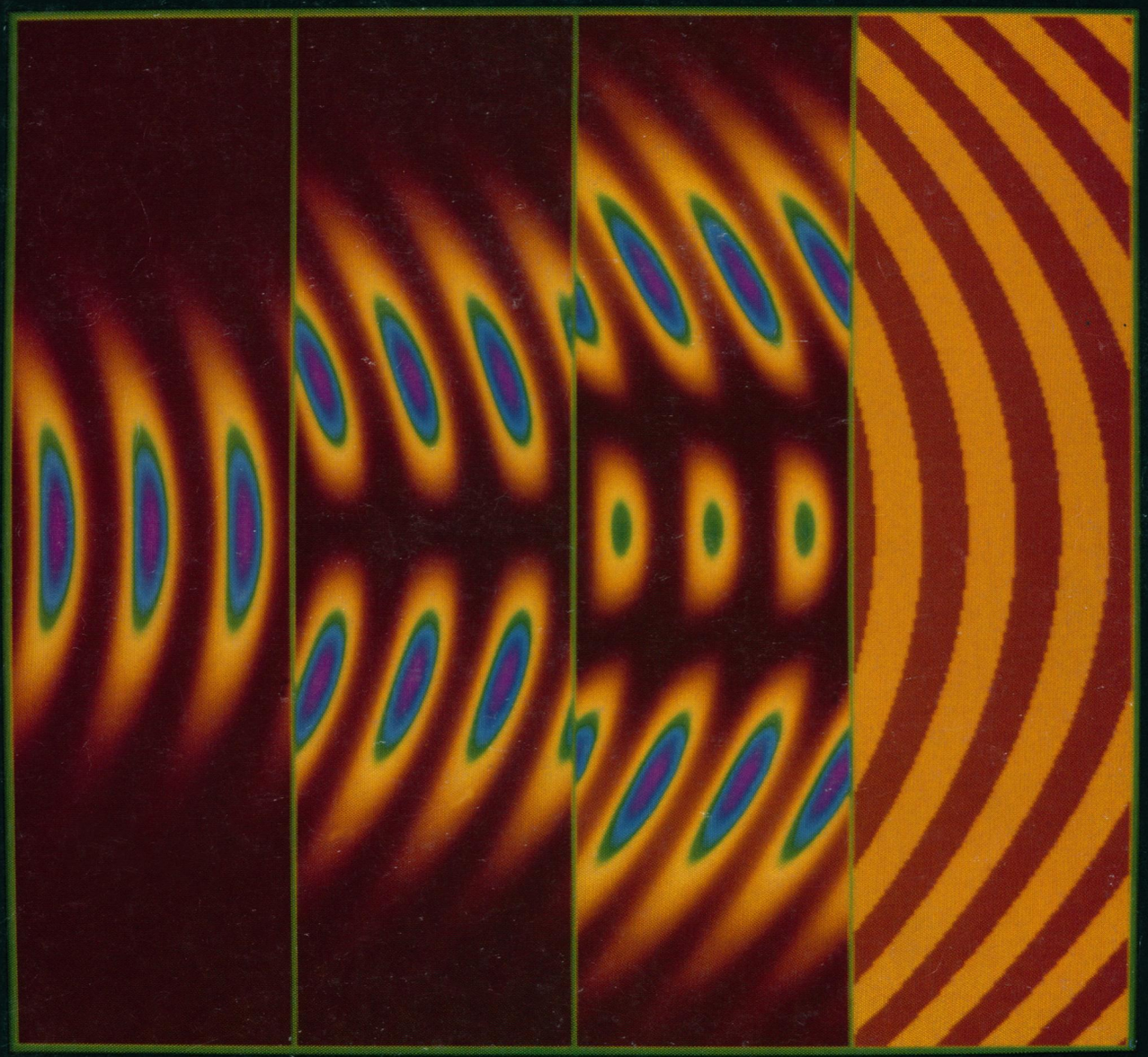
American Association for the Advancement of Science

SCIENCE

29 November 1991 $6.00
Vol. 254 ■ Pages 1269–1424

ENGINEERING A SMALL WORLD:

From Atomic Manipulation to Microfabrication



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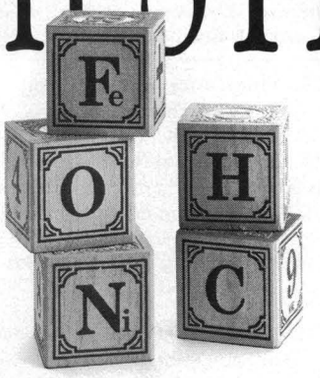

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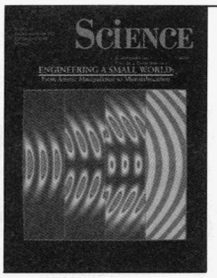
■ The American Association for the Advancement of Science was founded in 1848 and incorporated in 1874. Its objectives are to further the work of scientists, to facilitate cooperation among them, to foster scientific freedom and responsibility, to improve the effectiveness of science in the promotion 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.



COVER Cross section of a serpentine superlattice (100 angstrom period) and its three lowest energy electron wave functions as an example of fabrication on a small scale (see page 1326). The cross-sectional view (far right) shows the aluminum-rich regions (dark) that confine electrons to the gallium-rich regions (light) in the segregated aluminum-gallium-arsenic alloy. The most colorful portions of the wave functions (in sections to the left) are regions of maximum electron density; the reddish-brown areas indicate zero density. See the editorial on page 1277 and the special section beginning on page 1300. [Simulations by J. C. Yi of the University of California, Santa Barbara]

Research Article

Reports

Meetings

Book Reviews

WHAT DO YOU REALLY THINK ABOUT FETAL RESEARCH, FRAUD IN SCIENCE, HEALTHCARE ISSUES, YOUR JOB...?

AAAS is conducting the first Member Opinion Poll designed to find out what you think about current issues which have an impact on the Science and Technology community in general, or you directly.

Survey materials have been mailed to randomly selected members. **If you receive this 2-page questionnaire, we urge you to complete the survey and return it to us by December 20!** If you don't receive a questionnaire, please keep an eye out for the next Member Poll—your name may be selected in the future.

The topic for this first survey is intriguing, important, timely and to be revealed, with survey results, in February 1992.

This is your chance to voice your opinion.

If you have questions or topics to suggest for future Member Opionion Polls, please call Kathleen Markey, Member Research Manager at (703) 448-7862.

This Week in

SCIENCE

Small wonders

Between the micrometer and atomic scale is a size regime that is being explored by physicists, engineers, chemists, biologists, and materials scientists; this special issue of *Science* (pp. 1312 to 1342; see editorial by Brauman on p. 1277 and news section on p. 1300) highlights some of the challenges of studying and building structures on this scale. Although many biological structures are of this size, creating such small structures is a challenge to physical scientists who want to make devices such as quantum effect transistors and ultrasmall sensors. Microfabrication methods such as epitaxy and ion-beam writing are being used to create submicrometer structures, and chemical synthesis methods are being developed to create large structures rapidly, such as by self-assembly. Among the newest approaches is the use of the scanning tunneling microscope to manipulate and assemble atoms on surfaces.

Aspartate receptor

X-ray structures of the periplasmic domain of the aspartate receptor of *Salmonella* with and without its aspartate ligand reveal changes that may provide a starting point for understanding transmembrane signaling. Transmembrane proteins are difficult to crystallize, so only the exterior ligand-binding domains, which were cross-linked to form dimers by disulfide bonds, were studied by Milburn *et al.* (p. 1342). Nonetheless, binding by aspartate changed the relative orientation of the subunits, which are bundles of four α-helices. Models for how this change could transmit a signal in the complete receptor are proposed.

Membrane modeling

A molecular dynamics computer simulation for membranes in which the particles that make up the membrane self-assemble into layers has been developed by Drouffe *et al.* (p. 1353). Many computational models of membranes focus on the details of the membrane molecules, such as chain length and type of head group, but this often renders the model so complex that larger issues, such as shape transitions, cannot be explored because of the vast computational resources that would be required. These authors recognized that many different molecules can form membranes and thus the molecular details might not be so critical. The particles used in the model are simple, but because the complex forces that characterize solvent-membrane interactions, such as the hydrophobic effect, are included, large-scale processes such as quasi-thermal oscillations in vesicles can be explored.

Primary production

Picophytoplankton have been thought to be the major contributor to primary production (through photosynthesis), but work by Carpenter and Romans (p. 1356) suggests that the cyanobacterium *Trichodesmium* may be the most important primary producer and may also be the major source of fixed nitrogen in the eutropic zone, where nitrogen limits productivity. Improved measurements of abundance as well as a reevaluation of earlier distribution data allowed the role of these large phytoplankton (1 to 3 millimeters) to be realized. These results may account for the large disparities in productivity estimates for tropical oceans. In a second report, MacDonald and Carmack (p. 1348) estimate long-term rates of primary production in the Arctic Ocean by showing that the deep waters of the Canadian Basin can be modeled as a sediment trap.

Memory filters

Visual memory appears to select for new or unexpected information. Miller *et al.* (p. 1377) recorded from single neurons in the inferotemporal cortex of rhesus monkeys that were performing tasks that required them to remember items while they also viewed new items. The neuronal response was attenuated by stimuli that matched the item being held in working memory. Neurons in the inferotemporal cortex may act as adaptive filters to preferentially pass on new or not recently seen visual stimuli.

Barrier encounters

Movement of membrane proteins may be hindered by the presence of other proteins (for example, spectrin) that divide the membrane into domains. Edidin *et al.* (p. 1379) used laser optical tweezers to drag MHC (major histocompatibility complex) class 1 molecules through the membranes of nucleated cells in order to directly measure the distance an MHC molecule could travel before it hit a barrier. Transmembrane MHC molecules ($H\text{-}2D^b$) were more hindered than glycosylphosphatidylinositol-anchored MHC molecules (Qa2); the barrier-free path lengths were 0.6 and 1.7 micrometers, respectively. The barriers appear to reside mainly on the cytoplasmic side of the membrane.

Drosophila stripe switch

Regulation of the second stripe of expression of the pair-rule gene *even-skipped* (*eve*), one of the genes responsible for the formation of the segmented pattern in the *Dro-sophila* embryo, has been studied by Stanojevic *et al.* (p. 1385). They used site-directed mutagenesis and germline transformation assays to study the *eve* promoter and four proteins that bind to it. The protein binding sites of the maternal morphogen *bicoid* and of the gap gene *hunchback* mediate activation of *eve*, whereas the protein binding sites of the gap genes *Kruppel* and *giant* establish stripe borders and act as repressors. The *eve* promoter acts like an on-off switch by integrating the effects of these overlapping transcriptional regulators.

EDITED BY PHILLIP SZUROMI

Which RNA Sample Contains The Highest Percentage Of PolyA+?

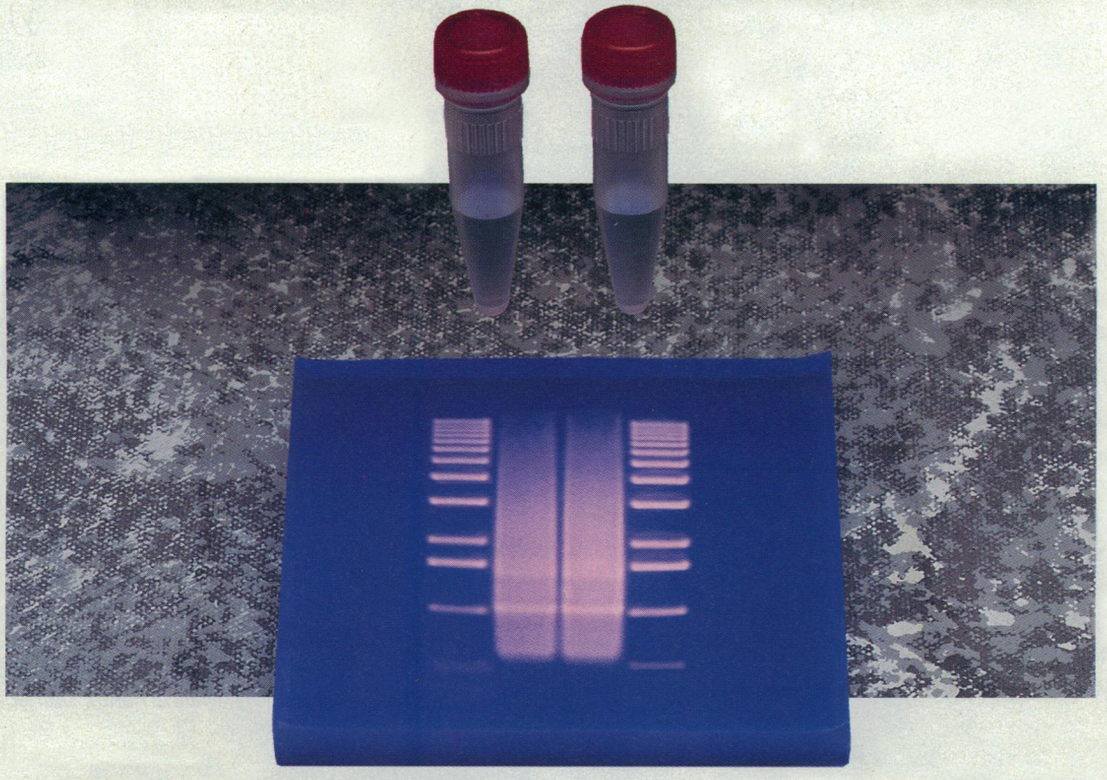


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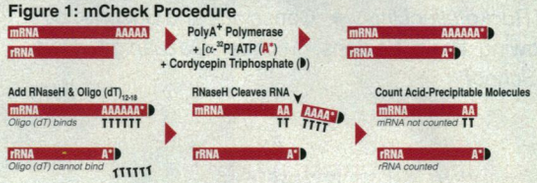
Figure 1: mCheck Procedure



In the presence of cordycepin triphosphate, PolyA polymerase adds 1–2 radiolabelled ATP's to 3' ends of all molecules. Oligo dT binds to RNA with true PolyA+ tails and RNase H cleaves the resulting hybrids. TCA precipitable counts are proportional to polyA+ RNA in the sample.

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Cognitive Neuroscience

A 3-day Seminar at AAAS ☆92, the AAAS Annual Meeting

Hyatt Regency Chicago, 6–11 February 1992 (Seminar: 8–10 February)

Seminar program organized by: *Michael Gazzaniga, Dartmouth Medical School*

SATURDAY, 8 FEBRUARY

Information Processing in the Nervous System: Molecular Basis *(8:30am–11:30am)*
Experience, Impulse Activity, and Gene Expression, *Ira Black, Robert Wood Johnson Medical School* ✦ Signal Transduction in the Nucleus of Neurons: Role of Inducible Proto-Oncogene Transcription Factors, *Thomas Curran, Roche Institute* ✦ Signal Transduction in the Brain: Role of Phosphoproteins, *Paul Greengard, Rockefeller Univ.* ✦ Molecular Basis of Neuronal Function, *Charles Stevens, Salk Institute*

Functional Imaging of Cognitive Activity in the Human Brain *(1:15pm–2:15pm)*
Topical lecture by Steven Hillyard, UC-San Diego

Conscious and Unconscious Processing of Sensory Information *(2:30pm–5:30pm)*
Unconscious Synthesis of Different Sensory Information, *Barry Stein, Medical College of Virginia* ✦ Blindsight, *Larry Weiskrantz, Univ. of Oxford* ✦ Dynamic Aspects of Visual-Cortical Function, *Torsten Wiesel, Rockefeller Univ.* ✦ Conscious and Unconscious Processes Following Brain Lesions, *Michael Gazzaniga, Dartmouth Medical School*

SUNDAY, 9 FEBRUARY

Selective Attention *(8:30am–11:30am)*
Organization and Development of Attentional Computations, *Michael Posner, Univ. of Oregon* ✦ Cognitive Neuroscience View of Selective Attention in Object Identification, *David LaBerge, UC-Irvine* ✦ Cellular Studies of the Circuitry of Visual Selective Attention in Primates, *Robert Desimone, NIMH* ✦ Effects of Visual Spatial Attention Measured with Performance and Positron Emission Tomography, *Steven Petersen, Washington Univ.* ✦ Separating Mechanisms of Awareness and Attention: A Cognitive Neuropsychological Approach, *Mary Jo Nissen, Univ. of Minnesota*

Finding Our Way: Neuronal Processing for 3-D Motion *(1:15pm–2:15pm)*
Topical lecture by Robert Wurtz, NIH

Memory *(2:30pm–5:30pm)*
High-level Representations in the Cerebral Hemispheres, *Stephen Kosslyn, Harvard Univ.* ✦ Priming and the Organization of Visual Object Memory, *Daniel Schacter, Harvard Univ.* ✦ Object Recognition in Mind and Brain, *Irving Biederman, USC* ✦ Probing the Nature of the Mental Representation of Visual Objects, *Lynn Cooper, Columbia Univ.* ✦ Visual Memory Circuits, *Mortimer Mishkin, NIMH*

MONDAY, 10 FEBRUARY

Computational Models *(8:30am–11:30am)*
Roles for Computational Models in Cognitive Neuroscience, James *McClelland, Carnegie Mellon Univ.* ✦ Mechanisms of Visual Development: Ocular Dominance and Orientation Selectivity, *Kenneth Miller, CalTech* ✦ Sparse Coding, Orthogonalization, and Pattern Completion in Theoretical and Real Hippocampal Networks, *Bruce McNaughton, Univ. of Arizona* ✦ Computational Model of Semantic Memory Impairment: Modality Specificity and Emergent Category Specificity, *Martha Farah, Carnegie Mellon Univ.*

Computations Underlying the Execution of Movement: A Biological Perspective *(1:15pm–2:15pm)*
Topical lecture by Emilio Bizzi, MIT

Biology of Language *(2:30pm–5:30pm)*
Rules of Grammar: Linguistic, Psycholinguistic, and Neurolinguistic Evidence, *Steven Pinker, MIT* ✦ Genetic Disorders, *Myrna Gopnik, McGill Univ.* ✦ Genetic Variation and the Differentiation of Cognitive Processes, *Thomas Bever, Univ. of Rochester* ✦ Brain Damage and Aphasia, *Alfonso Caramazza, Johns Hopkins Univ.* ✦ Studies of Language Comprehension with the PET Scan: Processing of French and Tamil Stories by Monolingual French Subjects, *Jacques Mehler, CNRS*

Advance registration fees: Regular members, $265; regular nonmembers, $315; student members, $125; student nonmembers, $150; postdoc members, $155; postdoc nonmembers, $180. Deadline for advance registration is 10 January 1992. On-site fees are $25 higher for regular members and regular nonmembers and $10 higher for all others. Fee includes access to the seminar and to all AAAS☆92 general sessions. **For a registration form** and a complete AAAS☆92 meeting program, see the 15 November 1991 issue of *Science* or call 202-326-6450.

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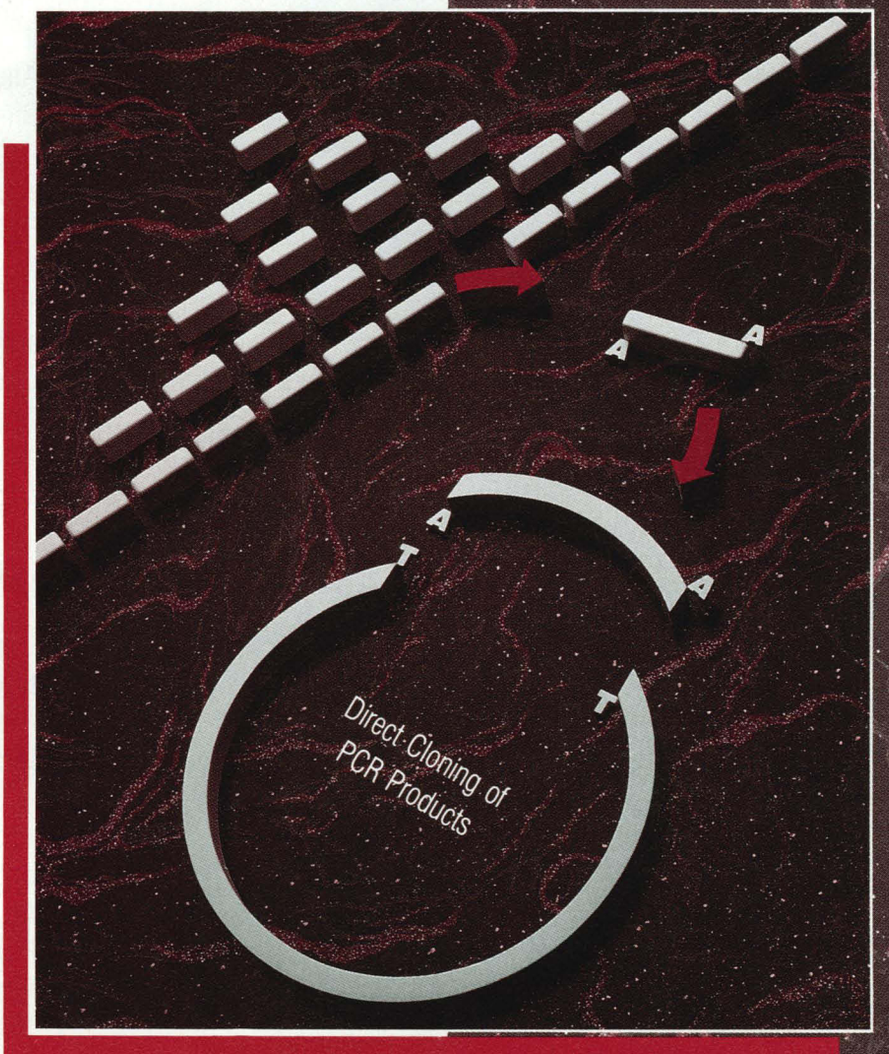

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1992–93
AAAS Fellowships for Scientists and Engineers

Congressional

AAAS Congressional Science & Engineering Fellows Program

Fellows spend one year on Capitol Hill working with Members of Congress or congressional committees as special assistants in legislative and policy areas requiring scientific and technical input. Two fellowships will be offered, with annual stipends of $38,000.

Executive Branch

AAAS-Sloan Executive Branch Science & Engineering Fellows Program

Fellows work in the White House Office of Science and Technology Policy, for one or two years, providing expertise in industrial R&D, technology transfer, international competitiveness, and related issues. One or two Fellows will be selected. Applications are invited from candidates with a minimum of five years industrial experience, through mid-level and senior executives. Stipends are negotiable, depending on qualifications and experience. Applicants must be U.S. citizens.

Diplomacy

AAAS Science, Engineering, & Diplomacy Fellows Program

Fellows work in international affairs on scientific and technical subjects for one year, either in foreign policy at the U.S. Department of State or in international development for the U.S. Agency for International Development. Approximately 12 Fellows will be selected. The annual stipend varies with experience, starting at approximately $38,000. Applicants must be U.S. citizens.

Environmental

AAAS Environmental Science & Engineering Fellows Program

Fellows work as special research consultants with the Office of Research and Development of the U.S. Environmental Protection Agency for 10 weeks in the summer. The detailed, future-oriented research assists ORD in assessing the significance of long-range environmental problems. The stipend is $900 a week. Applicants must be permanent residents of the U.S. Ten Fellows will be selected.

Applicants should be postdoctoral to midcareer scientists and engineers, from any physical, biological, or social science or any field of engineering. The programs are designed to provide each Fellow with a unique public policy learning experience; to make practical contributions to the more effective use of scientific and technical knowledge in the U.S. government; and to demonstrate the value of science and technology in solving important societal problems. All Fellows participate in a rigorous orientation on the relevant congressional and executive branch operations and foreign affairs plus a year-long seminar series on issues involving science, technology, and public policy. The Congressional, Diplomacy, and Executive Branch programs begin in September 1992 (application deadline January 15), and the Environmental program begins in June (application deadline February 15). For additional program information and application instructions, write:

Fellowship Programs/Directorate for Science and Policy Programs
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Gordon Research Conferences — *"Frontiers of Science"*

	Colby-Sawyer College (N) New London, NH	Colby-Sawyer College (S) New London, NH	New Hampton School New Hampton, NH	Kimball Union Academy Meriden, NH	Tilton School Tilton, NH
June 8-12	Multiphoton Processes T. Baer	Photoacoustic & Photothermal Phenomena G. Diebold	Nucleic Acids H. Noller J. Campbell	Second Messengers & Protein Phosphorylation P. Roach	Theoritical Biology & Biomathematics L. Edelstein-Kesher
June 15-19	Nuclear Chemistry D. Guerreau	Animal Cells & Viruses K. Yamamoto	Environmental Sciences: Water J. Schnoor	Lipid Metabolism Y. Marcel	Myogensis L. Leinwand
June 22-26	Origin of Life A. Schwartz	Solid State Ionics M. Whittingham	Energetic Materials, Chemistry of C. Capellos	High Pressure, Research at W. Bassett	Ion Channels R. Aldrich
June 29-July 3	Catalysis W. Goodman	Vascular Cell Biology J. Madri	Computational Chemistry J. McKelvey	Enzymes, Coenzymes & Metabolic Pathways J. Schloss K. Johnson	Glass M. Weber
July 6-10	Lasers in Medicine & Biology C. Puliafito M. Van Gemert	Liquid Crystal Polymers J. Blackwell	Heterocyclic Compounds L. Jungheim	Biocatalysis J. Frost J.D. Rozzell	Drug Carriers in Medicine & Biology C. Gardner
July 13-17	Microbial Toxins & Pathogenesis S.J. Normark	Chemotherapy of Clinical & Experimental Cancer J. Lazo	Organic Reactions & Processes B. Lipshutz	Interfaces, Chemistry at M. Hair	Magnetic Resonance in Biology & Medicine B. Gaffney
July 20-24	Corrosion - Aqueous D. MacDonald	Atomic & Molecular Interactions J. Valentini	Natural Products T. Hudlicky	High Temperature Chemistry C. Myers	Bioelectrochemistry C. Rafferty
July 27-31	Mammalian Gameto-genesis & Embryogensis R. Schultz	Order/Disorder in Solids R. Pick	Statistics in Chemistry & Chemical Engineering R. DeVeaux	Microstructure Fabrication, Chemistry & Chemical Physics of J. Melngailis	Nuclear Proteins, Gene Regulation & Chromatin Structure R. Kornberg
August 3-7	Medicinal Chemistry J.A. Bristol	Physical Electro-chemistry H. Abruna	Analytical Chemistry I. Warner	Hormone Action R. Evans	Ceramics, Solid State Studies in E. Fuller
August 10-14	Separation & Purification J.D. Sherman	Plasma Chemistry D. Ibbotson	Adhesion, Science of L. Penn	Peptide Growth Factor D. Clemmons	Photonuclear Reactions D. Skopik
August 17-21			Aging J. Papaconstantinou	Glycolipids & Sphingolipids G. Dawson	

Tenative 1993 Winter Schedule — California

	Doubletree Hotel **Ventura, California**	Casa Sirena Resort **Oxnard, California**
Jan. 4-8	Polymers	Superconductivity
Jan. 11-15	Composites	Alcohol
Jan. 18-22	Electrochemistry	Enzyme Organization & Cell Function
Jan. 25-29	Metals in Biology	Agricultural Science
Feb. 1-5	Mammalian DNA Repair	Temperature Stress in Plants
Feb. 8-12	Glycoproteins & Glycolipids	Angiotensin
Feb. 15-19	Quantitative Genetics	Fibronectin
Feb. 22-26	Kallikreins & Kinins	Magnesium in Biochemical Processes
March 1-5	Structures, Energetics & Dynamics of Gaseous Ions	Molecular Pharmacology

The 1993 Winter Gordon Research Conferences, as shown above, will be held January 4 - March 5, 1993 in California. Fixed Conference fees have not been established at this time.

The chair of each conference is requested to have the detailed program in the Director's office September 1, 1992 and the detailed Winter program will be published in the October 9, 1992 issue of *Science*.

EUROPEAN CONFERENCES 1992

SPRING — ITALY

MAY 3-8 — Centro Studi Cappucini della Cassa di Risparmio di San Miniato; San Miniato, Italy, Conference To Be Announced

MAY 3-8 — Centro Studi della Cassa di Risparmio di Volterra; Volterra, Italy, Conference To Be Announced

FALL — GERMANY

Schwaebisches Bildungszentrum, Irsee, Germany

Sept. 13-18 — Polymer Colloids

Sept. 20-25 — Complex Fluids

Oct. 4-9 — Molecular & Ionic Clusters

GENERAL INFORMATION

The Summer Gordon Research Conferences will be held June 8-August 21, 1992 in New Hampshire and June 15-August 21, 1992 in Rhode Island. GORDON RESEARCH CONFERENCES ADMITS SCIENTIFICALLY QUALIFIED CONFEREES OF ANY SEX, RACE, AGE, COLOR AND NATIONAL ORIGIN.

The Chair of each Conference is requested to have a detailed program in our office January 1, 1992, and the entire Summer program with application will be published in the March 6, 1992 issue of *Science*.

Requests for applications to the Summer Conferences, or for additional information should be addressed to: Dr. Alexander M. Cruickshank, Director, Gordon Research Conferences, Gordon Research Center, University of Rhode Island, Kingston, RI 02881-0801. Tel. (401)783-4011 or (401) 783-3372. FAX No.: (401) 783-7644.

1992 Schedule — New Hampshire & Rhode Island

Proctor Academy Andover, NH	Holderness School Plymouth, NH	Brewster Academy Wolfeboro,NH	Plymouth State College (N) Plymouth, NH	Plymouth State College (S) Plymouth, NH	Salve Regina College Newport, RI
Hemostasis B. Furie	Proteolytic Enzymes & Their Inhibitors S. Pizzo	Not Available	Cardiac Inotropic Agents L. Jones	Fractals F. Family	Not Available
Plant Molecular Biology S. Howell	Tribology F. Kennedy	Basement Membranes R. Burgeson	Diamond Synthesis S. Harris J. Angus	Physical Metallurgy A. Thompson	Biopolymers K. Breslauer C. Woodward
Molecular Biology, Diffraction Methods in I. Weber	Biological Regulatory Mechanisms R. Losick E. Craig	Radical Ions P. Rieger	Mitochondria & Chloroplasts T. Fox	Bioorganic Chemistry C. Townsend B. Imperiali	Sterochemistry D. Sternbach
Lysosomes A. Hubbard	Intermediate Filaments R. Liem	Polymers N. Field	Mutagenesis T. Kunkel	Thermosetting High Performance Materials R. Lagasse	Neural Development U. Rutishauser
Quinone and Redox- Active Amino Acid Cofactors H. Kagan	Particle Solid Interactions R. Kelly	Bacterial Cell Surfaces R. Kadner	Plant Senescence A. Mattoo	Reproductive Tract Biology P. Donahoe	Radiation Chemistry C. Braun
Particle Physics in the 90's J. Lach	Drug Metabolism G. Wilkinson	Electron Spectroscopy W. Eberhardt	Meioses N. Kleckner R.S. Hawley	Modeling in Solar Terrestrial Physics C. Goertz	Molecular Genetics R. Tjian
Fungal Metabolism M. Kurtz A. Lambowitz	Dielectric Phenomena J. Bendler	Pyrrole Compounds J. Kushner	Electron Distribution & Chemical Bonding G. DeTitta	Point & Line Defects P. Monney	Calcium Phosphates R. Wutheir L. Chow
Electronic Processes in Organic Materials L. Schein	Myelin R. Lazzarini	Inorganic Chemistry S. Harris	Solid State Chemistry F. DiSalvo	Software Tools & Libraries for Concur- rent Supercomputing D. Walker	Organometallic Chemistry J. Bercaw
Bioengineering & Orthopedic Science D. Eyre	Water & Aqueous Solutions J. Enderby	Vibrational Spectroscopy T. Keiderling	Electron-Donor- Acceptor Interactions S. Farid	Foams R. Dominguez	Polymer Physics D. Pearson
Gravitational Effects on Living Systems V.R. Edgerton	Organic Geo- chemistry J. Whelan	Biomolecular Recognition & Immobilization D. Litman	Motile & Contractile Systems E. Salmon	Modeling of Fluids in Permeable Media F. Orr, Jr.	Cancer G. Brodeur
		Condensed Matter Physics S. Kivelson			Proteoglycans J. Kimura

FIXED CONFERENCE FEES, 1992

Fixed Fees (New Hampshire Sites)

Conferee (double occupancy).....$440
($390. if postmarked 3 weeks prior to Conference)
Conferee (single occupancy - IF AVAILABLE).....$490
($440. if postmarked 3 weeks prior to Conference)
Non-Resident Conferee (meals, no room).....$400
($350. if postmarked 3 weeks prior to Conference)
Guest (double occupancy, meals).....$350
($300. if postmarked 3 weeks prior to Conference)
Guest (single occupancy - IF AVAILABLE).....$400
($350. if postmarked 3 weeks prior to Conference)

Fixed Fees (Rhode Island Site)*

Conferee (double occupancy).....$455
($405. if postmarked 3 weeks prior to Conference)
Conferee (single occupancy - IF AVALIABLE).....$505
($455. if postmarked 3 weeks prior to Conference)
Non-Resident Conferee (meals, no room).....$400
($350. if postmarked 3 weeks prior to conference)
Guest (double occupancy, meals).....$365
($315. if postmarked 3 weeks prior to Conference)
Guest (single occupancy - IF AVAILABLE).....$415
($365. if postmarked 3 weeks prior to Conference)

Children under 12 years of age are not permitted in the meeting rooms, dining rooms, or dormitories at any host sites.
*All rooms at the Rhode Island site are double with bath.

1. Full fixed fee charged regardless of time conferee attends Conference. Please note fees.
2. Fixed fee cannot be prorated or reduced for anyone (speakers, discussion leaders, conferees).
3. Non-resident conferees are expected to eat all meals in the conference Dining Room and, therefore, the Fixed Fee for non-residents includes the full meal charge.
4. Refunds — See General Information under cancellations.

PAYMENT:

The full fixed fee will be required IN ADVANCE of *ALL* PARTICIPANTS AND GUESTS. Attendance and/or accommodations will NOT be reserved unless this fee is received in our office 3 weeks prior to the Conference. Foreign participants will also be required to pay Gordon Research Conferences in advance in U.S. dollars payable by wire only to our U.S. bank. Checks drawn on Canadian banks and foreign banks cannot be accepted and will be returned. Scientists in Canada must use a bank draft obtained from their bank payable in U.S. dollars and drawn on a U.S. bank. Remittance information on the transfer must include the conferee's name, conferee number and Conference title. Detailed information on payment, travel etc. mailed with registration material.