Why it Matters

Magnetic Resonance Imaging

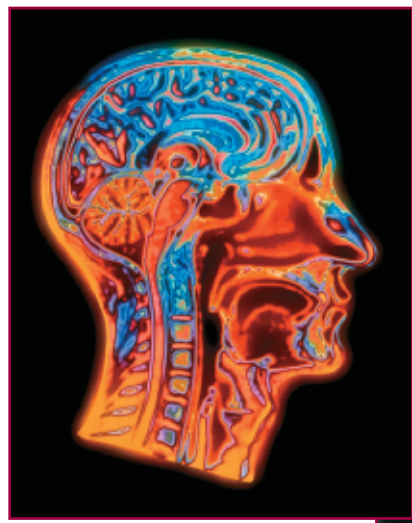
Magnetic resonance imaging, or MRI, is an imaging technique that has been used in clinical medicine since the early 1980s. MRI allows doctors to make two-dimensional images of or three-dimensional models of parts of the human body. The use of MRI in medicine has grown rapidly. MRI produces high-resolution images that can be tailored to study different types of tissues, depending on the application. Also, MRI procedures are generally much safer than *computerized axial tomography (CAT)* scans, which flood the body with X rays.

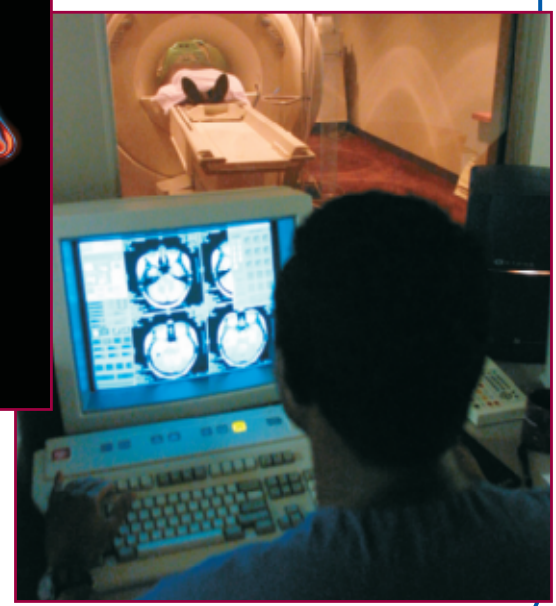
A typical MRI machine looks like a giant cube, 2–3 meters on each side, with a cylindrical hollow in the center to accommodate the patient as shown in the illustration. The MRI machine uses electromagnets to create magnetic fields ranging in strength from 0.5–2.0 T. These fields are strong enough to erase credit cards and to pull pens out of pockets, even across the MRI exam room. Because resistance would cause normal electromagnets to dissipate a huge amount of heat when creating fields this strong, the electromagnets in most MRI machines contain superconducting wires that have zero resistance.

The creation of an image with MRI depends on the behavior of atomic nuclei within a magnetic field. In a strong magnetic field, the nucleus of an atom tends to line up along the direction of the field. This behavior is particularly true for hydrogen atoms, which are the most common atoms in the body.

The primary magnet in an MRI system creates a strong, uniform magnetic field centered on the part of the patient that is being examined. The field causes hydrogen nuclei in the body to line up in the direction of the field. Smaller magnets, called *gradient magnets,* are then turned on and off to create small variations, or pulses, in the overall magnetic field. Each pulse causes the hydrogen nuclei to shift away from their alignment. After the pulse, the nuclei return to alignment, and as they do so, they emit radio frequency electromagnetic waves. Scanners within the MRI machine detect these radio waves, and a computer processes the waves into images.

Different types of tissues can be seen with MRI, depending on the frequency and duration of the pulses. MRI is particularly good for imaging the brain and spinal tissues and can be used to study brain function, brain tumors, multiple sclerosis, and other neurological disorders. MRI can also be used to create images of blood vessels without the surrounding tissue, which can be very useful for studying the circulatory system. The main drawbacks of MRI are that MRI systems are very expensive and that MRI cannot be used on some patients, such as those with pacemakers or certain types of metal implants.





The imaging magnet in most MRI machines is of the superconducting type. The magnet is the most expensive component of the MRI system.