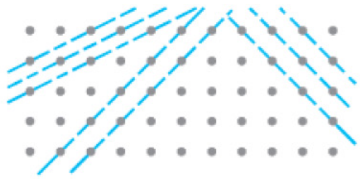
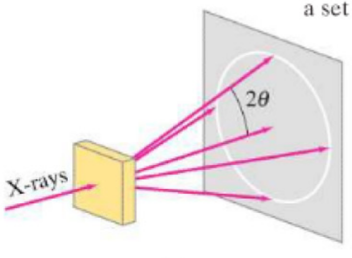


FIGURE 25–38 X-rays can be diffracted from many possible planes within a crystal.

Actual X-ray diffraction patterns are quite complicated. First of all, a crystal is a three-dimensional object, and X-rays can be diffracted from different planes at different angles within the crystal, as shown in Fig. 25–38. Although the analysis is complex, a great deal can be learned about any substance that can be put in crystalline form. If the substance is not a single crystal but a mixture of many tiny crystals—as in a metal or a powder—then instead of a series of spots, as in Fig. 25–36, a series of circles is obtained, Fig. 25–39, each corresponding to diffraction of a certain order m from a particular set of parallel planes.

FIGURE 25–39 (a) Diffraction of X-rays from a polycrystalline substance produces a set of circular rings as in (b), which is for polycrystalline sodium acetoacetate.



(b)

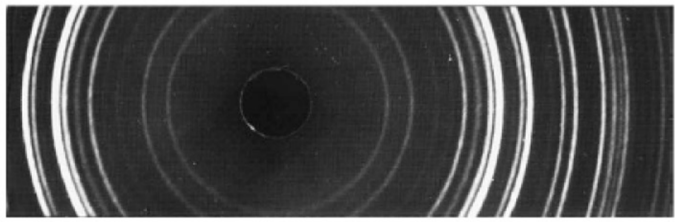
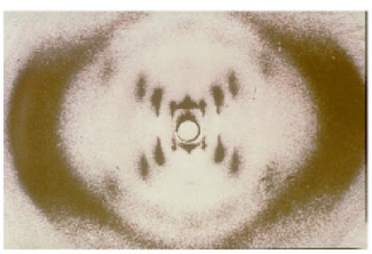


FIGURE 25–40 X-ray diffraction photo of DNA molecules taken by Rosalind Franklin in the early 1950s. The cross of spots suggested that DNA is a helix.



X-ray diffraction has been very useful in determining the structure of biologically important molecules, such as the double helix structure of DNA, worked out by James Watson and Francis Crick in 1953. See Fig. 25–40, and for models of the double helix, Figs. 16–44a and 16–45. Around 1960, the first detailed structure of a protein molecule, myoglobin, was elucidated with the aid of X-ray diffraction. Soon the structure of an important constituent of blood, hemoglobin, was worked out, and since then the structures of a great many molecules have been determined with the help of X-rays.

* 25–12 X-Ray Imaging and Computed Tomography (CT Scan)

* Normal X-ray Image

PHYSICS APPLIED
Normal X-ray image

For a conventional medical or dental X-ray photograph, the X-rays emerging from the tube (Fig. 25–35) pass through the body and are detected on photographic film or a fluorescent screen, Fig. 25–41. The rays travel in very nearly straight lines through the body with minimal deviation since at X-ray wavelengths there is little diffraction or refraction. There is absorption (and scattering), however; and the difference in absorption by different structures in the body is what gives rise to the image produced by the transmitted rays. The less the absorption, the greater the transmission and the darker the film. The image is, in a sense, a "shadow" of what the rays have passed through. The X-ray image is *not* produced by focusing rays with lenses as for the instruments discussed earlier in this Chapter.

CAUTION
X-ray images are a sort of shadow; no lenses are involved

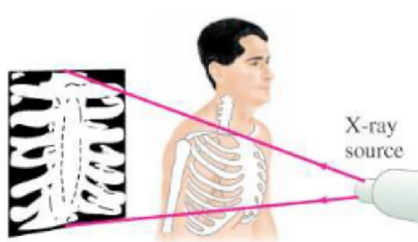


FIGURE 25–41 Conventional X-ray imaging, which is essentially shadowing.