

527 This Week in *Science*

Editorial

529 Wiring the Campuses

Letters

538 The Value of Animal Research: R. A. GOOD ■ Federal Housing and Poverty:
P. J. FERRARA ■ Racemization Dating: J. L. BADA; K. A. KVENVOLDEN

News & Comment

541 NSF: Hard Times Amid Plenty ■ How More Can Mean Less
544 A Clash Over Standards for Scientific Records
Bromley Moves West
545 NAS Elects New Members
546 Biotech Companies Lobby for Federal Regulation
547 NIH Director: The Final Lap?
548 *Briefings*: NAS Condemns Soviet Anti-Semitism ■ Did Queen Write Shakespeare's
Sonnets? ■ New Home for Ehrlich Institute ■ Pressing the Japanese ■ Federal Job
Exam Reformed ■ High School Science ■ Watch Out! Here Comes the
Greenhouse ■ Top Focus Needed for AIDS Effort

Research News

550 An Animal Genome Project? ■ Plant Maps, Public and Private ■ What to Do with
an Animal Map
553 China: A Living Lab for Epidemiology
555 Tapping into Nerve Conversations

Articles

559 Risk Within Reason: R. J. ZECKHAUSER AND W. K. VISCUSI
564 The Formation of Sunlike Stars: C. J. LADA AND F. H. SHU

Research Article

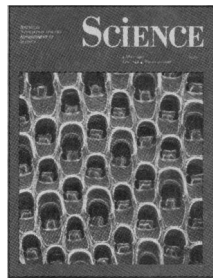
573 An RNA Polymerase-Binding Protein That Is Required for Communication
Between an Enhancer and a Promoter: D. R. HERENDEEN, K. P. WILLIAMS,
G. A. KASSAVETIS, E. P. GEIDUSCHEK

Reports

579 Evolutionary Significance of Morphospecies: A Test with Cheilostome Bryozoa:
J. B. C. JACKSON AND A. H. CHEETHAM
583 Anesthesia Cutoff Phenomenon: Interfacial Hydrogen Bonding:
J.-S. CHIOU, S.-M. MA, H. KAMAYA, I. UEDA

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COVER Skeleton of a colony of the cheilostome bryozoan *Steginoporella magnilabris*. Features of individual modules (zooids, each about 1 millimeter long) that are preservable in the fossil record are sufficient to discriminate between morphospecies that breed true and are genetically distinct. Thus paleontologists can study evolutionary patterns at the species level in this group. See page 579. [Scanning electron micrograph by Susann Braden, National Museum of Natural History SEM Lab, Smithsonian Institution]

- 585 A Mn²⁺-Dependent Ribozyme: V. DANGE, R. B. VAN ATTA, S. M. HECHT
- 588 Expression of a Zinc Finger Gene in HTLV-I- and HTLV-II-Transformed Cells: J. J. WRIGHT, K. C. GUNTER, H. MITSUYA, S. G. IRVING, K. KELLY, U. SIEBENLIST
- 591 In Vivo Receptor-Mediated Phosphorylation of a G Protein in *Dictyostelium*: R. E. GUNDERSEN AND P. N. DEVREOTES
- 593 Tick Anticoagulant Peptide (TAP) Is a Novel Inhibitor of Blood Coagulation Factor Xa: L. WAXMAN, D. E. SMITH, K. E. ARCURI, G. P. VLASUK
- 596 L-Cysteine, a Bicarbonate-Sensitive Endogenous Excitotoxin: J. W. OLNEY, C. ZORUMSKI, M. T. PRICE, J. LABRUYERE
- 599 K⁺ Current Diversity Is Produced by an Extended Gene Family Conserved in *Drosophila* and Mouse: A. WEI, M. COVARRUBIAS, A. BUTLER, K. BAKER, M. PAK, L. SALKOFF
- 603 Human Cortical Neuronal Cell Line: Establishment from a Patient with Unilateral Megalencephaly: G. V. RONNETT, L. D. HESTER, J. S. NYE, K. CONNORS, S. H. SNYDER
- 605 Identity of Inositol 1,2-Cyclic Phosphate 2-Phosphohydrolase with Lipocortin III: T. S. ROSS, J. F. TAIT, P. W. MAJERUS
- 607 Effect of Phospholipase C- γ Overexpression on PDGF-Induced Second Messengers and Mitogenesis: B. MARGOLIS, A. ZILBERSTEIN, C. FRANKS, S. FELDER, S. KREMER, A. ULLRICH, S. G. RHEE, K. SKORECKI *et al.*

Inside AAAS

- 611 AAAS Council Meeting, 1990: G. SEILER ■ U.S.—Chilean Research Grants ■ Pacific Division in June in Davis ■ Members Who Are Asked to Join Again ■ Security Controls on Communication ■ Education and Equity ■ Franklin Event

Book Reviews

- 614 A Shield in Space?, reviewed by M. BUNN ■ Science in Germany, A. J. ROCKE ■ The Geology of North America, W. B. HAMILTON ■ Some Other Books of Interest ■ Books Received

Products & Materials

- 618 Inhibitor of RNA Polymerase III ■ Laboratory Balances Feature Microchip Technology ■ T Cell Monoclonal Antibodies ■ Calculator Combines with Computer ■ Chromatography Software ■ Lab Partner Calculator ■ Molecular Biology Software for the Macintosh ■ Literature

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Wiring the Campuses

The rapid evolution of computing technology in the last decade has presented higher education with a number of challenges. In the coming decade, there will be even greater challenges, particularly in connecting computers to one another and to information servers of all kinds. Without a plan to deal with these new challenges, the productivity of U.S. universities will suffer.

The key ingredient in the spread of computing in higher education during the 1980s was the introduction of the personal computer. The per unit cost of the personal computer was low enough that purchase decisions could be made by heads of departments or by principal investigators. Trade-offs could be made within local budgets, often without the campus administration realizing how fast things were changing. In the coming decade the computing revolution will continue as hardware costs come down, speeds go up, and software takes more advantage of the hardware. Computers will cease to be merely a useful tool for scholarship but will become a principal tool. Access to library materials, to protein databases, and to specialized software and hardware will all be necessary for scholars to function effectively by the mid-1990s.

If universities are going to take advantage of the technology, they will have to plan now and invest now. Although it was painful for departments to discover that the campus administration was not going to provide new money for microcomputers, it was still possible for them to achieve a fair amount of computerization on their own. Networks are common goods; their value increases with the number of people and resources interconnected. Like highways and phone systems, they require central planning, management, and financing. The capital requirements for campus networks are quite high. At the University of California, San Diego, we are preparing a proposal for a new network that would require \$1.4 million for the fiber optics portion. Network management and building-level electronics will bring the cost up to \$2 million, exclusive of end-user electronics. If we had not put in a new phone system and local area networks, trenching costs and building modifications would have doubled the costs. Campuses that are older and more congested than ours will find the cost for trenching and retrofitting buildings much higher.

In the 1980s, higher education in the United States has managed to keep up with the computer age without an overall plan. This will not do in the 1990s. Already, the National Science Foundation has realized that scientists and engineers will need access to specialized computing facilities, and it has installed a national backbone network for this activity. Further, NSF has encouraged groups of colleges and universities to form regional networks that connect people to the backbone. It has done this by providing funding for the initial stages, particularly for the acquisition of hardware and installation of fiber.

The NSF's program in data communications is a good model, but it does not go far enough. Just as there is no point in building a national backbone if there are no regional networks to connect people to it, there is no purpose in having regional networks if the campus networks are inadequate to the task. At present, campuses are holding back from installing the needed fiber optics that will be required to take advantage of the national networks during the 1990s. Until universities see that there is a national policy regarding higher education data communications, they will continue to hold back.

NSF can further its good work by establishing a program to help "wire" the campuses with fiber optics. To encourage universities to formulate plans and to initiate project, the federal government should be prepared to provide matching funding—perhaps as much as 50% of the required costs for wiring campuses. A competitive grants program should be established to evaluate proposals, with first priority going to those that have the most innovative plans and are most likely to make effective use of the network. The new program should be established with add-on funds; it should not be implemented at the expense of individual investigators. If incentives are provided by the federal government to speed up the wiring of campuses, great progress can be made in both the quality and productivity of university-based research and teaching. Without some kind of federal help, universities will be slow and uncertain in their efforts to install fiber optic networks and will gradually lose the competitive edge they now enjoy over universities in other parts of the world.

—RICHARD C. ATKINSON, *Chancellor*, and DONALD W. ANDERSON, *Dean of Natural Sciences, University of California, San Diego, La Jolla, California 92093*