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Instrumentation

Annually *Science* devotes an issue to instrumentation. There are a number of reasons; chief among these is the interest in new developments by readers whose scientific disciplines span an extraordinary range. The interplay of science and technology in the instrumentation area is exceptional. Basic science and technology development are intertwined in ways that benefit both areas. The technology used in instrumentation is frequently based on new scientific developments and new methods in instrumentation often address current scientific needs. In this issue of *Science* there are many examples of this interplay, especially in the vital connections between modern biology and instrumentation.

Nuclear magnetic resonance spectroscopy has become a central method for structure determination in small molecules. Magnetic resonance imaging (MRI) is becoming the method of choice for three-dimensional anatomical mapping. Stehling, Turner, and Mansfield discuss the application of echo-planar imaging, which can be used to enhance the information content of MRI acquisitions. In this way, much more detail can be obtained about the tissues of interest, or data can be acquired in a much shorter period of time so that organs such as the heart can be imaged without blurring. In both cases, new and important problems can be addressed.

X-ray crystallography is the most definitive of structural methods. If phase information from scattered x-rays were available, extraction of the structure from the data would be much simpler. This problem is especially significant for biological macromolecules such as proteins, which have thousands of atoms in the unit cell. Hendrickson describes the use of anomalous diffraction of synchrotron radiation, which helps to solve this problem. The difference in scattering of radiation of different wavelengths provides the phase information that would otherwise have to be obtained from isomorphous replacement of atoms in the structure.

Sequence analysis of DNA is the key to understanding many of the problems of modern biology. It reveals similarities in homologous genes, which provides insight into function. It is required in the execution of the Human Genome Project, and it is necessary for connecting disease states with genetic variation. Hunkapiller, Kaiser, Koop, and Hood describe the challenges involved in solving the sequencing problem. New technology is required either to automate gel electrophoretic methods or to develop new sequencing methodologies. Many of these approaches will require extensive computational resources. Necessity is clearly going to drive new invention, which in turn is going to make a variety of new solutions accessible.

Scanning electrochemical microscopy is a particularly interesting example of the new and impressive development of scanning microscopies. Bard, Fan, Pierce, Unwin, Wipf, and Zhou describe this scanning probe, which provides surface images of sample topography and surface reactivity by taking advantage of the presence of electrically conducting and electroactive species. Although the resolution is lower than that in some other scanning microscopies, applications for imaging heterogeneous surfaces, especially those of practical interest, are numerous.

Chemical microsensors promise to supplement or replace traditional analytical chemical instrumentation in many applications. Hughes, Ricco, Butler, and Martin describe microelectronic, acoustic wave, optical fiber, and electrochemical microsensors—their fundamentals and some recent results. Increasing use of these new technologies can be expected in many areas.

Is the investment being made in science paying off? The reading of any recent issue of our significant journals says yes, and the articles in this issue of *Science* declare without question that extraordinary progress continues to be made which ensures that valuable results are being obtained in understanding nature and in solving important human problems. In many cases, new instrumentation is the key to continued progress.

—JOHN I. BRAUMAN