American Association for the Advancement of Science

Science

21 March 1986 $2.50
Vol. 231 ■ Pages 1341–1480

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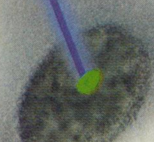

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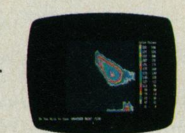

Isolate cells for propagation or analysis

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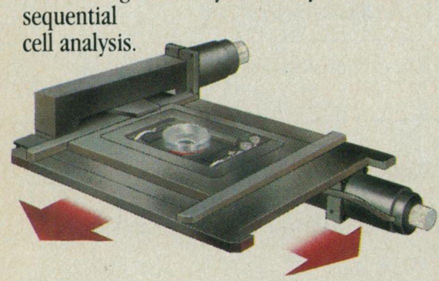

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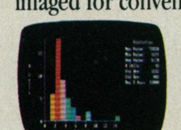
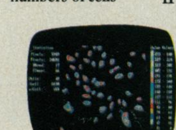


Perform quantitative fluorescence analysis on large numbers of cells



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SCIENCE

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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.

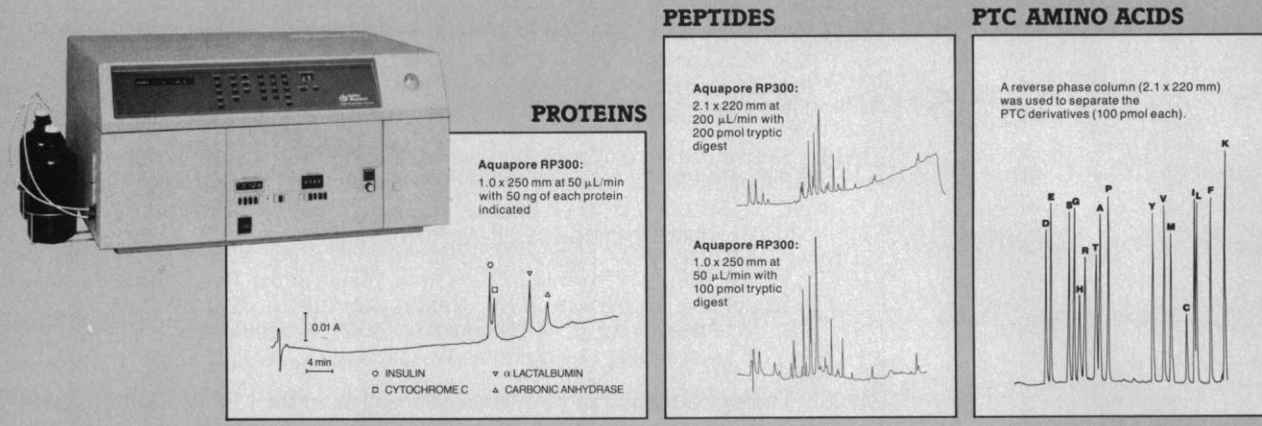
COVER Test flight in Earth's atmosphere of balloon and gondola system similar to two placed in the atmosphere of Venus in June 1985 by the VEGA spacecraft. These were the first balloons to float in the atmosphere of another planet. Gondola instruments measured in situ meteorological parameters; a world-wide network of 20 ground-based antennas monitored the Venus winds by means of radio signals transmitted by the balloons. See pages 1407–1425. [Photo: V. M. Linkin, Space Research Institute, Moscow, U.S.S.R.; emblem: R. A. Preston, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91125]

Book Reviews

Products & Materials

BIOSYSTEMS UPDATE

Announcing a Microbore HPLC System Designed for Protein/Peptide Isolation



The Model 130A is the first integrated separation system expressly designed for the isolation, purification and analysis of proteins and peptides by microbore HPLC. The advanced technology of the 130A allows samples to be collected in volumes as low as 50 microliters. Many samples can be collected on filter disks for microsequencing with the Applied Biosystems Model 470A Gas Phase Sequencer.

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This Week in SCIENCE

Unfavorable economics of Star Wars' lasers

THE cost to the United States to build orbiting laser platforms for defending against enemy missiles would be greater than the cost to an enemy to replace missiles destroyed by such a system (page 1387). In December 1984, President Reagan issued his Strategic Defense Initiative, which included a proposal for developing earth-orbiting lasers capable of destroying enemy missiles as they are launched. One requirement was that the system should be cheaper to build than would be countermeasures to offset its effectiveness. Field and Spergel estimate the cost of one straightforward countermeasure—stockpiling additional missiles to replace those that such a system could destroy—and the cost to the United States of building enough orbiting platforms—a minimum of 200 platforms (each weighing tens of tons) with laser generators, optical systems, power supplies, and pointing and tracking devices—to provide complete surveillance of the globe and to defend against known enemy missile stores. The balance is in favor of the ground-based missiles, whose replacement costs would be significantly lower than the costs to build the laser system. Other countermeasures might be even cheaper overall if directed toward obliterating the platforms rather than replacing missiles that had been destroyed.

Two-turn helix initiates viral assembly

ASSEMBLY of protein and RNA into a tobacco mosaic virus (TMV) particle proceeds from a small (two turns of a helix) aggregate of protein (page 1401). TMV is a rod-shaped virus with a central hole coated with RNA; it is the prototype virus in which protein-RNA interactions have been studied. Namba and Stubbs obtained fiber diffraction data for TMV that resolved the structure at 3.6 angstroms; from these data, a molecular model of the virus was built and details of the mode of viral assembly deduced. When RNA binds to the two-turn helix, electrostatic repulsive forces between neighboring carboxyl groups are overcome. This permits folding of the disordered protein into an ordered structure and elongation of the viral rod to produce a complete virus.

Data from Venus ballooning

LAST summer, two helium balloons with tethered instrument-carrying gondolas (cover) were dropped into Venus' atmosphere and floated above the planet, recording and transmitting to Earth information about meteorologic conditions. Seven reports in this issue (pages 1407–1425), Koshland's editorial (page 1349), and Kerr's Research News article (page 1369) describe the joint Soviet-French-American mission—the equipment, the tracking of the balloons from observation stations around the globe, the meteorologic data obtained, and the implications of the data for defining atmospheric dynamics of this closest-to-Earth planet. The two VEGA spacecraft that carried the balloons to Venus continued on from there to observe Comet Halley.

Moving in the fast lane: a California tradition

SOUTH of the equator, 500 to 2000 meters under the sea, a portion of northern California formed during the Cretaceous period (page 1425). About 30 to 50 million years later it was carried on a fast-moving plate to its present location (the Laytonville area in California), where it became a part of the North American continent. Paleomagnetic analyses by Tarduno *et al.* show that magnetization of materials in the Laytonville Limestone occurred at about 14° south latitude 97 to 89 million years ago. Fossil remains of marine protozoa (foraminifera) confirm the time of formation and point to a submarine tropical origin; physical characteristics of the limestone typify those of deep-sea Pacific deposits between 10° and 20° south latitude. An upside-down arrangement of fossil strata in several samples indicates that some blocks were overturned during their emplacement. The unusually rapid speed (14 to 30 centimeters per year) at which the Laytonville Limestone moved to its current location indicates that northward transport occurred on either the Kula plate (whose speed could account for the lower estimate of the annual rate of movement) or on the Escondido plate, which no longer exists, having been subducted under other tectonic plates.

Evolution of penicillin-interactive proteins

BACTERIAL proteins that break down penicillin, thus nullifying its lethal effects, evolved from surface penicillin-binding proteins that are part of the cell-wall synthesizing machinery (page 1429). Although this relatedness was proposed some 20 years ago, much of the structural data has pointed to dissimilarities between the two types of proteins: they are different in size, have different enzymatic activities and substrate preferences, and little sequence homology. Kelly *et al.* report x-ray crystallographic data for a penicillin-breakdown enzyme, β-lactamase. The likeness of the structure to that of a penicillin-binding molecule (analyzed earlier) found on bacterial surfaces indicates that, if three-dimensional folding of a molecule does not change, binding functions of the molecule can be accomplished despite dramatic changes in amino acid constituents. The helices and β sheets, the main structural features of the two molecules, are strikingly similar and are arranged alike in space. The evolution of a secreted protein that can rapidly inactivate penicillin from a surface protein that bound penicillin and then failed to function effectively probably was an important adaptation by bacteria in response to this potent antibiotic. Determination of how penicillin functioning is negated by such a protein may lead to development of an antagonist that could sustain penicillin's antibiotic effectiveness.

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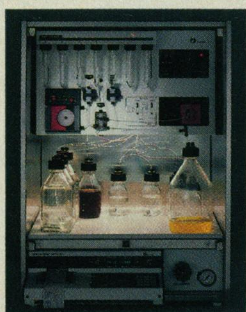

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SCIENCE

21 MARCH 1986
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Ballooning Around Venus

On 19 September 1783 a sheep, a rooster, and a duck went aloft—the first passengers in a balloon. Their trip was made possible by the finding of French scientists Joseph and Étienne Montgolfier that a fabric bag filled with hot air would rise. Shortly after their discovery the Montgolfiers launched an unmanned balloon which, to the astonishment of all, flew for 1.5 miles. In November 1783 the first manned flight took place when a balloon carrying two passengers traveled 5.5 miles in 23 minutes. The advancement of science had its protesters in that era, too: when scientists ballooning from Paris landed in a small rural village, they were attacked by peasants terrified by the arrival of beings from outer space.

The Montgolfiers came to their epic invention by observing that smoke flowed upward from fire and deducing that smoke had some mysterious property that they called "levity." The term seems fairly appropriate to describe ballooning, even though it now has a long tradition of scientific exploration and, sadly but inevitably, military applications. Ballooning conjures visions of a leisurely sightseer, whereas a spacecraft presents an image of a single-minded workaholic. Thus, the description in this issue of *Science* of the arrival of two balloons in the atmosphere of Venus strikes one not only as a scientific landmark but also as a delightful adventure. It seems appropriate that a visit to our nearest planetary neighbor, often only a mere 26 million miles away, was accomplished by a meandering balloon.

The proposal that a balloon could be used to explore the atmosphere of Venus was the idea of Jacques Blamont of France, who then enlisted the support of Soviet, French, and American scientists in a fine example of international cooperation. This cooperation was sustained and intimate as plans evolved from a focused mission to Venus alone to the final alternative of releasing a balloon from each of two Vega spacecraft on their way to Comet Halley. Moreover, the tracking of the balloons across Venus required the dedicated teamwork of scientists and engineers at radio observatories in ten different nations: Australia, Brazil, Canada, Great Britain, West Germany, South Africa, the Soviet Union, Spain, Sweden, and the United States.

These scientists had no easy task. The atmosphere of Venus has been described as a close approximation to the atmosphere of hell. The planet's surface temperature is about 470°C, in which even heavily insulated instruments may last only an hour. The balloons, therefore, were engineered to settle at an altitude of 54 kilometers, where the temperature is only 32°C. The winds on Venus blow with hurricane velocity, and the atmosphere contains primarily sulfuric acid as well as hydrochloric and hydrofluoric acids. At the balloons' altitude, solid-state materials could be used, whereas only vacuum tubes could last any time at lower atmospheric levels. The balloons, in fact, produced a wealth of valuable data for 46 hours.

This research is designed largely to satisfy curiosity about Venus, a planet almost the size of Earth but nearer the sun. Venus, like Uranus, rotates differently from the other planets. As in most basic research, there is a serendipitous and practical side in addition to the gathering of pure data. Although Venus rotates on its axis at about one-hundredth the rate of Earth, its atmosphere rotates far more rapidly. The greenhouse effect of Venus and the velocity of rotation of its atmosphere are significantly different from those of Earth. Since it is not easy to create meteorological experiments in a test tube, the prospect of testing ideas about meteorological behavior on Venus is attractive. In California, a state with an atmosphere as close to heaven as is conceivable, there has been some hellish weather recently. But warnings from meteorologists, armed continuously with information from space-based satellites during the recent floods, kept the loss of life very low. Weather prediction is still an imperfect art, but information from distant Venus may one day provide meteorological theory that will benefit earthbound nonballooners.

It is intriguing to speculate that a model for international cooperation was also developed by the teamwork of scientists from the Soviet Union, France, and the United States. Discovering common goals is easier in science than in world politics, but the search for enterprises that transcend international frictions cannot abate. Otherwise, the atmosphere of Earth may resemble that of Venus.—DANIEL E. KOSHLAND, JR.

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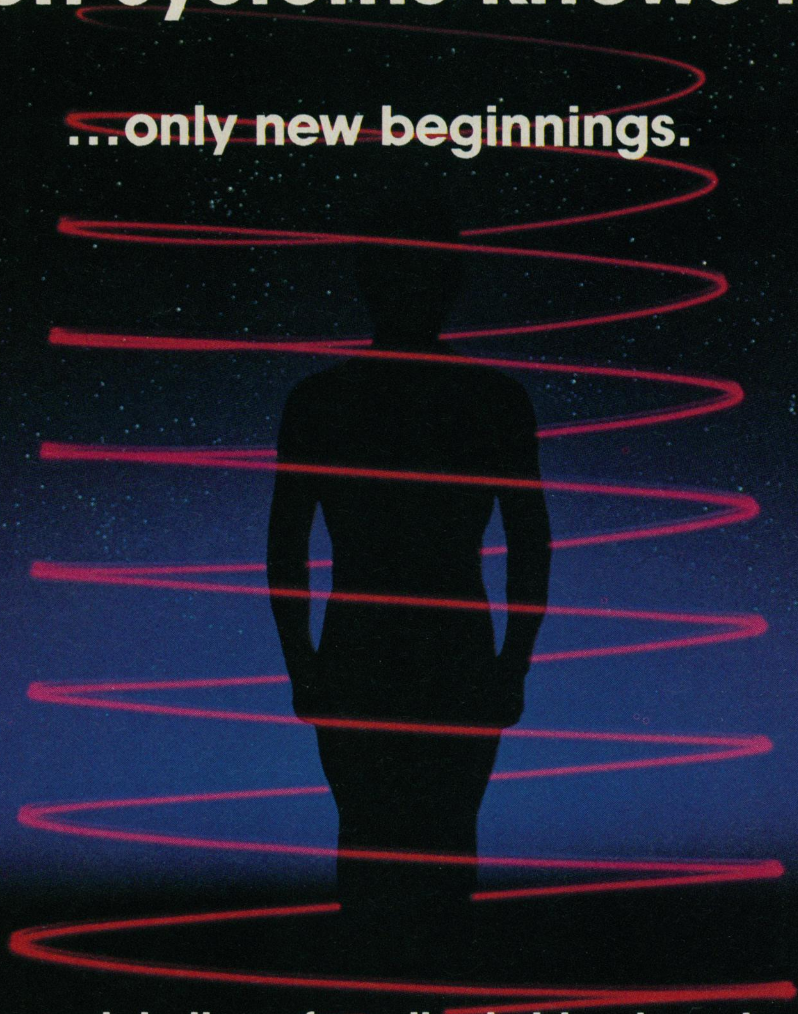

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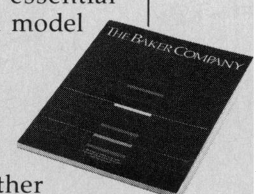

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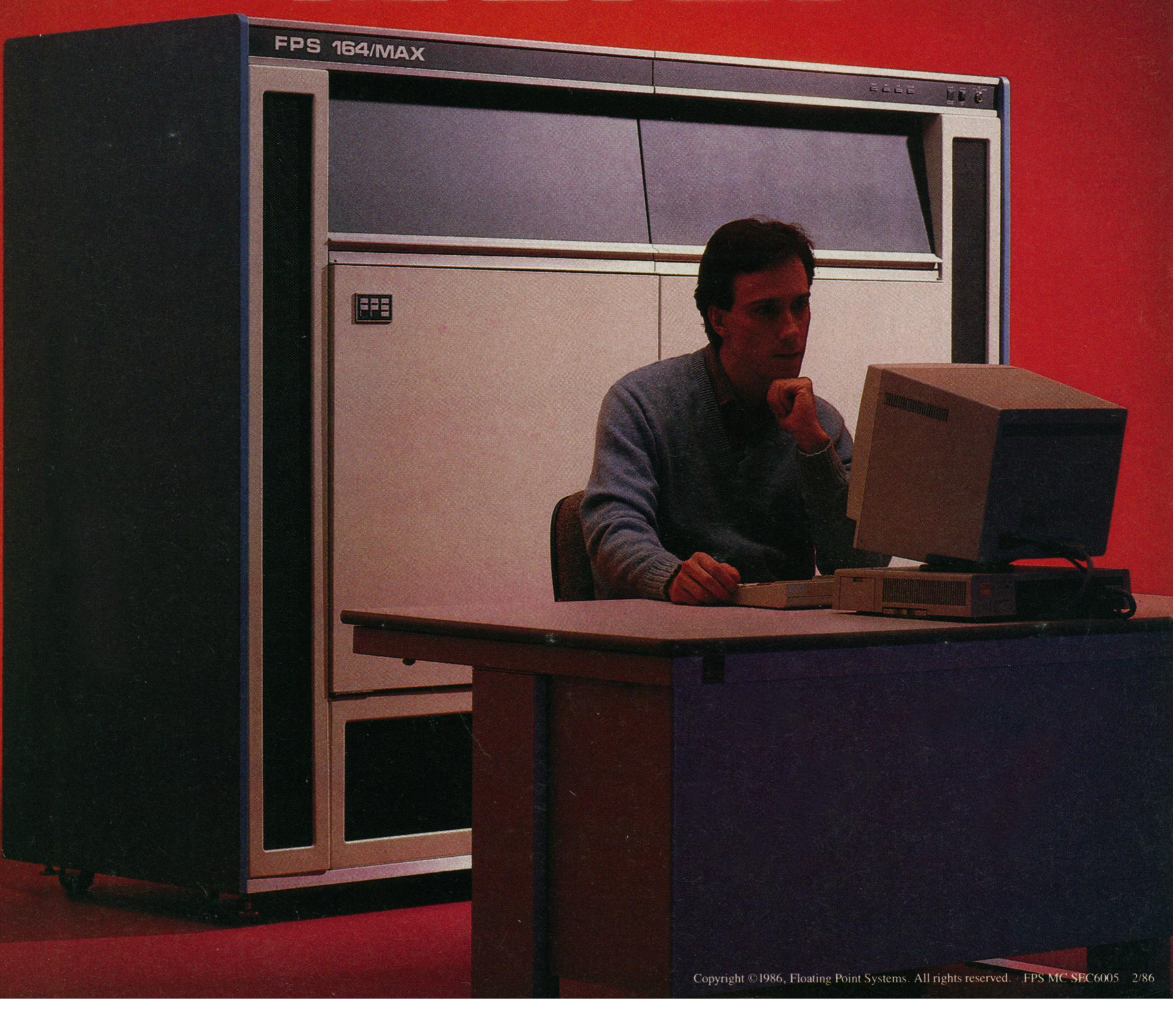

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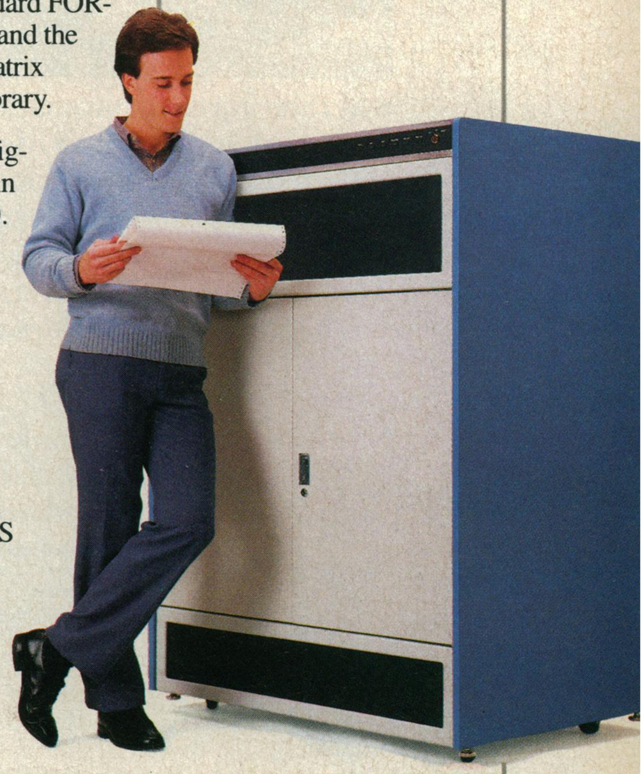

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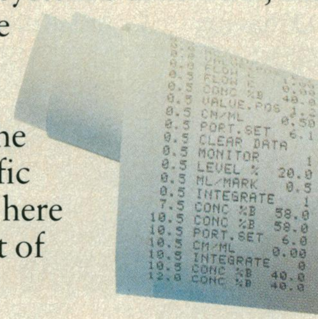
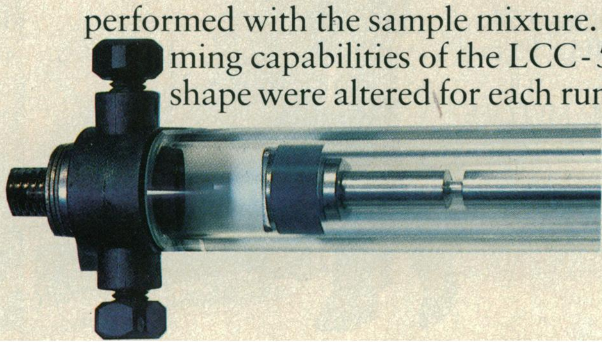
This FPLC case history explains how the researchers turned their chromatography problem into a discovery.

SEVEN PEAKS INSTEAD OF TWO. During the early stages of the project, the group invited a Pharmacia representative to come and demonstrate the FPLC System. The system was quickly assembled. Knowing the approximate characteristics of the sample's proteins (pI, stability and size), the representative consulted Pharmacia's comprehensive library of FPLC methodology. Conditions for the separation, including column type, monitor wave length, and buffer system, were thereby determined.

Next a separation run on a column prepacked with Mono Q™, an anion exchanger, was programmed into the system's controller, the LCC-500. The sample was then injected automatically by the MV-7 motorized valve. In the course of ten minutes, a totally unexpected chromatographic pattern had appeared on the controller's printout. The sample contained two specific proteins that should have given rise to two peaks. But here were seven peaks – casting some doubt upon the merit of this high performance liquid chromatography system.



SAME UNEXPLAINED RESULTS. That same day, several separations were performed with the sample mixture. Using the simple, automatic programming capabilities of the LCC-500, other conditions such as gradient shape were altered for each run. Because of the great speed of the system – 10 minutes per run in this case – many runs could be completed. Yet the same results appeared every time.

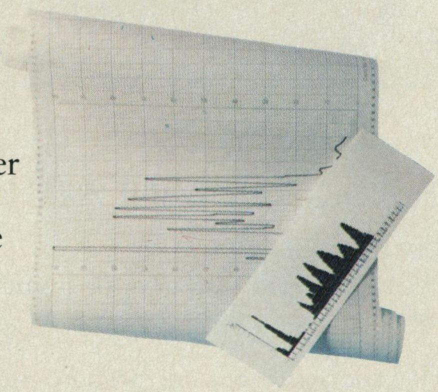


YOU CAN DISCOVER MORE

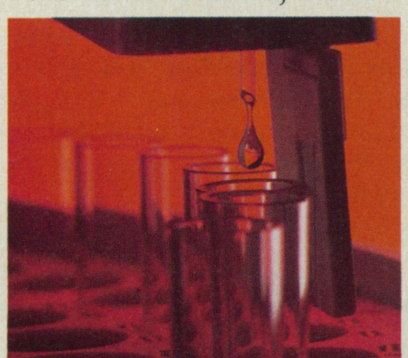
THE FIVE EXTRA PEAKS

THE BREAKTHROUGH. The reproducible results from the FPLC System convinced the researchers to take a second look at the seven peaks. After several days of further investigation they again contacted Pharmacia – the peaks were revealed to be iso-forms. No other high performance liquid chromatography system had been able to isolate these particular iso-forms, let alone in just ten minutes.

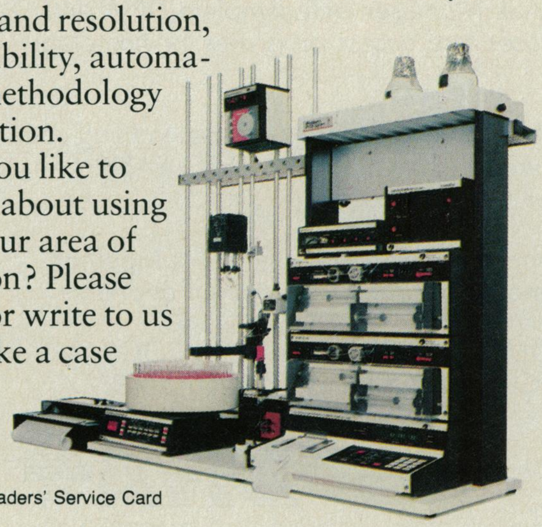
Central to the breakthrough was the system's biocompatibility, which enabled the researchers to maintain the biological activity of the collected fractions. This activity also permitted the study of the immunoregulatory activity of the fractions. The peaks were found to represent different immunostimulants and immunosuppressants, which had never before been so well separated and characterized. The FPLC System has enabled the group to extend their investigations into unexplored areas of biomedical research.



DISCOVER MORE. You can extend your own investigations, too. If your work involves the separation and purification of proteins, peptides, and other biomolecules, the FPLC System can provide you with advantages that turn problems into discoveries. Like the advantages that created success in this case history: high speed and resolution, biocompatibility, automation, and methodology documentation.



Would you like to learn more about using FPLC in your area of investigation? Please contact your Pharmacia representative or write to us at the address below. Maybe we can make a case for having an FPLC in your laboratory.



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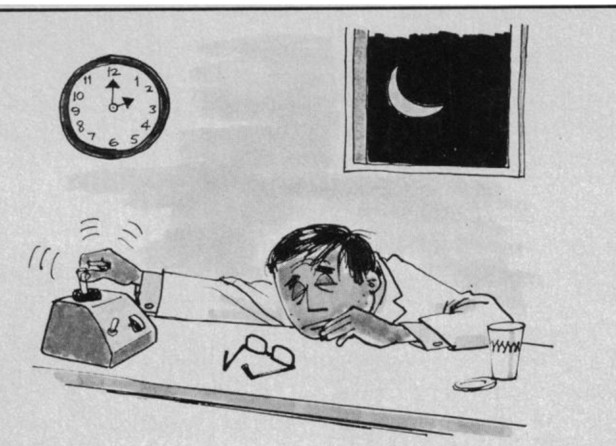

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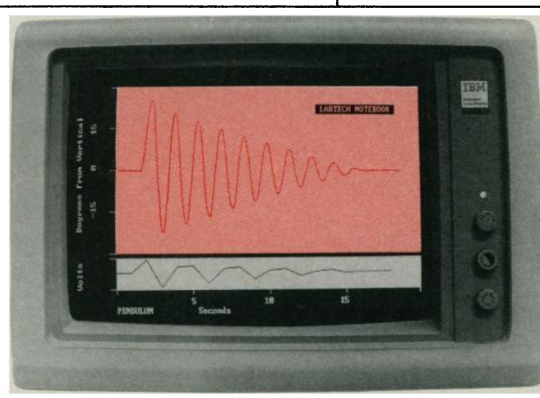

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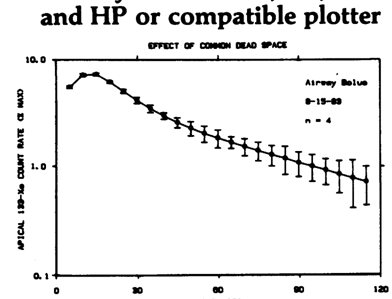

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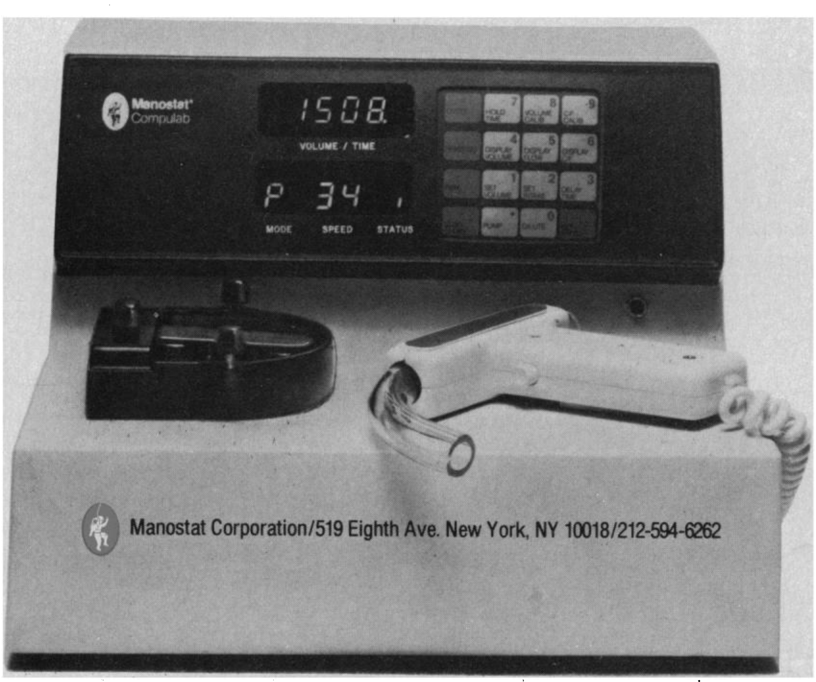

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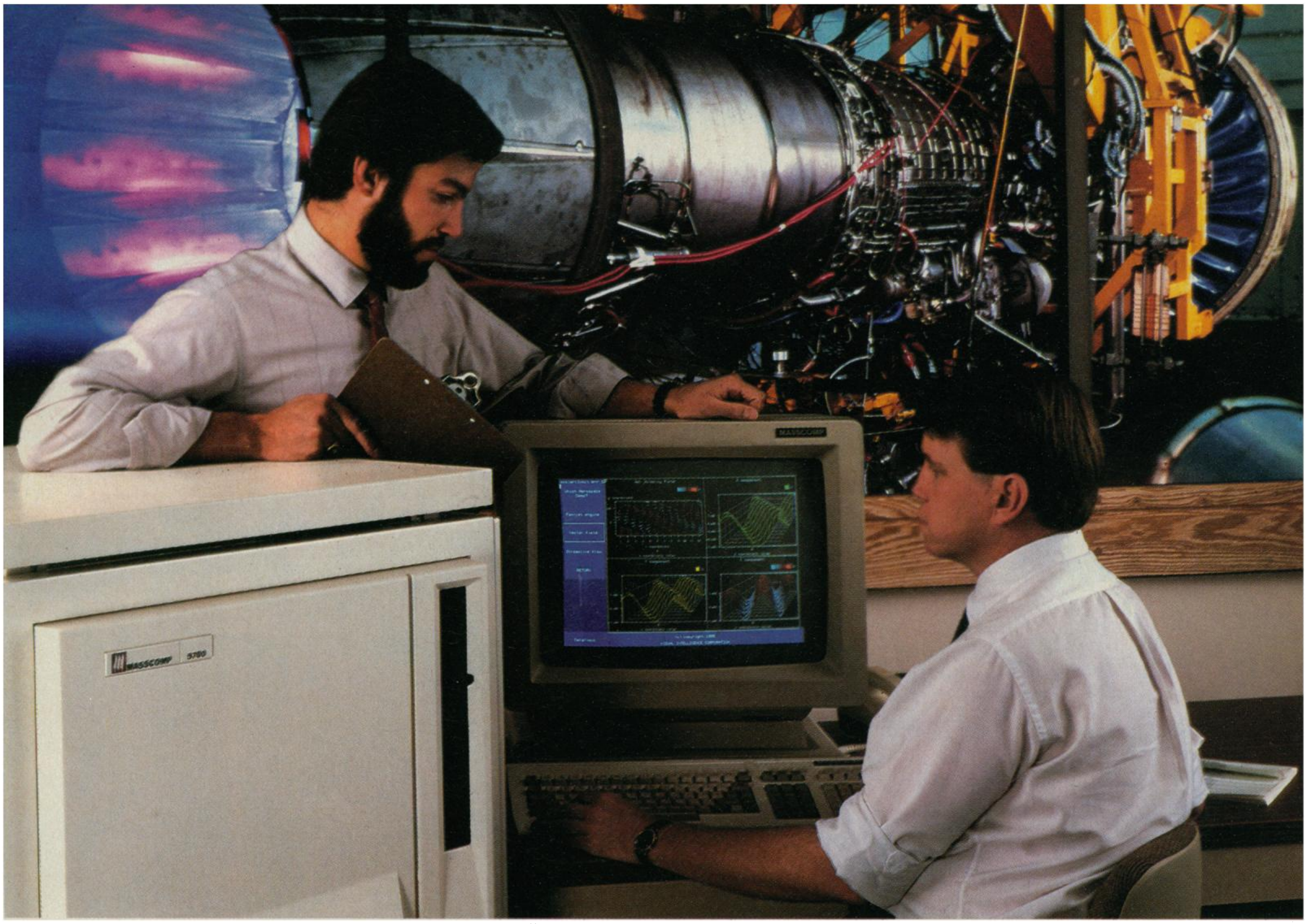

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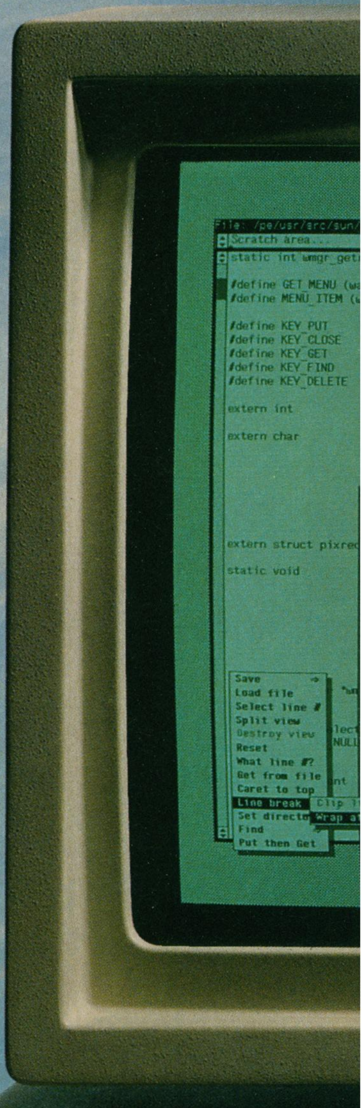

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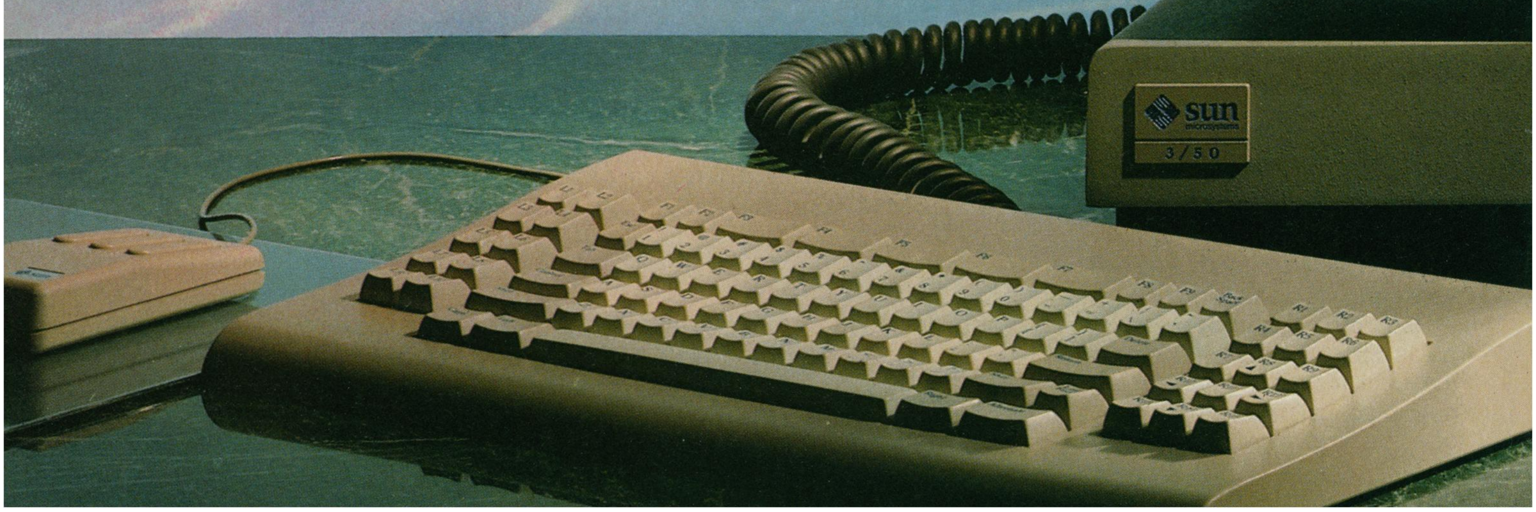


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