

703 This Week in *Science*

Editorial

705 Science at the Four-Year and Master's Universities

Perspective

707 U.S. Nuclear Power in the Next Twenty Years: B. I. SPINRAD

Letters

713 The Meadowcroft Rockshelter: J. M. ADOVASIO AND R. C. CARLISLE ■ Brainwave Counting: W. A. CONIGLIO ■ Flora Project: M. S. STRAUSS

News & Comment

717 AIDS and Drug Abuse: No Quick Fix

719 ARS Prodded into the Open

720 Anglo-French Nuclear Missile Under Study

722 *Briefing*: Army Releases Report on Biowarfare Lab ■ Investor Takes Major Position in BioTechnica ■ Bullish on Genentech ■ Beagle Theft at Irvine ■ Researcher Held in Kenya

723 Patent Claim Buildup Haunts Biotechnology

724 NIH Scientists Balk at Random Drug Tests

Research News

725 Academy Backs Genome Project

727 Pushing Back the Redshift Limit

729 Was There a Prelude to the Dinosaurs' Demise?

730 Superconductors Hotter Yet

Articles

737 Causes of the Liability Insurance Crisis: S. HARRINGTON AND ROBERT E. LITAN

742 Diode Laser-Pumped Solid-State Lasers: R. L. BYER

748 Molecular Phylogeny of the Animal Kingdom: K. G. FIELD, G. J. OLSEN, D. J. LANE, S. J. GIOVANNONI, M. T. GHISELIN, E. C. RAFF, N. R. PACE, R. RAFF

Research Articles

753 Glycosyl-Phosphatidylinositol Moiety That Anchors *Trypanosoma brucei* Variant Surface Glycoprotein to the Membrane: M. A. J. FERGUSON, S. W. HOMANS, R. A. DWEK, T. W. RADEMACHER

Reports

760 New Asymptotics for Old Wave Equations: J. R. KLAUDER

762 Biologically Effective Ultraviolet Radiation: Surface Measurements in the United States, 1974 to 1985: J. SCOTTO, G. COTTON, F. URBACH, D. BERGER, T. FEARS

764 Capture of Atmospheric Ammonium by Grassland Canopies: G. W. HEIL, M. J. A. WERGER, W. DE MOL, D. VAN DAM, B. HEIJNE

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COVER Subsets of developing T lymphocytes from a mouse, stained with fluorescently labeled monoclonal antibodies against the membrane glycoproteins, CD4 and CD8 ($\times 2800$). Helper T cells (orange, CD4⁺), cytotoxic and suppressor T cells (green, CD8⁺), and immature blast cells and their progeny (yellow, CD4⁺ and CD8⁺) each exhibit a characteristic pattern of ion-channel expression. See page 771. [Richard S. Lewis, University of California, Irvine 92717]

- 766 Effect of Neonatal Handling on Age-Related Impairments Associated with the Hippocampus: M. J. MEANEY, D. H. AITKEN, C. VAN BERKEL, S. BHATNAGAR, R. M. SAPOLSKY
- 769 A Newly Defined Property of Somatotropin: Priming of Macrophages for Production of Superoxide Anion: C. K. EDWARDS III, S. M. GHIASSUDIN, J. M. SCHEPPER, L. M. YUNGER, K. W. KELLEY
- 771 Subset-Specific Expression of Potassium Channels in Developing Murine T Lymphocytes: R. S. LEWIS AND M. D. CAHALAN
- 775 Expression of a Distinctive *BCR-ABL* Oncogene in Ph¹-Positive Acute Lymphocytic Leukemia (ALL): S. S. CLARK, J. MCLAUGHLIN, M. TIMMONS, A. M. PENDERGAST, Y. BEN-NERIAH, L. W. DOW, W. CRIST, *et al.*
- 778 Effects of Intracellular Free Magnesium on Calcium Current in Isolated Cardiac Myocytes: R. E. WHITE AND H. C. HARTZELL
- 780 A Fossil Reptile Embryo from the Middle Triassic of the Alps: P. M. SANDER
- 783 Mesoderm Induction in Amphibians: The Role of TGF- β 2-Like Factors: F. ROSA, A. B. ROBERTS, D. DANIELPOUR, L. L. DART, M. B. SPORN, I. B. DAWID
- 786 One Factor Recognizes the Liver-Specific Enhancers in α ₁-Antitrypsin and Transthyretin Genes: D. R. GRAYSON, R. H. COSTA, K. G. XANTHOPOULOS, J. E. DARNELL

Technical Comments

- 789 Elevated D₂ Dopamine Receptors in Drug-Naïve Schizophrenics: B. R. ZEEBERG, R. E. GIBSON, R. C. REBA; D. F. WONG, A. GJEDDE, H. M. WAGNER, JR., R. F. DANNALS, J. M. LINKS, L. E. TUNE, G. D. PEARLSON

Book Reviews

- 800 The Fall of the Bell System, *reviewed by* W. L. BALDWIN ■ Medical Science and Medical Industry, J. W. SERVOS ■ Sea Surface Studies, O. H. PILKEY ■ Interstellar Processes, Physical Processes in Interstellar Clouds, J. SILK ■ Books Received

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Science at the Four-Year and Master's Universities

The system of higher education in this country has gradually undergone a profound change from what existed a generation ago. Schools that were small teachers' colleges have metamorphosed into large comprehensive universities. They now offer broad curricula that include science and engineering. In general, they have few or no Ph.D. programs, but their faculties consist largely of professors who received their doctorates from research universities. The 601 comprehensive universities grant the majority of masters' degrees and about half of the baccalaureate degrees in this country. Their alumni are an expanding fraction of the students who complete the doctorate at research universities. They are increasingly active in cooperating with industry and in public service. They have important roles in the education of minorities, the economically disadvantaged, and late bloomers. If the scientific illiteracy of this country is to be ameliorated, they will be important partners in the effort.

The comprehensive universities vary in sponsorship and size. Some are private, but most (427) are state schools. The largest enrollment (35,000) is at San Diego State University. A minor fraction of the schools have succeeded in obtaining substantial funds for research through contracts and grants from industry, states, and the federal government. But most of the comprehensive universities, and especially the state schools, are handicapped in their functions of educating scientists and engineers. Typical teaching responsibilities average around 12 units. There are limited institutional funds for equipment, supplies, or travel. A relatively small number of their professors obtain federal grants. A National Science Board report* outlining deficiencies in undergraduate education contained comments particularly applicable to many of the state schools:

Laboratory instruction, which is at the heart of science and engineering education, has deteriorated to the point where it is often uninspired, tedious, and dull. Too frequently it is conducted in facilities and with instruments that are obsolete and inadequate. . . .

Faculty members are often unable to update their disciplinary knowledge continuously or maintain their pedagogical skills. . . .

Courses and curricula are frequently out-of-date in content, unimaginative, poorly organized for students with different interests, and fail to reflect advances in the understanding of teaching and learning.

Lack of equipment and inability to update their disciplinary knowledge are particularly frustrating to individuals who were indoctrinated in ways of the research universities. A substantial number of them have become deans, provosts, and presidents of comprehensive universities. In late January of this year, some of them from 27 states participated in a 3-day conference held in Long Beach, CA, and entitled "Science Research in the Comprehensive University," organized by the Chancellor's Office of California State University.

The conference included plenary talks and working sessions designed to lead to a document stating the case for enhanced support of research for these institutions. Among the speakers was Representative George E. Brown, Jr. (D-CA), who is an influential member of many of the top science-related committees. In a lecture he said, "All parts of the educational system should not have identical roles, but research should not be confined to the research universities. Research is an integral part of education. Mere assimilation from authorities is sterile. Education that does not build on natural curiosity can never be education of the highest kind."

The National Science Foundation has established a number of programs, such as matching instrumentation grants, designed to help undergraduate science. But the sums allocated to them are small. The National Science Board report recommended substantial support for improvement of teaching of undergraduate science and engineering, and that should be implemented. The states also have responsibilities. The quality of education of their scientists and engineers will be enhanced if professors are provided with the circumstances that enable them to lead a life of learning. In pursuing their goal to integrate research and teaching more effectively, the comprehensive universities are on the right track. Their cause merits support.—PHILIP H. ABELSON

*National Science Board, "Undergraduate Science, Mathematics and Engineering Education" (Washington, DC, March 1986).