

CHAPTER 19

Diagnostic Imaging, Radiation Oncology, and Surgery

► RADIOLOGY,
ONCOLOGY
SURGERY

After studying this chapter, you will be able to:

- 19.1** List the types of diagnostic imaging
- 19.2** Explain the uses of radiation therapy
- 19.3** List the types of surgery and some important surgical tools
- 19.4** Define the combining forms and suffixes used in building words that relate to diagnostic imaging and surgery
- 19.5** Identify the meaning of related abbreviations

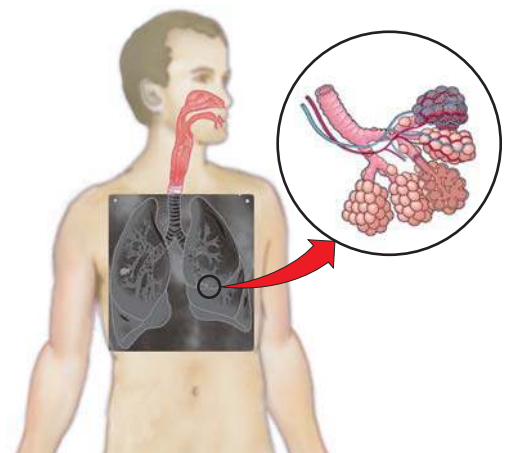
Radiology or **roentgenology** is the medical specialty that analyzes the results of imaging tests. The medical specialty that uses radioactive substances to view or to treat diseases is known as **nuclear medicine**. Either a radiologist or a nuclear medicine physician is a specialist in radiology. Generally, physicians do not administer the tests or treatment. Radiologic technologists are certified and registered by the American Registry of Radiologic Technologists (ARRT) in the following specialties:

- Radiographers who produce diagnostic images via conventional, CT, MRI, or ultrasound technologies.
- Nuclear medicine technologists who image nuclear scans to provide a diagnosis.
- Radiation therapists who administer ionizing radiation to patients to cure or relieve symptoms associated with cancer.

Each radiologic technologist works under the direction of a board-certified specialist in radiology. **Radiography** is the production of diagnostic images. **Cineradiography** allows a radiologist to view a sequence of images showing how tissues or organs work in an individual.

Diagnostic Imaging

Historically, if a doctor tried to diagnose an internal ailment, surgery was the only way to actually see the tissue and organs of a person. With the advent of imaging, it is now possible to view the interior of the human body without invasive procedures. **Imaging** is the production of visual output using x-rays, sound waves, or magnetic fields. **Diagnostic imaging**



The Web site (www.radiologyinfo.org) provides an explanation of the types of radiation therapy.

is the use of imaging to diagnose problems in the interior of a part of the body without surgery. The three major types of imaging are:

1. *X-ray technology* was the earliest form of imaging. It now ranges from black and white images produced by electromagnetic radiation to computer-enhanced images on a computerized axial tomography (CAT) scan. X-ray technology is widely used in dentistry and for numerous diagnostic situations such as bone fractures, tumor locations, and many other conditions.
2. *Ultrasonography* uses sound waves to produce a visual image of an area of the body's interior. Ultrasonography is routinely used to view the womb of a pregnant women.
3. *Magnetic resonance imaging (MRI)* uses a magnet to obtain images of an area of the body.

Radiology

In the early twentieth century, **x-rays** were discovered and the first images of the inside of a living person were made. X-rays are high-energy electromagnetic **radiation**, energy from the interior of a substance carried by a stream of electrically charged particles. There are three types of radioactive particles:

- **Gamma rays** have the most penetrating ability of the three types.
- **Alpha rays** have the least penetrating ability.
- **Beta rays** fall somewhere in the middle in penetrating ability.

The use of x-rays increased dramatically until it was discovered that extensive exposure to radiation could cause health problems (cancer, birth defects, and so on). Later, lower doses of x-rays that are considered safe dramatically altered the way disease is diagnosed. Now, x-rays are commonly used to detect pathology throughout the body and to treat certain diseases.

X-rays show images in black, white, and gray (Figure 19-1). They are useful for showing abnormalities such as broken bones, internal anomalies, or dental abnormalities, as well as for use in treating certain diseases.

X-rays reveal internal images by exposure of a picture on a photographic plate. The x-rays are directed toward the patient and when they travel through the patient, they come to the plate placed directly behind. Patients are positioned so that the best image may be obtained. Substances of the body may be **radiolucent**, allowing x-rays to pass through quickly (air is radiolucent), or **radiopaque**, blocking or absorbing x-rays (bone is radiopaque). In between radiolucent and radiopaque, there are many degrees of absorbability or resistance to the passage of x-rays. For example, fat is fairly absorbent; blood, lymph, and water are more so. Radiolucent substances appear black on x-ray images and radiopaque substances appear white. Substances in between radiolucent and radiopaque appear in various shades of gray.

X-rays can be dangerous, particularly to people who administer them in a clinical setting. X-rays cannot be seen, heard, touched, or smelled. They cannot travel through lead, a very dense substance, so that the use of lead vests or aprons is very common for radiologic technologists and for radiation therapists. Also, lead vests are often used to cover parts of the patient's body not being x-rayed. X-rays **ionize**, change neutral particles to positively charged **ions**, and, in doing so, destroy cancer cells and slow the growth of tumors. Control of x-rays has become more sophisticated; however, damage to surrounding tissue almost invariably occurs during *radiation therapy*, the



FIGURE 19-1 X-ray of an arthritic hand.

For an x-ray of human bones, go to www.accessexcellence.org/RC/VL/xrays.

use of x-rays to destroy cancer cells. Long-term, unprotected exposure to x-rays can cause cancer.

The use of computers has enhanced radiologic techniques. Not only is the detail of x-rays increased, but computer-guided x-rays can photograph at various angles and can photograph certain body parts (such as the heart) while they are working. Common procedures in cardiology which use computer imaging, such as cardiac catheterization, are discussed in Chapter 6. **Tomography**, the production of three-dimensional images, provides much anatomical and diagnostic information. **CT (computed tomography)** or **CAT (computerized axial tomography) scans** show a series of images conveyed to the computer as detailed pictures of slices of an organ or body part.

PET (positron emission tomography) scans are imaging tests that show the distribution of substances in tissue. They are often used to diagnose brain disorders. This is accomplished by bombarding the area being x-rayed with x-rays at many different angles. The computer interprets the normal density of various parts of the body and the density of a solution ingested. The result is a clear image of minute sections able to show abnormalities in detail.

Fluoroscopy is another imaging technique using x-rays. Instead of a photographic plate, the image is projected onto a fluorescent screen that shows visual images as light rays that are emitted when the x-rays pass through a patient. Fluoroscopy allows for observation of a body part in motion.

X-ray equipment varies depending on the intended use. For example, dental x-rays are taken with a machine that points the radiation to an area of the mouth. Chest x-rays are generally taken on a large plate that covers the front of the chest. CAT scans and PET scans also aim x-rays at particular body areas. The equipment for these scans is attached to a computer on which the image is shown.

The clarity of x-rays can be enhanced if a *contrast medium*, a dense substance that shows up as white on the x-ray film, is used for a particular area of the body. **Barium** and **iodine** substances are ingested to provide a dense substance in a particular area. A *barium swallow* is used for examination of the hypopharynx and the esophagus. A *barium enema* is the insertion of barium into the rectum and colon for a lower GI series.

Iodine is used in many imaging tests to highlight the interior of a cavity, tube, or vessel:

- *Angiography* is imaging of the blood vessels and chambers of the heart after an iodine substance is inserted through a catheter to the heart.
- *Digital subtraction angiography (DSA)* is a two-step imaging process described in Chapter 6.
- *Magnetic resonance angiography* is the imaging of the flow of blood through vessels.
- *Arteriography* is the imaging of arteries usually in the brain (usually to detect blockages).
- *Arthrography* is the imaging of joints after injection of an iodine substance.
- *Cholangiography* is an examination of the gallbladder and bile ducts.
- *Cholecystography* is an image taken after an iodine substance is swallowed and it reaches the gallbladder and bile ducts.
- *Hysterosalpingography* is imaging of the fallopian tubes after injection of a contrast medium containing iodine.
- *Lymphangiography* is imaging of the lymphatic vessels.

A commercial Web site (www.petscaninfocenter.com) gives detailed information about PET scans.

MORE ABOUT . . .

Diagnosing Breast Cancer

Mammograms are the most commonly used diagnostic tool for diagnosing breast tumors or lesions. They have increased early diagnosis tremendously. However, mammograms do not distinguish between benign and malignant growths, and they miss 10 percent of cancers. Researchers are working on using other imaging techniques to alleviate these two problems. PET scans are more effective at identifying benign growths. MRIs can detect 100 percent of tumors, but do not distinguish them from benign growths. The goal of the research is 100-percent detection of cancers with no unnecessary biopsies for benign growths.

In addition, radiologists are using new tools to make breast cancer treatment easier and more effective. In cases where a biopsy is necessary, a stereotactic breast biopsy is used to focus in on the area that needs to be examined. This technique allows radiologists and surgeons to perform the biopsy quickly and accurately.

- *Myelography* is imaging of the spinal cord to examine disks and check for anomalies.
- *Pyelography* is the imaging of the renal pelvis and urinary tract.
- *Venography* is the imaging of any vein after injection of a contrast medium.

Ultrasonography



FIGURE 19-2 A pregnant woman having an ultrasound.

To learn more about ultrasounds, go to <http://ultrasound.medical-information.org>.

Ultrasonography or *sonography* is the use of sound waves to produce images showing the interior of the body. An **ultrasound** image or a **sonogram** results when high-frequency sound waves are reflected off the body part being observed. The waves are received by a detector that converts them to electrical impulses, which can then be seen on a video monitor. The images produced have become clearer as the technology has advanced. Ultrasonography is a noninvasive method of observation. The equipment used for ultrasonography usually consists of a wand, which is attached to a monitor on which the image is seen, that is moved back and forth over the area being observed. It is used most frequently in monitoring fetal development during pregnancy (Figure 19-2). It is also commonly used for diagnosis, as in *echocardiography*, a test used in cardiovascular diagnosis, and ultra-sonography can be helpful in diagnosing disorders of many other organs (kidney, breast, uterus, gallbladder). A special type of ultrasound unit called a doppler is used on blood vessels.

Ultrasonography is also being commercialized in shopping malls where, for a fee, pregnant women can get a video image done by an ultrasound machine. Some women are having multiple ultrasounds to record the growth of their fetuses. Since no long-term studies have been done of frequent ultrasounds, and since many of the operators of this equipment in a shopping mall setting are unqualified to read ultrasounds, this practice is discouraged by medical professionals.

Magnetic Resonance Imaging (MRI)

Magnetic resonance imaging (MRI) creates images by tracking the magnetic properties within the nuclei of various cells. As the cells move, some

MORE ABOUT . . .

Stand-Up MRI

A new innovation in high-field open MRI Scanning is now available. The latest open MRI scanners eliminate the challenges created by the traditional cylindrical shape MRI scanners in the comfort of the patient, the ability of the patient to fit into the machine, and the ease for those individuals with claustrophobia. The scanner can easily place the area of interest into the center of the magnet gap for imaging.

The advantage of a walk-in MRI is multifold. The patient can be imaged in the weight-bearing position to view stress on the spine and joints, in a position of pain as well as in various other positions that simulate the abnormal condition. Patients can walk right in, stand or sit and nothing is in front of the face obstructing the patients view. The unit can also be rotated to a lying down position to accommodate any patient condition that is most comfortable.

atoms respond to magnetic fields and emit radio waves that produce an image. MRIs are commonly used to diagnose various tumors, defects in the cardiovascular system, and brain anomalies. MRIs do not use x-rays and, therefore, are considered safe and effective. Most MRIs do not require a contrast medium, but one may be used to enhance a scan in certain cases such as in viewing blood vessels. MRI equipment generally consists of a tube into which the patient is placed. While the patient is lying absolutely still, the magnet in the equipment obtains the scan.

Nuclear Medicine

Nuclear medicine uses radioactivity to test and treat disease. Radioactive chemicals, combined with blood or urine specimens *in vitro* (in a test tube), can reveal the presence of various hormones and drugs. Such information is used to monitor the use of medications with potentially harmful side effects. One test in particular, a **radioimmunoassay (RIA)**, is a common “drug” test, often given to participants in sports events, applicants for a job, or others who require regular drug testing. A radioimmunoassay is also used to determine the amount of a medication left in the body after a certain period of time. This information is useful in determining the correct dosage of certain medications. Lead-lined vials and syringes are used to protect workers from exposure.

Other studies in nuclear medicine are done *in vivo* (in the body). The basic goal of an *in vivo* test is to trace **radionuclides** (radioactive substances) ingested by the patient as they travel through the body. **Tracer studies** trace a specific **radiopharmaceutical** (combination of a chemical and a radionuclide designed to travel to a specific organ) while it makes its way through the organ. In this way, the function of an organ is imaged for observation and treatment. Similarly, a *scanner* (machine capable of creating **scans** or images) tracks the movement of radiopharmaceuticals within an organ to show how the organ functions. Common scans are:

- A *blood and heart scan*, a tracing of blood flow through the heart for diagnosing heart disease.
- A *bone scan* for bone cancer.

- A *brain scan*, for detecting anomalies in the brain that would allow a radiopharmaceutical to pass the BBB (blood-brain barrier).
- A *gallium scan*, using a specific radionuclide (gallium-67) to locate tumors and cysts.
- A *thyroid scan*, scanning the thyroid gland for thyroid cancer and function.

An **uptake test** in nuclear medicine is used to determine how quickly a radiopharmaceutical is absorbed by a particular organ or body part, as in a radioactive iodine uptake of the thyroid gland. A *perfusion study* in nuclear medicine tracks the passage of radiopharmaceuticals throughout the capillaries of the lungs, revealing any clots. A perfusion study may be used in combination with a ventilation study, which tracks an inhaled gas as it fills the air sacs of the lungs.

Radiation Oncology

Radiation oncology or *radiation therapy* is the specialty of those who treat benign and cancerous tumors. The goal of radiation therapy is to cure the patient or relieve the symptoms while sparing as much healthy tissue as possible. Radiation therapy is also used to relieve pain, thereby making the patient's remaining time more comfortable.

X-rays and radionuclides are potentially dangerous in high doses. They can cause damage and death to cells at which they are aimed. Cells that are treated with high-dose radiation are **irradiated**. Irradiation of cells is used in treating diseases with abnormal tissue growth, such as cancer. Radiation is given in doses necessary to penetrate and destroy the malignant cells. The radiation is measured in **rads** (radiation absorbed dose), which in turn is measured in **grays (gy)**, each gray equaling 100 rads. Tissue to be irradiated is either **radiosensitive** (as are most lymphomas), needing fewer grays to kill cells, or **radioresistant** (as are most sarcomas), needing more grays to kill cells.

Radiation is transmitted to cells using various techniques and machines depending on the location of the cancerous cells needing treatment. A *linear accelerator* is an *external beam machine* used to emit radioactive particles in a straight line directed at a malignancy. A *betatron* is a circular machine for delivery of radioactive material. A **stereotactic frame** is a device placed around the patient to direct a radiation beam to a specific spot in the brain.

In addition to equipment, radiotherapy may be delivered directly in **brachytherapy**, the implanting of radioactive elements directly into a tumor (**interstitial therapy**) or into an adjacent cavity (**intracavitary therapy**). Another type of radiotherapy is the introduction of radioactive materials that have a specific use (as radioactive iodine in thyroid therapy) when placed in the bloodstream. In the case of the thyroid, it is the only body organ to use iodine, so the treatment affects only the thyroid even though the material travels through the bloodstream.

Radiation therapy may be beneficial and even lifesaving, but it does have potential side effects. Some temporary effects are listed below:

- *alopecia*, loss of hair
- *nausea*, *vomiting*, or *diarrhea*
- *radiation anemia*, suppression of red blood cell production after treatment with radioactive material

- *inflammations* of the skin, mucous membranes, or epithelial tissue due to breakdown of tissue exposed to the radiation
- **malaise**, general ill feeling

Radiologists always need to have the clearest possible images for analysis. Correct positioning of the patient to provide the best views is the technologist's job. An image may be taken anterior-posterior (A/P), from front to back. It may be taken with the patient prone, supine, or in any body position. (Chapter 3 discusses directional terms and body planes.)

VOCABULARY REVIEW

In the previous section, you learned terms relating to diagnostic imaging. Before going on to the exercises, review the terms below and refer to the previous section if you have any questions. Pronunciations are provided for certain terms. Sometimes information about where the word came from is included after the term. The etymologies (word histories) are for your information only. You do not need to memorize them.

Term	Meaning
alpha [ÄL-fä] rays	Type of radioactive particle that has a low ability to penetrate the body.
barium [BÄ-rē-üm] Greek <i>barys</i> , heavy	Contrast medium that shows up as white on an x-ray.
beta [BÄ-tä] rays	Type of radioactive particle that has a medium ability to penetrate the body.
brachytherapy [bräk-ē-THÄR-ä-pē] brachy-, short + therapy	Implanting of radioactive elements directly into a tumor or tissue.
CAT (computerized axial tomography) scan	Scan that shows images as detailed slices of a body part or organ.
cineradiography [SĪN-ē-rā-dē-ÖG-rä-fē] cine-, movement + radiography	Radiography of tissues or organs in motion.
CT (computed tomography) scan	CAT scan.
diagnostic imaging	Use of imaging techniques in diagnosing illness.
fluoroscopy [flūr-ÖS-kō-pē] fluoro-, light + -scopy, observing	X-ray in which the image is projected onto a fluorescent screen.
gamma [GÄ-mä] rays	Commonly used radioactive particles with high penetrating ability.
gray (gy)	Unit of measure equal to 100 rads.
imaging [ĪM-ä-jĭng]	Production of a visual output using x-rays, sound waves, or magnetic fields.
interstitial [ĭn-tēr-STĪSH-äl] therapy	Substance is placed within the tissue or tumor.
intracavitary [ĪN-trä-CÄV-ĭ-tär-ē] therapy intra-, within + cavit(y)	Brachytherapy in which the radioactive substance is placed in a cavity near a cancerous lesion.

Term	Meaning
iodine [Ī-ō-dīn]	Substance used in radiopharmaceuticals for contrast medium and radiation therapy.
ion [Ī-ōn]	Positively charged particle used to ionize tissue.
ionize [Ī-ōn-īz]	To destroy cells by changing neutral particles to ions using x-rays.
irradiated [i-RĀ-dē-āt-ēd]	Treated with radiation.
magnetic resonance imaging (MRI)	Imaging produced by tracking the magnetic properties in the nuclei of various cells.
malaise [mă-LĀZ]	General feeling of illness.
nuclear medicine	Medical specialty for treating diseases with radioactive substances.
PET (positron emission tomography) scan	A series of images that shows the distribution of substances through tissue.
rad [răd] (radiation absorbed dose)	Unit of radioactive substance that can be absorbed in a particular period of time.
radiation [RĀ-dē-Ā-shŭn] From Latin <i>radius</i> , beam	Energy carried by a stream of particles from a substance.
radiography [RĀ-dē-ŎG-ră-fē] radio-, radiation + -graphy	Production of diagnostic images.
radioimmunoassay (RIA) [RĀ-dē-ō-ĪM-ŭ-nō-ĀS-sā] radio- + immuno-, immunity + assay	In vitro test to determine the amount of drugs or medication left in the body.
radiology [RĀ-dē-ŎL-ō-jē] radio- + -logy, study of	Medical specialty in diagnostic imaging and radiation treatment.
radiolucent [RĀ-dē-ō-LŪ-sĕnt] radio- + Latin <i>lucens</i> , shining	Able to be easily penetrated by x-rays.
radionuclide [RĀ-dē-ō-NŪ-klīd] radio- + nucl(ear)	Radioactive substance.
radiopaque [RĀ-dē-ō-PĀK] radi-, radiation + -opaque	Not able to be easily penetrated by x-rays.
radiopharmaceutical [RĀ-dē-ō-făr-mă-SŪ- tī-kăl] radio- + pharmaceutical	Chemical substance containing radioactive material.
radioresistant [RĀ-dē-ō-rē-ZĪS-tĕnt] radio- + resistant	Not greatly affected by radiation.
radiosensitive [RĀ-dē-ō-SĒN-sī-tīv] radio- + sensitive	Easily affected by radiation.
roentgenology [RĒNT-gĕn-ŎL-ō-jē] roentgeno-, roentgen + -logy	Radiology.
scan	Image obtained from the interior of the body.

Term	Meaning
sonogram [SŎN-ō-grām] sono-, sound + -gram, a recording	Ultrasound image.
stereotactic [STĒR-ē-ō-TĀK-tĭk] frame stereo-, three-dimensional + Greek <i>taxis</i> , frame	Headgear worn by patients needing pinpoint accuracy in the treatment of brain anomalies.
tomography [tō-MÖG-ră-fē] Greek <i>tomos</i> , cutting + -graphy	Type of imaging that produces three-dimensional images.
tracer study	Image that traces the passage of a radio-pharmaceutical through an organ or tissue.
ultrasonography [ŬL-tră-sō-NÖG-ră-fē] ultra-, beyond + sono- + -graphy	Use of sound waves to produce images of the interior of a body.
ultrasound [ŬL-tră-söwnd] ultra- + sound	Image resulting from ultrasonography; produced by sound waves.
uptake [ŬP-tāk]	Speed of absorption of a radiopharmaceutical by a particular organ or body part.
x-ray [ĖKS-ră]	High-energy particles of radiation from the interior of a substance.

CASE STUDY

Diagnosing a Disease

Nina Thorman made an appointment with her internist to discuss some weakness on her left side. After testing her reflexes and discussing her symptoms, her doctor referred her to a neurologist. Two weeks later while talking to the neurologist, Nina discovered that a series of tests might be necessary because some diseases (particularly neurological ones) are diagnosed by a process of elimination. (For example, multiple sclerosis does not show up in blood or urine tests, but does have several indicators that allow a neurologist to arrive at a diagnosis.) Nina was given an MRI to determine if a brain

tumor or other brain anomaly was affecting her on one side. The MRI showed some plaque on her brain. After a series of other tests, including a spinal tap to obtain CSF (cerebral spinal fluid) for analysis, the neurologist told Nina that she has multiple sclerosis. They discussed plans for management of the disease.

Critical Thinking

1. Why did the internist refer Nina to a neurologist for testing, rather than ordering an MRI himself?
2. Why was an MRI ordered as opposed to an x-ray?

DIAGNOSTIC IMAGING TERMS EXERCISES

Match the correct definition on the right with the term on the left.

- | | |
|---------------------|------------------------|
| 3. ____ ultrasound | a. blood-brain barrier |
| 4. ____ radiography | b. drug test |
| 5. ____ PET scan | c. in a test tube |
| 6. ____ CAT scan | d. imaging of a joint |

- | | |
|--------------------------|---|
| 7. ____ cineradiography | e. loss of hair |
| 8. ____ arthrography | f. imaging showing slices of tissue |
| 9. ____ radioimmunoassay | g. imaging showing movement of substances |
| 10. ____ in vitro | h. device for delivering radiation |
| 11. ____ BBB | i. imaging of tissues or organs in motion |
| 12. ____ betatron | j. image using sound waves |
| 13. ____ alopecia | k. the production of diagnostic images |

Matching

Write the letter of the meaning of each of the diagnostic imaging terms in the space provided.

- | | |
|---|---|
| 14. ____ sonogram | a. image that traces the passage of a radiopharmaceutical through an organ or tissue. |
| 15. ____ tomography | b. use of imaging techniques in diagnosing illness. |
| 16. ____ tracer study | c. medical specialty in diagnostic imaging and radiation treatment. |
| 17. ____ radiology | d. CAT scan |
| 18. ____ magnetic resonance imaging (MRI) | e. ultrasound image. |
| 19. ____ diagnostic imaging | f. radiology |
| 20. ____ fluoroscopy | g. imaging produced by tracking the magnetic properties in the nuclei of various cells |
| 21. ____ CT scan | h. headgear worn by patients needing pinpoint accuracy in the treatment of brain anomalies. |
| 22. ____ stereotactic frame | i. x-ray in which the image is projected onto a fluorescent screen. |
| 23. ____ roentgenology | j. type of imaging that produces three-dimensional images. |

Surgical Terms

Types of Surgery

Surgery is the removal of tissue, manipulation of tissue, or insertion of a device or transplanted body part or tissue. There are many types of surgery:

- **Preventative**, designed to prevent further disease (as in removal of a cancerous lesion likely to spread).
- **Manipulative** or **closed**, changed without incision (as in the alignment of a fracture).
- **Diagnostic**, helping to finalize a diagnosis (as in the removal of sample tissue for microscopic diagnosis or biopsy).
- **Minimally invasive**, with the smallest possible incision (as in surgeries that use laparoscopes).
- **Reconstructive** or **cosmetic**, designed to improve on or return a part of the body to its original functioning and/or appearance.

- **Cryogenic**, involving the use of freezing to destroy tissue.
- **Cauterizing**, involving the use of heat to destroy tissue.

Surgery and **operations**, the removal, transplant, or manipulation of tissue performed in surgery, can be described according to location on the body, obstruction being removed, machine or techniques being used, or where it is performed. Abdominal surgery is performed on the abdomen; craniofacial surgery is performed on the cranium and facial bones; hip surgery usually means repair or replacement of a hip; transplant surgery is the removal of and insertion of a body part or tissue; and dental surgery is performed on the mouth and gums. Cataract surgery is the removal of a lens of the eye, and **Mohs' surgery** is the removal of a carcinoma after mapping with a chemical to establish the narrowest possible margin of affected tissue. *Endoscopic* and *laparoscopic* surgeries are performed with the use of a camera attached to a lighted probe. *Inpatient* surgery takes place in the hospital with the patient admitted for one or more nights. *Ambulatory* or *outpatient* surgery takes place in a hospital, clinic, or office without admission to a hospital.

Surgical Implements

In the centuries before anesthesia and x-rays, surgery was basically performed using a knife and a lot of guesswork (Figure 19-3). Later, **aseptic** (germ-free) environments and instruments contributed to a gradually increasing surgical survival rate. Surgical implements include cutting and dissecting instruments, clamping devices, retracting, dilating, and probing instruments, injecting and suturing implements, and equipment to protect the surgical staff.

Cutting and dissecting instruments include various types of **scalpels** (knives), **surgical scissors**, and **curette** (also *curet*), sharp-edged instruments for scraping tissue. Surgical **clamps** or **forceps** are used to grasp and hold or remove something during surgery. Forceps may be placed around something (such as a baby's temple) to aid in pulling the baby out through the birth canal. Clamps are used to grab and hold tissue in place or to apply pressure to a blood vessel to control bleeding. **Retractors** are used to hold a surgical wound open, **dilators** are used to enlarge an opening, and **probes** are used to explore body cavities or to clear blockages. Hollow needles are used in surgery to inject or extract material. **Suture needles** and **needle holders** allow the surgeon to bind the surgical wound after surgery by sewing suturing material through the wound. **Staples** are another suturing implement. New glues and other materials can be used to suture without needles or staples.

Individuals participating in the surgical procedure must wear personal surgical protective clothing that includes scrub gowns or outfits (pants and top), protective headgear, face shields, protective glasses, and masks (Figure 19-4). Those people who will be performing or assisting in the surgery must also wear sterile gowns and latex or vinyl gloves. All must follow hospital and government rules (set by OSHA, Occupational Safety and Health Administration) and guidelines for **standard precautions** (set by the CDC, Centers for Disease Control and Prevention) with regard to blood and body fluids to prevent the spread of disease. Standard precautions are slightly more detailed than the previous universal precautions set by the government.

The American Society for Aesthetic Plastic Surgery's Web site (www.surgery.org) provides detailed information about plastic surgery.



FIGURE 19-3 A technician operating an MRI scanner.



FIGURE 19-4 Surgery being performed in an aseptic environment.

VOCABULARY REVIEW

In the previous section, you learned terms relating to surgery. Before going on to the exercises, review the terms below and refer to the previous section if you have any questions. Pronunciations are provided for certain terms. Sometimes information about where the word came from is included after the term. These etymologies (word histories) are for your information only. You do not need to memorize them.

Term	Meaning
aseptic [ā-SĔP-tĭk] a-, without + sepsis, presence of pathogens	Germ-free.
cauterizing [KĀW-tĕr-ĭz-ĭng] From Greek <i>kauterion</i> , branding iron	Destroying tissue by burning.
clamps [klāmps]	Implement used to grasp a body part during surgery.
closed	Performed without an incision.
cosmetic	Designed to improve the appearance of an exterior body part.
cryogenic [krĭ-ō-JĔN-ĭk] cryo-, cold + -genic, producing	Destroying tissue by freezing.
curette [kyū-RĔT]	Sharp instrument for scraping tissue.
diagnostic [dĭ-ăg-NŎS-tĭk]	Helping to finalize a diagnosis.
dilator [DĪ-lā-tŏr]	Implement used to enlarge an opening.
forceps [FŎR-sĕps] Latin, tongs	Surgical implement used to grasp and remove something.
manipulative [mă-NĪP-yū-lā-tĭv]	Done without an incision, as in the reduction of a fracture.
minimally invasive	Done with the smallest incision possible, such as the clearing of arterial blockages with tiny probes that use lasers.
Mohs' [mŏhz] surgery After Frederic Mohs (1910–2002), U.S. surgeon	Removal of a carcinoma after mapping with a chemical to establish the narrowest possible margin of affected tissue.
needle holder	Surgical forceps used to hold and pass a suturing needle through tissue.
operation	Any surgical procedure, such as the removal, transplant, or manipulation of tissue.
preventative [prĕ-VĔN-tă-tĭv]	Designed to stop or prevent disease.
probe	Sharp device for exploring body cavities or clearing blockages.
reconstructive [rĕ-cŏn-STRŬC-tĭv]	Designed to restore a body part to its original state or appearance.

Term	Meaning
retractor [rē-TRĀK-tōr]	An instrument used to hold back edges of tissue and organs to expose other tissues or body parts; especially used in surgery.
scalpel [SKĀL-pl] Latin <i>scalpellum</i> , small knife	Knife used in surgery or dissection.
standard precautions	Guidelines issued by the Centers for Disease Control for preventing the spread of disease.
staples	Metal devices used to suture surgical incisions.
surgery [SĔR-jēr-ē]	Removal, transplant, or manipulation of tissue.
surgical scissors	Scissors used for cutting and dissecting tissue during surgery.
suture [SŪ-chūr] needles	Needles used in closing surgical wounds by sewing.

CASE STUDY

Outpatient Surgery

James Wilson, an 80-year-old, scheduled his yearly appointment with his ophthalmologist. James has had cataracts but they were not yet ready to be removed. However, at this visit, the ophthalmologist suggested that removal of the right cataract and insertion of an intraocular lens would be a fast and comfortable solution to Mr. Wilson's ever-diminishing sight. The medical assistant scheduled Mr. Wilson for surgery at the Eye and Ear Center, a local outpatient clinic. The day of the surgery, Mr. Wilson was greeted by a patient care technician who escorted him into the surgical area. There he was given a surgical gown and covers for his shoes

and head. The doctor, anesthesiologist, and nurse all were in the operating room scrubbed and ready for surgery. Later that day, after several hours of rest and observation, Mr. Wilson's son picked him up to take him home.

Critical Thinking

24. Is Mr. Wilson's surgery an example of preventative, diagnostic, or cosmetic surgery?
25. Cataract operations are simple and localized in one eye. Why is it necessary for the doctors and assistants to be surgically aseptic?

SURGICAL TERMS EXERCISES

Know the Equipment

Write the name of the instrument that is being defined in each statement below.

forceps clamps probe surgical scissors curette dilator needle holder retractor staples surgical needles

26. Sharp instrument for scraping tissue: _____
27. Needles used in closing surgical wounds by sewing: _____
28. Device for exploring body cavities or clearing blockages: _____
29. Surgical forceps used to pass a suturing needle through tissue: _____

30. Instrument used to hold back edges of tissue and body organs to expose other tissues or body parts: _____
31. Instrument used to grasp a body part especially during surgery: _____
32. Implement used to enlarge an opening: _____
33. Surgical implement used to grasp and remove: _____
34. Metal devices used to suture surgical openings: _____
35. Scissors used for cutting and dissecting tissue during surgery: _____

Combining Forms and Abbreviations

The lists below include combining forms, suffixes, and abbreviations that relate specifically to diagnostic imaging and surgery. Pronunciations are provided for the examples.

COMBINING FORM	MEANING	EXAMPLE
cine	movement	<i>cineradiography</i> [SĪN-ě-rā-dē-ŌG-ră-fē], radiography of an organ in motion
electr(o)	electric; electricity	<i>electrocardiogram</i> [ē-lĕk-trō-KĀR-dē-ō-grām], graphic record of heart's electrical currents
fluor(o)	light; luminous	<i>fluoroscopy</i> [flūr-ŌS-kō-pē], deep tissue examination by x-ray
micr(o)	small; microscopic	<i>microsurgery</i> [mī-krō-SĔR-jēr-ē], surgery performed using magnification by a microscope
radi(o)	radiation	<i>radiopaque</i> [RĀ-dē-ō-PĀK], impenetratable to radiation
son(o)	sound	<i>sonogram</i> [SŌN-ō-grām], ultrasound image
ultra	beyond	<i>ultrasound</i> [ŪL-tră-sōwnd], imaging using sound frequencies beyond a certain frequency
SUFFIX	MEANING	EXAMPLE
-centesis	puncture	<i>amniocentesis</i> [ăm-nē-ō-sĕn-TĒ-sĭs], retrieval of amniotic fluid through a needle inserted into the amnion
-clasis	breaking	<i>osteoclasia</i> [ŌS-tē-ō-KLĀ-sĭs], intentional breaking of a bone
-clast	breaking	<i>osteoclast</i> [ŌS-tē-ō-klăst], instrument for breaking a bone
-ectomy	removal of	<i>appendectomy</i> [ăp-pĕn-DĔK-tō-mē], removal of the appendix
-gram	a recording	<i>sonogram</i> [SŌN-ō-grām], ultrasound image

SUFFIX	MEANING	EXAMPLE
-graph	recording instrument	<i>electroencephalograph</i> [ē-LĚK-trō-ĕn-SĚF-ă-lō-grăf], system for recording the brain's electrical activity
-graphy	process of recording	<i>ultrasonography</i> [ŮL-tră-sō-NŎG-ră-fē], imaging by the use of sound waves
-opsy	a viewing	<i>biopsy</i> [BĪ-ŏp-sē], removal of tissue from a living patient for examination
-ostomy	opening	<i>colostomy</i> [kō-LŎS-tō-mē], surgical opening in the colon
-pexy	fixation done surgically	<i>nephropexy</i> [NĚF-rō-pĕk-sē], surgical fixation of a floating kidney
-plasty	surgical repair	<i>rhinoplasty</i> [RĪ-nō-plăs-tē], plastic surgery of the nose
-rrhaphy	surgical suturing	<i>herniorrhaphy</i> [hĕr-nē-ŎR-ă-fē], surgical repair of a hernia
-scope	instrument for observing	<i>microscope</i> [MĪ-krō-skōp], instrument for viewing small objects
-scopy	a viewing	<i>microscopy</i> [mĭ-KRŎS-kō-pē], use of microscopes
-stomy	opening	<i>nephrostomy</i> [nĕ-FRŎS-tō-mē], surgical opening between the kidney and the exterior of the body
-tome	cutting segment	<i>osteotome</i> [ŎS-tē-ō-tōm], instrument for cutting bone
-tomy	cutting operation	<i>laparotomy</i> [LĂP-ă-RŎT-ō-mē], incision in the abdomen

ABBREVIATION	MEANING	ABBREVIATION	MEANING
Ba	barium	DSA	digital subtraction angiography
BaE	barium enema	ERCP	endoscopic retrograde cholangiopancreatography
CAT	computerized axial tomography	Fx	fracture
C-spine	cervical spine (film)	gy	unit of radiation equal to 100 rads
CT	computed tomography	IVC	intravenous cholangiography
CXR	chest x-ray	IVP	intravenous pyelogram
IVU	intravenous urography	rad	radiation absorbed dose
MRA	magnetic resonance angiography	RAI	radioactive iodine
MRI	magnetic resonance imaging	RIA	radioimmunoassay

ABBREVIATION	MEANING	ABBREVIATION	MEANING
MUGA	multigated acquisition scan	SPECT	single photon emission computed tomography
NMR	nuclear magnetic resonance (imaging)	U/S	ultrasound
PET	positron emission tomography	V/Q	ventilation perfusion scan
r	roentgen	XRT	radiation therapy
Ra	radium		

CASE STUDY

Receiving Treatment

Molly Pearl is 80 years old and is having frequent bouts of dizziness, has fallen five times, and is losing some feeling in her limbs. Her gerontologist has referred her to a clinic for neurological disorders where she is given a number of tests including an MRI and a CAT scan. The results of the tests show abnormalities that contribute to her symptoms.

Critical Thinking

36. Why do some imaging tests require the use of a contrast medium?
37. In what part of Molly Pearl's body did the MRI likely show abnormalities?

COMBINING FORMS AND ABBREVIATIONS EXERCISES

Build Your Medical Vocabulary

Complete the terms below by adding a suffix from the list in this section.

38. Kidney removal: nephro_____
39. Recording of the heart: cardio_____
40. Imaging of an artery: arterio_____
41. Suture of a vein: phlebo_____
42. Surgical fixing of the bladder: cysto_____
43. Instrument for viewing the uterus: hystero_____
44. Creation of an opening into the bladder: cysto_____
45. Cutting of a nerve: neuro_____

Root Out the Meaning

Separate the following terms into word parts and define each word part.

46. cineangiocardiology _____
47. cineradiography _____
48. electrodiagnosis _____
49. electroencephalography _____
50. electrolysis _____
51. electrophoresis _____
52. electrophysiology _____
53. electrosurgery _____
54. fluoroscopy _____
55. microscope _____

- 56. radiotherapy _____
- 57. radiopharmaceutical _____
- 58. sonogram _____
- 59. microsurgery _____
- 60. radiology _____
- 61. amniocentesis _____
- 62. colocentesis _____
- 63. thoracocentesis _____
- 64. arthroclasia _____
- 65. osteoclasia _____
- 66. vasectomy _____
- 67. cholecystogram _____
- 68. electromyogram _____
- 69. mammogram _____
- 70. venogram _____
- 71. angiography _____
- 72. colonography _____
- 73. hysteroplasty _____
- 74. dermatoplasty _____
- 75. keratoplasty _____

USING THE INTERNET

The governmental Agency for Health Care Policy and Research (www.ahcpr.gov/consumer/surgery/surgery.htm) maintains a Web site containing information about surgery. Go to the site and find at least five questions to ask your doctor before you have surgery.

CHAPTER REVIEW

The material that follows is to help you review this chapter.

Root Out the Meaning

Separate the following terms into word parts and define each word part.

- | | |
|--------------------------------|--------------------------------|
| 76. electrocauterization _____ | 103. ileostomy _____ |
| 77. electrochemotherapy _____ | 104. craniostomy _____ |
| 78. electrodesiccation _____ | 105. cystolithotomy _____ |
| 79. fluorometry _____ | 106. episiotomy _____ |
| 80. fluoroscope _____ | 107. laryngotracheotomy _____ |
| 81. fluoroscopic _____ | 108. phlebectomy _____ |
| 82. microscopy _____ | 109. tenotomy _____ |
| 83. radiography _____ | 110. tracheotomy _____ |
| 84. sonography _____ | 111. bronchoplasty _____ |
| 85. sonographer _____ | 112. dermatoplasty _____ |
| 86. ultrasonography _____ | 113. neuroplasty _____ |
| 87. ultrasound _____ | 114. rhinoplasty _____ |
| 88. arthrocentesis _____ | 115. tenomyoplasty _____ |
| 89. pericardiocentesis _____ | 116. angiorrhaphy _____ |
| 90. pleurocentesis _____ | 117. colpoperineorrhaphy _____ |
| 91. clastic _____ | 118. neurorrhaphy _____ |
| 92. adenoidectomy _____ | 119. hysteropexy _____ |
| 93. endarterectomy _____ | 120. nephropexy _____ |
| 94. laryngectomy _____ | 121. pleuropexy _____ |
| 95. lobectomy _____ | 122. endoscope _____ |
| 96. mastectomy _____ | 123. laparoscope _____ |
| 97. pneumonectomy _____ | 124. arthroscopy _____ |
| 98. prostatectomy _____ | 125. colonoscopy _____ |
| 99. onychectomy _____ | 126. sigmoidoscopy _____ |
| 100. mammography _____ | 127. adenotome _____ |
| 101. nephrosonography _____ | 128. dermatome _____ |
| 102. colostomy _____ | 129. mammatome _____ |

Complete the Sentence

Circle the term that best describes the *italicized* description of the correct answer

130. The roentogram required the use of *radioactive particles with high penetrating ability* in order to properly produce the visual needed to diagnose the condition. (alpha rays, beta rays, gamma rays)
131. The radiologist performed the *implantation of radioactive elements directly into the tumor* to reduce the size and hopefully eliminate the tumor altogether. (interstitial therapy, brachytherapy, intercavitary therapy)

132. A routine x-ray was not appropriate for the diagnosis of injured tissue because the tissue is *easily penetrated by x-rays*. (radiopaque, radiosensitive, radiolucent)
133. The small intestine was illuminated by the *contrast medium that showed up as white on the x-ray*. (barium, iodine, radionuclide)
134. _____ are *guidelines issued by the Centers of Disease Control for preventing the spread of disease*. (aseptic procedures, standard precautions, or preventive procedures)
135. The patient hoped surgery *designed to restore a body part to its original state of appearance* would be successful. (cosmetic, manipulative, reconstructive)

True or False

Indicate in the blank whether the statement is true (T) or false (F).

136. ____ Mohs' surgery is the removal of a carcinoma after mapping with a chemical to establish the narrowest possible margin of affected tissue. T F
137. ____ The destruction of tissue by burning is called cryocautery. T F
138. ____ Ultrasonography and sonography refer to the same process. T F
139. ____ Arthrography is the imaging of joints after injection of an iodine substance. T F
140. ____ A gallium scan, using a specific radionuclide (gallium-76) is used to locate tumors and cysts. T F
141. ____ An example of a manipulated or closed surgery would be correcting a simple dislocated joint. T F

Check Your Spelling

For each of the following terms, place a C if the spelling is correct. If it is not, write the correct spelling in the space provided.

142. kriogenic _____
143. suture _____
144. currette _____
145. interstitial _____

DEFINITIONS

Define the following terms, combining forms, and suffixes. Review the chapter before starting. Make sure you know how to pronounce each term as you define it.

TERM

- | | | |
|---|---|----------------------------------|
| 146. alpha [ǺL-fǻ] rays | 155. cineradiography [SĪN-ě-rā-dē-ŎG-rǻ-fē] | 165. diagnostic imaging |
| 147. aseptic [ā-SĔP-tĭk] | 156. clamps [klāmps] | 166. dilator [DĪ-lā-tor] |
| 148. barium [BǺ-rē-ŭm] | 157. -clasis | 167. -ectomy |
| 149. beta [BĀ-tǻ] rays | 158. -clast | 168. electr(o) |
| 150. brachytherapy [brǻk-ē-THĀR-ǻ-pē] | 159. closed | 169. fluor(o) |
| 151. CAT (computerized axial tomography) scan | 160. cosmetic | 170. fluoroscopy [flūr-ŎS-kō-pē] |
| 152. cauterizing [KǺW-tēr-iz-ĭng] | 161. cryogenic [krĭ-ō-JĔN-ĭk] | 171. forceps [FŎR-sĕps] |
| 153. -centesis | 162. CT (computed tomography) scan | 172. gamma [GǺ-mǻ] rays |
| 154. cine | 163. curette [kyū-RĔT] | 173. -gram |
| | 164. diagnostic [dĭ-ǻg-NŎS-tĭk] | 174. -graph |
| | | 175. -graphy |

TERM

176. gray (gy)	196. -pexy	215. -rrhaphy
177. imaging [ĪM-ă-jĭng]	197. -plasty	216. scalpel [SKĀL-pl]
178. interstitial [ĭn-tēr-STĪSH-ăł] therapy	198. preventative [prē-VĒN-tă-tive]	217. scan
179. intracavitary [ĪN-tră-CĀV-ĭ-tār-ē] therapy	199. probe	218. -scope
180. iodine [Ī-ō-dĭn]	200. rad [răd] (radiation absorbed dose)	219. -scopy
181. ion [Ī-ōn]	201. radiation [RĀ-dē-Ā-shŭn]	220. son(o)
182. ionize [Ī-ōn-ĭz]	202. radi(o)	221. sonogram [SŌN-ō-grām]
183. irradiated [ĭ-RĀ-dē-āt-ēd]	203. radiography [RĀ-dē-ŌG-ră-fē]	222. standard precautions
184. magnetic resonance imaging (MRI)	204. radioimmunoassay (RIA) [RĀ-dē-ō-ĪM-ŭ-nō-ĀS-sā]	223. staples
185. malaise [mă-LĀZ]	205. radiology [RĀ-dē-ŌL-ō-jē]	224. stereotactic [STĒR-ē-ō-TĀK-tĭk] frame
186. manipulative [mă-NĪP-yŭ-lă-tĭv]	206. radiolucent [RĀ-dē-ō-LŪ-sĕnt]	225. -stomy
187. micr(o)	207. radionuclide [RĀ-dē-ō-NŪ-klĭd]	226. surgery [SĒR-jĕr-ē]
188. minimally invasive	208. radiopaque [RĀ-dē-ō-PĀK]	227. surgical scissors
189. Mohs' [mōhz] surgery	209. radiopharmaceutical [RĀ-dē-ō-făr-mă-SŪ-tĭ-kăl]	228. suture [SŪ-chŭr] needles
190. needle holder	210. radioresistant [RĀ-dē-ō-rē-ZĪS-tĕnt]	229. -tome
191. nuclear medicine	211. radiosensitive [RĀ-dē-ō-SĒN-sĭ-tĭv]	230. tomography [tō-MŌG-ră-fē]
192. operation	212. reconstructive [rē-cŏn-STRŪC-tĭv]	231. -tomy
193. -opsy	213. retractor [rē-TRĀK-tŏr]	232. tracer study
194. -ostomy	214. roentgenology [RĒNT-gĕn-ŌL-ō-jē]	233. ultra
195. PET (positron emission tomography) scan		234. ultrasonography [ŪL-tră-sō-NŌG-ră-fē]
		235. ultrasound [ŪL-tră-sŏwnd]
		236. uptake [ŪP-tāk]
		237. x-ray [ĖKS-ră]

Abbreviations

Write the full meaning of each abbreviation.

ABBREVIATION

238. BA	247. gy	256. r
239. BaE	248. IVC	257. Ra
240. CAT	249. IVP	258. rad
241. C-spine	250. IVU	259. RAI
242. CT	251. MRA	260. RIA
243. CXR	252. MRI	261. SPECT
244. DSA	253. MUGA	262. U/S
245. ERCP	254. NMR	263. V/Q
246. Fx	255. PET	264. XRT

Name _____ Date _____

Chapter 19: Word- Building (20 questions—1 pts. each)

Using the following combining forms and suffixes, complete the word that best fits the definition of each word relating to diagnostic imaging and surgery listed below. Combining forms and suffixes may be used more than once.

-centesis	-gram	-pexy	-scopy
-clasis	-graphy	-plasty	son(o)
-ectomy	micr(o)	radi(o)	-stomy
electr(o)	-opsy	-rrhaphy	-tome
fluor(o)	-ostomy	-scope	-tomy

1. Surgical excision of a muscle: my _____
2. Making of an opening in the colon: _____ ostomy
3. Radiograph of the heart: cardio _____
4. Surgery performed under magnification: _____ surgery
5. Intentional fracturing of a bone: osteo _____
6. Removal of tissue for examination: bi _____
7. Examination of tissue using a fluoroscope: _____ scopy
8. Suture of the loins: laparo _____
9. Diagnosis using x-rays: _____ diagnosis
10. Puncture into the amniotic sac: amnio _____
11. Surgical alteration of the nose: rhino _____
12. Destruction of nerve tissue by electricity: _____ neurolysis
13. Surgical repair of the breast: mammo _____
14. Motion picture of organ movement by x-ray: _____ cinematography
15. Radiograph of a blood vessel: angio _____
16. Tiny suture material: _____ suture
17. Slender knife for separating nerve fibers: neuro _____
18. Instrument that records uterine electrical activity: _____ hystero-graph
19. Incision into a vein: phlebo _____
20. Imaging of the breast by x-ray: mammo _____