resolution than given by most electron microscopy. Although interpretation of AFM images may be less controversial, understanding the limits of its resolution is not so simple. There is evidence that suggests that "atomic resolution" images are often moiré patterns formed as many points on the tip slide over an underlying periodic surface. There is a lot to be gained from a widespread appreciation of the atomic aspects of scanning probe microscopy.

The book is focused on the use of STM with simple surfaces. It begins with a gorgeous gallery of STM images. The first chapter is a broad overview comprehensible at an undergraduate level of physics. Theoretical aspects of STM imaging are covered in the next seven chapters of Part I. They are atomic-scale tunneling, wavefunctions at surfaces, the simple Tersoff-Hamann theory, and the author's extension of the theory to deal with atomic states beyond the *s*-wave approximation. Chapters 7 and 8 deal with interatomic forces and the role of interaction forces in imaging. Material such as this is not covered in Sarid's (1992) book on AFM. The introductory chapters of Part II (instrumentation) give a good review of the basics of piezoelectric scanners, vibration isolation, servo electronics, and mechanical design for STMs. They serve as an excellent introduction for the AFM also. A fifteenth chapter is devoted entirely to the AFM and is probably all that is needed (unless you plan to build your own instrument).

There is another level beyond the strictly practical matters of setting up servo parameters properly. I still feel a sense of wonder at using such simple equipment to sense, image, and manipulate atoms and molecules. It brings quantum mechanics to life. As a primer on the relevant quantum phenomena, Chen's book is an absolute delight. His discussion of quantum transmission is simple, yet it leads to a powerful generalization of the Bardeen theory for tunneling in condensed matter. Many simple connections with basic physics and chemistry are made. I had not realized how profound Linus Pauling's picture of "resonance energy" is: We see on page 177 how the time evolution of the charge distribution on a hydrogen molecular ion follows a simple oscillatory pattern, "tunneling" back and forth between protons at what Pauling christened the "resonance" frequency. In the same chapter, we see how to combine hydrogenic wavefunctions correctly for this problem. I gather that this beautiful piece of work had languished in Westinghouse library until Chen found it.

There has been real progress in both biological AFM and STM in the last two years. High-resolution images are being made reliably underwater (the real power of the techniques). The biology community probably needs a book that goes beyond Chen's. Personal computers and programs such as Mathmatica allow mathematical novices to appreciate quantum transmission (Walker and Gathright, 1993). There have been significant advances in understanding the imaging of molecules (Sautet and Joachim, 1992) and tunneling in water (Lindsay et al., 1994). Such a book is not yet written. When it is, Chen's work will be a required prerequisite.

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Motility Assays for Molecular Motors by Jonathan M. Scholey in Methods in Cell Biology, vol. 39

Academic Press, Inc., New York, 20 chapters, 1993. 304 pages. $45.00

Reviewed by Ewa Prochniewicz, Department of Biochemistry, University of Minnesota Medical School

Until recently, most research aimed at understanding the molecular mechanism of muscle contraction and cell motility was done using complementary methods of physiology and biochemistry. Physiological experiments dealt with the mechanics of intact muscle and cell locomotion, whereas biochemical studies utilized purified proteins in solution to characterize enzymatic properties of motor proteins and their interactions with actin and microtubules. However, the correlation of data obtained by the two methods was difficult, because the results of physiological experiments were not directly related to the actions of single-motor molecules, and purified proteins in solution generated neither force nor directional movement. The recent development of molecular motility assays fills the gap between biochemistry and physiology, permitting study of the measurement of motion and force using purified motor proteins (myosin, dynein, or kinesin) and the protein filaments with which they interact (actin or microtubules).

In "Motility Assays for Molecular Motors" Jonathan M. Scholey provides a timely summary of a wide range of these techniques and outlines the current problems in this exciting and promising field. The movements discussed range from those of single molecules to intracellular organelles. Many of the experiments using single molecules are focused on the fundamental step size, i.e., the distance (on the nanometer scale) a motor protein moves its load/molecule of ATP

hydrolyzed. In vitro motility assays have been used for defining the polarity of microtubules and characterizing the molecular bases of such intracellular processes as organelle transport, membrane translocation, and chromosome movement. A few chapters of the book are devoted to the methods of biochemical characterization of motor proteins, including their expression in bacteria. Each chapter contains a large section describing technical details including the methods of preparation of purified proteins, cell extracts, and microscope slide surfaces. These sections include valuable comments concerning the denaturation of proteins caused by surface adsorption and excessive illumination. The descriptions of equipment including microscopes, video imaging systems, and digital analysis methods provide valuable technical detail needed for the design of the most suitable videomicroscopy setup for a particular motile system. Most chapters contain schematic illustrations of techniques and high-quality reproductions of microscope images of motile systems. Each chapter is complemented by a list of references including the titles of quoted papers.

In summary, this book presents a wide range of approaches and techniques in studies on the molecular mechanism of biological movement and indicates the possibilities of future development. As stated in the short summary on the back cover, "this volume should prove of practical value to investigators of the cytoskeleton and many related areas of cell and developmental biology."

The Photosynthetic Bacterial Reaction Center II: Structure, Spectroscopy, and Dynamics edited by Jacques Breton and André Verméglio

Plenum Press, New York and London, published in cooperation with NATO Scientific Affairs Division, 1992. 429 pages.

Reviewed by Robert S. Knox, Department of Physics and Astronomy, University of Rochester

In photosynthetic organisms, the essential step in the conversion of light into chemical energy occurs at a special pair of chlorophyll or bacteriochlorophyll molecules situated in a complex of transmembrane proteins that have two broad functions: (1) to provide a pathway for transport of the pure excitation energy (excitons, created by light absorption) to the pair through "antenna" chromophores and (2) to provide stabilization of the separated charge products and transport pathways away from the pair. The centrally situated protein containing the special pair, a few of the antenna chromophores, and most of the electron transport molecules, is the reaction center (RC). This protein, along with its associated antenna proteins, comprises the photosynthetic unit. In bacteria, one type of RC suffices. In green plants, two exist, operating largely in series.

The book under review deals with the bacterial RC alone and consists of the proceedings of a NATO Advanced Study Institute held at Cadarache, near Aix-en-Provence, France, in May 1992. This workshop was the fourth in an informal series that originated at about the time of Michel and Deisenhofer's Nobel-prize-winning x-ray determination of the structure of the RC of *Rhodopseudomonas viridis*. The first workshop was held in Feldafing, Germany, in March 1985, the second in Cadarache in September 1987, and the third again at Feldafing in March 1990. The *Biophysical Journal* reader will ask whether this is not just another conference volume. In one sense it may well not be. An extraordinarily rich multidisciplinary research effort is being played out in this field, and this is the latest in a series that provides a vivid picture of the impact that a structure determination of essentially a single protein complex can have.

The availability of the *R. viridis* RC structure, along with that of *Rhodobactor sphaeroides* (from groups at LaJolla and Argonne) has had both a practical and a philosophical effect on research in the primary bioenergetics of photosynthesis. Ever since its isolation by Clayton and Reed in 1968, the bacterial RC had attracted the attention of a small army of biologists, biochemists, chemists, and physicists, particularly spectroscopists and theorists among them. Their goal was to set up a molecular model of the RC by making it consistent with all relevant data, particularly spin resonance, infrared, optical, and Raman spectra. When the x-ray-determined structure was presented on a silver platter, what then was left to do? I recall this question being asked in public, no doubt mostly in jest, by one of the heavily involved researchers.

The end of history, as we know, does not come that easily. The game had been turned around: were now all these diagnostic spectra and theories readily consistent with what was now on the platter? The answer was and still is "no," the most famous instance being that of broken symmetry. Electron transfer at the RC proceeds in a particular direction despite the observed near-perfect C2 symmetry of the center. As vexing has been the problem of the "voyeur bacteriochlorophyll," a component whose structural position puts it in or very near the primary pathway. Its contribution to electron-transfer kinetics is far from settled and its potential influence on rates has sparked great theoretical interest. Since the structure posed so many new problems, those working with related chlorophyll-proteins could not help but wonder whether attempts to use spectra alone to estimate structure (in terms of chromophore locations and orientations) would henceforth be taken seriously. There was a prime source of encouragement in that the most significant spectrally-deduced aspect of the structure, the special pair, was indeed found in the *viridis* and *sphaeroides* structures. This pair had been identified as such by its EPR and ENDOR signatures in the early 1970s.