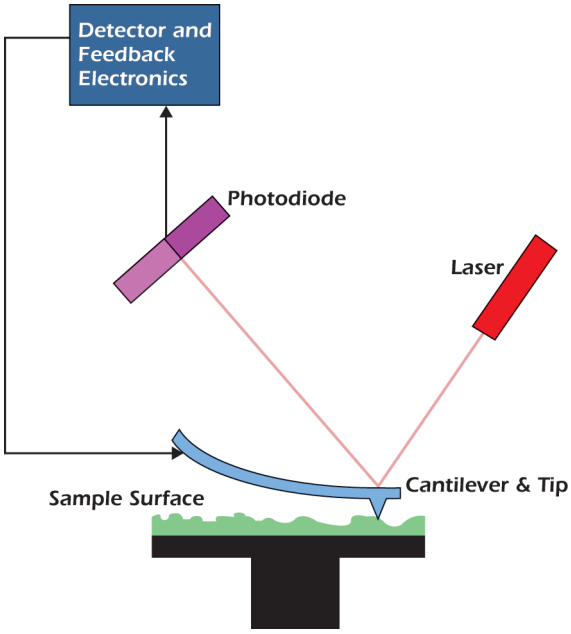
Chapter 1

Web Text Box 2

The Atomic Force Microscope



Imaging single atoms: the atomic force microscope

The amount of detail we can see through either a simple light microscope or the more powerful transmission electron microscope, in other words their resolution, is limited by the wavelength of their source of illumination, visible light in the case of the light microscope or an electron beam in the case of the transmission electron microscope. In a transmission electron microscope it is possible to see the smallest cellular structures and even individual macromolecules but to see yet finer detail, for instance the individual atoms that make up these structures, we have to turn to the atomic force microscope. The atomic force microscope can image and measure structures at the Nano scale, way smaller than is possible in the transmission electron microscope. It can do this because it works in a completely different way. Unlike other microscopes it has no lenses. Instead, at the heart of the atomic force microscope is a cantilever with a silicon tip only a few nanometers across. The tip is scanned across a surface and minute deflections of the probe are detected by a laser beam aimed at the back of the

cantilever. Such is the sensitivity of the system that even deflections by individual atoms can be detected. Crucially, unlike the transmission electron microscope which must operate under high vacuum, the atomic force microscope can look at living material in physiological buffers. The result is a three-dimensional map of a surface such as a cell membrane or a real time image of dynamic interaction between proteins, for example a single DNA molecule and its polymerase.

In Chapter 20 of the book we use Cystic Fibrosis to illustrate many of the concepts covered in the book. CFTR, the chloride channel whose absence in CF patients causes the symptoms of the disease, was recently studied by atomic force microscopy. Figure 11 in Schillers. 2008. Pflugers Arch 456: 163-77. is a nice example of the sort of images generated by this technique.