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Instrumentation and Equipment

The scientific enterprise continues to develop new, rewarding frontiers to explore. A key factor is exploitation of opportunities that are created by instrumentation and equipment. This issue of *Science* presents a sample of such opportunities.

Synchrotrons capable of producing ultraviolet radiation and x-rays have been in operation for some years. However, their numbers have increased both here and abroad. In addition their outputs of radiation have been greatly improved by installation of periodic magnetic insertion devices called wigglers and undulators. The flux of energy per unit area of synchrotron radiation exceeds that of older conventional sources by factors of 10^6 to 10^8. An arbitrary portion of the spectrum can be sharply defined and used for particular experiments. An enormous number of studies that previously were impractical can now be performed. Gruner discusses the feasibility of performing time-resolved x-ray diffraction of biological materials. Many biological processes occur on a millisecond time scale, and these are now close to being accessible to investigation.

Prewitt and colleagues list a large number of experiments that have been performed on both inorganic and organic materials. As crystallographers they are pleased with an ability to determine structure of crystals having dimensions on the order of 10 micrometers. They also mention experiments that determine structure of surfaces both of inorganics and organics. In many—or even most—solids the surface structure differs from that of the bulk. Ability to obtain such information is of increasing potential economic importance. Molecular beam epitaxy is now producing a large number of new types of layered materials. Another application is in macromolecular crystallography. The small size of the x-ray beam and its collimation allow possible resolution of reflection maxima from viruses with unit cells as large as 1000 angstroms (mass of about 10,000,000 daltons).

One of the most exciting opportunities of our times is the sequencing of the human genome. It will be an enormous task. But it will be done. Were the techniques of yesteryear employed, the cost would be many billions of dollars, and many years—perhaps decades—would be required. However, human ingenuity is being applied to make the task easier and less costly. In this issue Gray and colleagues describe their work on chromosome purification and, in a research article, Prober and colleagues present a new system for rapid DNA sequencing. Chromosomes can be isolated from cells, stained with a DNA-specific fluorescent dye, classified by flow cytometry, and purified by flow sorting. With newly developed high-speed sorting, microgram quantities of some individual chromosomes having a purity of 90 percent can be isolated in a day or less. The authors suggest that the speed of the separation process might eventually be improved by an order of magnitude.

In the new DNA sequencing method, fluorescent molecules are added to DNA fragments by enzymatic chain extension reactions. The labeled fragments are separated by polyacrylamide gel electrophoresis and identified as they migrate past a fluorescent detection system. The wavelength of the fluorescent radiation differs for each terminal base. Sensitivity of detection is very good. After an initial period of electrophoresis the sequencer is capable of determining 50 bases per hour per lane. Twelve lanes can be used.

Proteins for therapeutic applications are major crude products of recombinant DNA technology. To be safe for human use, the proteins must be highly purified. A major means of achieving this is the use of liquid chromatography. The crucial factors in such separations are interactions between the proteins and the column packing. Regnier has analyzed the interactions that occur when various types of packing are used. He points out that only a fraction of those amino acid residues at or near the exterior surface of a three-dimensional protein can interact with a particular type of chromatographic matrix.

Electroencephalography is now being supplemented by an increasingly useful magnetoencephalography (MEG). Rose, Smith, and Sato describe use of MEG in determining the location of epileptic discharges. Sensitive superconducting quantum interference device (SQUID) sensors can detect the tiny magnetic fields that are produced when the electric discharges occur. With information derived from a number of detectors the location of the source of the discharge can be determined. The procedure holds promise of becoming a valuable noninvasive diagnostic aid.—PHILIP H. ABELSON