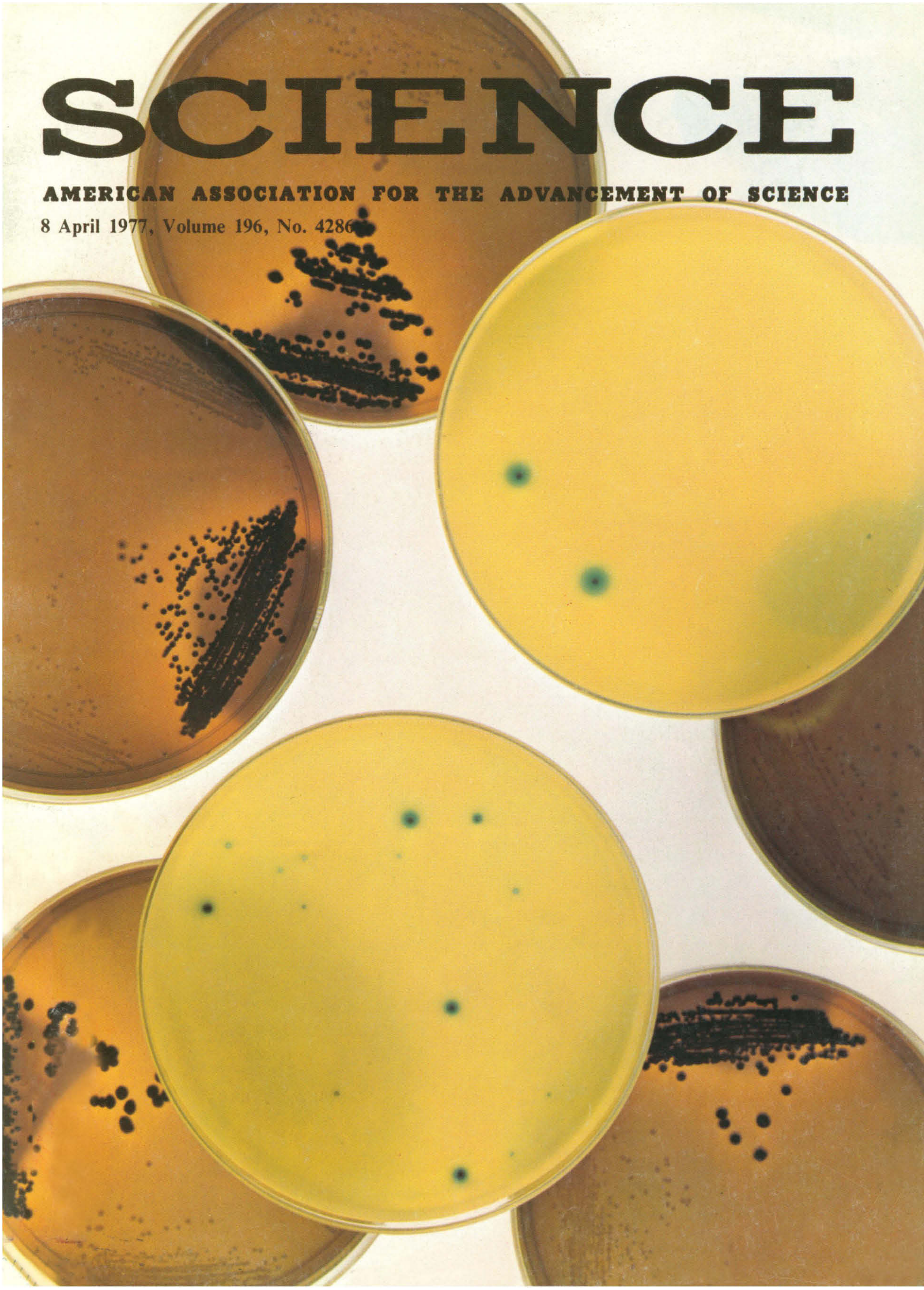
SCIENCE

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

8 April 1977, Volume 196, No. 4286



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8 April 1977

Volume 196, No. 4286

SCIENCE

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COVER

Charon 11 vector phages (dark indigo plaques) can be distinguished on *lac*$^+$ bacteria (lower left, yellow plate) from reconstituted vector phages with the *lac* fragment reversed (light blue plaques) and from the phages with foreign DNA (small colorless plaques). On *lac*$^-$ bacteria (upper right, yellow plate) the reverse phages are also colorless. The brown plates verify safety features of the host bacteria. See page 161. [Frederick Blattner *et al.*, University of Wisconsin.]

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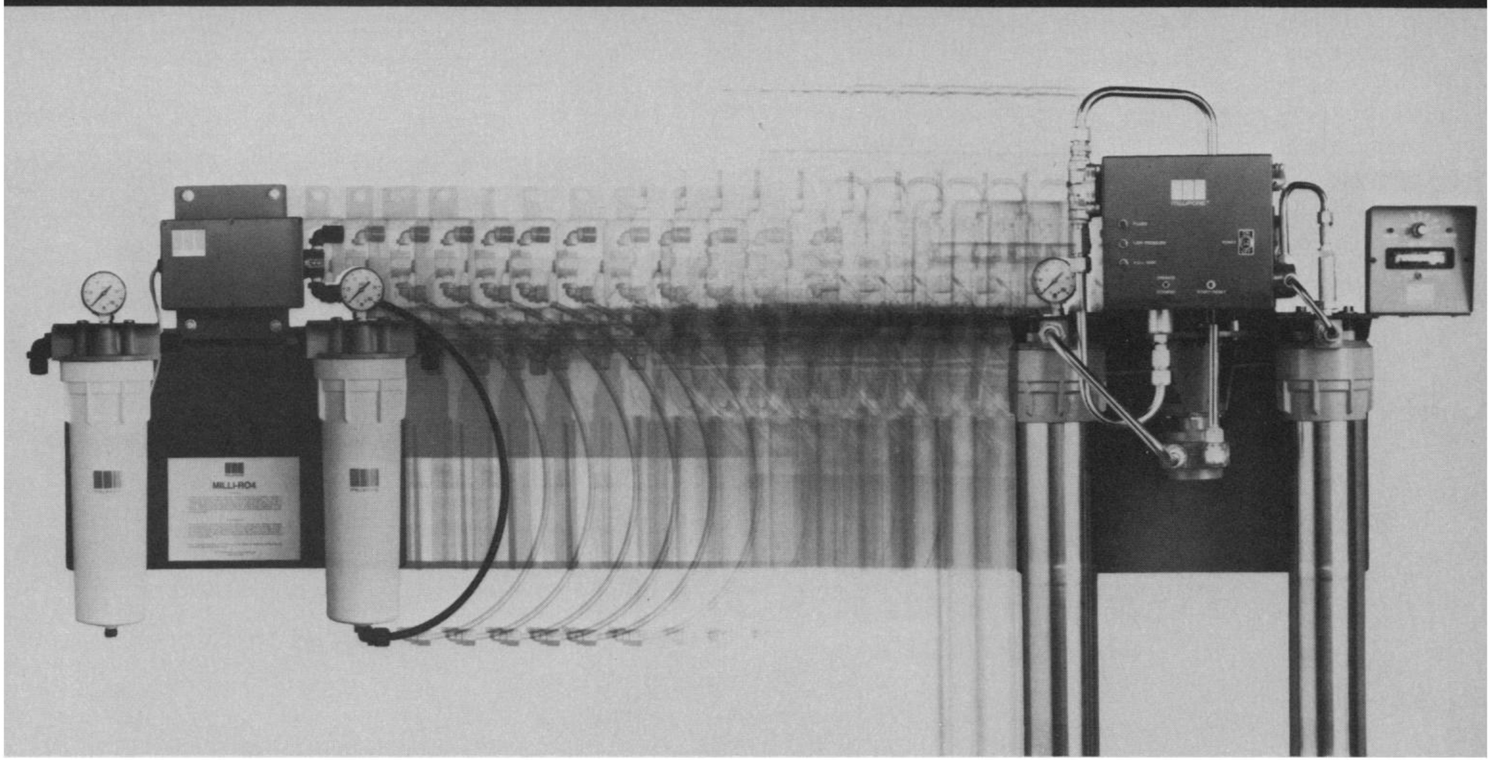

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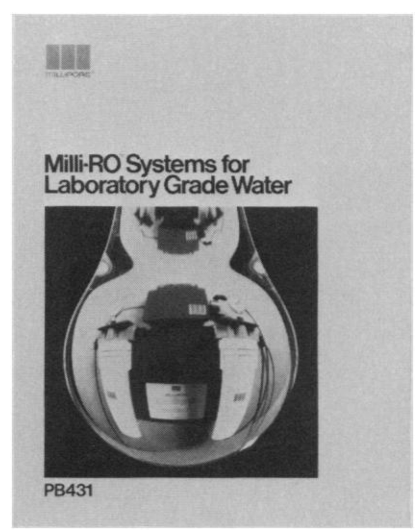

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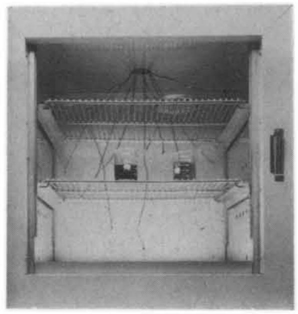

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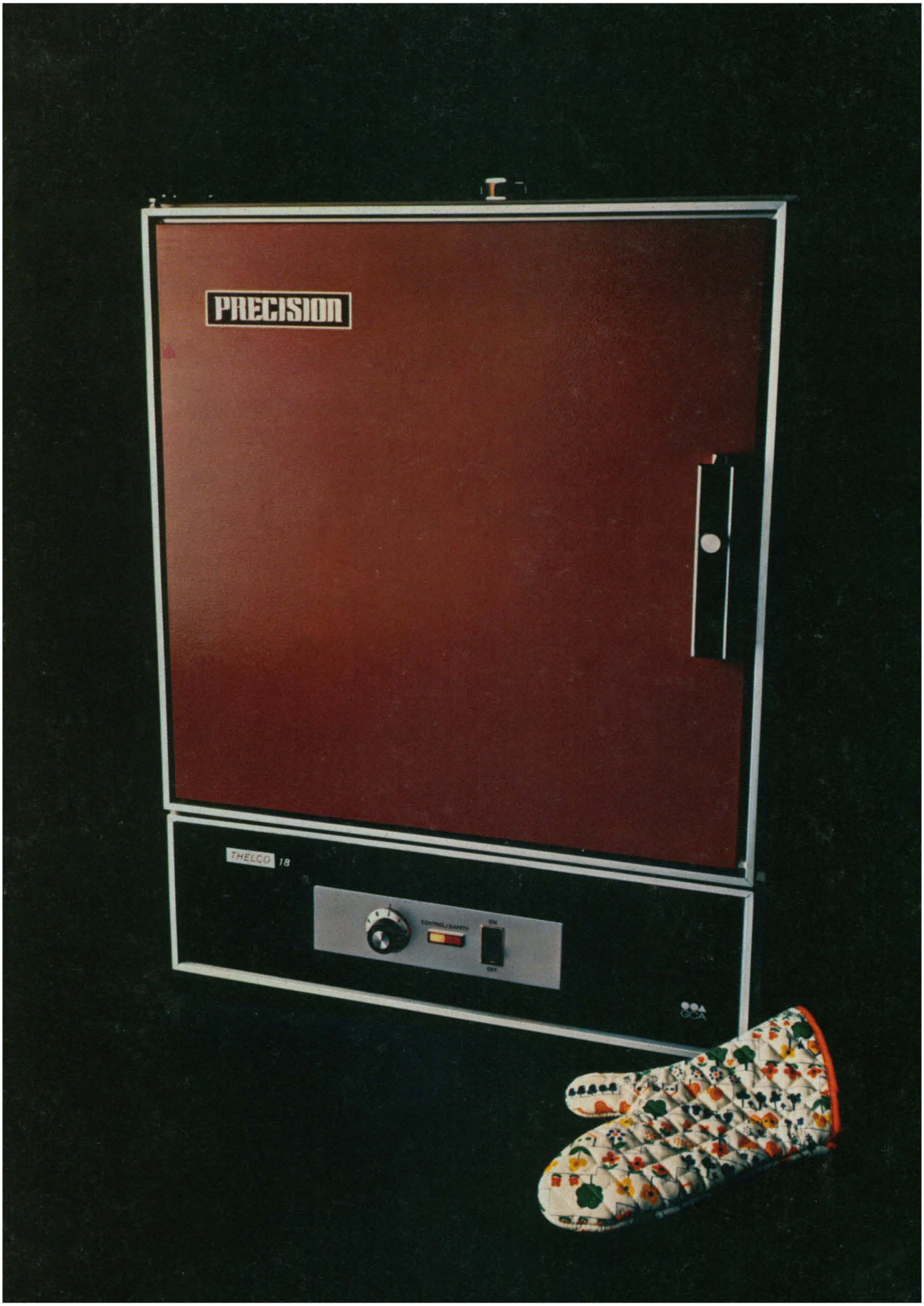
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LETTERS

Recombinant DNA Research: International Cooperation

The World Health Organization (WHO) carries a major responsibility to protect the health of mankind. This is a social responsibility that must be fulfilled, not only in securing the benefits derivable from basic and applied biomedical sciences, but also in coordinating those measures aimed at the reduction of the risks associated with the natural environment of man as well as his multiform activities.

It is thus appropriate that WHO has given and gives great attention to the problem of research in genetic manipulation and, in particular, to recombinant DNA technology. In 1975 the WHO Advisory Committee on Medical Research recommended to the Director-General that "the continuation, under appropriate safeguards, of microbiological research, including genetic manipulation and cell fusion studies, is of the utmost importance for progress in medicine and public health." Accordingly, a Special Programme on Safety Measures in Microbiology has been set up within WHO. Among other items, its objectives include a close review of this research activity. Specifically, WHO can serve as an international focus for the collection and dissemination of information, so that appropriate initiatives can be considered at the national and international levels. WHO can also see that the various initiatives are coordinated, especially for the development of the safest possible biomaterials and the evolution of techniques which reduce the hazards of working with them.

Clearly, a most crucial parameter in deciding the best avenues to these ends is the assessment of the so-called "conjectural" or "potential" risks associated with recombinant DNA research. The evaluation of their specific nature and level, as quantitatively as possible, can create formidable limits both to the design of experiments and to the interpretation of the ensuing results. Nevertheless, careful risk assessment is a necessary prerequisite to reconciling the different, and often conflicting, scientific views on this subject.

The WHO special programme is intended to stimulate all concerned and competent scientists (i) to cooperate in the design of appropriate experiments for the acquisition of relevant data on risk assessment; (ii) to see that the most meaningful experiments are performed as safely as possible and without delay; and (iii) to ensure wide participation in the analysis of the results, be they positive or negative. To this end a letter has been circulated to more than 200 involved scientists, and their answers are being analyzed.

But any exercise in the assessment of risks must include an equally careful analysis of the expected benefits. It is therefore of the utmost importance that recombinant DNA research be developed with close consideration not only to its contributions to the fundamental problems in molecular genetics but also to the conversion of their solutions into practical and beneficial applications. Explicit action toward these goals should go beyond conferences and courses to collaborative research. Results of experiments will be required to ensure that the claims of proponents of a lively continuation of research in genetic manipulation are legitimate.

Once the risks are more critically assessed, and the benefits more clearly defined, appropriate steps ought to be taken by the various national and international bodies concerned. These initiatives should lead to an improved concept of international cooperation toward safer and more productive research in this as well as other areas of biomedical science.

V. SGARAMELLA
Consultant, World Health Organization Special Programme on Safety Measures in Microbiology, Consiglio Nazionale delle Richerche, Pavia, Italy

Is Sweden More Energy-Efficient?

In their article "Efficient energy use and well-being: The Swedish example" (3 Dec. 1976, p. 1001), Schipper and Lichtenberg draw the conclusion that Sweden is more energy-efficient than the United States by comparing the economic output per unit of energy consumption in the two countries. They further conclude that the living standards are the same in each country. Although the study is an interesting analysis, these conclusions are a misinterpretation of the facts. Based on the simplistic criterion used in the analysis, the states of New York, Rhode Island, Vermont, Connecticut, and Hawaii are more efficient in economic productivity per unit of energy use than is Sweden. Although such studies as that of Schipper and Lichtenberg are beneficially provocative in the energy conservation debate, they may also become exhortations for unrealistic energy conservation targets.

A basic fallacy in their study is the omission of the difference in the mix of industrial, service, and agricultural activities within the two countries. An analysis of different economic activities in the United States reveals that energy use per unit of labor varies by as much as a factor of about 75 between energy-intensive operations, such as oil refineries, to such low-energy users as printing and publishing. For example, the United States refines 133 percent more oil per capita than Sweden: but Sweden produces 77 percent more newspapers and 141 percent more books per capita than the United States. Because of the differing industrial mixes among the states of the United States, there is a variation of about a factor of 5 in the economic output per unit of energy among the 50 states—even though the United States has a mobile labor market, a common economic basis, a common currency system, and common consumer product availabilities and life-style. Similarly, variations in the detailed industry mix in each nation can result in large variations in the energy used per unit of economic output and can be misinterpreted as differences in technical efficiency of energy use and in implementation of conservation.

Schipper and Lichtenberg mask the true comparison of the economic value added in manufacturing per unit of energy use as shown in their table 9 [column E_J (kwh/$)]. Manufacturing use of electricity is certainly separable from the available mix of generation sources, and this comparison should have been made on equivalent primary energy input (the gross kilowatt-hours total described in the heading of table 9). If this table is thus recalculated, then the kilowatt-hours of total energy (t) per dollar of value added would show the United States at 16.5 kwht per dollar and Sweden at 21.2 kwht per dollar. Thus, Sweden's manufacturing is only 78 percent as economically effective in the use of energy as is U.S. manufacturing. This should not be interpreted as indicating either Swedish wastefulness or a potential for conservation—rather it is undoubtedly the result of the economic optimization of the use of all the resources (capital, labor, materials) available in each country.

Further, international comparisons, as between Sweden and the United States, are distorted by the difficulty of converting monetary exchange rates into comparisons of real purchasing values. The comparison of the well-being or scale of living among nations cannot be inferred by the dollar equivalent of monetary exchanges. Total personal income per family is a better measure of economic well-being than gross domestic product per capita because of the differences in the national savings fraction and differences in family composition.

The Swedish total family income, including government-provided social services, in 1971 was about 78 percent of that in the United States, even after adjusting the relative Swedish income upward to correct the exchange rate for higher purchasing power in Sweden. It would probably be very difficult to convince an average American family that it would not be lowering its living standards if it accepted a Swedish family income. The comparisons by Schipper and Lichtenberg of automobiles, television, food, and housing support the differences in standard of living suggested by the differences in total personal income per family.

With regard to conservation techniques, because of the relative international mobility of technologies, worldwide differences among nations in the effectiveness with which energy is used industrially are likely to become similar in a short time. There are, of course, individual national differences in resource availability, demography, and social structure which give rise to selective cases of improved efficiency of energy use to meet specific end purposes. For example, the combination of electricity generation with district heating that is fairly common in Sweden and Northern Europe represents a more efficient energy use system for these purposes. However, it is not necessarily the most efficient in terms of the total national resources that need to be applied for these same purposes. For this reason, district heating in the United States has only rarely been used, even though the technologies have been available for decades.

CHAUNCEY STARR, STANFORD FIELD
Electric Power Research Institute, 3412 Hillview Avenue, Palo Alto, California 94303

We share the concern expressed by Starr and Field over misuse of simplistic measures like energy use per unit of GNP (gross national product). Unfortunately the literature is also replete with (to paraphrase Starr and Field) "exhortations toward energy supply targets" based primarily upon manipulations of that ratio (*1*). Careful reading of our work, however, shows that our conclusions were not based upon that ratio, but instead arose from consideration of energy use efficiencies and the mix of economic activities in Sweden and the United States. We compared the most important energy-using activities, and not aggregate ratios, as Starr and Field mistakenly assert.

Ironically, they also ignore our sixth conclusion, in which we state that "consideration of . . . only the energy/GNP ratio . . . obscures dramatic differences in intensity (or efficiency) and economic structure." We could not have expressed our concerns over the abuse of the energy/GNP ratio more strongly.

Moreover, the comparison of the energy/GNP ratio for individual states within the United States, as attempted by Starr and Field, is of little meaning unless the data are adjusted for the energy embodied in flows of goods across state boundaries, climate, and so forth. Such adjustments were explicitly made in our article and found to be of vital importance in our comparisons. As 40 percent of U.S. energy is used in industry, ignoring the energy embodied in steel produced in Indiana and shipped to New York, for example, makes such comparisons almost useless.

We also took structure into account explicitly, another part of our work overlooked by Starr and Field in their letter. We noted differences in production and consumption mix. The figures given by Starr and Field are incomplete. Had they drawn upon the figure for oil refining given in our table 10, they would have seen in the very next line in that table that, compared to the United States, Sweden produces four times more paper and pulp per capita, far more energy-intensive products than refined oil. This activity accounts for as much energy consumption in Sweden as the combined refining and chemical sectors in the United States. These data and our explicit discussion of structure contradict the implication of Starr and Field that the United States (producing more oil and less newspapers) has a more energy-intensive manufacturing sector than Sweden. In fact, the reverse is true. One of our Swedish references (*2*) points out that if the United States produced the same product mix that Sweden does with U.S. technology, U.S. energy use would be considerably higher. As we said in our article, the higher energy/GNP ratio in manufacturing in Sweden arose because of this structural phenomenon and the vagaries of "simplistic" aggregation of the energy/GNP ratio, since virtually all important energy-intensive products in Sweden are made with modern, more energy-efficient technology than are the same products in the United States. There may be minor differences due to different kinds of steel or oil products manufactured, but the overall conclusion, that energy-intensive products in Sweden are produced more

efficiently than in the United States, largely because of higher relative fuel prices in Sweden, is supported by a large number of other American and Swedish analyses referenced in our original article and in a recent study (*3*) sponsored by the Electric Power Research Institute as well.

Our conclusions were also not very sensitive to the method of accounting for electric power, a topic we dealt with in considerable detail. In several tables we provided energy use totals that reflected both electricity use counted with and without real thermal conversion losses and imaginary losses allocated to hydropower. We also explained that allocating thermal losses to hydropower distorts the economics of energy use, both because the relatively inexpensive hydropower available in Sweden stimulates relatively higher use of electric-intensive processes and because the use of combined heat and electricity cycles makes the Swedish heat rate considerably lower than that in the United States.

We also dwelt at great length upon the subject of international comparisons of well-being and the difficulty of measuring living standards with the GNP. We are not familiar with the measure of well-being "total personal income per family" offered by Starr and Field and could find no economists who had used this. However, the difference in this index between Swedish and American incomes is almost exactly cancelled out by the difference in family size, Swedish families in 1971 being only 79 percent as large as American families. Furthermore a comparison based only upon material goods is unrealistic. The Swedish comprehensive health care and housing for the aged counts, as well as washers and dryers, in measuring well-being. In any case, the issue is not who is wealthier. Our comparison was based on "how well" energy is used, not "how much."

We share the optimism of Starr and Field over the international spread of conservation techniques. However, we do not find 12 inches of attic and wall insulation or automobiles with a fuel efficiency of 24 miles per gallon—ingredients in Swedish energy use—"unreasonable conservation targets" as Starr and Field imply. With regard to district heating, we questioned the overall effectiveness of this technique in Sweden and did not consider it a major factor in our conclusion. Elsewhere, however, the Swedes appear to share our enthusiasm for additional conservation, having embarked upon a national investment campaign that has already shown results. Thus international comparisons reveal both important techniques for using energy effectively, as well as the high degree of flexibility in long-run energy needs.

Leaders in the power industry have shown a great degree of skepticism toward suggestions that the United States could significantly improve energy-use efficiency. This skepticism is understandable if the basis for those suggestions is crude comparisons of energy/GNP ratios. The same skepticism should also be applied to industry forecasts of "needs" that use such aggressive measures [see (*1*) and articles in (*4*)]. We certainly agree that there are grounds for debate over what are "reasonable" conservation targets. The letter from Starr and Field, however, is founded primarily on generalizations, aggregations, and selective use of the available data. A careful reading of our article shows that there are indeed many promising Swedish techniques and policies that provide for more effective use of energy and other resources.

LEE SCHIPPER, A. J. LICHTENBERG
Energy and Resources Program, University of California, Berkeley 94720

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2. B. Carlsson, in *IUIs Långtidsbedömning 1976* (Industrins Utrednings Institut, Stockholm, 1976), p. 270; lecture at Industrial Energy Day, Stockholm, May 1976.
3. J. Alterman, J. Dunkerley, J. Darmstadter, "How industrial societies use energy: A comparative analysis" (Resources for the Future, Washington, D.C., in press).
4. *The Transitional Storm* (Edison Electric Institute, New York, 1977).

Controversial Grant Proposal

My editorial of 11 March (p. 939) refers to a move by the House of Representatives in April 1976 to shut off funds for a controversial National Science Foundation grant proposal. This is incorrect. It was a grant proposal to the National Institute on Drug Abuse (Department of Health, Education, and Welfare), rather than one to the National Science Foundation. The congressman involved, of course, was Representative Robert Michel (R–Ill.). A report on this action appeared in the 30 April 1976 issue of *Science* (News and Comment, p. 450).

I apologize for any embarrassment this inadvertent error might have caused the National Science Foundation.

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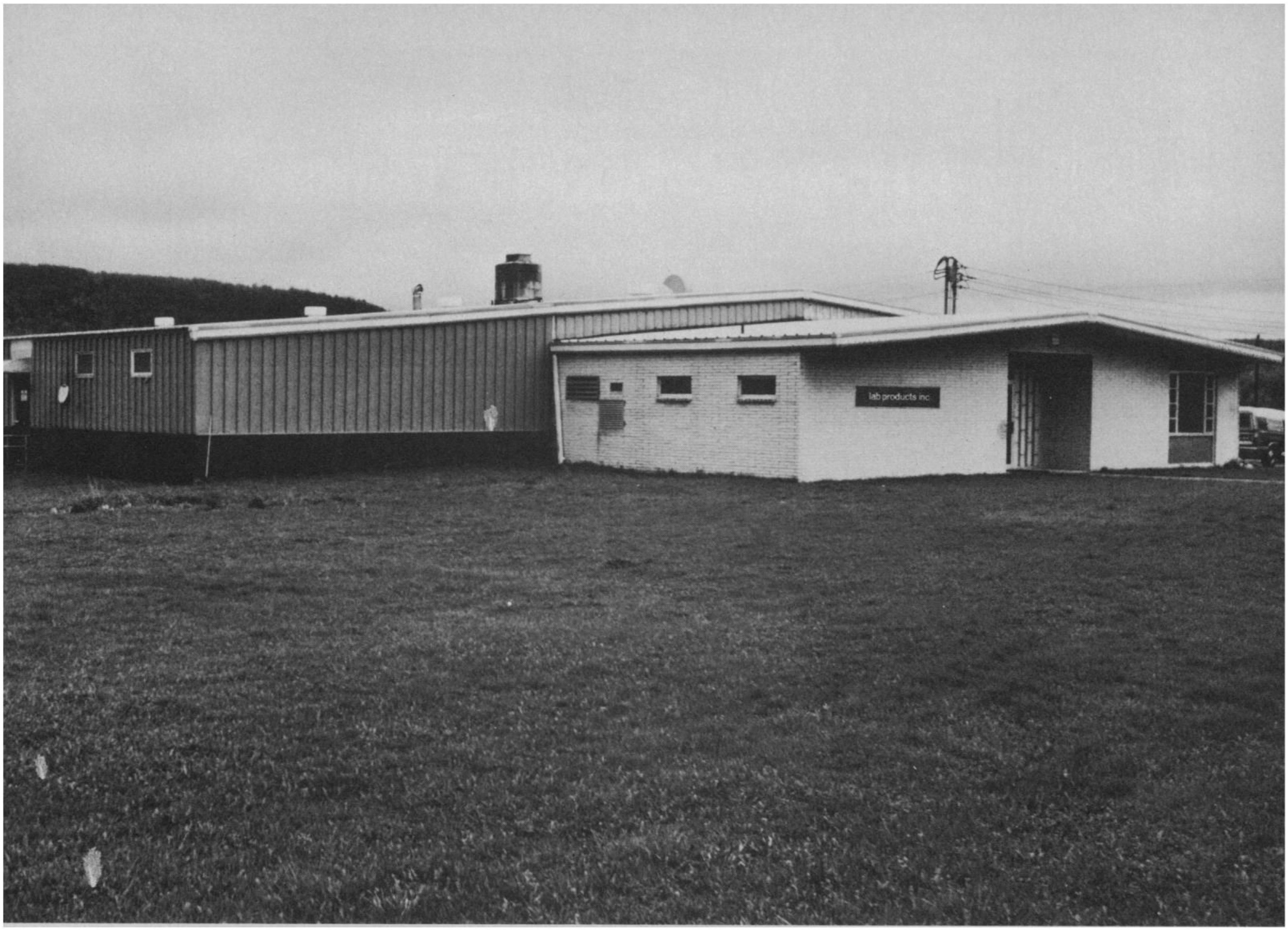

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8 April 1977, Volume 196, Number 4286

SCIENCE

The Recombinant DNA Debate

For the last 3 years scientists, laymen, and responsible government institutions have engaged in open, public analysis of the hazards that might result from recombinant DNA research, hazards that remain speculative. A set of safety guidelines* for the conduct of the experiments emerged from the discussions. In the absence of all the necessary facts, the guidelines were made extremely stringent in order to compensate for possible errors in judgment, and they apply to all studies funded by the federal government. There is now a concentrated effort to obtain federal legislation imposing the guidelines on all recombinant DNA experiments in the United States, regardless of the source of funds. Similar guidelines exist in many countries.

The foregoing summary reflects neither the current level of interest, emotion, or confusion on the subject in the United States, nor the attitudes reflected in graphics accompanying relevant newspaper and magazine articles and television shows—fanciful ugly bugs crawling out of test tubes, DNA double helices ending in monster heads, chimeric animals that insult the Greek imagination.

The nature of the current debate was evident at the public forum on recombinant DNA held at the National Academy of Sciences from 7 to 9 March. The forum successfully fostered an exchange of views among scientists and the public, although the atmosphere was often charged. The encounter illuminated the arguments of both biologists and laymen who refer to themselves as "opponents" of recombinant DNA research.

It was argued that all recombinant DNA research should be stopped and the nation should instead give priority to the distribution of existing methods of health care and sound nutrition to the citizens of the world. This argument is specious. Certainly there is a need to rectify inexcusable inequities in the distribution of food and health care. But recombinant DNA research is neither an alternative to such action nor a competitor for the necessary funds. Rather it provides for future opportunities to solve problems that are unsolved or that may yet arise.

Another argument was the denial of any positive value in the research. This country, through representative government, long ago committed itself to the importance and support of basic biological research. That investment has now yielded a powerful tool for investigating basic processes relevant to understanding serious and intractable diseases. There is no other way at hand or foreseeable to investigate the structure of the genome of complex organisms. Has the purpose of the investment been forgotten? Surely when a distinguished biologist couples denial of any positive value in the research with a denial that the bacterial chromosome can be characterized as a DNA molecule or with a denial that insulin is clinically useful, we must wonder just what the debate is all about.

It was argued that because recombinant DNA techniques may make genetic engineering (deliberate modification of the genes of complex organisms, including man) feasible, all such work should stop. The argument assumes a public consensus that genetic engineering is evil, although the arguers concede, with everyone else, that the subject needs intense, universal discussion. The argument also denies historical lessons that teach us to distinguish carefully between the acquisition of knowledge and its application.

It is difficult to take demands for bans on "all" recombinant DNA research seriously when they come from those who demand to be heard but do not stay to listen. Those now labeled "proponents" of the research worked long and hard for prohibiting certain experiments and matching containment requirements to estimated risks for others. The cautious analytical approach is a discouraging tactic against uninformed fear, mysticism, and political opportunism. But it must continue; nothing less than science itself is at stake.

—MAXINE F. SINGER

*"Guidelines for research involving recombinant DNA molecules," *Fed. Regist.* **41** (No. 131) (1976).

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The X99 series comprises three new units. Model 599 has a spectral range of 4000 to 200 cm^{-1}; model 399 has a spectral range of 4000 to 400 cm^{-1}; and model 299 has a spectral range of 4000 to 600 cm^{-1}. Each of the units has a microcomputer to control the recorder and optical systems. The monochromator frequency can be displayed continuously to 0.1 cm^{-1} on the digital readout. Integrated scan controls allow the operator to select a single parameter (scan time, slit setting, or relative noise) and the instrument automatically sets the other two. The user then sets the gain with a patented Auto-Chek system. Resolution is to within 0.5 cm^{-1} with all models. Ordinate scale expansion is continuously variable in both linear absorbance and percent transmission in discrete steps from 0.1 to 10×. Abscissa expansion is standard to 20× in discrete steps. Perkin-Elmer. Circle 705.

Ultrasonic Cup Horn

This device enables one to sonicate samples in sealed vials, ampoules, or other vessels without direct exposure to a sonic horn or tip. The cup horn also provides for direct liquid cooling of the radiating surface and the sample container which allows continuous sonication without a temperature buildup. Cup horns will accommodate vessels whose diameters do not exceed 3 inches. A transparent polycarbonate cup allows the sample to be observed during sonication. Heat Systems-Ultrasonics. Circle 706.

Measurement of Atmospheric Electricity

The model 700 ion flux meter counts electron impacts on its 10-square-centimeter probe within 2 percent. Its range is 10^{-4} to 10^{-13} ampere. The model 710 ion collector-counter separates ions at three mobility ranges: 22, 66, and 300 volts. It counts ions of either polarity and provides volumetric data on air ion concentration. The model 740 remote control console facilitates data collection from difficult sites. The model 730 electric field meter measures a-c and d-c fields and it will detect gradients as low as 0.1 volt per centimeter. The series is rounded out by the model 340 air ion generator which will produce ions of either polarity continuously. Ozone output is low. Santek. Circle 712.

Bench-Top Chemostat

BioFlo defines parameters such as agitation, aeration, temperature, nutrient addition, and harvesting of cells grown in pure culture. It can also be equipped with miniature probes and controllers for dissolved oxygen and *p*H regulation. An integral air pump is included as well as a slide-out autoclave rack and two 13-liter reservoirs. New Brunswick Scientific. Circle 711.

Organic Carbon Analyzer

PHOTOChem determines the organic carbon in solution in concentrations from 2000 parts per million to 50 parts per billion and lower including all volatile organic compounds. The device uses photochemical oxidation and does not require external gas or pure air and water connections. It features a replaceable filter cartridge. The sample solution is passed through an irradiation chamber where carbon compounds are oxidized. The carbon dioxide is purged with water that circulates in a reaction chamber-purifying loop. The subsequent change in resistivity of the water is measured and converted to milligrams of carbon per liter and this figure is displayed. Barnstead. Circle 707.

Disposable Water Dispensers

A "transit kit" consists of a disposable automatic watering valve and a pouch of treated water to provide laboratory animals with water during transport. This kit eliminates the need for substitutes commonly used which in turn reduces equilibration time in the laboratory and stress during shipping. Cold Spring Products. Circle 709.

Skeletal Vascular Casting

Anatomists who wish a three-dimensional preservation of vascular structure down to precapillaries with preservation

of skeletal structure now are offered a technique to do this. The technique consists of injecting a dyed, liquid plastic mass into the blood vessels, allowing the mass to set, then stripping the soft tissues with the leather beetle, *Dermestes vulpinus*. Former techniques of stripping involved corrosive chemicals that also destroyed the skeleton. Whole body skeletal-vascular casts are available and custom projects will be undertaken. International Biologics. Circle 708.

Back-Lighted Digitizers

The Cybergraph system now includes a feature that enables the operator to prepare computer graphics from negatives. Back-lighted digitizers allow one to use computer or calculator language to process data derived from x-rays or other negatives. Resolution is 1000 lines per inch, accuracy is to within 0.01 inch standard with accuracy to 0.005 inch available as an option. Lung volumes, orthodontic histories, and ventricular measurements are a few of the medical applications possible with this accessory. Talos Systems. Circle 714.

Electronic Balances

The semiautomatic TB-1600S has a weighing range of 1.6 kilograms, a taring range of 125 grams, a 2-second stabilization time, 0.01-gram readability, and reproducibility to within 0.005 gram. The TB-1000 and TB-1000S have the same features but their capacity is 1 kilogram. In all three models, weight measurement is a function of torque applied to special alloy metal bands. Taring is additive and does not subtract from the full working range of each balance. Up to 125 grams of tare may be dialed in by means of a control knob. Torsion Balance. Circle 716.

Gas Chromatographs

The 429 series gas chromatographs are microprocessor controlled; they can store and execute up to 15 user-variable programs and have three fixed programs which provide for pneumatic control routines. Temperatures, flow rates, detector sensitivity and attenuation, polarity, and auto-zero routines are programmable on a time basis. The pneumatic control routines provide back flushing, heart cutting, and solvent venting. The systems are modular and may be assembled to suit the users' needs. Packard Instrument. Circle 717.

Vertical Slab Polyacrylamide Gel Electrophoresis

The new unit separates 8, 12, 16, and 24 samples, up to 180 by 223 by 3 millimeters, at one time. This eliminates the handling of single rods and, because the samples are adjacent, direct comparison of patterns may be made. Cooling is accomplished by water circulated through platens on both sides which reduces temperature gradients and eliminates distortion of the bands. The apparatus is easily disassembled for cleaning and gel removal. Shandon Southern Instruments. Circle 718.

Data Recording System

The Physioscribe is available with optional accessories and in various configurations for a wide variety of recording tasks. The basic unit consists of a chassis with variable-speed chart drive, a biopotential amplifier channel, two transducer amplifier channels, one time and event marker channel and features an individual inking system. Chart speed varies from 1 to 25 millimeters per second. Accessories are available for many physiological recording applications. Stoelting. Circle 715.

Literature

Systems and Methods for Biochemical Research is a general catalog of laboratory apparatus for a wide variety of biochemical separations such as isoelectric focusing, gel filtration, ion exchange, and chromatography. LKB Instruments. Circle 719.

Electronic Instrument Rental Catalog includes full specifications of over 800 instruments and is indexed by manufacturers. Continental Leasing. Circle 734.

Secondary Ion Mass Spectrometer describes the model 300-10 including full design specifications. Extranuclear Laboratories. Circle 720.

Gels for Hydrophobic Interaction Chromatography are listed in a bulletin devoted to Octyl-Sepharose CL-4B and Phenyl-Sepharose CL-4B. Pharmacia Fine Chemicals. Circle 721.

Thermistors describes the YSI 49000 series of space-qualified thermistors for temperature compensation, measurement, and control. Yellow Springs Instrument. Circle 722.

Sound Level Meter is devoted to the Featherweight model 1680, a self-contained portable sound measuring device. Thermo Systems. Circle 723.

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