

The Musculoskeletal System

The musculoskeletal system consists of bones, joints, cartilage, ligaments, tendons, and muscles. These different organs work together to achieve a variety of functions which include movement, protection, support, and storage.

Bones

Bone is a hard form of connective tissue that makes up most of the skeleton. It is primarily composed of collagen and minerals such as calcium and phosphorus. In the earliest stages of development, the skeleton is made up of cartilaginous tissue which is softer and more flexible. After birth, that fibrous tissue is converted into osseous (bone) tissue (Table 3.1).

TECH TIP 3.1 Puppies commonly have their dewclaws removed soon after birth because they are still made of primarily cartilaginous tissue. If the owners wait too long, then the dewclaw becomes osseous tissue and the surgical procedure is far more involved. Dewclaws should be removed to avoid injuries later in the dog's life. Dogs often get their dewclaws caught on fabric and end up tearing the digit.

Table 3.1 Formation of bone.

Osseous tissue	Another name for bone tissue.
Ossification	Process of bone formation.
Osteoblast	Bone cell that forms bone tissue. Also known as an immature bone cell.
Osteoclast	Bone cell that absorbs and removes bone tissue. Also known as a phagocyte of bone.
Osteocyte	Bone cell (Figure 3.1).

Steps of Ossification

Bone formation is a constant process in that new bone tissue is continuously being formed while older bone tissue is continuously being removed. The older tissue must be removed to prevent the bone from becoming too thick or too heavy. Within the osseous tissue are cells called osteoblasts and osteoclasts. The osteoblasts are the immature bone cells that help to build bone tissue by supplying the minerals needed for bone formation. Once the osteoblasts mature, they become osteocytes, which act as part of the structural

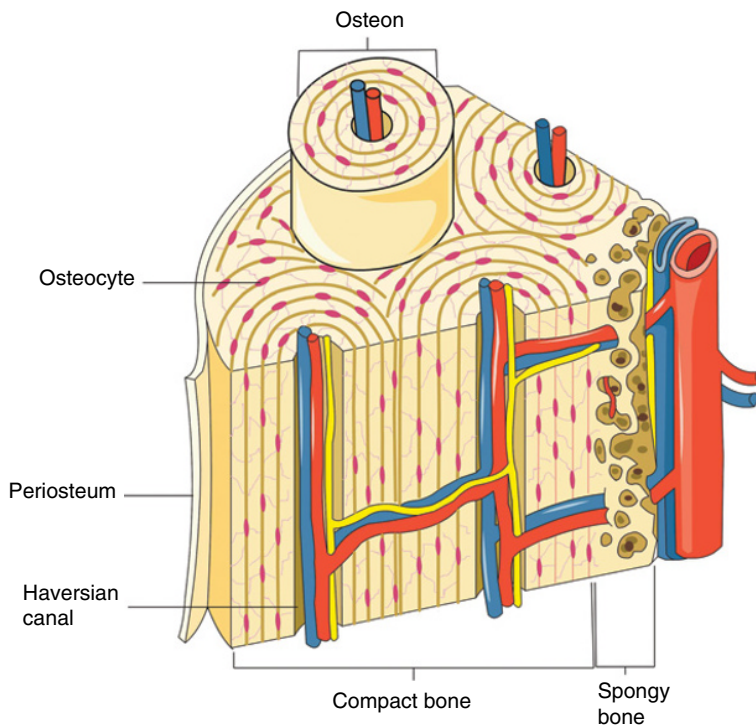


Figure 3.1 Cross-section of bone. Source: Courtesy of shutterstock/mmutlu.

matrix of bone. Osteoclasts are responsible for removing bone tissue that is no longer needed by resorbing and digesting it. If the bone is injured, then the osteoblasts patch the break while the osteoclasts smooth it out and remove the leftover materials. Even if the body is not injured, the osteoblasts are continuously making new bone tissue and the osteoclasts are removing the older bone tissue. This constant process is what enables the bone to handle everyday stresses as well as repair itself once injured.

Anatomy of a Bone

Bones are grouped into different categories based on their shapes and functions. Regardless of the category they fall in, their basic anatomy is the same. Label the bone in Figure 3.2 using the terms listed in Table 3.2.

TECH TIP 3.2 Rules for “endo-,” “myo-,” and “peri-”

When the prefixes **endo-**, **myo-**, and **peri-** are attached to a term that ends with the suffixes **-ium** or **-eum**, their meanings change. Endo- becomes the inner lining of the root that it's attached to, myo- becomes the muscle lining of the root that it's attached to, and peri- becomes the membrane surrounding the root that it's attached to. For example:

Endocardium is the inner lining of the heart.
Myocardium is the muscle lining of the heart.
Pericardium is the membrane surrounding the heart.

Classifications of Bone

Bones are divided into different classifications based on their shape and function.

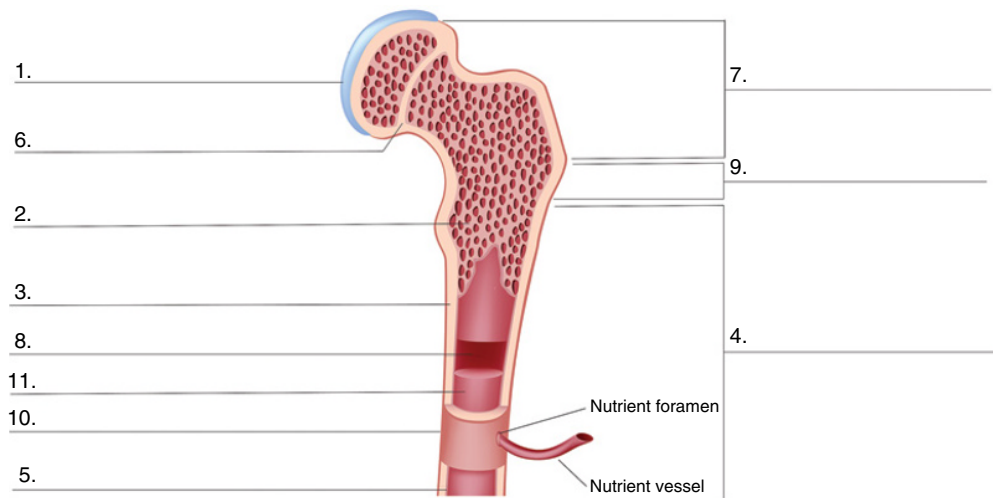


Figure 3.2 Anatomy of a long bone. Source: Courtesy of shutterstock/Alila Sao Mai.

Table 3.2 Bone anatomy.

Articular cartilage (1)	Thin layer of cartilage covering the surface of bones at a joint.
Calcium	The most abundant mineral in the body. When combined with phosphorus it forms calcium phosphate, which is the principal calcium salt and hard material found in bones and teeth.
Cancellous bone (2)	Spongy or porous bone found at the ends of long bones and in the inner portions of long bones.
Collagen	Structural protein making up the white fibrous strands found in bone.
Compact bone (3)	Hard, dense bone tissue that forms the outer layer of bone. Also known as cortical bone .
Diaphysis (4)	The shaft of a long bone. The plural form is diaphyses .
Endosteum (5)	The inner lining of bone. This forms the lining of the medullary cavity.
Epiphyseal plate (6)	Cartilaginous region of long bones where lengthwise growth takes place. This is also known as the physis or growth plate .
Epiphysis (7)	Each end of a long bone. It is composed of cancellous bone and covered with articular cartilage. The plural form is epiphyses .
Medullary cavity (8)	Central, hollowed-out portion in the shaft of a long bone that contains yellow bone marrow.
Metaphysis (9)	The flared portion of a long bone between the epiphyseal plate and diaphysis.
Periosteum (10)	Membrane surrounding bone. This fibrous tissue contains blood vessels and nerves.
Red bone marrow (11)	Found in cancellous bone and is the site of hematopoiesis (blood formation).
Yellow bone marrow	Found in the diaphysis of bone and consists of fatty tissue.

- Long bones:** These bones are longer than they are wide. They are found in the front and rear limbs. Examples of long bones include the femur, tibia, radius, and metacarpals.
- Short bones:** These bones are cuboidal (cube shaped). Examples of short bones include the carpals and tarsals.
- Flat bones:** These bones are actually two sheets of compact bone that allow for protection. Flat bones are flat and thin. Examples include the scapula, ribs, and bones of the pelvis and skull.
- Sesamoid bones:** Sesamoid bones are small bones that are embedded in tendons. They get their name because of their sesame seed shape. The patella is an example of a sesamoid bone. Horses have other sesamoid bones that will be discussed in later chapters.
- Irregular bones:** These bones don't fit into the previous categories because they share traits of several categories. The best example of this classification is the vertebrae.

Related Terms and Processes

The bones of the skeleton have various protrusions and depressions that allow for structural support (Table 3.3 and Figure 3.3).

Table 3.3 Bone processes.

Acetabulum	Cup-like depression in the pelvis that creates the hip joint.
Bone head	Rounded articular process separated from the shaft of the bone by a neck. The bone head is usually covered in articular cartilage. Examples include the femoral head and humeral head.
Condyle	Knuckle-like projections at the distal end of some long bones. They are usually covered by articular cartilage and articulate with other bones. Examples include the femoral and humeral condyles.
Crest	High projection or border projection of a bone. An example is the crest of the ilium (also known as the wing of the ilium).
Foramen	A hole in bone that allows for the passage of nerves and vessels. Examples include the obturator foramen and the foramen magnum.
Fossa	Shallow cavity or depression in bone. An example would be the trochanteric fossa which lies between the greater and lesser trochanter.
Groove	A narrow linear depression. Also known as a sulcus . An example is the bicipital groove on the humerus.
Olecranon	Bony process at the proximal end of the ulna.
Sinus	A hollow space or cavity in bone. An example is the nasal sinuses.
Trochanter	Large, blunt, roughened process on the femur for the attachment of muscles and tendons.
Tubercle	Rounded process on many bones for the attachment of muscles and tendons. The best example is the humeral tubercle.
Tuberosity	Small roughened process on many bones for the attachment of muscles and tendons. Examples include the tibial tuberosity and ischiatic tuberosity.

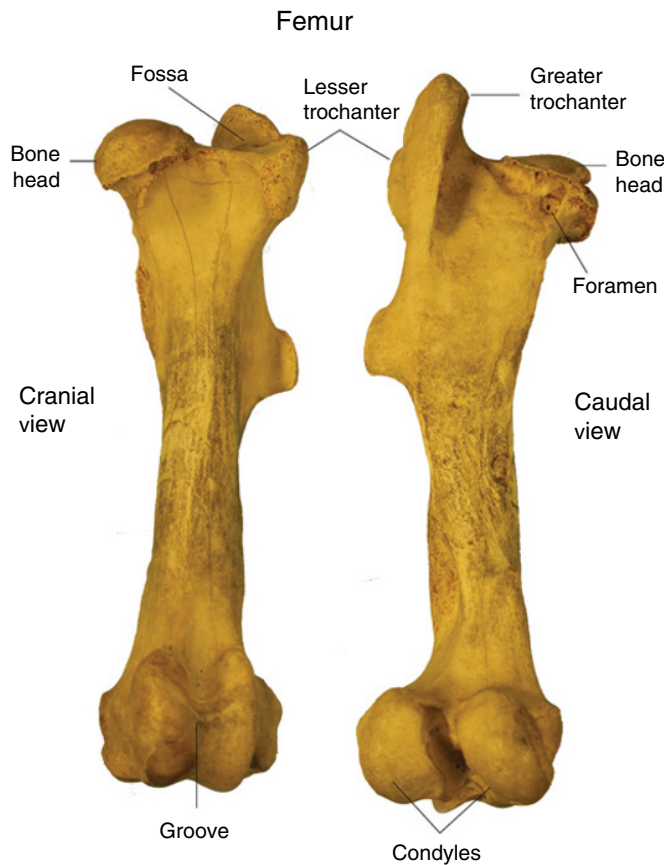


Figure 3.3 Processes on the femur of a cow.

Divisions of the Skeleton

If we look at the skeleton as a whole, we can divide it into three portions: the axial skeleton, which consists of bones along the axis (center) of the body; the appendicular skeleton, which consists of the bones of the appendages (extremities); and the visceral (splanchnic) skeleton, which consists of bones that are embedded in tissue. We will focus on small animal skeletal structure in this chapter. Large animals and exotics will be covered in later chapters.

The Axial Skeleton

Bones of the axial skeleton include the skull, vertebrae (backbones), ribs, and sternum. Notice that only bones along the axis (midline) of the body are a part of the axial skeleton. A common misconception is that the pelvis and scapula are a part of the axial skeleton. However, they don't originate from the midline and instead play a role in the function of the limbs. Therefore, they're a part of the appendicular skeleton.

The Skull

The skull is composed of several bones that surround and protect the brain (Figure 3.4).

Ethmoid bone	Bone that forms the roof of the nasal cavity and the floor of the rostral cranial cavity (orbits of the eyes).
Frontal bone	Paired bones making up the upper part of the face; the cranial aspect of the skull.
Occipital bone	The caudal aspect of the skull.
Parietal bone	Paired bones forming the sides and roof of the cranium.
Sphenoid bone	Wedge-shaped bone at the base of the skull.
Temporal bone	Paired bones forming the lower sides of the skull.
Facial bones	Facial bones make up the front of the skull. Within these facial bones are spaces of air called sinuses .
Hyoid bone	Horseshoe-shaped bone at the base of the tongue and below the thyroid cartilage.
Incisive bone	Bone bearing the incisors. Also known as the premaxilla .
Lacrimal bone	Bone forming the medial aspect of the orbit (eye socket).
Mandibular bones	Horseshoe-shaped bones forming the lower jaw.
Maxillary bones	Two identical bones that form the upper jaw.
Nasal bones	Two bones forming the bridge of the nose.
Palatine bone	Bone that forms the hard palate.
Vomer	Bone forming the base of the nasal septum. A septum is a partition.
Zygomatic bones	Bones forming the hard part of the cheek and the lower portion of the orbit (eye socket).

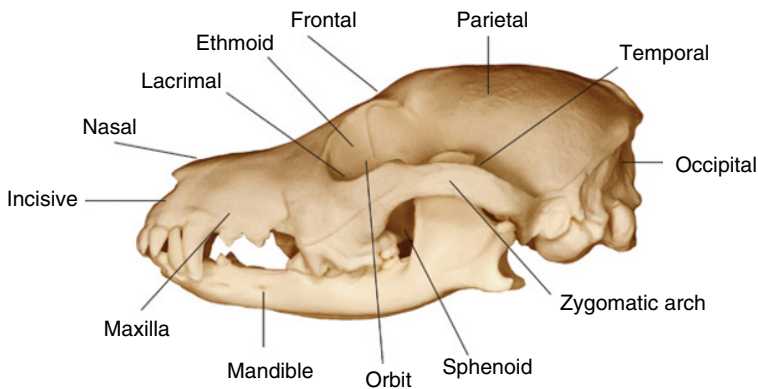


Figure 3.4 Bones of the dog's skull.

The Backbones

The vertebral column, or spinal column, is composed of a series of backbones called vertebrae. They are arranged based on size and function. The vertebrae differ based

on function, but the general anatomy is the same (Figures 3.5 and 3.6). Figure 3.5 depicts the parts of a vertebra. Note the spinal cord, which passes through the opening in the middle, called a foramen.

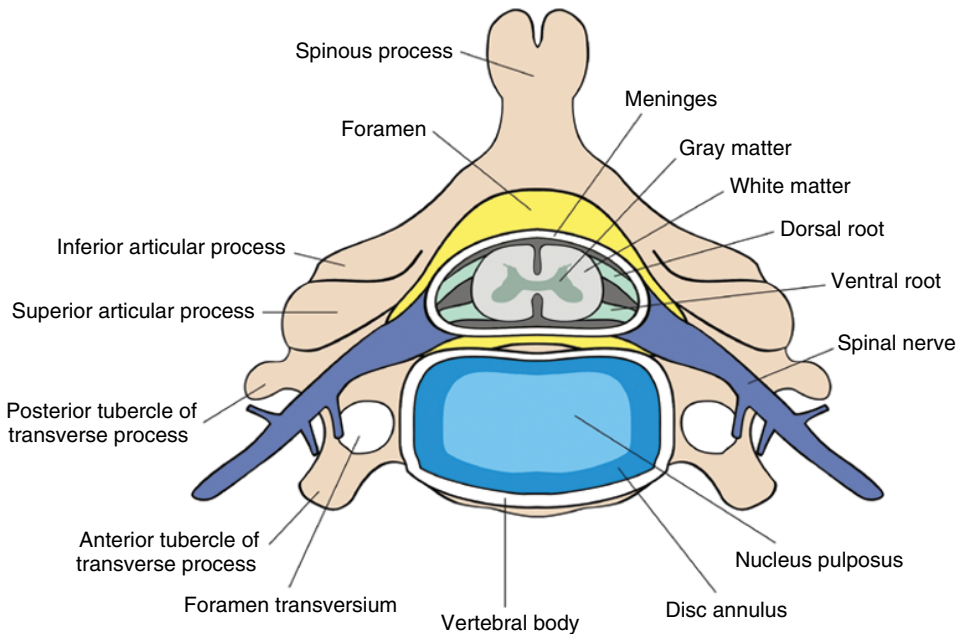


Figure 3.5 Anatomy of a vertebra. Source: Courtesy of shutterstock/udaix.

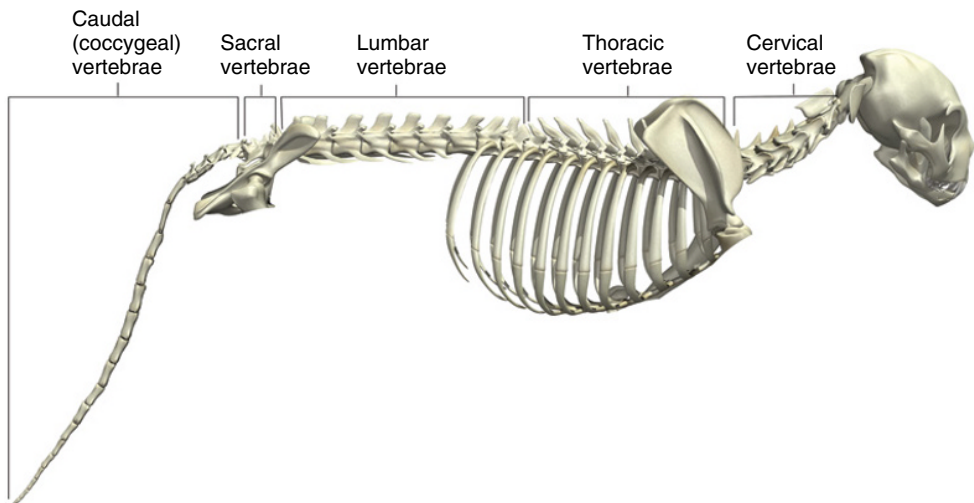


Figure 3.6 Vertebral column of the cat. Source: Courtesy of shutterstock/Linda Bucklin.

Bones of the Thorax

The chest cavity is made up of the ribs and sternum. The number of ribs varies based on species. Each pair of ribs attaches to the thoracic vertebrae; therefore, the number of thoracic vertebrae corresponds with the number of pairs of ribs.

For example, there are 13 thoracic vertebrae in the dog; thus, there are 13 pairs of ribs in the dog or 26 in total.

The sternum, or breastbone, lies along the midline of the chest and comprises the ventral portion of the rib cage. The sternum is made up of three portions

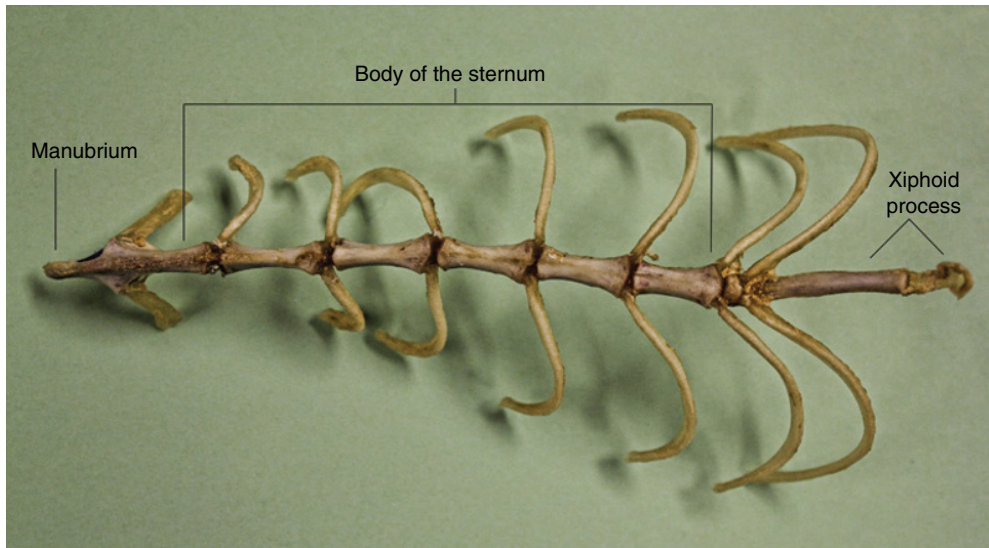


Figure 3.7 Parts of the sternum.

called sternebrae (Figure 3.7). The upper portion of the sternum is called the manubrium, the mid-portion is called the body, and the lower portion is called the xiphoid process.

The xiphoid process is an important structure for veterinary technicians. We use the xiphoid process as a landmark when taking abdominal radiographs, and we use it to determine where to stop shaving when we are shaving an animal for abdominal surgery. Veterinarians use the xiphoid as a guide for where to incise the patient for surgery.

The Appendicular Skeleton

Bones of the appendicular skeleton include the bones of the front and rear limbs and bones of the limb girdles (pelvis and scapula). Label the thoracic limb in Figure 3.8 using the terms listed in Table 3.4. Label the pelvic limb in Figure 3.9 using the terms listed in Table 3.5.

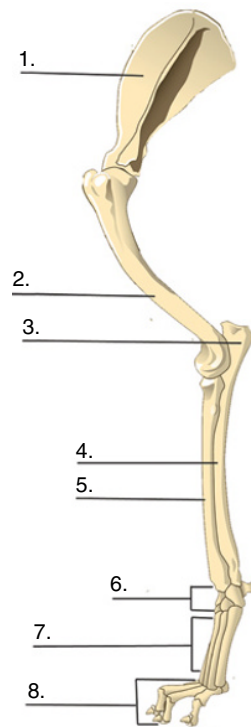


Figure 3.8 Thoracic limb of the dog. Source: Courtesy of shutterstock/Maluson.

Table 3.4 The thoracic limb.

Bones	Location
Scapula (1)	A flat, triangular bone at the top of the shoulder commonly known as the shoulder blade.
Clavicle	Also known as the collarbone ; some animals have a reduced (imperfect) clavicle, while other species completely lack one. Only species capable of grasping with their front limbs possess one. Examples include cats and primates.
Humerus (2)	Bone of the upper front limb between the shoulder and the elbow.
Radius (5)	One of two bones in the lower front limb between the elbow and the wrist (carpus).
Ulna (4)	One of the two bones in the lower front limb between the elbow and wrist (carpus).
Olecranon (3)	Bony process on the proximal aspect of the ulna.
Carpals (6)	Six to eight bones (depending on species) grouped together in two rows to make up the carpus.
Metacarpals (7)	A group of long bones between the carpals and phalanges.
Phalanges (8)	Commonly known as the digits. Each phalanx has three phalanges.

Table 3.5 The pelvic limb.

Bones	Location
Pelvis	The pelvis is made up of three pairs of bones: the ilium (1), ischium (2), and pubis (3).
Femur (4)	Commonly called the thigh bone. The femur is between the hip and stifle.
Patella (5)	Large sesamoid bone found in the stifle. Commonly called the kneecap.
Fabella	Sesamoid bone found in the back of the femoral condyles. Most species have two.
Tibia (7)	The larger medial bone of the lower hindlimb.
Fibula (6)	The smaller lateral bone of the lower hindlimb.
Tarsals (9)	Seven bones that make up the tarsus (hock).
Calcaneus (8)	One of the seven tarsal bones that sits in the back of the tarsus. Commonly called the heel bone .
Metatarsals (10)	Group of bones between the tarsus and the phalanges.

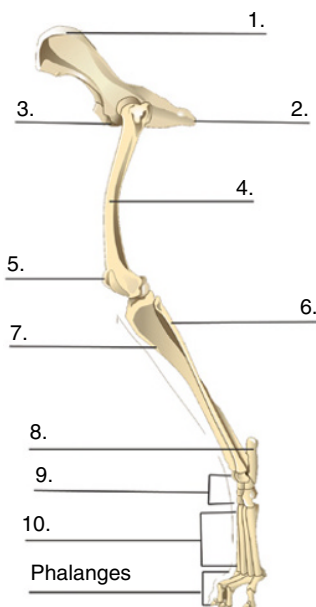


Figure 3.9 Pelvic limb of the dog. Source: Courtesy of shutterstock/Maluson.

The Visceral Skeleton

The visceral skeleton contains bones that are embedded in tissues. This part of the skeleton helps to form an organ. Examples of bones of the visceral skeleton include the following:

- Os penis Bone found in the penis of some carnivores (Figure 3.10).
- Os rostri Bone found in the nose of pigs.
- Os cordis Bone found in the heart of ruminants.

Additional Bone Pathology Terms

The following terms don't break down correctly using our rules of medical terminology.



Figure 3.10 Radiograph showing the os penis of the dog. Source: Courtesy of Beth Romano, AAS, CVT.

- Achondroplasia** Hereditary condition in which the bones and cartilage of the limbs fail to grow to normal size. Commonly known as **dwarfism**, achondroplastic breeds include the dachshund and basset hound (Figure 3.11).
- Amputation** Removal of a limb or other appendage (Figure 3.12).
- Calcification** Deposit of calcium salts in tissue.
- Callus** Bone deposit formed at the ends of a bone fracture; it is absorbed as the fracture is repaired and then replaced by true bone.
- Chemonucleolysis** Procedure to dissolve a portion of the center of an intervertebral disk (IVD) to treat a herniated IVD.
- Creptitation** Crackling sounds produced by the grating of broken bones. Also known as **crepitus**.
- Decalcification** Loss of calcium salts in bone and teeth (Figure 3.13).
- Dislocation** Displacement of a bone from its joint.
- Fracture** Sudden breaking of bone (Figure 3.14).
- Herniation of IVD** Abnormal protrusion of an IVD into the neural cavity or spinal nerves (Figure 3.15).

TECH TIP 3.3 Achondroplasia is considered normal conformation for breeds such as basset hounds and dachshunds. In other breeds it's considered a type of chondrodystrophy or chondrodysplasia. Examples includes Alaskan Malamutes and Norwegian Elkhounds.



Figure 3.11 Long-haired dachshund. Source: Courtesy of WikiCommons/Svenska Mässan.

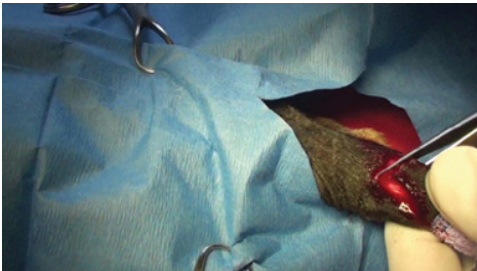
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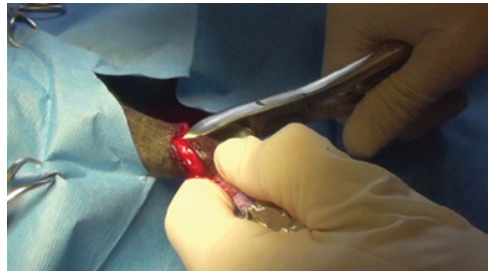
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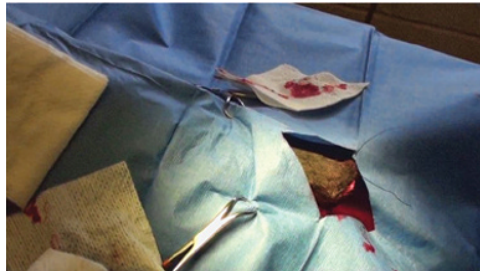


Figure 3.12 Tail amputation surgery progression. (A) Note the skeletal appearance of the tail due to lack of blood supply. (B) An initial incision is made at the proximal aspect of the tail. (C) Scissors are used to cut soft tissue around the vertebrae. (D) Bone cutters are used to cut between the vertebrae. (E) Sutures are placed once the tail has been removed. Source: Courtesy of Greg Martinez, DVM; www.youtube.com/drgregdvm.



Figure 3.13 Decalcification of the bones in the hindlimb of a cat. Note the fracture of the femur due to the loss of bone density. Healthy bones will appear solid white on a radiograph. Source: Courtesy of Sarah Goos, CVT.

- Lordosis** Downward or ventral curvature of the lumbar spine; also known as **swayback**.
- Orthopedic** Branch of surgery dealing with the skeletal system.
- Osteoporosis** Decreased bone density due to loss of bone tissue. Bones become porous and fragile such that they can break easily. In animals, it is most often caused by malnutrition (Figure 3.16).
- Reduction** Correction of a fracture. There are open reductions (after incision) and closed reductions (without incision).
- Sequestrum** Piece of dead bone tissue that has separated from healthy bone tissue during necrosis (cell death).

TECH TIP 3.4 Lordosis, or swayback, is often seen in cats in heat or in lambs born with a copper deficiency.

- Immobilization** Act of preventing a bone from being moved. Examples include sutures, bandages, and casts (see Figure 3.14d).
- Kyphosis** Abnormal, increased dorsal curvature of the spine; also known as **hunchback**.
- Laminectomy** Removal of part of the vertebral arch to relieve pressure from a ruptured IVD.

Joints

A joint is defined as two or more bones that come together. The naming of joints is simple if you know your bone anatomy. The medical name of a joint consists of the bones that make up that joint. They are usually, not always, listed in anatomical order and are usually connected by the combining vowel of the letter “o.” Table 3.6 lists the major joints with their common names and Figure 3.17 shows the joints in a dog.

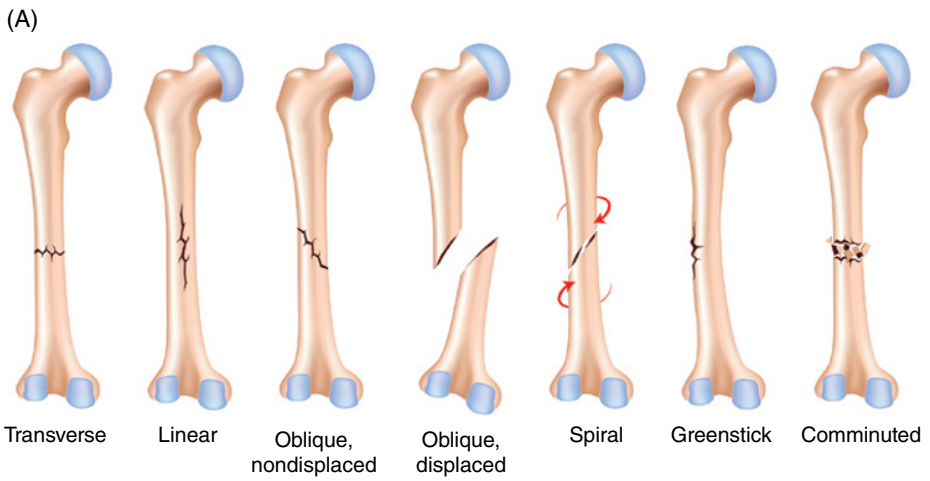


Figure 3.14 (A) Different types of fractures. Source: Courtesy of shutterstock/Alila Medical Images. (B) Radiograph of a transverse fracture of the metatarsals. (C) Radiograph after orthopedic surgery to repair the fractured metatarsals. (D) Cast placed for immobilization after orthopedic surgery of fractured metatarsals.

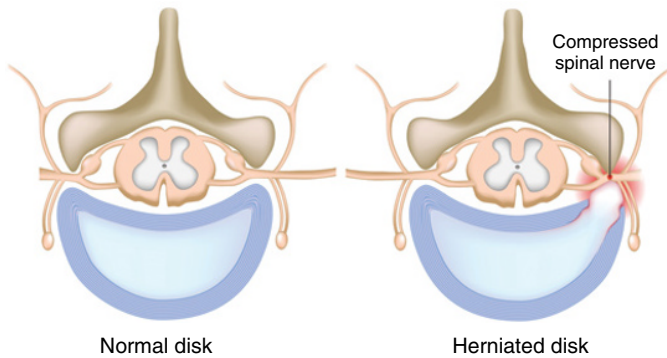


Figure 3.15 Herniation of an intervertebral disk (IVD). In many cases, the disk stays within the spinal canal and instead compresses the spinal cord. Source: Courtesy of shutterstock/Alila Sao Mai.

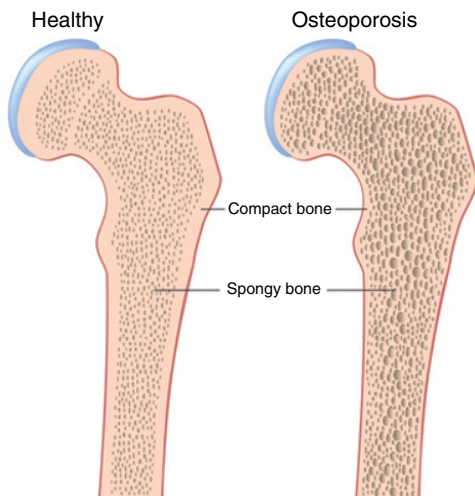


Figure 3.16 Comparison of healthy bone to a bone with osteoporosis. Source: Courtesy of shutterstock/Alila Sao Mai.

skull, which are joined together by a suture. A suture is a line of union of adjoining bones of the skull. They appear as jagged little lines (Figure 3.18A).

Examples of amphiarthroses (singular: amphiarthrosis) include the joints between the vertebrae and the symphysis between the pubic bones. A symphysis is a line of union in which two bones are united by fibrocartilage (Figure 3.18B). These types of joints allow for limited mobility.

Diarthroses, or freely movable joints, are also known as synovial joints. Examples of synovial joints include the hip, elbow, shoulder, and hock. These joints have varying degrees of mobility so they can be further divided based on their range of motion. Table 3.7 lists the different types of synovial joints.

Anatomy of a Joint

Joints can be divided into three basic categories based on their function. Categories of joints include synarthroses (immovable joints), amphiarthroses (partially movable joints), and diarthroses (freely movable joints).

Examples of synarthroses (singular: synarthrosis) include the bones of the

The most common joint injuries involve synovial joints. Stifle injuries such as torn cranial cruciate ligaments (anterior cruciate ligaments) are very common in high-energy dogs. Figure 3.19 shows the general anatomy of a synovial joint, while Figure 3.20 shows the structures of a specific joint, the stifle.

Table 3.6 Joints.

Atlanto-axial joint	Joint between the atlas and axis. Commonly known as the “no joint” .
Atlanto-occipital joint	Joint between the atlas and occipital bone. Commonly known as the “yes joint.” It is the only joint in which the bones are not listed in anatomical order.
Carpus	Joint consisting of the carpal bones. Commonly known as the wrist in small animals and the knee in horses.
Coxofemoral joint	Joint between the pelvis (os coxae) and the femur. Commonly known as the hip .
Femorotibial joint	Joint between the femur and the tibia. Commonly known as the stifle . Within the stifle is a cartilage pad, called the meniscus , to withstand compressive forces.
Humeroradioulnar joint	Joint where the humerus meets the radius and ulna. Commonly known as the elbow .
Sacroiliac joint	Joint between the sacrum and the ilium.
Scapulohumeral joint	Joint between the scapula and humerus. Commonly known as the shoulder .
Tarsus	Joint consisting of the tarsal bones. Commonly known as the hock . The malleolus is the rounded process on either side of the tarsus.

TECH TIP 3.5 You will commonly hear owners refer to the stifle as the knee in small animal medicine; however, it is not proper use of terminology. The only time we use the term knee in veterinary medicine is to describe the carpus in horses. Owners of dogs and cats generally don't know what a stifle is so you may need to communicate in lay terms that it is equivalent to the knee.

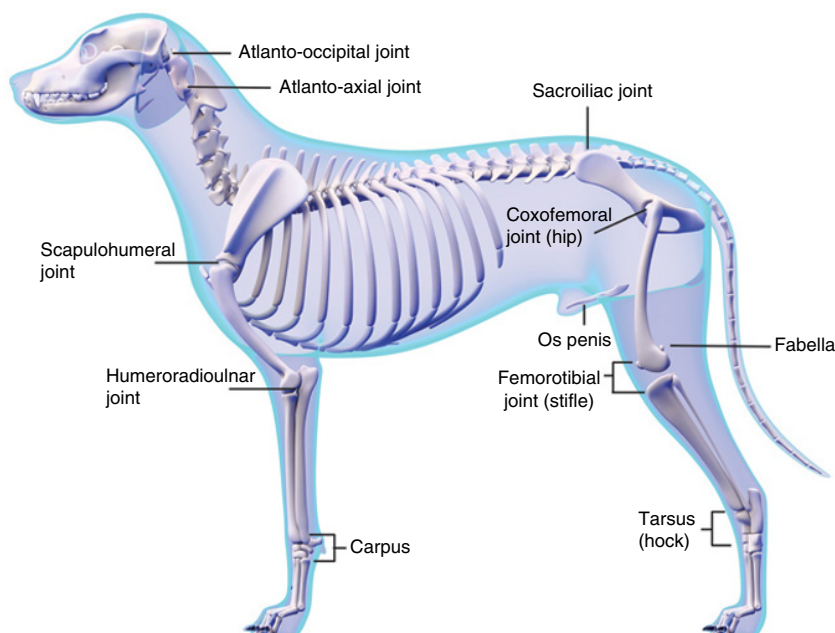
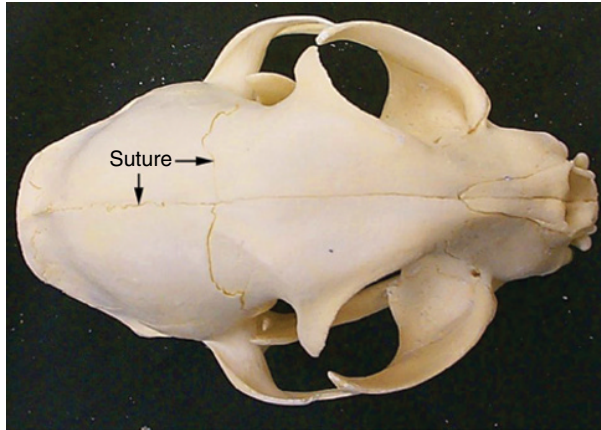


Figure 3.17 Diagram of the joints in a dog. Source: Courtesy of shutterstock/decade3d.

(A)



(B)

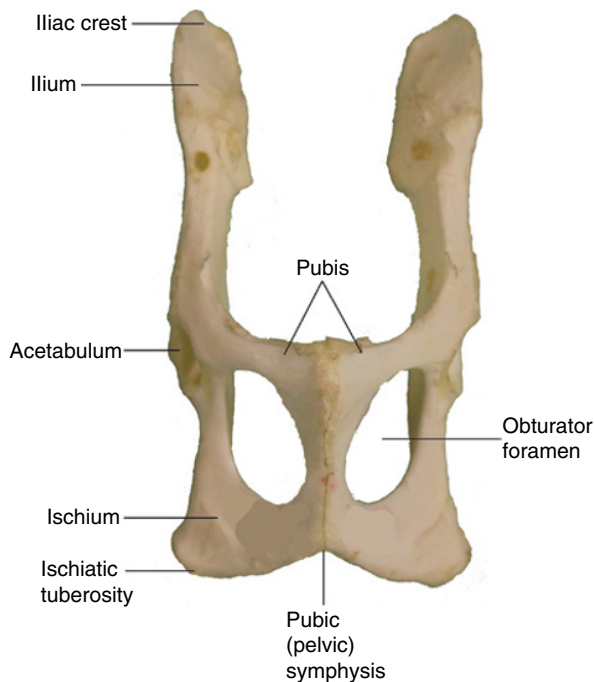


Figure 3.18 (A) Suture joints in the cat skull. (B) Anatomy of the pelvis showing a symphysis.

Table 3.7 Synovial joints.

Ball and socket	Joint in which the rounded head of one bone fits into the socket of another. Examples include the hip and shoulder joints. Also known as enarthroses or spheroid joints .
Gliding	These joint surfaces are flat, allowing for a gliding motion. Examples include the carpus. Also known as arthrodial joints .
Hinge	This joint allows for movement in one plane (one direction), similar to a door hinge. Examples include the elbow and stifle. Also known as ginglymus joints .
Pivot	These are pulley-shaped or pivot-like joints. An example is the atlanto-axial joint. Also known as a trochoid joint .
Saddle	This joint can only be found in humans and non-human primates. The surfaces of both bones are concave in one plane and convex, or saddle-shaped, in the other. It allows for all range of motion except an axial twist. The best example is the carpometacarpal joint of the thumb.

TECH TIP 3.6 The term “suture” has two different meanings depending on the context in which it is used. Sutures are commonly called stitches. We use sutures to close deep wounds.

A suture is also a line of union that joins two bones, such as the sutures on the skull that join the skull bones together.

Articulation	Where two or more bones come together; also known as a joint .
Bursa	Sac of fluid near a joint that acts as lubrication to ease friction between tissues. Bursae (plural form) can be found anywhere two types of tissue slide against one another. They can be found between bones and ligaments, skin and bones, and bones and tendons.
Ligament	Connective tissue that binds bone to bone.
Suture	Line or site of union of adjoining bones of the skull.
Symphysis	Line or site of union in which two bones are united by fibrocartilage.
Synovial cavity	Space between bones at a synovial joint which contains synovial fluid.
Synovial fluid	Viscous (sticky) fluid within the synovial cavity that acts as a lubricant between bones.
Synovial joint	A freely movable joint, also known as diarthrosis .
Synovial membrane	Membrane lining the synovial cavity that produces synovial fluid.
Tendon	Connective tissue that binds muscle to bone.

Joint Pathology and Procedures

Anterior drawer sign	Cranial movement of the proximal tibia in relation to the distal femur to check for cranial cruciate ligament damage in the stifle.
Congenital articular rigidity (CAR)	Condition present at birth in which the joints of the limbs are fixed in position. Commonly seen in calves, limbs are fixed in strange flexed positions.

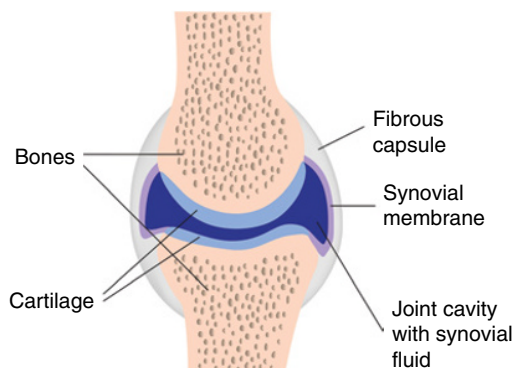


Figure 3.19 Anatomy of a healthy synovial joint. Source: Courtesy of shutterstock/Alila Sao Mai.

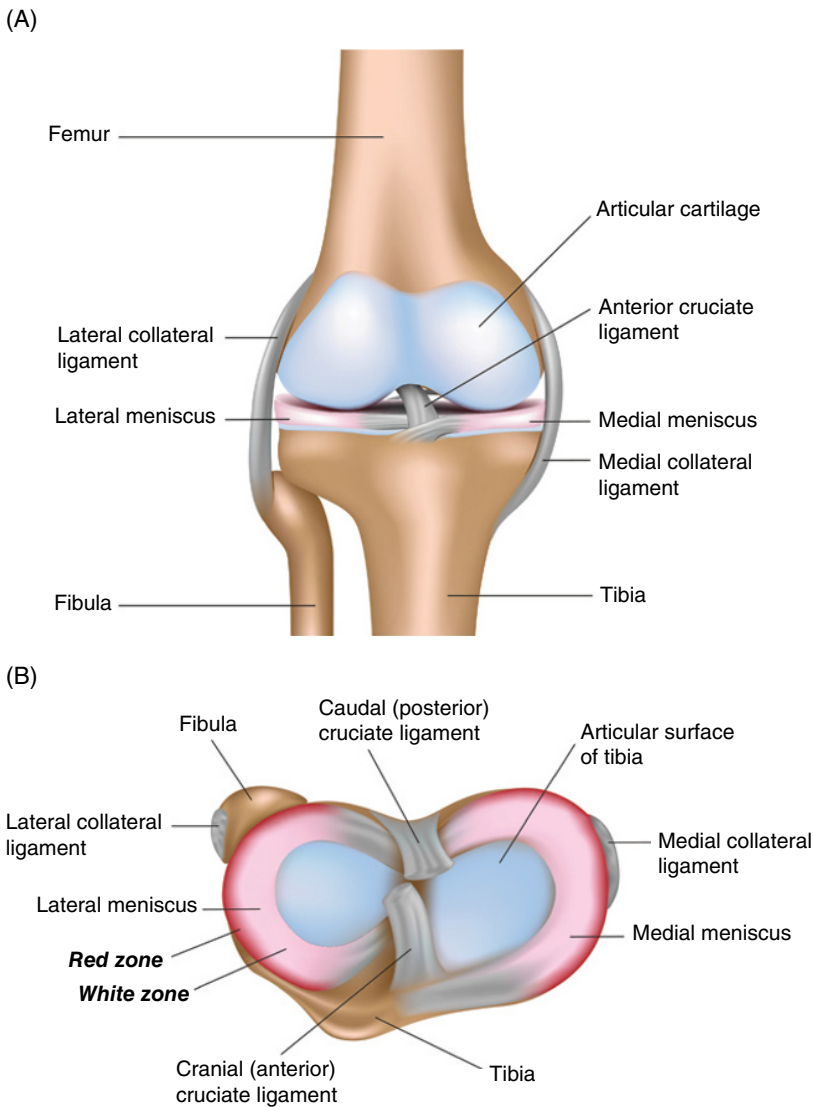


Figure 3.20 (A) Structures of the stifle. (B) Meniscus of the stifle. Source: Courtesy of shutterstock/Alila Sao Mai.

Extracapsular technique (extra cap)

Technique using nonabsorbable suture to replace the cranial cruciate ligament.

Gait

Manner of walking.

Gout

Inflammation of a joint due to the increased presence of uric acid crystals in the joint. Most commonly seen in chickens.

Lame; lameness

Incapable of normal locomotion.

Luxation

Displacement of a bone from its joint; also known as **dislocation** (Figure 3.21).

Osteochondritis dissecans (OCD)

Inflammatory condition in which the articular cartilage separates from the underlying bone.

Pannus	Inflammatory fluid overlying synovial cells, commonly seen with rheumatoid arthritis.
Rheumatoid arthritis (RA)	Inflammation of joints due to an autoimmune disease. Most commonly seen in dogs.
Subluxation	Partial displacement of a bone from its joint (Figure 3.22).
Tibial plateau leveling osteotomy (TPLO)	Procedure which changes the slope of the tibial plateau to help stabilize the stifle after tearing the cranial cruciate ligament. This is a common procedure in large breed dogs (Figure 3.23).
Tibial tuberosity advancement (TTA)	Procedure to advance the tibial tuberosity to stabilize the stifle after tearing the cranial cruciate ligament.
Total hip replacement (THR)	Replacement of the femoral head and acetabulum to correct hip dysplasia (Figure 3.24).
Triple pelvic osteotomy (TPO)	Procedure in which the pelvis is cut in three different locations to change the angle at which the acetabulum meets the femoral head. This is a common procedure for correcting hip dysplasia in younger dogs (Figure 3.24).



Figure 3.21 Radiograph of a dislocated hip in a dog. Source: Courtesy of Lindsey Towery, CVT.

TECH TIP 3.7 A torn cranial cruciate ligament, also known as an anterior cruciate ligament (ACL), is probably the most common orthopedic injury in veterinary medicine. The ACL is a constant load-bearing ligament in the stifle that, when torn, can cause extreme pain and inflammation, which will prevent the animal from putting weight on the hindlimb. Without the ACL, the femur slides behind the tibia when the limb is in use.

TPLO is a surgery which relocates the tibial plateau, which is the part of the tibia in contact with the distal femur. By moving the tibial plateau, the ACL is no longer needed to carry the load of the hindlimb.

TECH TIP 3.8 Autoimmune disease is a disease in which the immune system attacks one's own good cells. There are many examples of autoimmune disease that will be covered in later chapters.

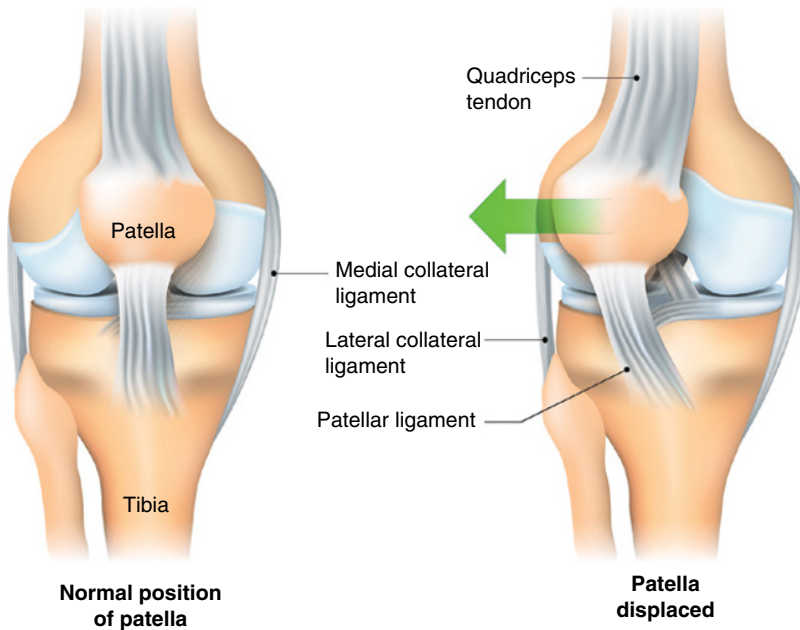


Figure 3.22 Diagram of subluxation of the patella. Source: Courtesy of shutterstock/Designua.

Muscles

A muscle is an organ composed of bundles of fibers that contract to produce movement. In general, muscles are responsible for locomotion and structural support. Through movement, muscles can also assist in other functions including the functions of viscera (internal organs) and generating body heat.

Types of Muscles

Muscles can be divided into three groups based on their location and function. Table 3.8 lists the different types of muscles and their functions.

Some muscles work together to achieve a similar function. These muscles are termed synergistic. For example, the quadriceps muscle actually consists of four different muscles (heads) all working together to extend the stifle. Other muscles work against each other to achieve opposite functions. These muscles are

termed antagonists. Examples of antagonists include the biceps brachii and triceps brachii. While the biceps work to flex the elbow, the triceps work to extend the elbow.

All muscles have the ability to contract and relax to produce movement. If a muscle contracts, then it is tightening, or shrinking, and drawing things together. When the muscle relaxes, it loosens its tension and returns to its original form.

Fascia is a fibrous connective tissue that envelopes, separates, and supports the muscles listed in Table 3.8. Within the fasciae lie the muscle's blood supply, nerve supply, and lymph. Figure 3.26 shows the white fascia between the layers of skeletal muscle on the cat. Notice the spider web appearance.

Functions of Muscle

While some muscles are named based on their anatomical location, other muscles are named based on their point of attachment.

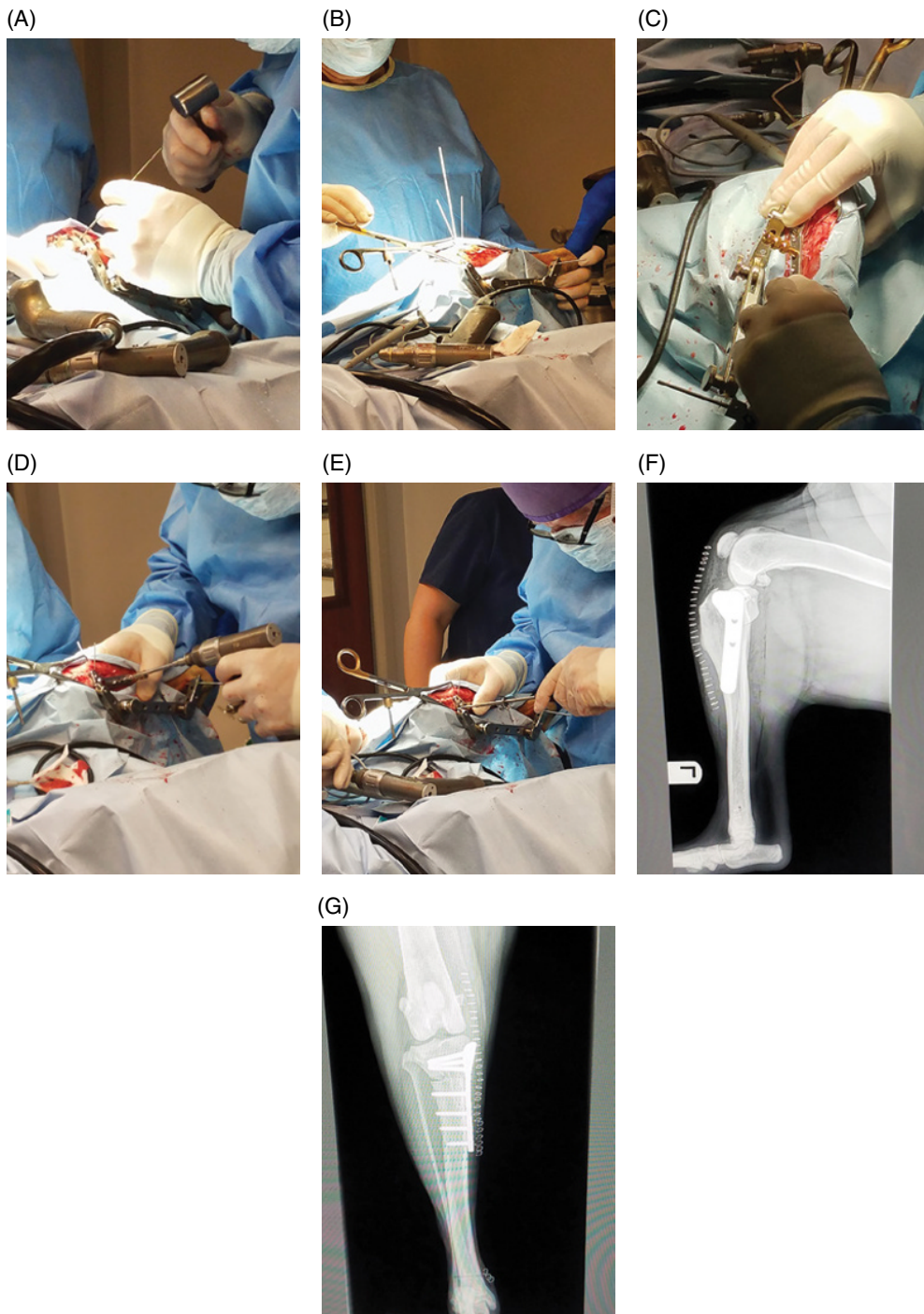


Figure 3.23 Tibial plateau leveling osteotomy (TPLO) surgery. (A) An osteotome is used to make small nicks in the bone where the osteotomy was performed to rotate the tibial plateau. The veterinarian measures a specific distance to rotate the osteotomy to correspond to the amount of degrees of rotation to end up with the desired tibial plateau angle. (B) After the bone is rotated, the jig is in place to keep the bone stable and aligned when rotating the tibial plateau. The pins are placed to secure the bone after it is rotated in preparation for the placement of the plate. (C) With the jig still in place, the plate has been contoured to the bone, and a drill guide is in a hole in the plate, ready for the bone to have the first hole drilled to place a screw in the plate. (D) A screw is being placed through the plate hole into the bone using a power screwdriver. (E) A total of six screws were placed, three above and three below the osteotomy. (F) Post-surgical lateral radiograph of the stifle. (G) Post-surgical cranial radiograph of the stifle. Source: Courtesy Steven Shimer, CVT.

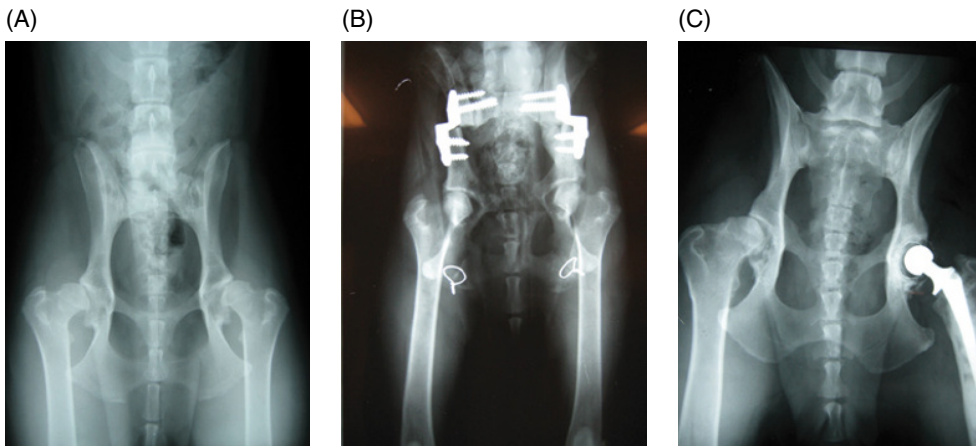


Figure 3.24 (A) Hip dysplasia. Note that the head of the femur is not seated firmly in the acetabulum of the pelvis. (B) Triple pelvic osteotomy correcting the hip dysplasia. Note that after the three incisions are made, the femoral head is now seated firmly in the acetabulum. (C) Total hip replacement. Note the artificial femoral head and acetabulum that have replaced the animal's hip joint.

Table 3.8 Muscle types (see also Figure 3.25)

Cardiac muscle	Striated, involuntary muscle found in the heart.
Skeletal muscle	Striated, voluntary muscles attached to bones all over the body; responsible for movement.
Visceral muscle	Smooth, involuntary muscles responsible for the functioning of internal organs. Also known as smooth muscle .

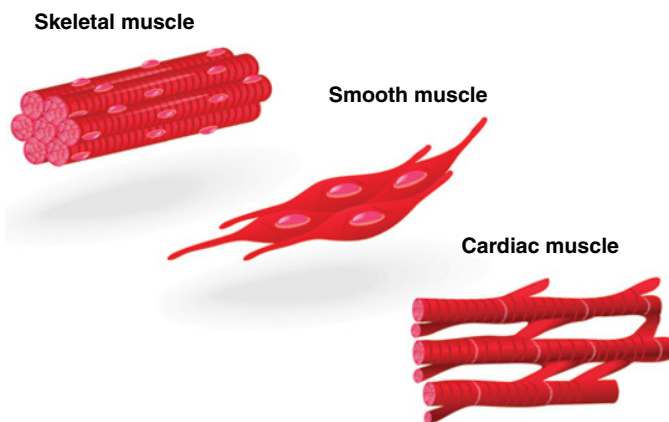


Figure 3.25 The three muscle types. Source: Courtesy of shutterstock/Designua.

There are two points of attachment for a muscle: a stationary bone and a movable bone. The stationary bone is considered the origin of the muscle. The origin is the

point of attachment that is closest to the midline of the body. The stationary bone is held in place by other muscles. The bone that moves is considered the insertion of

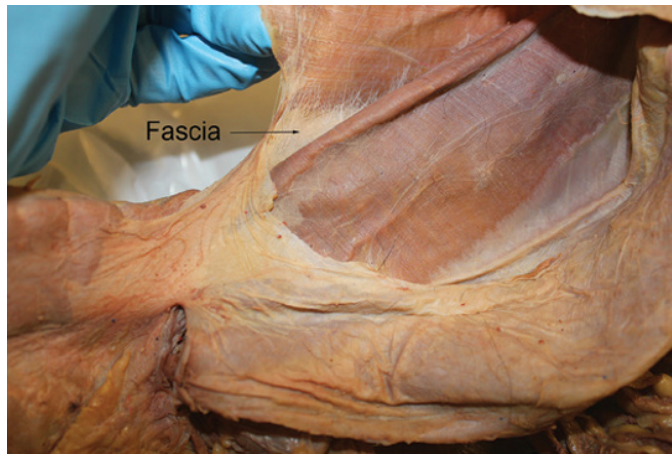


Figure 3.26 Dissected cat displaying the fasciae between the abdominal muscles.

the muscle and is generally farthest from the midline of the body. If describing the skeletal muscles on the limbs, then the origin is generally the proximal point of attachment and the insertion is the distal point of attachment. When describing

how the muscle moves we measure its range of motion using the degrees of a circle. Range of motion measures the range in which a joint can be flexed or extended. The following is a list of muscle functions and their definitions.

Abduction	Movement away from the midline of the body.
Adduction	Movement toward the midline of the body.
Dorsiflexion	Backward bending (flexion); an example is the neck.
Extension	Increasing the angle between two bones at a joint.
Flexion	Decreasing the angle between two bones at a joint.
Pronation	The act of turning the palmar or plantar surface downward.
Supination	The act of turning the palmar or plantar surface upward.
Rotation	Circular movement that turns a body part around a central point (axis).

Additional Myopathy Terms

Adhesion	Fibrous band that connects two surfaces that are normally separate. Often results from surgery in which scar tissue forms around incisions.
Ambulatory	Able to walk; also known as ambulant or ambulation .
Atrophy	No development due to a decrease from the normal cell size.
Fascia	Fibrous connective tissue that envelopes, separates, and supports the muscles. Plural is fasciae (see Figure 3.26).
Hyperplasia	Increased development due to an increase in cell numbers.
Hypertrophy	Excessive development due to increase in cell size.
Hypoplasia	Incomplete development due to decrease in cell numbers.
Laxity	Looseness.
Myasthenia	Muscle weakness.
Myasthenia gravis	Syndrome of muscular weakness that is aggravated by activity and relieved by rest. May be inherited in dogs and cats.

Myoclonus	Repetitive contractions of skeletal muscles that persist during sleep. Sometimes seen in dogs with distemper virus.
Myotonia	Disorder in which there is delayed relaxation of a muscle after contraction.
Tenosynovitis	Inflammation of the tendon and tendon sheath. May be seen with chronic arthritis or injuries such as paw lacerations on lawn edging.
Tetany	Continuous muscle spasms or twitching.
Tonus	Muscle tone; balanced muscle tension.

Building the Terms

Now it's time to assemble the word parts listed in Tables 3.9, 3.10 and 3.11. This will get easier each time if you memorize the meaning of the combining forms,

prefixes, and suffixes. Remember your five basic rules to medical terminology when building and defining these terms. You'll notice some word parts are repeated from the previous chapters.

Table 3.9 Combining forms.

Combining Form	Definition	Combining Form	Definition
Acetabul/o	Acetabulum	Mandibul/o	Mandible; lower jaw
Ankyl/o	Stiff	Maxill/o	Maxilla; upper jaw
Arthr/o	Joint	Metacarp/o	Metacarpals
Articul/o	Joint	Metatars/o	Metatarsals
Brachi/o	Arm	My/o	Muscle
Burs/o	Bursa	Myel/o	Bone marrow; spinal cord
Calc/o	Calcium	Myos/o	Muscle
Calcane/o	Calcaneus	Necr/o	Death
Carp/o	Carpus	Olecran/o	Olecranon
Chondr/o	Cartilage	Orth/o	Bone
Clavicul/o	Clavicle	Oss/e, oss/i	Bone
Costal/o	Rib	Oste/o	Bone
Cost/o	Rib	Pariet/o	Side
Crani/o	Skull	Patell/o	Patella
Dactyl/o	Toes; digits	Ped/o	Child; foot
Electr/o	Electricity	Pelv/i, pelv/o	Pelvis; pelvic bone; hip
Erg/o	Work	Perone/o	Fibula
Fasci/o, fasc/i	Fascia	Phalang/o	Phalanges; digits

Table 3.9 (Continued)

Combining Form	Definition	Combining Form	Definition
Femor/o	Femur	Pub/o	Pubis
Fibr/o	Fibrous connective tissue	Radi/o	Radius; X-ray
Fibros/o	Fibrous connective tissue	Rhabdomy/o	Striated (skeletal) muscle
Fibul/o	Fibula	Rheumat/o	Watery flow
Hem/o	Blood	Sacr/o	Sacrum
Hemat/o	Blood	Sarc/o	Connective tissue (flesh)
Humer/o	Humerus	Scapula/o	Scapula
Hydr/o	Fluid; water	Sphen/o	Wedge
Ili/o	Ilium	Spondyl/o	Vertebra
Ischi/o	Ischium	Stern/o	Sternum
Kinesi/o	Movement	Synov/o	Synovial membrane; tendon sheath
Kyph/o	Humpback; bent; hump	Tars/o	Tarsus
Lacrim/o	Tear; tear duct	Ten/o	Tendon
Lamin/o	Lamina	Tendin/o	Tendon
Leiomy/o	Smooth (visceral) muscle	Tibi/o	Tibia
Ligament/o	Ligament	Ton/o	Tension
Lord/o	Curve; swayback; bent backward	Uln/o	Ulna
Malleol/o	Malleolus	Vertebr/o	Vertebra

Table 3.10 Prefixes.

Prefix	Definition	Prefix	Definition
a-, an-	no; not; without	hypo-	deficient; below; under; less than normal
ab-	away from	inter-	between
ad-	toward	meta-	change; beyond
amph-	around; on both sides; doubly	pan-	all
anti-	against	peri-	surrounding; around
de-	lack of; down; less; removal of	poly-	many; much
dia-	through; complete	sub-	under; below
dys-	bad; painful; difficult; abnormal	supra-	above; upper
endo-	in; within	sym-	together; with
epi-	above; upon; on	syn-	together; with
hyper-	above; excessive		

Table 3.11 Suffixes.

Suffix	Definition	Suffix	Definition
-ac, -al, -ar, -ary, -eal, -ic, -ous	pertaining to	-oma	tumor; mass; fluid collection
-algia	pain	-osis	abnormal condition
-blast	immature; embryonic	-pathy	disease condition
-centesis	surgical puncture to remove fluid	-pexy	surgical fixation; to put in place
-clast	to break	-physis	to grow
-cyte	cell	-plasia	development; formation; growth
-desis	surgical fixation; to bind; tie together	-plasty	surgical repair
-dynia	pain	-poiesis	formation
-ectomy	removal; excision; resection	-porosis	condition of pores (spaces)
-emia	blood condition	-rrhaphy	suture
-fication	process of making	-sclerosis	hardening
-genesis	producing; forming	-scopy	visual examination
-graphy	process of recording	-sthenia	strength
-ion	process	-tome	instrument to cut
-itis	inflammation	-tomy	process of cutting into; incision
-kinesis	movement	-therapy	treatment
-malacia	softening	-trophy	development; nourishment
-metry	measurement	-y	condition

Parts	Medical Term	Definition
Acetabul/o + -ar	= Acetabular	: _____
Ankyl/o + -osis	= Ankylosis (Figure 3.27)	: _____
Arthr/o + -centesis	= Arthrocentesis	: _____
Arthr/o + -desis	= Arthrodesis	: _____
Arthr/o + -graphy	= Arthrography	: _____
Arthr/o + -plasty	= Arthroplasty	: _____
Arthr/o + -scope	= Arthroscope	: _____
Arthr/o + -scopy	= Arthroscopy	: _____
Arthr/o + -tomy	= Arthrotomy	: _____
Brachi/o + -al	= Brachial	: _____
Hem/o + Arthr/o + -osis	= Hemarthrosis	: _____

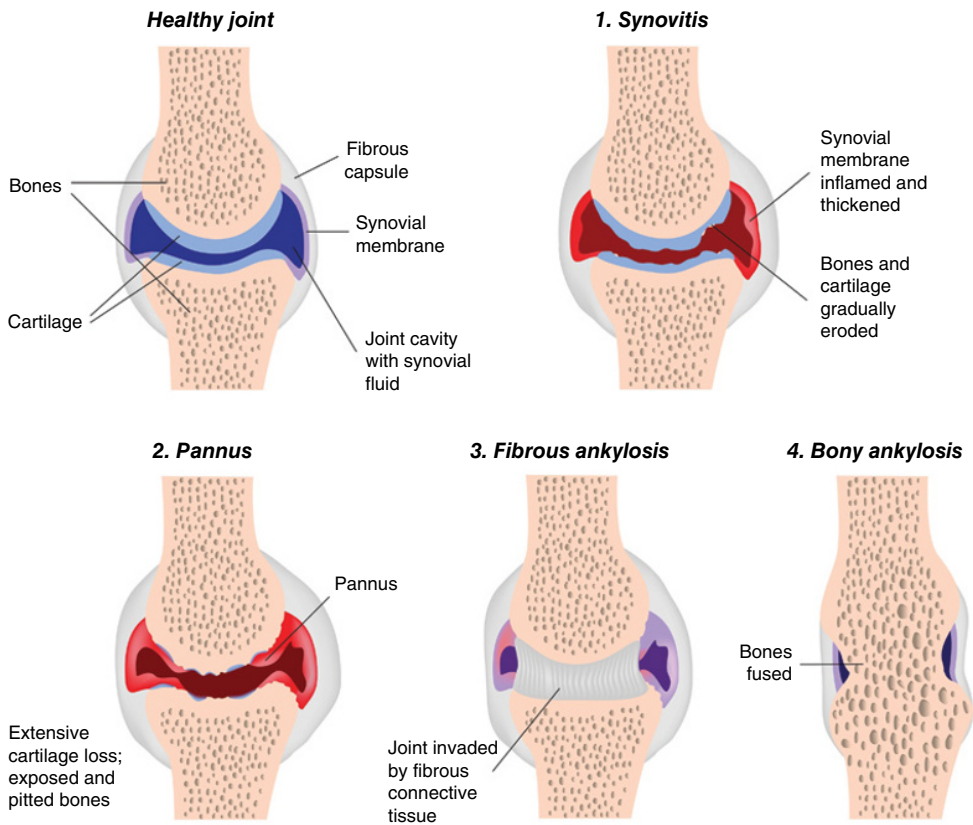


Figure 3.27 Stages of rheumatoid arthritis. Source: Courtesy of shutterstock/Alila Sao Mai.

Hydr/o	+ Arthr/o	+ -osis	= Hydrarthrosis (Figure 3.28)	:	_____
poly-	+ Arthr/o	+ -itis	= Polyarthrititis	:	_____
Calcane/o	+ -al		= Calcaneal	:	_____
hyper-	+ Calc/o	+ -emia	= Hypercalcemia	:	_____
hypo-	+ Calc/o	+ -emia	= Hypocalcemia	:	_____
Carp/o	+ -al		= Carpal	:	_____
Chondr/o	+ Cost/o	+ -al	= Chondrocostal	:	_____
Chondr/o	+ -oma		= Chondroma	:	_____
Chondr/o	+ -malacia		= Chondromalacia	:	_____
Chondr/o	+ Sarc/o	+ -oma	= Chondrosarcoma	:	_____
supra-	+ Clavicul/o	+ -ar	= Supraclavicular	:	_____
Cost/o	+ -al		= Costal	:	_____
inter-	+ Cost/o	+ -al	= Intercostal	:	_____
sub-	+ Cost/o	+ -al	= Subcostal	:	_____
Crani/o	+ -tome		= Craniotome	:	_____
Crani/o	+ -tomy		= Craniotomy	:	_____
poly-	+ Dactyl/o	+ -y	= Polydactyly (Figure 3.29)	:	_____
syn-	+ Dactyl/o	+ -y	= Syndactyly	:	_____
dys-	+ -plasia		= Dysplasia	:	_____



Figure 3.28 Hydrarthrosis. Source: Courtesy of Lindsey Steele, AAS.

Fasci/o	+ -itis		= Fasciitis	:	_____
Femor/o	+ -al		= Femoral	:	_____
Fibr/o	+ -oma		= Fibroma	:	_____
Fibul/o	+ -ar		= Fibular	:	_____
Humer/o	+ -al		= Humeral	:	_____
Hydr/o	+ -therapy		= Hydrotherapy	:	_____
Ili/o	+ -ac		= Iliac	:	_____
Ischi/o	+ -al		= Ischial	:	_____
Kinesi/o	+ -logy		= Kinesiology	:	_____
Leiomy/o	+ -oma		= Leiomyoma	:	_____
Leiomy/o	+ Sarc/o	+ -oma	= Leiomyosarcoma	:	_____
Ligament/o	+ -ous		= Ligamentous	:	_____
Malleol/o	+ -ar		= Malleolar	:	_____
Mandibul/o	+ -ar		= Mandibular	:	_____
Maxill/o	+ -ary		= Maxillary	:	_____
Metacarp/o	+ -ectomy		= Metacarpectomy	:	_____
Metatars/o	+ -algia		= Metatarsalgia	:	_____
Electr/o	+ My/o	+ -graphy	= Electromyography	:	_____
My/o	+ -ectomy		= Myectomy	:	_____
My/o	+ -pathy		= Myopathy	:	_____
My/o	+ -plasty		= Myoplasty	:	_____
My/o	+ -tomy		= Myotomy	:	_____
Myel/o	+ -oma		= Myeloma	:	_____
Myel/o	+ -poiesis		= Myelopoiesis	:	_____

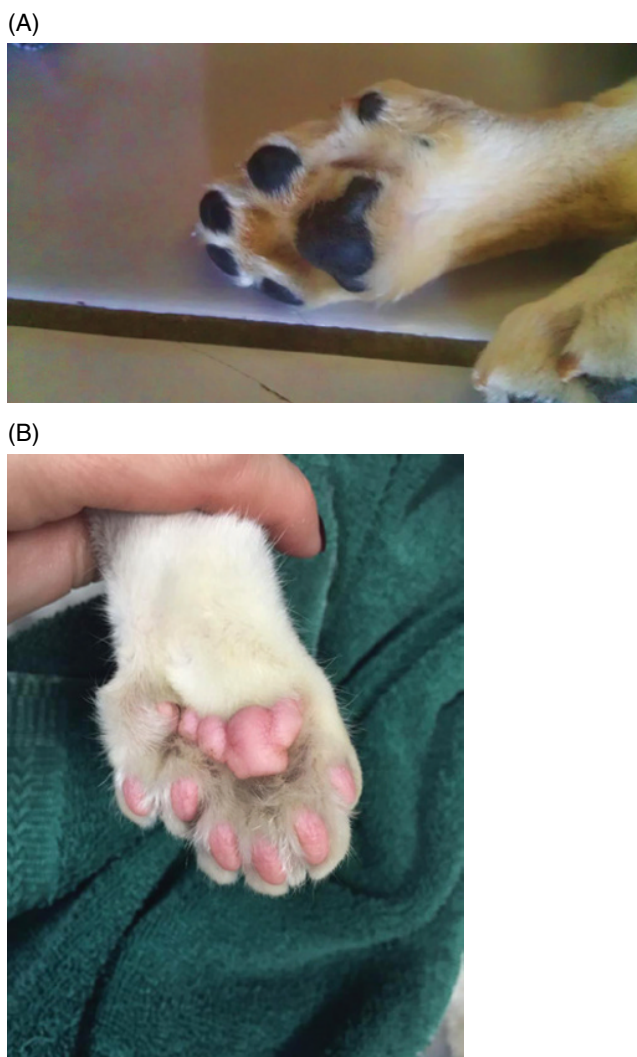


Figure 3.29 (A) Polydactyly in a Lab mix puppy. Note the extra dewclaw. Source: Courtesy of Beth Romano, AAS, CVT. (B) Polydactyly in a cat. Source: Courtesy of Donna Tunis, CVT.

TECH TIP 3.9 Myelopoiesis is often used to describe the production of white blood cells, specifically the production of a group of white blood cells called granulocytes.

Myos/o	+ -itis	= Myositis	: _____
Nectr/o	+ -osis	= Necrosis	: _____
Olecran/o	+ -al	= Olecranal	: _____
Oste/o	+ -algia	= Ostealgia	: _____
Oste/o	+ -itis	= Osteitis	: _____
Oste/o	+ Arthr/o + -itis	= Osteoarthritis (Figure 3.30)	: _____
Oste/o	+ -centesis	= Osteocentesis	: _____
Oste/o	+ Chondr/o + -osis	= Osteochondrosis	: _____

Oste/o	+ dys-	+ -trophy	= Osteodystrophy	: _____
Oste/o	+ -genesis		= Osteogenesis	: _____
Oste/o	+ -malacia		= Osteomalacia	: _____
Oste/o	+ Myel/o	+ -itis	= Osteomyelitis	: _____
Oste/o	+ Nocr/o	+ -osis	= Osteonecrosis	: _____
Oste/o	+ -pexy		= Osteopexy	: _____
Oste/o	+ -plasty		= Osteoplasty	: _____
Oste/o	+ Sarc/o	+ -oma	= Osteosarcoma (Figure 3.31)	: _____
Oste/o	+ -sclerosis		= Osteosclerosis	: _____
Oste/o	+ -tome		= Osteotome	: _____
pan-	+ Oste/o	+ -itis	= Panosteitis	: _____
peri-	+ Oste/o	+ -itis	= Periosteitis	: _____
Pelv/i	+ -metry		= Pelvimetry	: _____
Perone/o	+ -al		= Peroneal	: _____
Phalang/o	+ -eal		= Phalangeal	: _____
Pub/o	+ -ic		= Pubic	: _____
Radi/o	+ -al		= Radial	: _____
Radi/o	+ -graphy		= Radiography (Figure 3.32)	: _____
Scapul/o	+ -ar		= Scapular	: _____
supra-	+ Scapul/o	+ -ar	= Suprascapular	: _____
Spondyl/o	+ -itis		= Spondylitis	: _____
Spondyl/o	+ -osis		= Spondylosis	: _____
Stern/o	+ -al		= Sternal	: _____
Patell/o	+ -ar		= Patellar	: _____
sub-	+ Patell/o	+ -ar	= Subpatellar	: _____
Synov/o	+ -itis		= Synovitis	: _____
Tars/o	+ -ectomy		= Tarsectomy	: _____
Tendin/o	+ -ectomy		= Tendinectomy	: _____

TECH TIP 3.10 The Prefix “pan-”

Beware of pan- when attached to certain combining forms and suffixes. For example, the term “panosteitis” is not defined as an inflammation of all bones. That would be rare. Instead, it is defined as an inflammation of all **parts** of a bone. Ask yourself what makes the most sense when using the prefix pan- before literally defining a term.

TECH TIP 3.11 A tenectomy was once considered to be an alternative to a declaw. Today, however, the practice is considered by most to be inhumane.

A cat scratching the furniture is a common complaint of owners. Shelters are filled with cats that have been relinquished because of their scratching. Scratching posts can be purchased to try to redirect the behavior, but all too often frustrated owners will come to the clinic for a “quick fix.” While controversial, many veterinarians will still perform declaws. Declawing has been outlawed in other countries and many states are now in the process of trying to ban the practice.

Declawing involves surgically removing the distal phalanx of each digit. Soft paws are caps that can be placed on the nails of the cat. A tenectomy involves cutting the tendons responsible for the control of the cat’s nails. Once performed, the cat is unable to retract its nails.

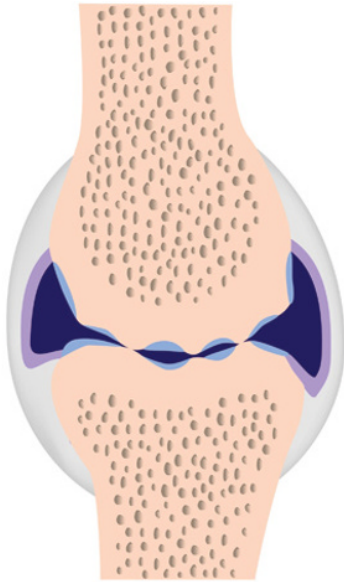


Figure 3.30 Osteoarthritis of a synovial joint.
Source: Courtesy of shutterstock/Alila Sao Mai.



Figure 3.31 Osteosarcoma on the distal radius.
Source: Courtesy of Stacey Fowler, LVT.



Figure 3.32 (A) Radiography of a dog. Source: Courtesy of shutterstock/Kanwarjit Singh Boparai. (B) Radiograph of a dog showing bullets from a gunshot wound. Source: Courtesy of shutterstock/P. Fabian.

Tendin/o	+ -itis	= Tendinitis	: _____
Ten/o	+ -ectomy	= Tenectomy	: _____
Ten/o	+ -rrhaphy	= Tenorrhaphy	: _____
Ten/o	+ -tomy	= Tenotomy	: _____
Tibi/o	+ -al	= Tibial	: _____
Uln/o	+ -ar	= Ulnar	: _____
Vertebr/o	+ -al	= Vertebral	: _____

Abbreviations

Table 3.12 Abbreviations.

Abbreviation	Definition
AAHA	American Animal Hospital Association
ACL	Anterior cruciate ligament
AVMA	American Veterinary Medical Association
Bilat.	Bilateral
CAR	Congenital articular rigidity
CCL; CrCL	Cranial cruciate ligament
CK	Creatine kinase (muscle enzyme)
CVT	Certified veterinary technician
DJD	Degenerative joint disease
DVM; VMD	Doctor of Veterinary Medicine
EMG	Electromyogram
FHO	Femoral head osteotomy
GSW	Gunshot wound
Ⓛ	Left
LVT	Licensed veterinary technician
MPL	Medial patellar luxation
M/S	Musculoskeletal
NAVTA	National Association of Veterinary Technicians of America
NSAID	Nonsteroidal anti-inflammatory drug
OCD	Osteochondritis dissecans
OSA	Osteosarcoma
Ortho	Orthopedic or orthopedic procedure
PDR	Physicians' Desk Reference
PROM	Passive range of motion
Ⓡ	Right
RA	Rheumatoid arthritis
ROM	Range of motion
RVT	Registered veterinary technician
THR	Total hip replacement

Table 3.12 (Continued)

Abbreviation	Definition
TPLO	Tibial plateau leveling osteotomy
TPO	Triple pelvic osteotomy
TTA	Tibial tuberosity advancement
VPB	Veterinary pharmaceuticals and biologicals

Case Study: Define the medical terms and abbreviations in bold print

You'll notice some terms from the previous chapters

Partner, a two-year-old German Shepherd, comes to your clinic with **lameness**. The clinic is accredited by **AAHA**. The owners had noticed an abnormal **gait** in the past couple of weeks after a trip to the dog park. Upon **P/E** Partner wasn't ambulatory.

The doctor notes **bilat.** weakness in the rear limbs. There is slight atrophy of the rear leg muscles. To rule out an **ACL** tear the **DVM** checks **anterior drawer** signs. If there's an ACL rupture, then a **TPLO** would be necessary due to the dog's size. Anterior drawer sign was normal so **PROM** is checked next. The vet notices that the **® coxofemoral** joint has a decreased **ROM** so **radiographs** are ordered.

Osteitis is ruled out and Partner is diagnosed with hip dysplasia. The **femoral head** isn't aligned with the **acetabulum** so a **TPO** is performed to correct the problem.

Three weeks later Partner returns for **PT**, and he seems far more energetic. The **CVT** takes him to the back to begin his **hydrotherapy**. All the techs in the clinic are members of **NAVTA**.

Exercises

3-A: Match the combining forms with their meaning.

- | | |
|----------------------------|---------------|
| 1. _____ Skull | A. Cost/o |
| 2. _____ Lower jaw | B. Crani/o |
| 3. _____ Death | C. Hem/o |
| 4. _____ Connective tissue | D. Hydr/o |
| 5. _____ Tension | E. Kinesi/o |
| 6. _____ Rib | F. Leiomy/o |
| 7. _____ Movement | G. Mandibul/o |
| 8. _____ Vertebrae | H. Necr/o |
| 9. _____ Blood | I. Sarc/o |
| 10. _____ Water; fluid | J. Spondyl/o |
| 11. _____ Smooth muscle | K. Ton/o |
| 12. _____ Ulna | L. Uln/o |

3-B: Write the correct medical term in the blank.

1. _____: Pertaining to below the ribs
2. _____: Softening of cartilage
3. _____: Inflammation of vertebrae
4. _____: Inflammation of fascia
5. _____: Pertaining to the upper jaw
6. _____: Disease condition of muscle
7. _____: Abnormal condition of bones and cartilage
8. _____: Removal of the hock
9. _____: Hardening of bone
10. _____: Study of movement
11. _____: Movement away from the midline
12. _____: Manner of walking
13. _____: Looseness
14. _____: Decrease in the angle between two bones
15. _____: Continuous muscle spasms
16. _____: Knuckle-like process at the ends of some long bones
17. _____: Membrane surrounding bone
18. _____: Shaft of a long bone
19. _____: Displacement of a bone from its joint
20. _____: Bony process on the proximal ulna

3-C: Define the following terms.

1. Hypocalcemia _____
2. Myasthenia _____
3. Rhabdomyoma _____
4. Hypertrophy _____
5. Fracture _____
6. Dysplasia _____
7. Achondroplasia _____
8. Ankylosis _____
9. Hemarthrosis _____
10. Tenorrhaphy _____

3-D: Define the following suffixes.

- | | |
|--------------------|---------------------|
| 1. _____: -blast | 7. _____: -emia |
| 2. _____: -pexy | 8. _____: -al |
| 3. _____: -malacia | 9. _____: -poiesis |
| 4. _____: -metry | 10. _____: -kinesis |
| 5. _____: -cyte | 11. _____: -tome |
| 6. _____: -desis | 12. _____: -physis |

3-E: Define the following prefixes.

- | | |
|------------------|------------------|
| 1. _____: pan- | 5. _____: peri- |
| 2. _____: hypo- | 6. _____: dys- |
| 3. _____: ab- | 7. _____: endo- |
| 4. _____: inter- | 8. _____: supra- |

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3-F: Define the following abbreviations.

- | | |
|-----------------|-----------------|
| 1. _____: AVMA | 8. _____: TPO |
| 2. _____: VPB | 9. _____: TTA |
| 3. _____: RVT | 10. _____: CAR |
| 4. _____: THR | 11. _____: CCL |
| 5. _____: Ortho | 12. _____: PDR |
| 6. _____: GSW | 13. _____: OCD |
| 7. _____: EMG | 14. _____: TPLO |

3-G: Circle the correct term in parentheses.

- Sac of fluid near a joint that helps lubricate: (fascia, bursa)
- Partial displacement of a bone from its joint: (subluxation, fracture)
- Striated, voluntary muscle that controls movement: (skeletal, visceral)
- Inflammation of muscles: (arthritis, myositis)
- Connective tissue that binds bone to bone: (ligament, tendon)
- Hunchback: (kyphosis, lordosis)
- A freely movable joint: (suture, synovial)
- Removal of a limb or other appendage: (laminectomy, amputation)
- Crackling sounds heard due to two broken bones rubbing together: (calcification, crepitation)
- Hole in bone that allows for the passage of nerves and vessels: (foramen, callus)

3-H: Define the following medical terms.

- _____ : Amputation
- _____ : Ossification
- _____ : Necrosis
- _____ : Fibular
- _____ : Laminectomy
- _____ : Reduction
- _____ : Articulation
- _____ : Osteoblast
- _____ : Patellar
- _____ : Phalangeal
- _____ : Pelvimetry
- _____ : Chondrosarcoma
- _____ : Subcostal
- _____ : Tenotomy
- _____ : Osteopexy

3-I: List the three types of muscle and circle the correct answers for each in parentheses.

Types of muscle	Voluntary or involuntary	Smooth or striated
_____	(Voluntary, involuntary)	(Smooth, striated)
_____	(Voluntary, involuntary)	(Smooth, striated)
_____	(Voluntary, involuntary)	(Smooth, striated)

Answers can be found starting on page 675.

Review Tables

Fill in the tables and refer to Tables 3.9–3.12 for answers.

Table 3.13

Combining Form	Definition	Combining Form	Definition
Acetabul/o		Mandibul/o	
Ankyl/o		Maxill/o	
Arthr/o		Metacarp/o	
Articul/o		Metatars/o	
Brachi/o		My/o	
Burs/o		Myel/o	
Calc/o		Myos/o	
Calcane/o		Necr/o	
Carp/o		Olecran/o	
Chondr/o		Orth/o	
Clavicul/o		Oss/e, oss/i	
Cost/o		Pariet/o	
Costal/o		Oste/o	
Crani/o		Patell/o	
Dactyl/o		Ped/o	
Electr/o		Pelv/i, pelv/o	
Erg/o		Perone/o	
Fasci/o, fasc/i		Phalang/o	
Femor/o		Pub/o	
Fibr/o		Radi/o	
Fibros/o		Rhabdomy/o	
Fibul/o		Rheumat/o	
Hem/o		Sacr/o	
Hemat/o		Sarc/o	
Humer/o		Scapula/o	
Hydr/o		Sphen/o	

Table 3.13 (Continued)

Combining Form	Definition	Combining Form	Definition
Ili/o		Spondyl/o	
Ischi/o		Stern/o	
Kinesi/o		Synov/o	
Kyph/o		Tars/o	
Lacrim/o		Ten/o	
Lamin/o		Tendin/o	
Leiomy/o		Tibi/o	
Ligament/o		Ton/o	
Lord/o		Uln/o	
Malleol/o		Vertebr/o	

Table 3.14

Prefix	Definition	Prefix	Definition
a-, an-		hypo-	
ab-		inter-	
ad-		meta-	
amph-		pan-	
anti-		peri-	
de-		poly-	
dia-		sub-	
dys-		supra-	
endo-		sym-	
epi-		syn-	
hyper-			

Table 3.15

Suffix	Definition	Suffix	Definition
-ac, -al, -ar, -ary, -eal, -ic, -ous		-oma	
-algia		-osis	
-blast		-pathy	
-centesis		-pexy	
-clast		-physis	
-cyte		-plasia	
-desis		-plasty	
-dynia		-poiesis	
-ectomy		-porosis	
-emia		-rrhaphy	
-fication		-sclerosis	
-genesis		-scopy	
-graphy		-sthenia	
-ion		-tome	
-itis		-tomy	
-kinesis		-therapy	
-malacia		-trophy	
-metry		-y	

Table 3.16

Abbreviation	Definition
AAHA	
ACL	
AVMA	
Bilat.	
CAR	
CCL; CrCL	
CK	

Table 3.16 (Continued)

Abbreviation	Definition
CVT	
DJD	
DVM	
EMG	
FHO	
GSW	
Ⓢ	
LVT	
MPL	
M/S	
NAVTA	
NSAID	
OCD	
OSA	
Ortho	
PDR	
PROM	
®	
RA	
ROM	
RVT	
THR	
TPLO	
TPO	
TTA	
VPB	