 July Deadline)¹

Mail to: Science Innovation ’93, P.O. Box 630285, Baltimore, MD 21263. Or fax (credit card payments only) to 202-289-4021.

Important Footnotes

1. Deadline for advance registration is 16 July. Registrations received after this date will not be processed, however, you may register on site at the Hynes Convention Center beginning at noon on 6 August. One-day registration is available on site only at the following rates: Regular member-$195, regular nonmember-$245, student member-$95, student nonmember-$125.

2. To qualify for student rate, you must be a graduate or undergraduate student and must attach a copy of your student ID card. Registrations received without appropriate verification will be charged at the Regular rates.

3. Membership: $47 of dues plus international postage fees are allocated to Science. Canadian dues include GST. Please allow 6-8 weeks for receipt of first issue of Science.

4. Cancellations must be received in writing by 23 July 1993. No refunds will be made for cancellations received after this date. Refunds are subject to a $50 cancellation charge and will be processed after the meeting.

5. Checks must be in United States currency and must be payable on a U.S. bank. Please make checks payable to Science Innovation ‘93.
Hotel Reservation Form

SEND CONFIRMATION TO (please type or print legibly)

First/Given Name Last/Family Name

Institution/Company (if part of address)

Address

City State Zip Country

Phone FAX

Names of All Room Occupant(s) (name) (name)

(name) (name)

Hotel Choice Hotel Name

1st 

2nd 

3rd 

4th 

Most important (check one):

☐ proximity to the meeting site ☐ comparable room rate

Type of room desired (check one):

☐ Single (1 person, 1 bed) ☐ Double (2 people, 1 bed) ☐ Double/Double (2 people, 2 beds)

☐ Triple (3 people, 2 beds) ☐ Quadruple (4 people, 2 beds) ☐ 1-bedroom suite ☐ 2-bedroom suite

ARRIVAL DATE DEPARTURE DATE

TIME TIME

Special housing needs:

☐ Wheelchair-accessible room ☐ Nonsmoking room

☐ Other

All reservations must be guaranteed with a deposit or credit card guarantee 14 days prior to arrival.

☐ VISA ☐ MasterCard

Credit Card #

Exp. Date Card User Name (please print)

Signature

If you do not wish to use a credit card guarantee, a deposit check for the first and last night's stay will be required by the assigned hotel at least 14 days prior to arrival. Deposit checks should not be sent to the housing bureau; if received they will be returned. The check should be sent directly to the hotel where you have been assigned after you receive the hotel confirmation. If credit card information is not provided or if a deposit check is not received 14 days prior to arrival, the hotels reserve the right to release your reservation. AAAS has negotiated discounted room rates at the hotels listed. We strongly encourage you to stay at one of these official hotels. You will get a chance to meet and network informally with fellow Science Innovation participants. In addition, for each participant's stay in one of these hotels, AAAS gets credit for our part in filling the hotel. This helps to defray speaker costs, which in turn helps to keep registration fees lower. Thank you for your support.

MAILING INSTRUCTIONS (9JULY DEADLINE)

Send your completed form via mail or fax (not both) to:
Science Innovation '93, AAAS Housing Bureau, Prudential Tower, Suite 400, P.O. Box 490, Boston, MA 02199 FAX 617-536-0813

Reservation forms must be received by 9 July 1993. Housing requests received after 9 July 1993 are conditional on room availability. Do not mail this form to AAAS; see the mailing address above. It is recommended that you keep a photocopy of this form for your records. The meeting will be located at the Hynes Convention Center #10 on map.

Science Innovation '93 Boston 6-10 August 1993

HOTEL ROOM RATES

<table>
<thead>
<tr>
<th>Hotel Name</th>
<th>Single</th>
<th>Double</th>
<th>Extra Person</th>
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<td>5133</td>
<td>520</td>
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<tr>
<td>2 Back Bay Hilton</td>
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<tr>
<td>3 Colonnade Hotel</td>
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<td>5 Boston Park Plaza</td>
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<td>6 Copley Plaza</td>
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<td>145</td>
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<tr>
<td>7 57 Park Plaza</td>
<td>100</td>
<td>110</td>
<td>15</td>
</tr>
<tr>
<td>8 Guest Quarters Suites</td>
<td>110</td>
<td>120</td>
<td>20</td>
</tr>
<tr>
<td>9 Hyatt Regency Cambridge</td>
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<td>120</td>
<td>25</td>
</tr>
</tbody>
</table>

*Headquarters Hotel

RESERVATIONS

The AAAS Housing Bureau will make hotel reservations on a first-come, first served basis upon receipt of a properly completed Science Innovation '93 housing form. Reservations will be processed in order of receipt, based on choice and availability. Acknowledgments will be sent directly to the occupant by the Housing Bureau and will be followed by a confirmation from the assigned hotel. Telephone reservations cannot be accepted. To complete this form:

[1] Use a separate reservation form for each room requested, not for each individual. Send only one form if sharing with a colleague; duplicate forms cause delays in processing and may result in double charges.
[2] List at least four hotels, in order of preference, where you'd like to stay. Check whether rate or proximity is most important to you.
[3] Check the type of room you would like.
[4] Complete the remainder of the form, being sure to include your arrival and departure dates, credit card number and expiration date (if using credit card for your deposit), and any special requests you might have (nonsmoking room, wheelchair accessibility, etc.).
[5] Please be thorough; failure to include all pertinent information may delay processing of your reservation.
[6] Children: there is usually no charge for children under a particular age; check with the hotel to which you are assigned.

CANCELLATIONS/CHANGES

To cancel or make changes to reservations, contact the Housing Bureau at 617-536-9028 until 9 July. After that, please contact the hotel directly. No refunds will be given for cancellations made less than 72 hours prior to the opening of the conference.
What is Science Innovation?

Science Innovation is the annual conference on the latest techniques and instruments in biomedical research. This is a conference by scientists for scientists that focuses on the process and methods for doing science rather than the findings. The Innovation Meeting is sponsored by the American Association for the Advancement of Science and its renowned journal SCIENCE. Join us in Boston...don’t miss Science Innovation ‘93.

Employment Exchange

The Employment Exchange is a career opportunities/career development service for job candidates and employers. Interview scheduling, position posting, a message center, job and resume referrals, career development seminars, and private interview booths are provided during the week of Science Innovation ‘93. If you have positions to be filled or are currently seeking employment, you should take advantage of this program.

EMPLOYER BENEFITS

An employer who enrolls with the Employment Exchange will receive several benefits including:

- Access to hundreds of top-notch candidate’s resumes cross-referenced by discipline.
- On-site interview facilities and scheduling services at no extra charge.
- Unlimited position available postings.
- Copy of the “Pre-Meeting Bulletin”, including a brief synopsis of each available candidate enrolled with the Exchange.
- Special rates for Science Innovation exhibitors, nonprofit organizations, and AAAS Corporate Members.

CANDIDATE BENEFITS

Candidates who enroll with the Employment Exchange receive the following benefits:

- FREE enrollment for AAAS member candidates. Nonmembers pay a modest $10 enrollment fee.
- Hundreds of current position openings in a variety of disciplines and experience levels.
- On-site interview facilities, including on-the-spot interviews.
- Access to full descriptions of all available positions.
- On-site career development seminars.
- Employment Exchange Only fee for non-conference attendees.

For more information and an enrollment form, contact: Jacquelyn Roberts, AAAS Employment Exchange, Suite 1163, 1333 H Street, NW, Washington, DC 20005 (Phone: 202-326-6737; FAX 202-842-1065)
nisms, prebiotic earth history, early evolution and radiation of protists, and the science of micropaleontology in general. This part of the book makes excellent reading, even for the non-specialist. It discusses why microfossils are important both scientifically and economically, sets the stage for understanding why some groups have been well studied and others not, and puts the evolution of the various groups in a geological framework that allows even the non-expert to begin to understand why some groups of protists have aroused such intense interest. The chapter by Knoll and Lipps, entitled “Evolutionary history of prokaryotes and protists,” is extremely valuable in this regard and is the high point of the book for this reviewer.

The remainder of the book deals with the major known groups of fossil organisms. The chapters are well written and full of information. Golubic and Knoll deal with the general metabolic diversity of prokaryotes, including the preservation potential of prokaryotic fossils, which organisms are most likely to be found as fossils (and when), and some aspects of the interpretation of such preserved forms. The major focus of their chapter is accord-

ingly the most recognizable and abundant (most highly preserved) group, the cyanobacteria. I was disappointed that there is not more discussion of cyanobacterial anoxygenic photosynthesis and what impact, if any, the knowledge of such metabolic abilities has had on the interpretation of cyanobacterial-like fossils.

Chapters dealing with acritarchs and prasinophytes, dinoflagellates, ebridians, chrysophytes, and diatoms are followed by longer chapters devoted to the calcareous nannoplankton, foraminifera, and radiolarians and by a brief discussion of the tintinnids. Each chapter includes a historical perspective and an account of the morphology of the organisms or fossils, the biology and systematics of the organisms, their place in the paleontological record, and, when appropriate, the advantages or disadvantages of the group for biostratigraphy. Although at some points, especially in the longer chapters, one may feel bludgeoned with information, it is impossible not to appreciate the attention to detail, which should make these chapters excellent reference sources. One should also happily note the inclusion of the minor groups of organisms (such as the ebridians treated by Ersinisse and McCartney), to which only experts are exposed. Especially with regard to these minor groups, the discussions of timing of their occurrences in the rock record, their abundances and difficulties in identification, and their uses for economic biostratigraphy serve to explain why they are not well studied or particularly well known. A final noteworthy feature of the book is the annotated lists of supplementary reading that conclude each chapter.

In summary, this is much more than a textbook. It is a valuable reference for those who would like to be refreshed on the biology and paleobiology of some major groups of organisms and a primer for those with interests that take them backward through time. The juxtaposition of the biological, ecological, and geological information, especially as it pertains to mass extinctions of various groups of protists, offers an interesting perspective from which to view other kinds of geological and biological problems.

Kenneth H. Nealson
Center for Great Lakes Studies,
University of Wisconsin,
Milwaukee, WI 53204
Managing Motion

Vestibular and Brain Stem Control of Eye, Head and Body Movements. HIROSHI SHIMAZU and YOSHIAKU SHINODA, Eds. Japan Scientific Societies, Tokyo, and Karger, New York, 1992. xii, 466 pp., illus. $264. From a meeting, Tokyo, May 1990.


Vestibular and oculomotor physiology has been at the forefront of our understanding of sensory-to-motor transformations for many years. The major reasons for this are the inherent simplicity of eye movement mechanics and the accessibility of the motoneurons. Detailed descriptions of motoneuron behavior in awake, trained primates have been available for more than 25 years. Single-neuron recording studies have been paired with neuroanatomical tracing techniques, often focused on the same neurons, to yield rather detailed descriptions of both the signals and the connectivity that underlie eye movement control. Since in the oculomotor system the controlled variables are known to be eye position and velocity, in recent years a great deal of effort has been devoted to understanding how the appropriate control signals are generated. Vestibular and Brain Stem Control of Eye, Head and Body Movements provides a fine and up-to-date overview of this classical approach to vestibular and oculomotor physiology. With a few exceptions, the contributions are devoted to neuroanatomical description of the pathways involved in oculomotor control or the results of single-neuron recordings in awake animals. I particularly enjoyed the paper by Böttner-Ennever; the author's lucid writing style and vast experience with the topic have resulted in a fine overview of the connectivity of the paramedian brainstem cell groups, an area of great importance to oculomotor neurophysiologists. The papers by Henn and his colleagues on torsional eye movements are of considerable current interest in that they directly address questions about the means by which visual information must be transformed in order to produce the appropriate motor response.

Sensing and Controlling Motion, a rather massive tome with 114 papers, is the most up-to-date and comprehensive overview of the state of vestibular research that is currently available. The material presented is of formidable breadth, ranging from experiments designed to uncover the neurotransmitters involved in the vestibular pathways to recent advances in clinical vestibular testing. The volume is particularly strong in its description of recent work on the elucidation of the neurotransmitters involved in vestibular and oculomotor pathways (for example, the reader is referred to the excellent paper by Spencer and Baker). It is interesting to see this line of research so well represented here, as the vestibular system has long been the domain of those who do single-neuron studies in awake animals, an approach exemplified by Vestibular and Brain Stem Control. Indeed the vestibular and oculomotor systems lend themselves very well to attempts to bridge the gap between those who study neurotransmitters and membrane properties and those who use a systems approach, generally in awake primates. Since the connectivity...
with drawings and photographs. Astronomers will like it and celestial mechanicians will love it, but scientists in other fields may find it a little too specialized for their tastes.

Donald E. Osterbrock
Lick Observatory,
University of California,
Santa Cruz, CA 95064

The Construction of Stars


Our current understanding of stellar evolution is one of theoretical astronomy's greatest achievements. The ability to derive the general properties of known stars—including the sun—from basic physical laws has enabled astronomers to establish the age of our galaxy, the origins of all elements heavier than helium, and (indirectly) the size of the observable universe. Current unsolved problems in this field affect our understanding of theoretical physics (the solar neutrino problem) and of the evolution of life on earth (star and planet formation; solar irradiance variations and the greenhouse effect).

In Structure and Evolution of Single and Binary Stars, de Loore and Doom set out to introduce the physical principles and results of stellar structure and evolution at a level accessible to advanced physics and astronomy undergraduate students. After a brief introduction of observed stellar properties, the authors develop the basic building blocks and describe the numerical techniques needed to construct a model star on a modern computer. They then delve into our current understanding of the evolution of single and double stars as a function of their mass and describe how present theory explains the wonderful variety of single and binary stars we observe in the universe today. They conclude their account with many tables summarizing the structural properties of model stars.

For the most part, de Loore and Doom present a clear picture of the tools and results of modern stellar evolutionary theory. The description of the main physical ingredients for a model star—the thermodynamic properties of the gas, nuclear reaction rates, and opacities—provides an excellent introduction for a student and a good review for any practicing astronomer. The problems in these chapters help to develop the important results or aid the beginner in acquiring an intuitive understanding of how stellar interiors work. The chapters on the evolution of low-, intermediate-, and high-mass single stars are reasonably complete and note both the main successes and some of the remaining uncertainties of standard models. The chapter on the evolution of massive binary stars—the primary interest of both authors—is very good, and the tabular material in the last chapter should be useful for astronomers trying to confront observations of stars with theoretical predictions.

In spite of these general strengths, the book is not an ideal introduction to modern stellar evolution theory. For example, simple derivations of the mass-luminosity relation for main-sequence stars and the thin-shell instability for red giant stars would give students and researchers alike a better appreciation for the behavior of detailed

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Vignettes: Conversational Gambits

New Year's Day 1988 found me seated in a lounge at Los Angeles International Airport, waiting for an incoming passenger. Academic that I am, I had brought along some research to pass the time: a paperback entitled How to Recognize the Antichrist. At the bar a middle-aged man and woman laughed and talked, seemingly oblivious to my presence. But as the man left, he stopped at my table and demanded, "Well, do you think you'll recognize him?" Caught off guard, I mumbled that I wasn't sure, since I hadn't yet finished the book. "I think he exists now," said the man earnestly. "Actually, I'm kind of pleased, because the sooner the better." —Paul Boyer, in When Time Shall Be No More: Prophecy Belief in Modern American Culture (Harvard University Press)

Once a graduate student offered to explain why MIT types tended to hang together at parties. If you just wander around at random, he said, "People come up and ask questions like 'How do you like Boston?' . . . What does that mean? How am I supposed to answer a question like that?"

—Fred Happgourd, in Up the Infinite Corridor: Mit and the Technical Imagination (Addison-Wesley)

theoretical computations. The material on star formation—one of the most active fields in astronomy today—is not current, and the description of the evolution of low-mass binary stars is incomplete. Finally, a discussion of solar neutrino measurements—the most controversial test of standard evolutionary models for the sun—would have illustrated the uncertainties in the elementary physics used in modern calculations. I think this volume would be a reasonable choice as the main textbook for an introductory graduate course on stellar structure and evolution. It presents the main aspects of the theory very nicely, but it does not provide students with a good picture of the most active areas of current research.

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