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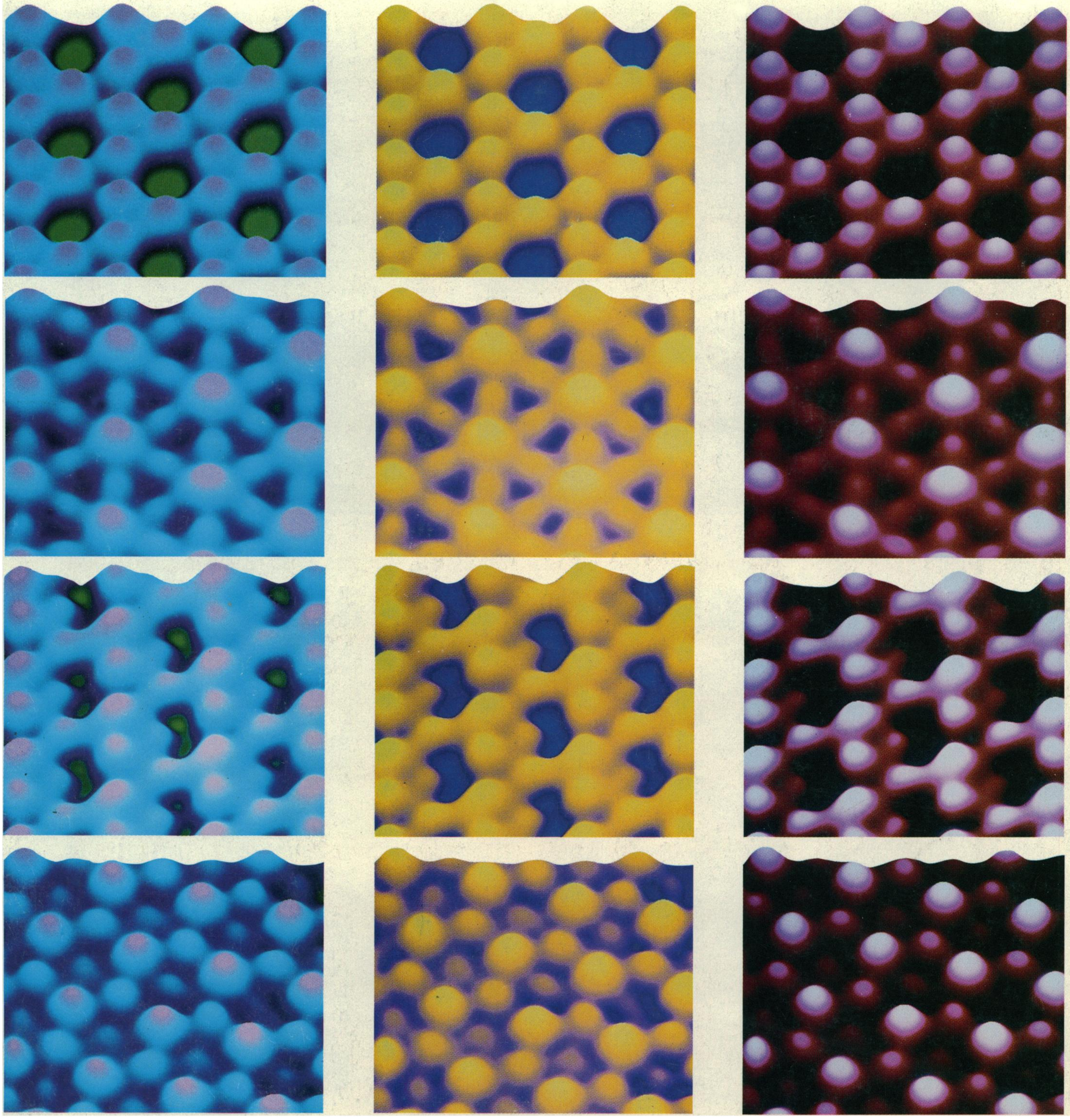

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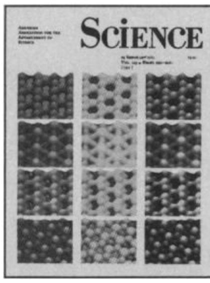
■ The American Association for the Advancement of Science was founded in 1848 and incorporated in 1874. Its objects are to further the work of scientists, to facilitate cooperation among them, to foster scientific freedom and responsibility, to improve the effectiveness of science in the promotion of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



COVER Scanning tunneling microscope images (25 angstroms by 25 angstroms) of iodine atoms adsorbed on a platinum(III) substrate. Four structural geometries of the adsorbed iodine are presented (*top to bottom*), each displayed in three color schemes (*left to right*). The structures provide information about the iodine—platinum bonding forces. See page 1050. [B. C. Schardt *et al.*, Department of Chemistry, Purdue University, West Lafayette, IN 47907; color images photographed directly from the computer screen of a Nanoscope II tunneling microscope manufactured by Digital Instruments, Santa Barbara, CA]

Reports

Book Reviews

Products & Materials

This Week in SCIENCE

Diamond films

A procedure has been developed for growing diamond films on non-diamond substrates (page 1047). Diamond was deposited with mass-selected carbon ion beams onto silicon substrates at room temperature; this is a far cry from the conditions of extreme temperature and pressure at which diamonds naturally form within the earth. Robertson *et al.* report that the planes of the diamond crystals, characterized by x-ray diffraction procedures, were oriented parallel to the corresponding silicon planes, confirming heteroepitaxial growth of diamond on the silicon layer. The results are consistent with a model for epitaxial growth in which the first carbon ions deposited are shallowly implanted below the silicon surface. The "subplantation" of these atoms ensures further growth of the crystal in an orientation corresponding to that of the silicon lattice. This is a gem of an accomplishment for semiconductor technology, because diamond has high heat but negligible electric conductivity.

Ancient Egyptian climates and cultures

FIELD studies in the Eastern Sahara desert (southern Egypt west of the Nile) have revealed much about past local climates and cultures (page 1053). In ancient times, Wadi Arid and Wadi Safsaf were valleys; today both are aggraded and covered with sand. Radar images made by instruments on the Space Shuttle Columbia revealed signatures of underlying ancient drainage systems. In the past, this region experienced a number of humid and subhumid periods, but currently it receives less than 1 millimeter of rain a year. Szabo *et al.* used uranium-series elements to date deposited carbonates that had precipitated from ground water when the water table was high and rainfall was between 175 and 600 millimeters per year. Humid or subhumid conditions pertained 15,000, 45,000, 141,000, 212,000, and greater than 300,000 years ago. Artifacts from the middle and lower (Acheulian) Paleolithic were also recovered and dated by associated carbonates. The hand axes and other artifacts indicate that hominids inhabited this region at least 212,000 years ago and were still there (though their occupation was intermittent) at least until 45,000 years ago; the past 20,000 years appear to have been too arid for human occupation.

Virulence gene

PHAGOCYTIC cells provide host animals with one form of protection against bacterial pathogens: these cells can engulf pathogens and enclose them in vacuoles, the vacuoles then fuse with other intracellular vacuoles and granules that contain toxic substances (some of which are called "defensins"), and the defensins and other compounds can kill the bacteria. Certain pathogens, however, actually depend on phagocytic cells for their growth and, though engulfed, do not get killed. One such organism is *Salmonella typhimurium*, which lives inside phagocytic cells of mice and other animals and causes a disease similar to human typhoid. Fields *et al.* made molecular and genetic comparisons of normal bacteria and mutant bacteria that were unable to survive in macrophages in vitro (page 1059). In the mutants, the *phoP* gene was altered; the bacteria were susceptible in vitro to the toxic effects of defensins and lacked normal virulent properties in vivo. The identification of this gene should facilitate investigations of how *phoP* operates, how it regulates other genes, and how these gene activities affect the target defensins.

Fever inducer

ENDOGENOUS pyrogens are soluble factors that induce fevers; some well-known pyrogens are cachectin, interleukin-1, and interferon-α. The endogenous pyrogens are produced by and released from circulating cells; they use prostaglandins as secondary mediators, and the fevers they cause can be inhibited by prostaglandin inhibitors. A pyrogen that has some but not all of the properties of those previously characterized is described by Davatelis *et al.* (page 1066); it is released by macrophages and, because of its role in inducing local inflammatory responses, is called macrophage inflammatory protein-1 (MIP–1). An intravenous injection of MIP-1 causes a fever in rabbits; the magnitude of the febrile response is dose dependent. Although the kinetics of MIP-1–induced febrile responses are similar to those of fevers produced by other endogenous pyrogens—all responses peak within one hour of the injection and the fever curves are monophasic—MIP-1 does not induce prostaglandins and MIP-1–induced fevers cannot be prevented by prostaglandin inhibitors. The rapidity of the response suggests, however, that MIP-1, like other pyrogens, communicates closely with the body's thermostat, the hypothalamus.

Anatomy of anxiety

HUMAN anxiety, whether "normal" (as represented by anticipatory anxiety) or "pathologic" (as observed in panic attacks), is an emotion that leads to increased neuronal activity in the brain's temporal poles (page 1071). Where neurons are active, blood flow increases, and such increases can be detected by positron emission tomography. Reiman *et al.* show that the temporal pole flow rate increased bilaterally when people were anticipating danger—a painful electric shock to their fingers. The subjects knew that they would receive a shock within two minutes of receiving a tracer substance; they also knew that the longer it took for the shock to come the more painful it would be. Their anxiety was apparent not only in the blood flow rate but also in heart rate, electrodermal activity, and subjective assessments of how they were feeling. Comparable bilateral increases in temporal pole blood flow had been recorded in similar experiments of biochemically induced panic responses.

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SCIENCE

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Scientific Competency Through Fun

Concern for the scientific education of the children of the United States is much in the news. Recent test scores of American children in comparison with those of their Japanese and European counterparts have created part of the alarm, and lower enrollments in science programs at college and graduate levels have added fuel to the fire. The argument that global competitiveness requires more scientists is being used to add pressure for expanded mathematics and science programs. But there should be a second reason for expansion: fairness, which requires that all children start out with an equal chance for a good education. Part of the reason for the low American test scores is that many schools are underfunded, and most of these are located in regions where the underprivileged and recently arrived immigrants tend to accumulate. Those are precisely the groups who most desperately need the education system to provide the basis for equality of opportunity.

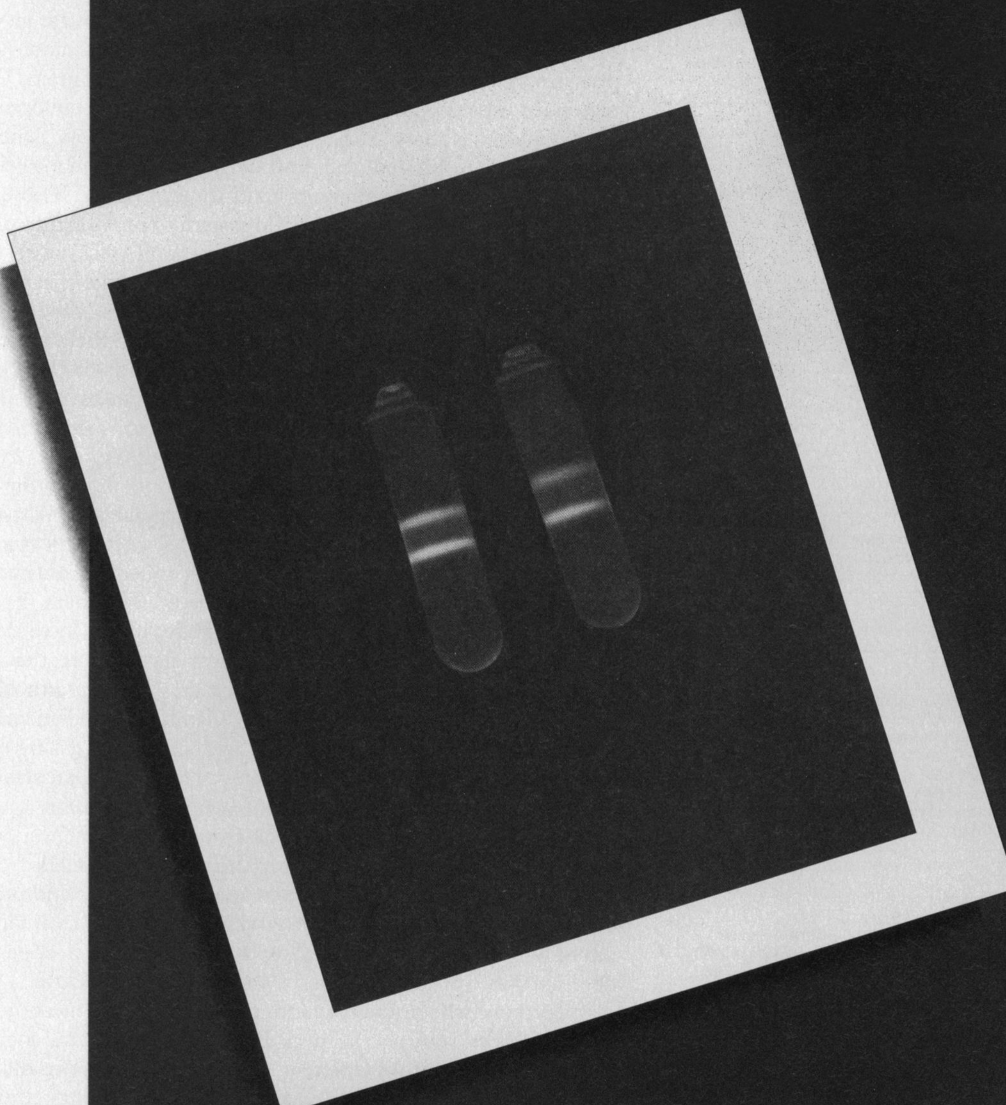
Fortunately, producing an adequate supply of scientists and giving scientific literacy to the nonscientists can be accomplished by the same means—teaching excellent science to every child at the elementary school level. Expanding the base of the pyramid in this way will increase the number of students who emerge from their academic training as the scientists of the future. It will also provide vital background for those who never go on to scientific careers. Voters, judges, and insurance salemen can have an understanding of the complexity of the scientific world, as well as the ability to operate the computers and sophisticated equipment that even the most menial jobs will require in the future.

If scientific competence is to be extended to all, then the teaching of mathematics in the elementary schools will have to be a fundamental target. Although mathematics may become a minor tool for many adults, even some in science, almost invariably scientists say they did well in mathematics in elementary school; those intimidated by science say, in disproportionate numbers, "I was never good at math." The myth that mathematics must be difficult lends its study an element of Greek tragedy, in which catastrophic failure inevitably lurks somewhere down the road. It seems essential, therefore, that programs in elementary school mathematics be made to be fun and be taught in an atmosphere of leisure to remove the anxiety that is so often self-fulfilling. Gambling in elementary school may sound like the ultimate in degradation, but playing with cards and rolling dice can introduce principles of probability; flipping coins can be associated with Gaussian distribution; cutting through spheres and cones and squares can teach solid geometry on personal computer screens. A recent report of the National Academy of Sciences* supports such programs and gives excellent advice on how to improve the teaching of science. Studies indicate that there are a higher number of men than women among computer enthusiasts, suggesting a possible bias of many early computer games, which tend to be oriented toward conventional male interests—war, sports strategy, and car races. So it appears that mathematics must be developed as fun before it can be required as an essential.

To those who argue that such programs would mean more time spent on mathematics than on other subjects, such as English, history, and social studies, the answer is, yes, because mathematics is different and intrinsically more difficult. This difficulty arises not necessarily because of higher conceptual challenges but because the skills of mathematics are cumulative. If one learns the history of Greece poorly, that has a minor effect on learning the history of Rome. But if one fails to understand fractions, the ability to complete more advanced calculation, such as algebra or trigonometry, is fatally impaired.

It is time to recognize that smokestack industry, with its large manual labor force, is disappearing. To be fair to our youth who will not be scientists, and to provide a broader base for future personnel in science, we must develop excellent programs at the elementary level. This improvement requires more money for schools, better salaries for teachers, and more demanding curricula. But all of that may not help unless there are imaginative changes in instruction that will make science fun and build confidence while helping students to a real understanding of scientific approaches. We have tried money without imagination, and it has failed. We have provided imagination without money, and it has failed. Perhaps this time, by analyzing the problem deeply, we can provide both ingredients simultaneously. It might be fair, effective, and fun all at the same time.—DANIEL E. KOSHLAND, JR.

*National Research Council, *Everybody Counts: A Report to the Nation on the Future of Mathematics Education* (National Academy Press, Washington, DC, 1989).



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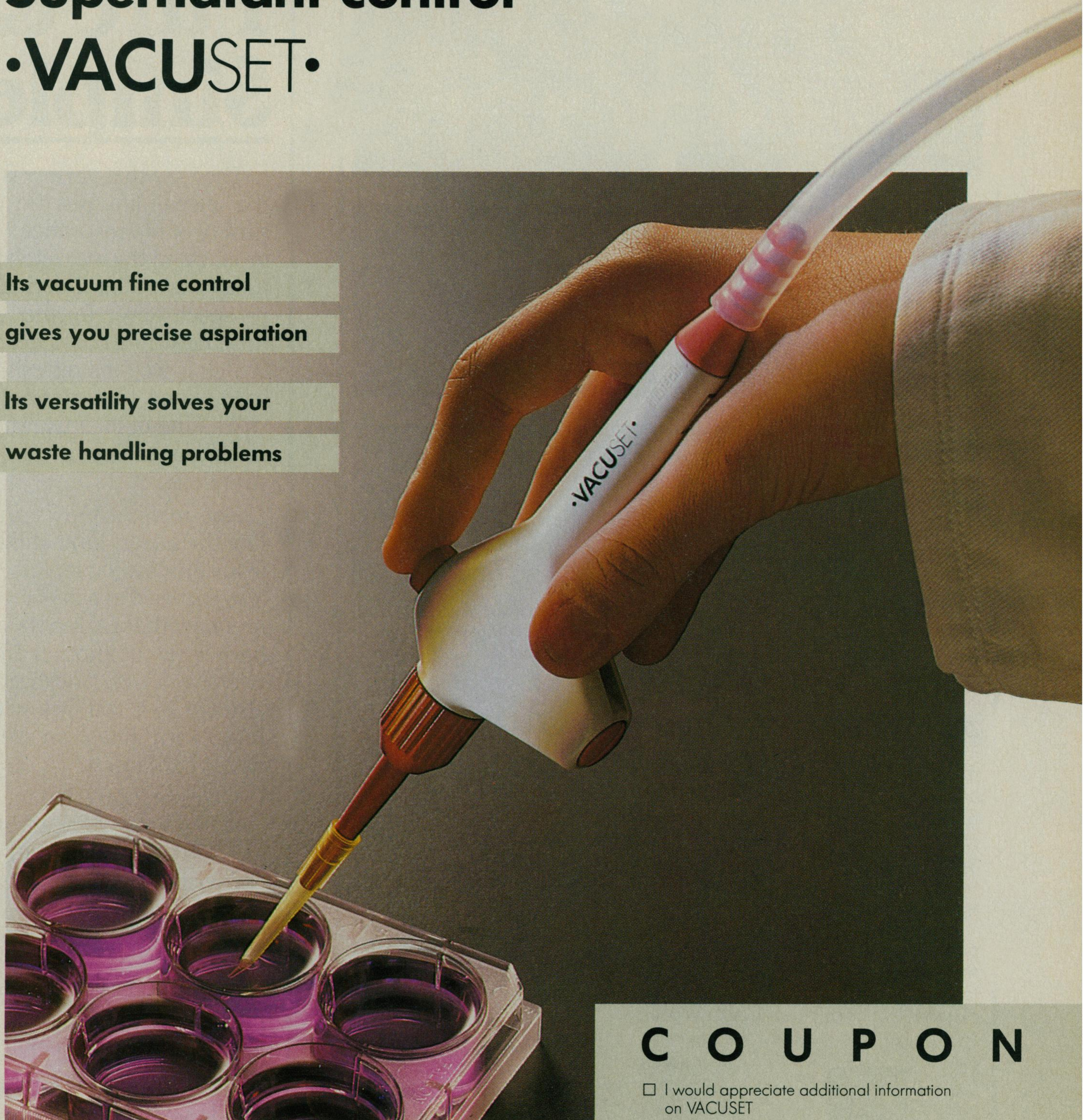

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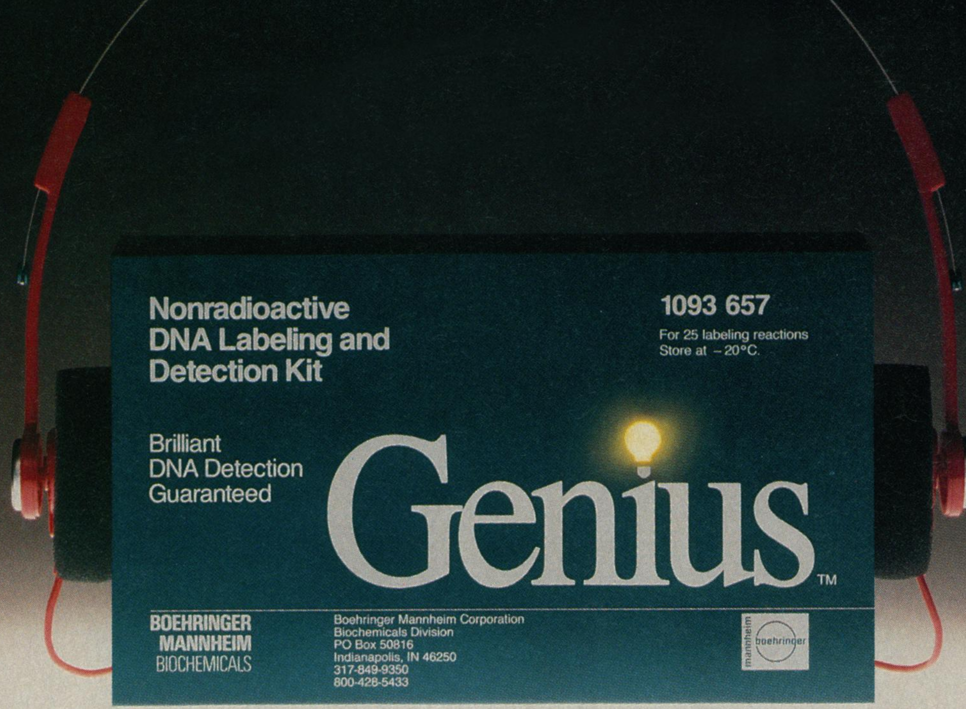

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Latest LSC technology cuts sample and cocktail costs; increases throughput

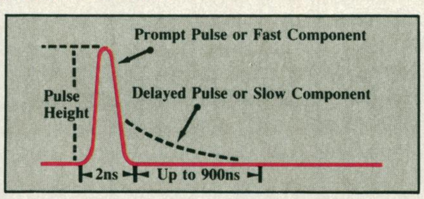
In the past, liquid scintillation counting used traditional technology to overcome background noise. Now, there's a new, more sensitive technology – TR-LSC or Time-Resolved Liquid Scintillation Counting – that reduces background noise by an additional 30%-40%, and more. This new patented technology is available only in Packard's Tri-Carb® liquid scintillation analyzers.

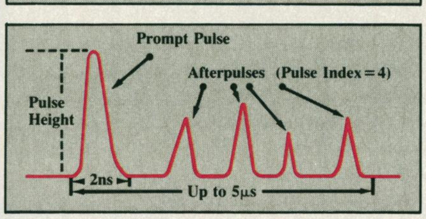
Originally developed for extremely low level counting, TR-LSC technology has now been applied to a broad range of applications. While these don't always require high sensitivity, additional benefits have been realized. By increasing sensitivity, TR-LSC reduces sample and cocktail consumption while shortening the time required for accurate counts. The benefits? Lower cocktail costs, lower disposal costs, and increased throughput.

How TR-LSC is superior to older technology

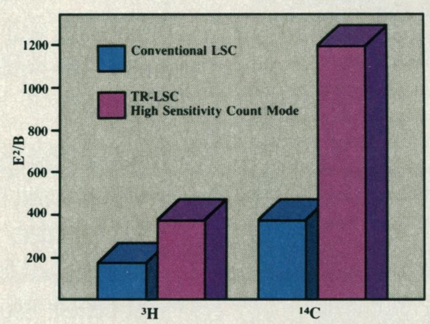
Traditional counters are based on two-dimensional pulse analysis: pulse height and pulse counts. They provide a level of sensitivity that's merely adequate for most applications.

Patented TR-LSC adds a third dimension to pulse analysis: a pulse index that measures over time the afterpulses associated with background. In doing so, TR-LSC clearly distinguishes between beta pulses and background pulses. By identifying, and reducing, background noise, TR-LSC provides a great level of sensitivity (see chart comparing E^2/B values) and more accurate counts.





The typical beta scintillation pulse (top) is very fast and may be followed by a delayed component. The typical background pulse is followed by a series of afterpulses. Patented TR-LSC distinguishes between the two.



Typical E^2/B values for ^3H and ^{14}C using traditional and TR-LSC counting.

Achieve accurate counts on samples as small as 25 µL

Traditional technology limits sensitivity. The improved sensitivity of TR-LSC, however, allows you to achieve accurate DPM results for single and dual label samples in volumes as small as 25 µL. That can add up to substantial savings in sample and cocktail costs.

Slash radioactive waste disposal costs

Counting smaller samples will also reduce radioactive liquid disposal costs, which can be $500 per drum, or higher. While you may not pay this cost directly, your operating budget could be affected. With TR-LSC you can cut operating costs while reducing environmental hazards.

Increase sample throughput by over 80%

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Rome, Italy/March 7-8
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Symposium on the Pathogenesis and Control of Viral Infections
Beijing, Republic of China/April 24-26
Scientific Organization: F. Aiuti (I), Z. Zonghan (PRC) and S. Guoxian (PRC)
8th Workshop on Development and Function of the Reproductive Organs
Touraine, France/May 23-25
Scientific Organization: N. Josso (F)
1st International Congress on G.I.F.T.: from Basics to Clinics
Rapallo, Italy/June 8-10
Scientific Organization: R.H. Asch (USA) and L. De Cecco (I)
Membrane Technology in Clinical Pathology, Biochemistry and Pharmacology
L'Aquila, Italy/June 19-23
Scientific Organization: R. Verna (I), R.P. Blumenthal (USA), J.A. Hannover (USA) and R.P. Garay (F)
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Dubrovnik, Jugoslavia
Aug. 31-Sept. 1
Scientific Organization: F. Naftolin (USA)
Establishment of a Successful Human Pregnancy
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years after the war. It was inevitable, Stokes argues, that the United States would be forced to allow Hoechst to attain a comparable size. This policy fit well with the interests of West Germans, who wanted I.G. to be broken up into a few firms large enough to compete well in the international market.

Why were the successor firms so successful? Stokes concludes convincingly that the continuities from the preceding era—in organizational structures, managerial acumen and structures, systems of technology and information, leading personnel, and even physical plant—were most crucial. In addition, the new firms and their strategies adapted themselves to the dominant postwar American worldview. Their emphasis on export fit well into the ideology of free trade and assuaged the long-standing American fear of German autarky.

Stokes stresses the ability of former I.G. managers to be creative and adaptive in the postwar era, pointing out the irony that the same men often had exhibited the same qualities while serving the National Socialist state. But Stokes does not address one important issue in his fine book: did the close collaboration with National Socialism permanently alter I.G. Farben managers and thereby influence the postwar West German chemical industry? Stokes emphasizes that I.G. was willing to "howl with the wolves" during the Third Reich, but he does not say whether the reversion was permanent.

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Technology of Warfare

The War of Invention. Scientific Developments, 1914–18. GUY HARTCUP. Brassey's (Pergamon), McLean, VA, 1988. xii, 226 pp. + plates. $43.

In his introduction to this book, Guy Hartcup observes that, though World War I was the first major technological war in history, historians have not really attempted to assess the totality of the scientific and technological equipment developed in that struggle. In *The War of Invention* Hartcup attempts to fill this void by discussing not only well-known innovations like the tank and chemical warfare but also "less familiar advances involving physical, chemical and medical research which changed the face of warfare" (p. viii). He is further intent upon illuminating the role of the first "boffins," the scientists and engineers who invented the new equipment.

In this effort, Hartcup has relied primarily on documents in the British Public Record Office, explaining that Continental archives yielded much less information on technical aspects of the war and space permitted only brief references to American developments. The book is thus primarily an examination of British developments in the realms of chemical research in munitions, weapons for trench warfare, chemical warfare, naval and air warfare, medicine, and industrial research and does not fulfill the jacket's claim that it provides "a comprehensive view of the application of science and technology to military, naval and air operations in the 1914–1918 war." Only a much longer study of such developments in *all* the major powers could do that. If this work were taken as comprehensive, it would appear that the British were the primary innovators, though its tantalizing glimpses of French, German, and American events seem to suggest that such was not necessarily the case. Though Hartcup attempts to draw certain comparative conclusions at the end, it would seem necessary and appropriate to base such comparisons on more than the often cursory glimpses of developments on the part of the other warring powers.

The examination of aviation, a topic this reader knows better than others treated in the book, is occasionally problematic. In his discussion of the National Physical Laboratory's role in prewar aircraft research, Hartcup cites as a particular success story its collaboration with the Royal Aircraft Factory in the development of the prototype of the BE2C, the Royal Flying Corps's standard reconnaissance craft, which he then credits with a speed of 140 miles per hour (pp. 18–19). Yet contemporaries complained that the NPL's research was only belatedly disseminated to the aircraft industry as a whole. Furthermore, the BE2C, though a success when introduced in 1912, was a deathtrap for its wartime pilots, possessing a speed some 60 miles per hour less than that cited by Hartcup.

Hartcup's approach to the topic of aircraft engines is rather idiosyncratic. In concentrating solely on the rotary engine and specifically W. O. Bentley's improvement of the French Clerget he ignores important devel-