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Fifty years ago, biochemists described cells as small vessels that contain a complex mixture of chemical species undergoing reactions through diffusion and random collision. This description was satisfactory inasmuch as the intricate pathways of metabolism and, later, the basic mechanisms of gene regulation and signal transduction were still being unraveled. Gradually, and in part as a result of the parallel growth in our structural understanding of the molecular components of the cell, the limitations of this "chemical reactor" view of the cell became plain. Armed with a more precise knowledge of the structural bases of molecular interactions, the focus shifted more and more to the mechanisms by which these molecular components recognize and react with each other. Moreover, it also became clear that cells are polar structures and that the cell interior is neither isotropic nor homogeneous; that many of the essential processes of the cell, such as chromosomal segregation, translocation of organelles from one part of the cell to another, protein import into organelles, or the maintenance of a voltage across the membrane, all involve directional movement and transport of chemical species, in some cases against electrochemical gradients. Processes such as replication, transcription, and translation require directional readout of the information encoded in the sequence of linear polymers. Slowly, the old paradigm was replaced by one of a small "factory" of complex molecular structures that behave in machine-like fashion to carry out highly specialized and coordinated processes. These molecular machines are often complex assemblies of many proteins and contain parts with specialized functions, for example, as energy transducers or molecular motors, converting chemical energy (either in the form of binding energy, chemical bond hydrolysis, or electrochemical gradients) into mechanical work through conformational changes and displacements.

To understand the behavior of this molecular machinery requires a fundamental change in our conceptual and practical approaches to biochemical research. The cell, it appears, resembles more a small clockwork device than a reaction vessel of soluble components. Many of the functions of this device (which besides replication, transcription, translation, and organelle transport, include cell crawling, cell adhesion, protein folding, protein and nucleic acid unfolding, protein degradation, and protein and nucleic acid splicing) are indeed mechanical processes, and basic physical concepts such as force, torque, work, energy conversion efficiency, mechanical advantage, etc., are needed to describe them. The recent development of experimental methods that permit the direct