

CHAPTER 13: SKELETAL SYSTEM

Building a Medical Terminology Foundation 2e by Kimberlee Carter; Marie Rutherford; and Connie Stevens

- 13.1 – Introduction to the Skeletal System
- 13.2 – Anatomy (Structures) of the Skeletal System
- 13.3 – Physiology (Function) of the Skeletal System
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- Vocabulary & Check Your Knowledge
- References

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13.1 - Introduction to the Skeletal System

Learning Objectives

- Identify the anatomy of the skeletal system and describe the main functions of the skeletal system
- Analyze, translate, and define medical terms and common abbreviations of the skeletal system
- Practice the spelling and pronunciation of skeletal system terminology
- Identify the medical specialties associated with the skeletal system and explore common diseases, disorders, and procedures

Skeletal System Word Parts

Click on prefixes, combining forms, and suffixes to reveal a list of word parts to memorize for the musculoskeletal system.

Prefix

- **a-** (absence of, without)
- **ab-** (away from)
- **ad-** (towards)
- **brady-** (slow)
- **dys-** (painful, difficult, abnormal, laboured)
- **hyper-** (above, excessive)
- **inter-** (between)
- **intra-** (within, in)
- **poly-** (many, much)
- **sub-** (below, under)
- **supra-** (above)
- **sym-** (together, joined)

- **syn-** (together, joined)

Combining Form

- **ankyl/o** (stiff, bent)
- **aponeur/o** (aponeurosis)
- **arthr/o** (joint)
- **burs/o** (bursa)
- **carp/o** (carpals, wrist)
- **chondr/o** (cartilage)
- **clavic/o** (clavicle, collarbone)
- **clavicul/o** (clavicle, collarbone)
- **cost/o** (ribs)
- **crani/o** (cranium)
- **disk/o** (intervertebral disk)
- **femor/o** (femur, upper leg bone)
- **fibul/o** (fibula, lower leg bone)
- **humer/o** (humerus, upper arm bone)
- **ili/o** (ilium)
- **ischi/o** (ischium)
- **kinesi/o** (movement, motion)
- **kyph/o** (increased convexity of the spine)
- **lord/o** (bent forward, increased concavity of the spine)
- **lumb/o** (loin, lumbar region of the spine)
- **mandibul/o** (mandible, lower jawbone)
- **maxill/o** (maxilla, upper jawbone)
- **menisc/o** (meniscus, crescent)
- **myel/o** (spinal cord)
- **oste/o** (bone)
- **patell/o** (patella, kneecap)
- **pelv/i** (pelvis, pelvic bone)
- **pelv/o** (pelvis, pelvic bone)
- **petr/o** (stone)
- **phalang/o** (phalanges, bones of finger and toes)
- **pub/o** (pubis)
- **rachi/o** (vertebral spine, vertebral column)
- **radi/o** (nerve root)
- **scapul/o** (scapula, shoulder blade)
- **scoli/o** (crooked, curved)
- **spondyl/o** (vertebra, spine, vertebral column)
- **stern/o** (sternum, breastbone)
- **tars/o** (tarsals, ankle bones)
- **ten/o** (tendon)

- **tendin/o** (tendon)
- **tend/o** (tendon)
- **tibi/o** (tibia, lower leg bone)
- **uln/o** (ulna, lower arm bone)
- **vertebr/o** (vertebra, spine, vertebral column)

Suffix

- **-al** (pertaining to)
- **-algia** (pain)
- **-ar** (pertaining to)
- **-asthenia** (weakness)
- **-centesis** (surgical puncture to aspirate fluid)
- **-clasia** (break)
- **-clasis** (break)
- **-clast** (break)
- **-desis** (surgical fixation, fusion)
- **-ectomy** (excision, surgical removal, cutting out)
- **-gram** (the record, radiographic image)
- **-graphy** (process of recording, radiographic imaging)
- **-ic** (pertaining to)
- **-itis** (inflammation)
- **-lysis** (loosening, separating, dissolution)
- **-malacia** (softening)
- **-oid** (resembling)
- **-oma** (tumour)
- **-sis** (abnormal condition)
- **-penia** (abnormal reduction)
- **-physis** (growth)
- **-plasty** (surgical repair)
- **-rrhaphy** (suturing, repairing)
- **-sarcoma** (malignant tumour)
- **-schisis** (split, fissure)
- **-scopy** (process of viewing, visual examination)
- **-tomy** (incision, cut into)
- **-trophy** (nourishment, development)

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Introduction to the Skeletal System

The skeletal system forms the framework of the body. It is the body system composed of bones, cartilage and ligaments. Each bone serves a particular function and varies in size, shape and strength. Bones are weight-bearing structures in your body and can therefore change in thickness as you gain or lose weight. The skeletal system performs the following critical functions for the human body:

- supports the body
- facilitates movement
- protects internal organs
- produces blood cells
- stores and releases minerals and fat

Watch The Skeletal System: Crash Course Anatomy & Physiology #19 (11 min) on YouTube

Skeletal System Medical Terms

Skeletal System Medical Terms (Text Version)

Practice the following **skeletal system** words by breaking into word parts and pronouncing.

1. **ulnoradial**

- uln/o/radi/al
- pertaining to the ulna and radius

2. **tarsectomy**

- tars/ectomy
- excision of the tarsal

3. **osteocyte**

- oste/o/cyte
- bone cell

4. **cranioschisis**

- crani/o/schisis
- fissure of the cranium

5. **carpectomy**

- carp/ectomy
- excision of a carpal (wrist)

6. **chondroplasty**

- chondr/o/plasty
- surgical repair of cartilage

7. **cranioplasty**

- crani/o/plasty
- surgical repair of the cranium

8. **pelvisacral**

- pelv/i/sacr/al
pertaining to the pelvis and sacrum

9. **subscapular**

- sub/scapul/ar
- pertaining to below the scapula

10. **tenosynovitis**

- ten/o/synov/itis
- inflammation of the tendon and synovial membrane

11. **sarcopenia**

- arc/o/penia
- abnormal reduction of connective tissue presenting as skeletal muscle mass loss and loss of strength

12. **tibial**

- tibi/al
- pertaining to the tibia

13. **discitis**

- disc/itis
- Inflammation of the intervertebral disk

14. **phalangectomy**

- phalang/ectomy
- excision of the phalanges

15. **sternoclavicular**
 - stern/o/clavicul/ar
 - pertaining to sternum and clavicle
16. **humeral**
 - humer/al
 - pertaining to the humerus
17. **arthralgia**
 - arthr/algia
 - painful joint
18. **lumbosacral**
 - lumb/o/sacr/al
 - pertaining to the lumbar region of the spine and sacrum
19. **hyperkinesia**
 - hyper/kines/ia
 - condition of excessive movement
20. **radial**
 - radi/al
 - pertaining to radius
21. **vertebroplasty**
 - vertebr/o/plasty
 - surgical repair of the vertebral column
22. **arthrodesis**
 - arthr/o/desis
 - surgical fixation of a joint
23. **rachischisis**
 - rach/ischisis
 - fissure of vertebral column
24. **pubic**
 - pub/ic
 - pertaining to pubis
25. **intercostal**

- inter/cost/al
 - pertaining to between the ribs
26. **osteopetrosis**
- oste/o/petr/osis
 - abnormal condition of stone-like bones
27. **ankylosis**
- ankyl/osis
 - abnormal condition of stiffness
28. **sternoid**
- stern/oid
 - resembling the sternum
29. **chondrectomy**
- chondr/ectomy
 - excision of cartilage
30. **osteonecrosis**
- oste/o/necr/osis
 - abnormal condition of bone death (lack of blood supply)
31. **synovial sarcoma**
- synovi/al sarcoma
 - malignant tumor pertaining to the synovial membrane
32. **dystrophy**
- dys/trophy
 - abnormal development
33. **synovectomy**
- synov/ectomy
 - excision of the synovial membrane
34. **osteopenia**
- oste/o/penia
 - abnormal reduction of bone mass
35. **kyphosis**
- kyph/osis

- abnormal condition of convexity of the spine
36. **osteitis**
- oste/itis
 - inflammation of bone
37. **hypertrophy**
- hyper/trophy
 - excessive development
38. **spondylosis**
- spondyl/osis
abnormal condition of the vertebrae
39. **spondylarthritis**
- spondyl/arthr/itis
 - inflammation of the vertebra and joint
40. **cranial**
- crani/al
 - pertaining to the cranium
41. **osteoclasia**
- oste/o/clasis
surgical breaking of a bone
42. **costochondral**
- cost/o/chondr/al
 - pertaining to ribs and cartilage
43. **arthroscopy**
- arthr/o/scopy
process of viewing a joint
44. **pelvic**
- pelv/ic
 - pertaining to pelvis, pelvic bone
45. **lumbar**
- lumb/ar
 - pertaining to the lumbar region of the spine

46. **osteomyelitis**

- oste/o/myel/itis
- inflammation of bone and bone marrow

47. **osteoblast**

- oste/o/blast
- developing bone cell

48. **tenorrhaphy**

- ten/o/rrhaphy
- suturing of a tendon

49. **clavicular**

- clavicul/ar
- pertaining to the clavicle

50. **rachiotomy**

- rachi/o/tomy
- incision into the vertebral column

51. **intracranial**

- intra/crani/al
- pertaining to within the cranium

52. **tendinitis**

- tendin/itis
- inflammation of the tendon

53. **costectomy**

- cost/ectomy
- excision of rib(s)

54. **vertebrocostal**

- vertebr/o/cost/al
- pertaining to vertebrae and ribs

55. **bursectomy**

- burs/ectomy
- excision of bursa

56. **laminectomy**

- lamin/ectomy
 - excision of the lamina
57. **craniotomy**
- crani/o/tomy
 - incision into the cranium
58. **pubofemoral**
- pub/o/femor/al
 - pertaining to pubic bone and femur
59. **submandibular**
- sub/mandibul/ar
 - pertaining to under the mandible
60. **patellectomy**
- patell/ectomy
 - excision of the kneecap
61. **lumbocostal**
- lumb/o/cost/al
 - pertaining to the lumbar region of the spine and ribs
62. **intervertebral**
- inter/vertebr/al
 - pertaining to between the vertebrae
63. **femoral**
- femor/al
 - pertaining to the femur
64. **lordosis**
- lord/osis
 - abnormal condition of increased concavity of the spine (bent forward)
65. **arthroplasty**
- arthr/o/plasty
 - surgical repair of a joint
66. **iliofemoral**
- ili/o/femor/al

- pertaining to the ilium and femur
67. **bursitis**
- burs/itis
 - inflammation of the bursa
68. **arthrography**
- arthr/o/graphy
 - process of recording a joint
69. **subcostal**
- sub/cost/al
 - pertaining to below the ribs
70. **sternoclavicular**
- stern/o/clavicul/ar
 - pertaining to the sternum and clavicle
71. **dyskinesia**
- dys/kines/ia
 - condition of difficult movement
72. **bradykinesia**
- brady/kines/ia
 - condition of slow movement
73. **sacral**
- sacr/al
 - pertaining to the sacrum
74. **arthritis**
- arthr/itis
 - inflammation of a joint
75. **diskectomy**
- disk/ectomy
 - excision of the intervertebral disk
76. **maxillitis**
- maxill/itis
 - inflammation of the maxilla

77. **suprapatellar**

- supra/patell/ar
- pertaining to above the knee cap

78. **ischiofibular**

- ischi/o/fibul/ar
- pertaining to the ischium and fibula

79. **tenomyoplasty**

- ten/o/my/o/plasty
- surgical repair of the tendon and muscle

80. **arthrocentesis**

- arthr/o/centesis
- surgical puncture to aspirate fluid from a joint

81. **osteosarcoma**

- oste/o/sarcoma
- malignant tumour of bone

82. **osteochondritis**

- oste/o/chondr/itis
- inflammation of bone and cartilage

83. **ostectomy**

- ost/ectomy
- excision of bone

84. **osteoarthritis**

- oste/o/arthritis
- inflammation of the bone and joint

85. **carpal**

- carp/al
- pertaining to carpal (wrist)

86. **chondromalacia**

- chondr/o/malacia
- softening of cartilage

87. **submaxillary**

- sub/maxill/ary
 - pertaining to under the maxilla
88. **arthroclasia**
- arthr/o/clasia
 - surgical breaking of a joint
89. **meniscitis**
- menisc/itis
 - inflammation of the meniscus
90. **meniscectomy**
- menisc/ectomy
 - excision of the meniscus
91. **maxillectomy**
- maxill/ectomy
 - excision of the maxilla
92. **substernal**
- sub/stern/al
 - pertaining to below the sternum
93. **osteomalacia**
- oste/o/malacia
 - softening of bone
94. **scoliosis**
- scoli/osis
 - abnormal condition of (lateral) curved spine
95. **ulnoradial**
- uln/o/radi/al
 - pertaining to the ulna and nerve root

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13.2 - Anatomy (Structures) of the Skeletal System

The skeletal system includes all of the bones, cartilages, and ligaments of the body that support and give shape to the body and body structures. The **skeleton** consists of the bones of the body. For adults, there are 206 bones in the skeleton. Younger individuals have higher numbers of bones because some bones fuse together during childhood and adolescence to form an adult bone. The primary functions of the skeleton are to provide a rigid, internal structure that can support the weight of the body against the force of gravity, and to provide a structure upon which muscles can act to produce movements of the body.

In addition to providing for support and movements of the body, the skeleton has protective and storage functions. It protects the internal organs, including the brain, spinal cord, heart, lungs, and pelvic organs. The bones of the skeleton serve as the primary storage site for important minerals such as calcium and phosphate. The bone marrow found within bones stores fat and houses the blood-cell producing tissue of the body.

The skeleton is subdivided into two major divisions: the **axial** and **appendicular**.

The Axial Skeleton

The **axial skeleton** forms the vertical, central axis of the body and includes all bones of the head, neck, chest, and back (see Figure 13.1). It serves to protect the brain, spinal cord, heart, and lungs. It also serves as the attachment site for muscles that move the head, neck, and back and for muscles that act across the shoulder and hip joints to move their corresponding limbs.

The axial skeleton of the adult consists of 80 bones, including the **skull**, the **vertebral column**, and the **thoracic cage**. The skull is formed by 22 bones. Also associated with the head are an additional seven bones, including the **hyoid bone** and the **ear ossicles** (three small bones found in each middle ear). The vertebral column consists of 24 bones, each called a **vertebra**, plus the **sacrum** and **coccyx**. The thoracic cage includes the 12 pairs of **ribs**, and the **sternum**, the flattened bone of the anterior chest.

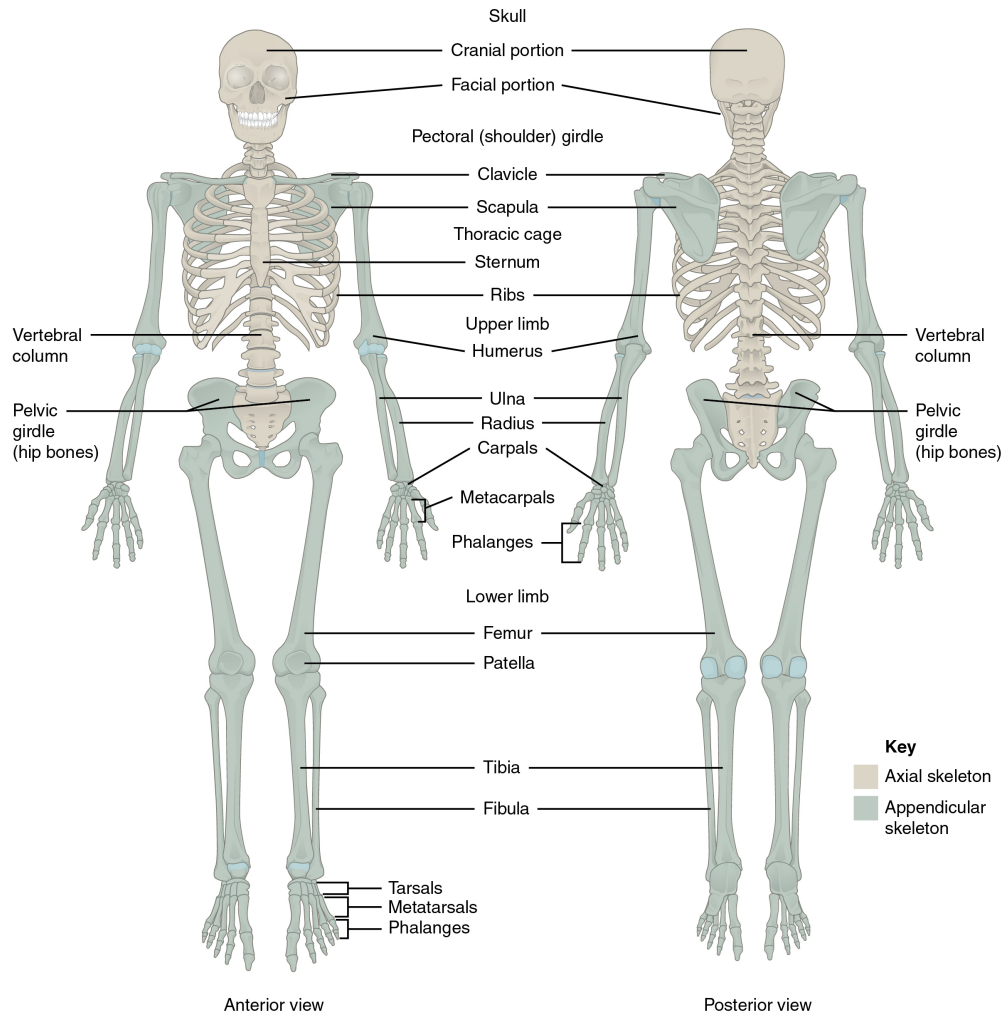


Figure 13.1 Axial and Appendicular Skeleton. The axial skeleton supports the head, neck, back, and chest and thus forms the vertical axis of the body. It consists of the skull, vertebral column (including the sacrum and coccyx), and the thoracic cage, formed by the ribs and sternum. The appendicular skeleton is made up of all bones of the upper and lower limbs. From Betts et al., 2013. Licensed under CC BY 4.0. [Fig. 13.1 Image description.]

Did You Know 1?

The axial skeleton has 80 bones and includes bones of the skull (and face), vertebral column, and thoracic cage.

The **cranium** or skull supports the face and protects the brain. It is subdivided into the bones of the skull and the bones of the face.

Bones of the Skull

- **Frontal** – forms the forehead
- **Parietal** – the upper lateral sides of the cranium
- **Occipital** – the posterior skull and base of the cranial cavity
- **Temporal** – the lower lateral sides of the cranium
- **Sphenoid** – the ‘keystone’ bone that forms part of the base of skull and eye sockets
- **Ethmoid** – forms part of the nose and orbit and base of the cranium
- **Auditory ossicles** – the small bones of the middle ear
- **External auditory meatus** – the external opening of the ear and temporal bone

Bones of the Face

- **Zygomatic** – the cheekbone
- **Maxillary** – the upper jaw and hard palate
- **Palatine** – the lateral walls of the nose
- **Lacrimal** – the walls of the orbit
- **Inferior conchae** – the lower lateral wall of the nasal cavity
- **Vomer** – the separates the left and right nasal cavity
- **Mandible** – the lower jaw bone (The only movable bone of the skull)
- **Hyoid** – the bone located between the mandible and larynx, not connected to other bones

Bones of the Vertebral Column

The vertebral column is also known as the spinal column or spine (see Figure 13.2). It consists of a sequence of vertebrae (singular = vertebra), each of which is separated and united by an **intervertebral disc**. Together, the vertebrae and intervertebral discs form the vertebral column. It is a flexible column that supports the head, neck, and body and allows for their movements. It also protects the spinal cord, which passes down the back through openings in the vertebrae.

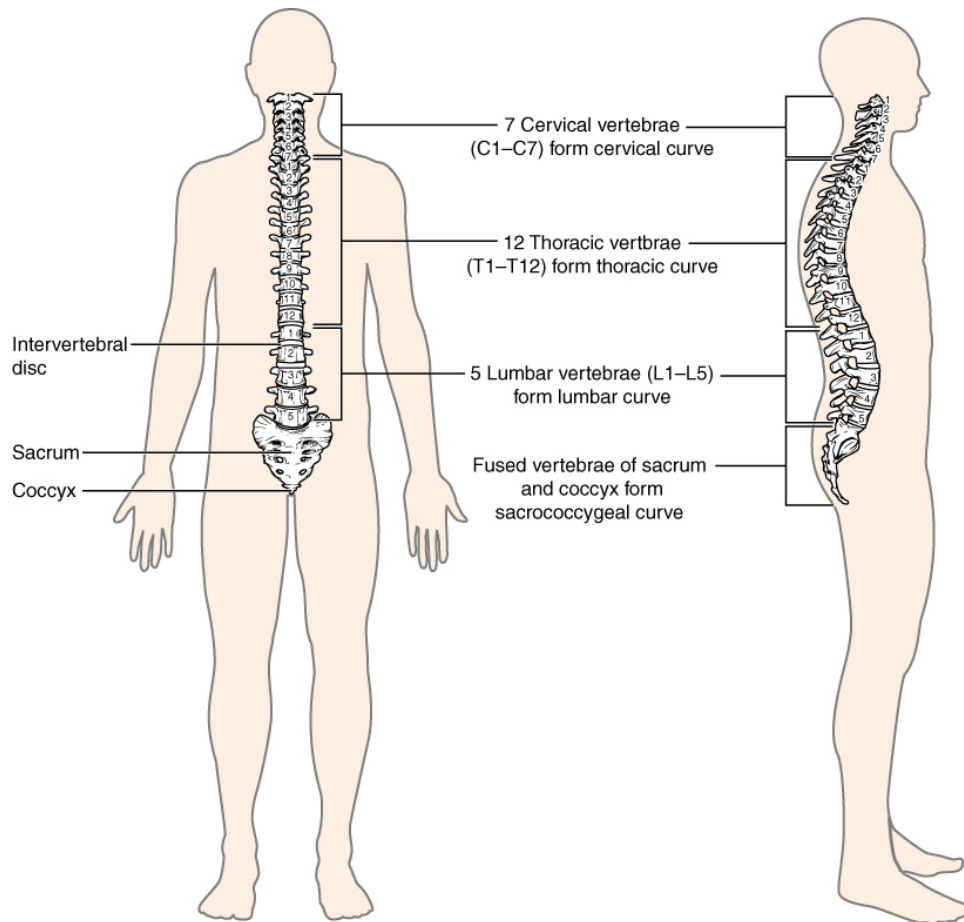


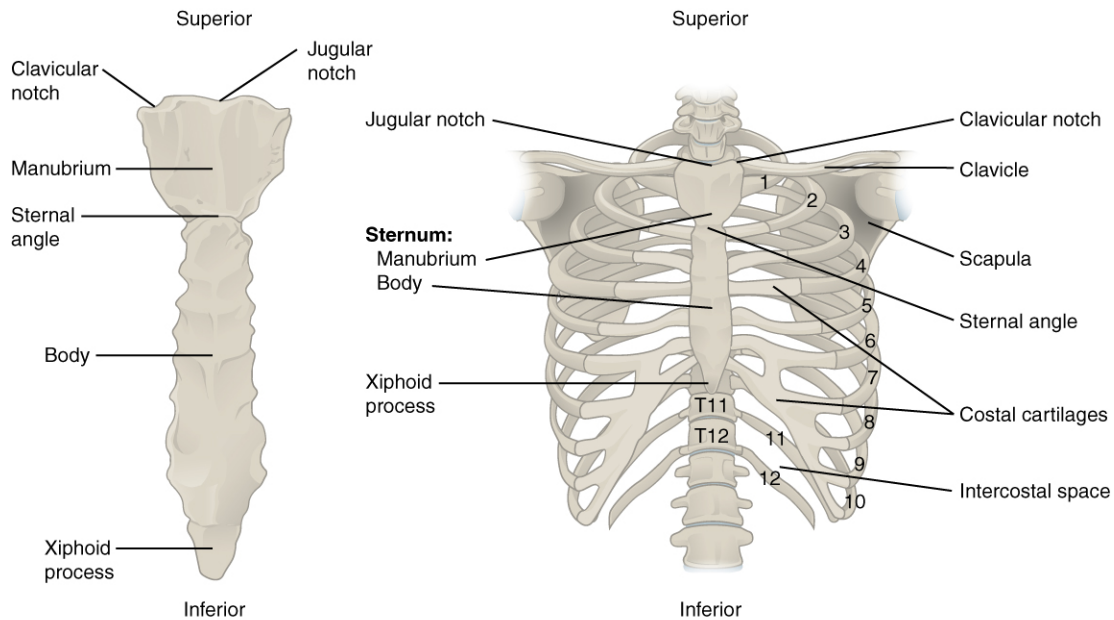
Figure 13.2 Vertebral Column. The adult vertebral column consists of 24 vertebrae, plus the sacrum and coccyx. The vertebrae are divided into three regions: cervical C1–C7 vertebrae, thoracic T1–T12 vertebrae, and lumbar L1–L5 vertebrae. The vertebral column is curved, with two primary curvatures (thoracic and sacrococcygeal curves) and two secondary curvatures (cervical and lumbar curves). From Betts et al., 2013. Licensed under CC BY 4.0. [Fig. 13.2 Image description.]

Types of Vertebrae

- **Cervical:** C1 to C7 – the first 7 vertebrae in the neck region
- **Thoracic:** T1 to T12 – the next 12 vertebrae that form the outward curvature of the spine
- **Lumbar:** L1 to L5 – the next 5 vertebrae that form the inner curvature of spine
- **Sacrum:** the triangular-shaped bone at the base of the spine
- **Coccyx:** the tailbone

Bones of the Thoracic Cavity

The thoracic cage (rib cage) forms the thorax (chest) portion of the body. It consists of 12 pairs of ribs with their costal cartilages and the sternum (see Figure 13.3). The ribs are anchored posteriorly to the 12 thoracic vertebrae (T1–T12). The thoracic cage protects the heart and lungs.



(a) Anterior view of sternum

(b) Anterior view of skeleton of thorax

Figure 13.3 Thoracic Cage. The thoracic cage is formed by the (a) sternum and (b) 12 pairs of ribs with their costal cartilages. The ribs are anchored posteriorly to the 12 thoracic vertebrae. The sternum consists of the manubrium, body, and xiphoid process. The ribs are classified as true ribs (1–7) and false ribs (8–12). The last two pairs of false ribs are also known as floating ribs (11–12). From Betts et al., 2013. Licensed under CC BY 4.0. [Fig. 13.3 Image description.]

Ribs

There are 12 sets of **ribs** and can be divided as such:

- 7 **true ribs** as they are attached to the front of the sternum
- 3 **false ribs** as they are attached to the cartilage that joins the sternum
- 2 **floating ribs** as they are not attached to the front of the sternum

Sternum

The **sternum**, also known as the breast bone, is divided into 3 parts:

- **manubrium** – the upper portion of the breastbone
- **body** – the middle portion of the breastbone
- **xiphoid process** – the lower portion of the breastbone and is made up of cartilage

Concept Check 2

Answer the following questions:

- What is the medical term for the upper jaw bone and for the lower jaw bone?
- What medical term is used for the bones of the inner ear?
- How many bones make up the cervical region of the vertebral column?

The Appendicular Skeleton

The **appendicular skeleton** includes all bones of the upper and lower limbs, plus the bones that attach each limb to the axial skeleton. There are 126 bones in the appendicular skeleton of an adult.

Did You Know 2?

The appendicular skeleton has 126 bones. It is divided into the bones of the upper limbs and lower limbs that attach each limb to skeleton (Betts et al., 2013).

Bones of the Pectoral Girdle

- **Scapula:** the shoulder blades
- **Clavicle:** the collar bones. It connects the sternum to the scapula
- **Acromion:** the extension that forms the bony point of the shoulder

Bones of the Upper Limbs

The bones of the upper limbs include the bones of the arms, wrists, and hands.

Bones of the Arm

- **Humerus**: the bone in upper arm
- **Radius** – the bone that runs thumb-side of the forearm
- **Ulna** – the bone that runs on the side of the little finger of the forearm

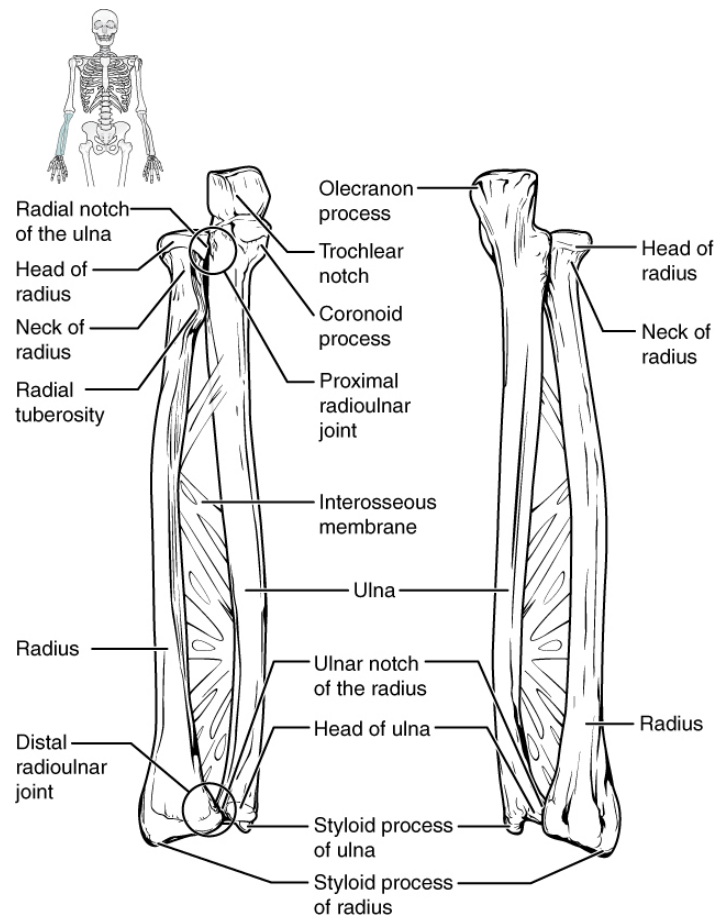


Figure 13.4 Ulna and Radius. The ulna is located on the medial side of the forearm, and the radius is on the lateral side. These bones are attached to each other by an interosseous membrane. From Betts et al., 2013. Licensed under CC BY 4.0. [Fig. 13.4 Image description.]

Bones of the Wrist and Hand

- **Carpals** – the wrist bones
- **Metacarpals** – the bones in the palm of hand

- **Phalanges** – the finger and toe bones

Each phalanx has three bones: the distal, medial, and proximal. The exception is the thumb and big toe which has two bones: distal and proximal (see Fig 16.5 below). There are 30 bones in each upper limb. Can you count them on your limb?

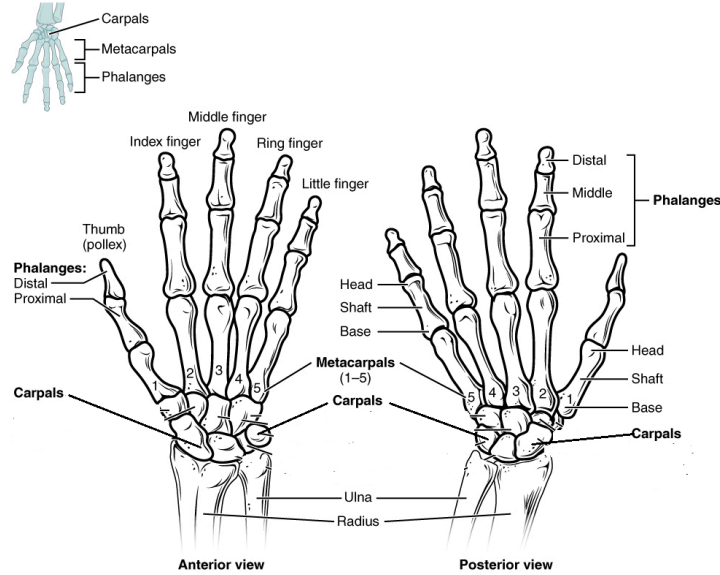


Figure 13.5 Bones of the Hands. From Betts et al., 2013. Licensed under CC BY 4.0. [Fig. 13.5 Image description.]

Bones of the Pelvic Region

The bones of the pelvic region protect the reproductive, urinary, and excretory organs.

- **Pelvic girdle** – the hip or coxal bone. It is formed by the fusion of three bones during adolescence
- **Ilium** – the largest part of the hip bone
- **Ischium** – the lower portion of the pelvic girdle
- **Pubis** – the anterior portion of the pelvic girdle
- **Pelvis** – consists of four bones: the left and right hip bones as well as the sacrum and coccyx
- **Acetabulum** – the large socket in the pelvic bones that holds the head of the femur

The shape of the pelvic girdle is different for males than females. In the male, it is a funnel shape. In the female it is shaped like a basin to accommodate for the fetus during pregnancy.

Did You know 3?

The femur is the longest and strongest bone of the body, and accounts for approximately one-quarter of a person's total height (Betts et al., 2013).

Bones of the Lower Limbs

The bones of the lower limb include bones of the leg and the feet.

Bones of the Leg

- **Femur** – the thigh bone and is also referred to as the upper leg bone. It is the longest and strongest bone in the human body
- **Patella** – the kneecap
- **Tibia** – the shin bone. It is a medial bone and the main weight-bearing bone of the lower leg
- **Fibula** – the smaller of the lower leg bone (see Figure 13.6)

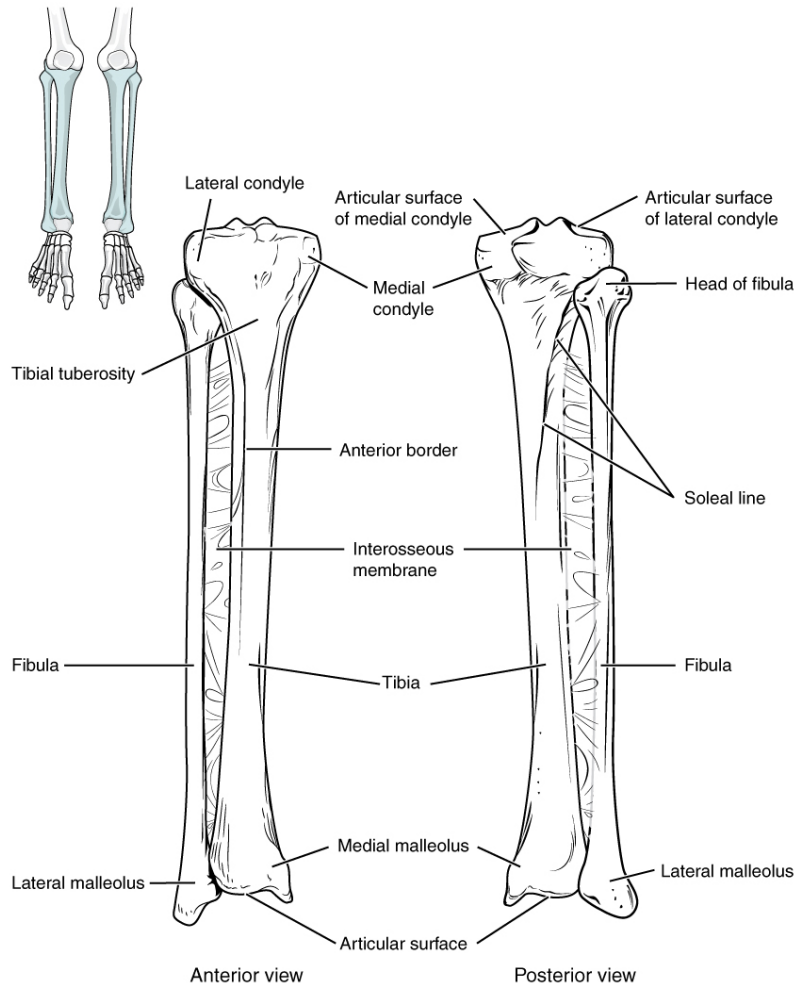


Figure 13.6 Tibia and Fibula. The tibia is the larger, weight-bearing bone located on the medial side of the leg. The fibula is the slender bone of the lateral side of the leg and does not bear weight. From Betts et al., 2013. Licensed under CC BY 4.0. [Fig. 13.6 Image description.]

Bones of the Ankles and Feet

- **Tarsals** – the ankle bones (7 total)
- **Malleous** – the bony protrusions of the ankle bones
- **Talus** – the superior ankle bones
- **Calcaneous** – the heel bones
- **Metatarsals** – the foot bones
- **Phalanges** – the bones of the toes (see Figure 13.7)

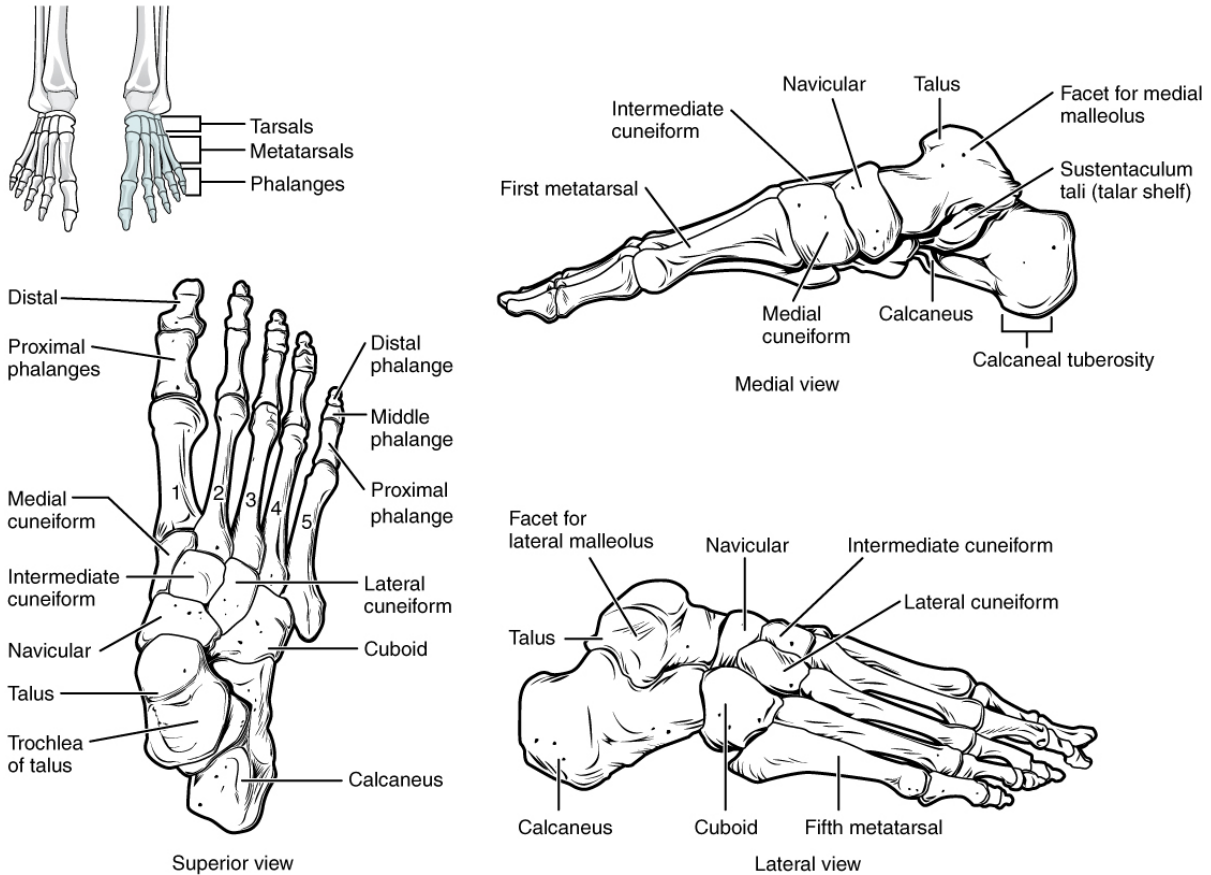


Figure 13.7 Bones of the Foot. The bones of the foot are divided into three groups. The posterior foot is formed by the seven tarsal bones. The mid-foot has the five metatarsal bones. The toes contain the phalanges. From Betts et al., 2013. Licensed under CC BY 4.0. [Fig. 13.7 Image description.]

Check Your Knowledge of the Skeletal System

Concept Check 1

Answer the following questions:

- Is the humerus the same as the funny bone?
- What is the medical term for the kneecap?

Musculoskeletal System-Skeleton Anatomy

Musculoskeletal System-Skeleton Anatomy (Text Version)

Label the diagram with the correct words listed below:

- | | | |
|---------------------|---------------------|-----------------|
| 1. Fibula | 9. Vertebral column | 17. Scapula |
| 2. Clavicle | 10. Tibia | 18. Metatarsals |
| 3. Femur | 11. Ulna | 19. Sternum |
| 4. Cranial portion | 12. Phalanges | 20. Metacarpals |
| 5. Radius | 13. Ribs | 21. Patella |
| 6. Facial portion | 14. Tarsals | 22. Humerus |
| 7. Vertebral column | 15. Phalanges | 23. Carpals |
| 8. Pelvic girdle | 16. Pelvic girdle | |

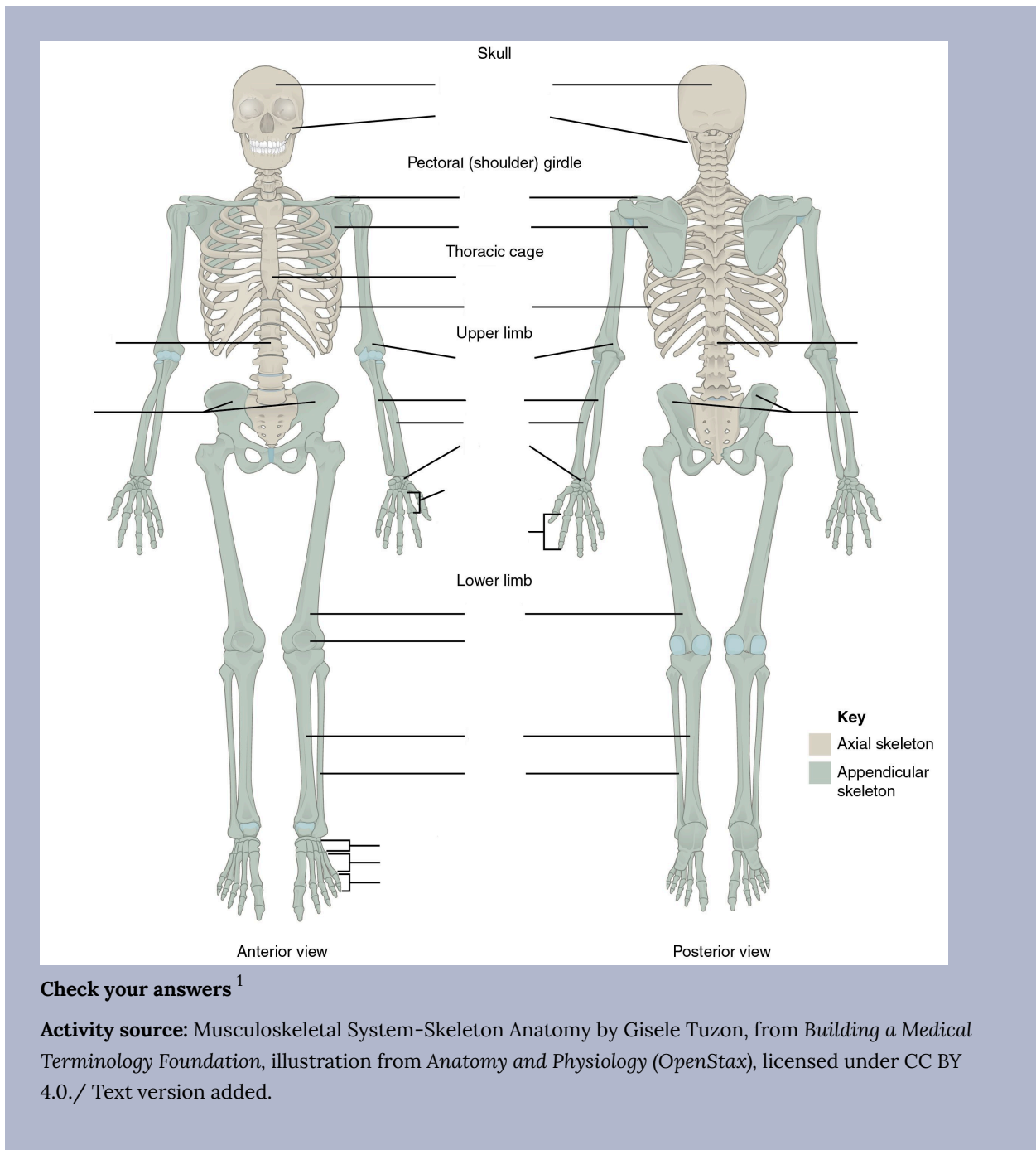


Image Descriptions

Figure 13.1 image description: This diagram shows the human skeleton and identifies the major bones. The left panel shows the anterior view (from the front) and the right panel shows the posterior view (from the back). Labels read (from the top of skull): skull (cranial portion, facial portion), pectoral shoulder girdle, clavicle, scapula, thoracic cage (sternum, ribs), upper limb (humerus, ulna, radius, carpals, metacarpals, phalanges), vertebral

column, pelvic girdle (hip bones), lower limb (femur, patella, tibia, fibula, tarsals, metatarsals, phalanges). [Return to Figure 13.1].

Figure 13.2 image description: This image shows the structure of the vertebral column. The left panel shows the front view of the vertebral column. Labels and the right panel shows the side view of the vertebral column. Labels read (from top): 7 cervical vertebrae (C1-C7) form cervical curve, 12 thoracic vertebrae (T1-T12) form thoracic curve, intervertebral disc, 5 lumbar vertebrae (L1-L5) form lumbar curve, Fused vertebrae of sacrum and coccyx form sacrococcygeal curve, sacrum, coccyx. [Return to Figure 13.2].

Figure 13.3 image description: This figure shows the skeletal structure of the rib cage. The left panel shows the anterior view of the sternum. Labels read (from top): clavicular notch, jugular notch, manubrium, sternal angle, body, xiphoid process. The right panel shows the anterior panel of the sternum including the entire rib cage. Labels read (from top): jugular notch, clavicular notch, clavicle, sternum (manubrium, body, xiphoid process), scapula, sternal angle, costal cartilages, intercostal space. Ribs are numbered 1-12 from the top. [Return to Figure 13.3].

Figure 13.4 image description: This diagram labels the bones of the lower arm (excluding the hands). Labels read (from top): olecranon process, head of radius, radial notch of the ulna, trochlear notch, coronoid process, radial tuberosity, proximal radioulnar joint, neck of radius, radius, interosseous membrane, ulna, ulnar notch of the radius, head of the ulna, distal radioulnar joint, styloid process of ulna, styloid process of radius. [Return to Figure 13.4].

Figure 13.5 image description: This diagram shows an anterior and posterior view of the hands with corresponding labels. Anterior view labels read (from top): middle finger, ring finger, index finger, little finger, thumb, phalanges (distal, proximal), metacarpals, carpals, ulna, radius. Posterior view labels read (from top): Phalanges (distal, middle, proximal), head shaft and base of proximal phalange, head shaft and base of metatarsal, metatarsals 1-5, carpals, ulna, radius. [Return to Figure 13.5].

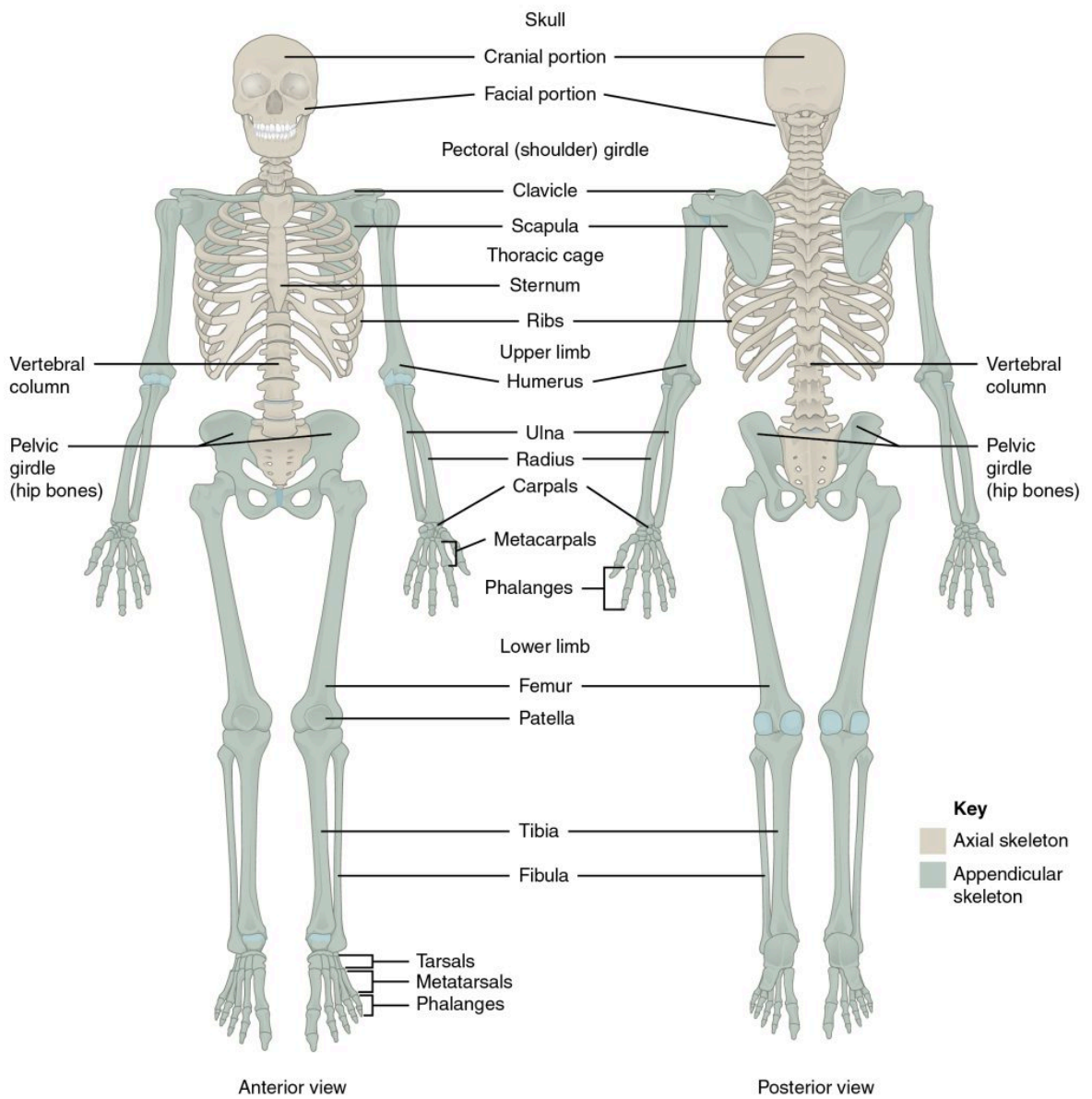
Figure 13.6 image description: This image shows the structure of the tibia and the fibula. The left panel shows the anterior view. Labels read (from top): lateral condyle, medial condyle, tibial tuberosity, anterior border, interosseous membrane, fibula, tibia, medial malleolus, lateral malleolus, articular surface. The right panel shows the posterior view. Labels read (from top): articular surface of medial and lateral condyles, medial condyle, head of fibula, soleal line, interosseous membrane, tibia, fibula, medial malleolus, lateral malleolus, articular surface. [Return to Figure 13.6].

Figure 13.7 image description: This figure shows the bones of the foot. The left panel shows the superior view. Labels read (from toes): distal, proximal phalanges, distal phalange, middle phalange, proximal phalange, medial cuneiform, intermediate and lateral cuneiforms, navicular, cuboid, talus, trochlea of talus, calcaneus. The top right panel shows the medial view. Labels read (from left to right starting at toe): first metatarsal, medial cuneiform, intermediate cuneiform, navicular, talus, calcaneus, facet for medial malleolus, sustentaculum tali (talar shelf), calcaneal tuberosity. The bottom right panel shows the lateral view. Labels read (from left at the heel to right): calcaneus, talus, facet for lateral malleolus, cuboid, navicular, intermediate and lateral cuneiforms, fifth metatarsal. [Return to Figure 13.7].

Attribution

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Notes



1.

13.3 - Physiology (Function) of the Skeletal System

The bones of the skeletal system are comprised of an inner spongy tissue referred to as bone marrow. There are two types of bone marrow, red and yellow. The red bone marrow produces the red blood cells and it does so by a process called **hematopoiesis**. The yellow bone marrow contains adipose tissues which can be a source of energy. The bones of the skeletal system also store minerals such as calcium and phosphate. These minerals are important for the physiological processes in the body and are released into the bloodstream when levels are low in the body.

Joints

Watch Joints: Crash Course Anatomy & Physiology #20 (10 min) on YouTube (<https://youtu.be/DLxYDoN634c>)

Most bones connect to at least one other bone in the body. The area where bones meet bones or where bones meet cartilage are called **articulations**. Joints can be classified based on their ability to move. At **movable** joints, the articulating surfaces of the adjacent bones can move smoothly against each other. However, other joints may be connected to each other by connective tissue or cartilage. These joints are designed for stability and provide for little or no movement. Importantly, joint stability and movement are related to each other. This means that stable joints allow for little or no mobility between the adjacent bones. Conversely, joints that provide the most movement between bones are the least stable.

Did You Know?

The left and right hip bones are connected by an amphiarthrosis joint.

Based on the function of joints, there are 3 types of joints:

- **Synarthrosis** condition of joints which allow no movement
 - example: joints of the skull
- **Amphiarthrosis** condition of joints which allow some movement
 - example: joints of the pubic symphysis

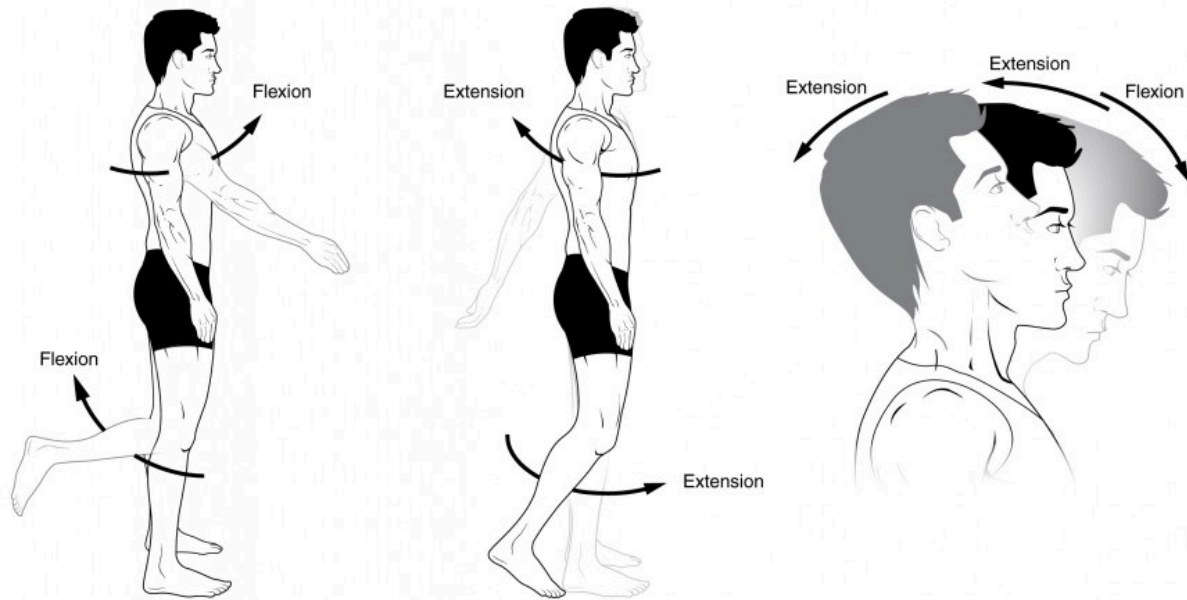
- **Diarthrosis** condition of joints which allow for free movement
 - example: joints of the knee

Structures associated with joints are:

- **Cartilage:** the elastic connective tissue that is found at the ends of bones, nose tip, etc
- **Synovial membrane:** the lining or covering of synovial joints
- **Synovial fluid:** the lubricating fluid found between synovial joints
- **Ligaments:** the tough, elastic connective tissue that connects bone to bone
- **Tendons:** the fibrous connective tissue that attaches muscle to bone
- **Bursa:** the closed, fluid-filled sacs that work as a cushion
- **Meniscus:** C-shaped cartilage that act as a shock absorber between bones

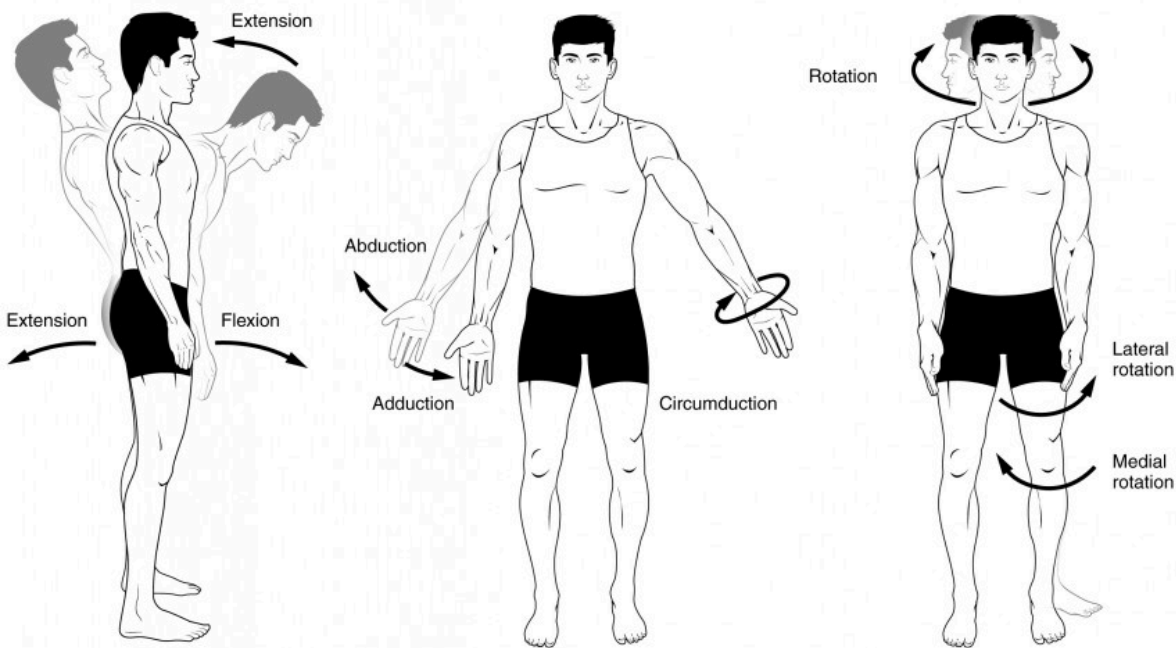
Body Movements

Synovial joints are movable joints and provide most of the body movements. Body movement occurs when the bones, joints and muscles work together.



(a) and (b) Angular movements: flexion and extension at the shoulder and knees

(c) Angular movements: flexion and extension of the neck



(d) Angular movements: flexion and extension of the vertebral column

(e) Angular movements: abduction, adduction, and circumduction of the upper limb at the shoulder

(f) Rotation of the head, neck, and lower limb

Figure 13.8 *Movements of the Body, Part 1*. Synovial joints give the body many ways in which to move. (a) and (b) Flexion and extension motions are in the sagittal (anterior and posterior) plane of motion. These movements take place at the shoulder, hip, elbow, knee, wrist, metacarpophalangeal, metatarsophalangeal, and interphalangeal joints. (c) and (d) Anterior bending of the head or vertebral column is flexion, while any posterior-going movement is extension. (e) Abduction and adduction are motions of the limbs, hand, fingers, or toes in the coronal (medial and lateral) plane of movement. Moving the limb or hand laterally away from the body, or spreading the fingers or toes, is abduction. Adduction brings the limb or hand toward or across the midline of the body, or brings the fingers or toes together. Circumduction is the movement of the limb, hand, or fingers in a circular pattern, using the sequential combination of flexion, adduction, extension, and abduction motions. Adduction/abduction and circumduction take place at the shoulder, hip, wrist, metacarpophalangeal, and metatarsophalangeal joints. (f) Turning of the head side to side or twisting of the body is rotation. Medial and lateral rotation of the upper limb at the shoulder or lower limb at the hip involves turning the anterior surface of the limb toward

the midline of the body (medial or internal rotation) or away from the midline (lateral or external rotation). From Betts et al., 2013. Licensed under CC BY 4.0. [Fig. 13.8 Image description.]

Flexion and Extension

Flexion and **extension** are movements that take place within the sagittal plane and involve anterior or posterior movements of the body or limbs. For the vertebral column, **flexion** (anterior flexion) is an anterior (forward) *bending* of the neck or body, while **extension** involves a posterior-directed motion, such as *straightening* from a flexed position or bending backwards. **Lateral flexion** is the bending of the neck or body toward the right or left side. These movements of the vertebral column involve both the joints as well as the associated intervertebral disc.

In the limbs, flexion *decreases* the angle between the bones (bending of the joint), while extension *increases* the angle and straightens the joint (see Figure 13.8(a-d)). You will discover in the muscular system chapter that the associated muscles to these movements are the flexor and extensor.

Abduction and Adduction

Abduction and **adduction** motions occur within the coronal plane and involve medial-lateral motions of the limbs, fingers, toes, or thumb. For example, abduction is raising the arm at the shoulder joint, moving it laterally away from the body, while adduction brings the arm down to the side of the body (see Figure 13.8(e)). In the muscular system chapter you will discover that the associated muscles to these movements are the abductor and adductor.

Circumduction

Circumduction is the movement of a body region in a *circular* manner, in which one end of the body region being moved stays relatively stationary while the other end describes a circle. It involves the sequential combination of flexion, adduction, extension, and abduction at a joint (see Figure 13.8(e)).

Rotation

Rotation can occur within the vertebral column, at a **pivot joint**, or at a **ball-and-socket joint**. Rotation of the neck or body is the *twisting* movement produced by the summation of the small rotational movements available between adjacent vertebrae. At a pivot joint, one bone rotates in relation to another bone.

Rotation can also occur at the **ball-and-socket joints** of the shoulder and hip. Here, the humerus and femur rotate around their long axis, which moves the anterior surface of the arm or thigh either toward or away from the midline of the body (see Figure 13.8(f)).

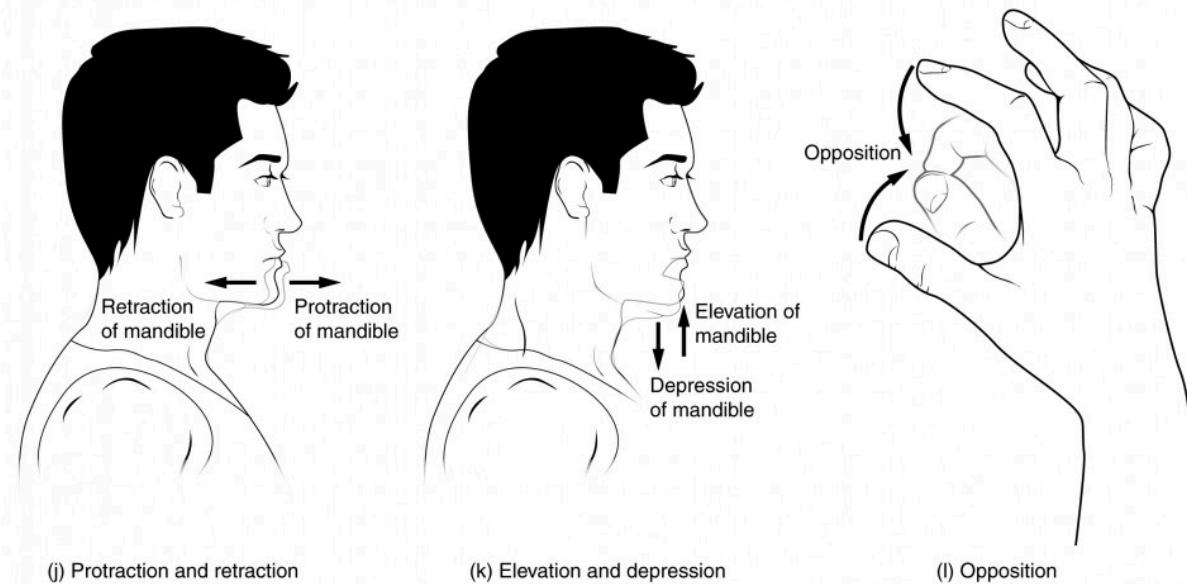
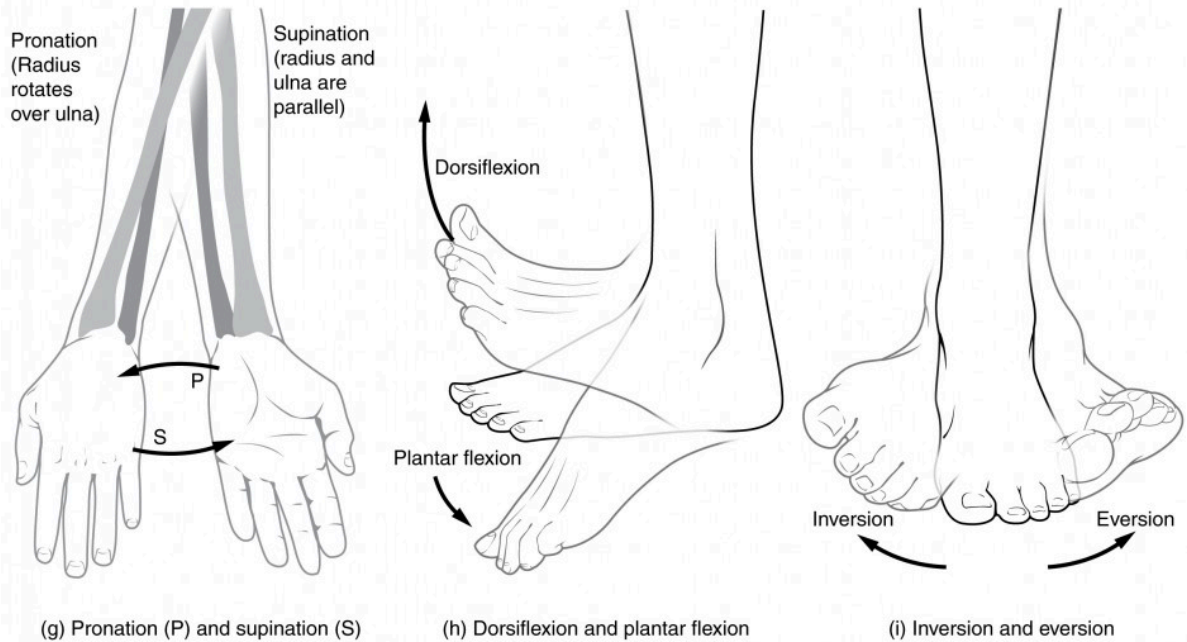


Figure 13.9 Movements of the Body, Part 2. (g) Supination of the forearm turns the hand to the palm forward position in which the radius and ulna are parallel, while forearm pronation turns the hand to the palm backward position in which the radius crosses over the ulna to form an “X.” (h) Dorsiflexion of the foot at the ankle joint moves the top of the foot toward the leg, while plantar flexion lifts the heel and points the toes. (i) Eversion of the foot moves the bottom (sole) of the foot away from the midline of the body, while foot inversion faces the sole toward the midline. (j) Protraction of the mandible pushes the chin forward, and retraction pulls the chin back. (k) Depression of the mandible opens the mouth, while elevation closes it. (l) Opposition of the thumb brings the tip of the thumb into contact with the tip of the fingers of the same hand and reposition brings the thumb back next to the index finger. From Betts et al., 2013. Licensed under CC BY 4.0.

Supination and Pronation

Supination and pronation are movements of the forearm. In the anatomical position, the upper limb is held next to the body with the *palm facing forward*. This is the **supinated position** of the forearm. In this position, the radius and ulna are parallel to each other. When the *palm of the hand faces backwards*, the forearm is in the **pronated position**, and the radius and ulna form an X-shape.

Pronation is the movement that allows the palm of the hand to face *backwards*, while in *supination* the palm of the hand faces *forwards*. It helps to remember that supination is the motion you use when scooping up soup with a spoon (see Figure 13.9(g)).

Dorsiflexion and Plantar Flexion

Dorsiflexion and **plantar flexion** are movements at the ankle joint, which is a hinge joint. Lifting the front of the foot so that the top of the *foot moves (upward)* toward the anterior leg is dorsiflexion, while lifting the heel of the foot from the ground or pointing the *toes downward* is plantar flexion. These are the only movements available at the ankle joint (see Figure 13.9(h)).

Inversion and Eversion

Inversion and eversion are complex movements that involve the multiple plane joints among the tarsal bones of the posterior foot (intertarsal joints) and thus are not motions that take place at the ankle joint. **Inversion** is the turning of the foot to angle the bottom of the foot *toward the midline*, while **eversion** turns the bottom of the foot away from the midline. The foot has a greater range of inversion than eversion motion. These are important motions that help to stabilize the foot when walking or running on an uneven surface and aid in the quick side-to-side changes in direction used during active sports such as basketball, racquetball, or soccer (see Figure 13.9(i)).

Protraction and Retraction

Protraction and **retraction** are anterior-posterior movements of the scapula or mandible. Protraction of the scapula occurs when the *shoulder is moved forward*, as when pushing against something or throwing a ball. Retraction is the opposite motion, with the scapula being *pulled posteriorly* and medially toward the vertebral column. For the mandible, protraction occurs when the lower jaw is pushed forward to stick out the chin, while retraction pulls the lower jaw backwards (see Figure 13.9(j)).

Depression and Elevation

Depression and **elevation** are downward and upward movements of the scapula or mandible. The *upward movement of the scapula* and shoulder is elevation, while a *downward movement* is depression. These movements

are used to shrug your shoulders. Similarly, the elevation of the mandible is the upward movement of the lower jaw used to close the mouth or bite on something, and depression is the downward movement that produces an opening of the mouth (see Figure 13.9(k)).

Concept Check

- Discuss the joints involved and movements required for you to cross your arms together in front of your chest.
- Differentiate between pronation and supination.

Musculoskeletal System Body Movements

Musculoskeletal System Body Movements (Text Version)

Practice the following endocrine system words by breaking into word parts and pronouncing.

1. **adduction**
 - moving toward the midline
2. **rotation**
 - turn around on own axis
3. **extension**
 - increased angle between bone and joint by placing a limb in a straight position
4. **abduction**
 - moving away from the midline
5. **inversion**
 - turning inward
6. **supination**

- turn the palm up

7. **eversion**

- turning outward

8. **pronation**

- turn the palm down

9. **flexion**

- decreasing the angle of a joint by bending a limb

Activity source: Musculoskeletal System Body Movements by Kimberlee Carter, from *Building a Medical Terminology Foundation* by Kimberlee Carter and Marie Rutherford, licensed under CC BY- 4.0. /Text version added.

Musculoskeletal System – Operative Report

Musculoskeletal System – OPERATIVE REPORT (Text version)

Using the words below fill in the operative report:

- chondromalacia
- x-rays
- arthritis
- Orthopedic
- arthroscopy
- total hip arthroplasty
- femoral
- tendinitis

PATIENT NAME: Mrs. Karen SMITH

AGE: 72 Sex: Female

DATE OF SURGERY: February 24

PREOPERATIVE DIAGNOSIS: Degenerative arthritis of both hips; more severe on the right side.

POSTOPERATIVE DIAGNOSIS: Severe degenerative arthritis and severe _____ [Blank 1] of the right hip.

NAME OF PROCEDURE: Total hip arthroplasty.

HISTORY: Mrs. Karen Smith is a 72-year-old widow who has been living alone and independently since her husband's premature death 15 years ago. Mrs. Smith has worked for 30 years at the production line in a factory and is now retired.

Mrs. Smith has been experiencing discomfort in her hips, especially the right one, over the parts twenty

years or so. However, what started as a mild discomfort over time turned into severe pain. Now the pain is so bad that she is afraid that it might soon rob her of her independence. She first sought help for her hip pain many years ago. After physical examination, her family physician ordered _____[Blank 2] for both hip joints. Based on the results, it was concluded that the pain was due to severe _____[Blank 3] mainly due to wear and tear. She was advised to lose weight and to take over-the-counter painkillers as needed. She was also referred to a physiotherapist. However, despite the fact that she has lost 10% of her original body weight of 170 pounds and has been adhering to the exercise regimen recommended by her physiotherapist, the pain has grown worse over the years and now is almost unbearable. She was last visited by an orthopedic surgeon and subsequently was admitted to the General Hospital Outpatient _____[Blank 4] Clinic for _____[Blank 5] of both hips.

OPERATIVE REPORT: The patient was brought to the operating room by anesthesia personnel. She was placed on the operating table. A Foley catheter was inserted. The patient was then placed into the lateral decubitus position with her right side up. The right lower extremity was prepped and draped in standard fashion for a _____[Blank 6]. Dissection was carried sharply down through the soft tissue to the greater trochanter. The greater trochanter was used as a landmark to orient the remainder of the dissection which was continued posteriorly and proximally to expose the iliofemoral joint.

The acetabulum was reamed. A 50 mm acetabular shell was used. Femur was debrided using a _____[Blank 7] canal curette. The length of the femoral stem was then checked with the canal curette in place. Appropriate femoral stem and head were selected and implanted. Intraoperative radiographs were obtained to ensure proper component position.

The hip was then checked for range of motion. The patient reached 90 degrees of flexion and full extension with no instability. No abnormality was detected in the surrounding soft tissue. There was no indication of _____[Blank 8].

The area was then closed in a layered fashion. The subcutaneous tissues were closed using surgical Vicryl 5-0 sutures. An incisional VAC was placed over the wound as well. Sponge and needle counts were correct at the end of the operation. The patient tolerated the procedure well and was returned to the recovery room in good condition.

Michael Porter, MD, Orthopedic Surgery

Note: Report samples (H5P and Pressbooks) are to encourage learners to identify correct medical terminology and do not represent the Association for Health Documentation Integrity (AHDI) formatting standards.

Check your answers: ¹

Activity source: Musculoskeletal System – Operative Report by Saeedah Akram and Heather Scudder, from *Building a Medical Terminology Foundation* by Kimberlee Carter and Marie Rutherford, licensed under CC BY- 4.0. /Text version added.

Musculoskeletal System – Operative Report

Musculoskeletal System – Operative Report (Text version)

Use the words below to fill in the operative report:

- orthopedic
- supination
- colles
- carpal
- tenomyoplasty
- sterilized
- aligned
- fluoroscopy
- tenorrhaphy
- sutured
- splint
- arthralgia
- akinesia
- atrophy

PATIENT NAME: Liam PALMER

AGE: 22

SEX: Male

DOB: December 4

DATE OF ADMISSION: May 5

DATE OF PROCEDURE: May 5

ATTENDING PHYSICIAN: Michael Porter, MD, Orthopedic Surgery

PREOPERATIVE DIAGNOSIS: Fx of the distal end of radius.

POSTOPERATIVE DIAGNOSIS: Fx of the distal end of radius.

ANESTHESIA: General.

INDICATION: This 22-year-old male had been skating earlier today when he lost his balance and fell. Trying to break the fall with an outstretched arm, he landed on his right arm, breaking his wrist. Mr. Palmer was brought to the _____[Blank 1] clinic in Toronto General Hospital. The wrist has been kept in a neutral position since even a slight movement was painful. The injured area is edematous and any attempt for active or passive flexion, extension, _____[Blank 2], or pronation caused a sharp pain that shoots all the way to the right shoulder. Posterior-Anterior and lateral x-rays of the wrist and forearm confirmed _____[Blank 3] fracture of the distal end of radius with the broken piece displaced posteriorly. The _____[Blank 4] bones were intact. The patient required surgery to fix the broken bone. Although not certain at that point, there was a possibility that the patient also required _____[Blank 5].

PROCEDURE: The surgery was done under general anesthesia. The patient's arm was placed in a proper position to allow for an easy and unobstructed access to the surgical area. The surgical area was _____[Blank 6]. A longitudinal incision was made to access the fracture. The fractured bone was realigned, and a metal plate was used to secure the _____[Blank 7] bone and restore stability. Throughout the surgery _____[Blank 8] was used to ensure proper reduction of the bone. The surrounding muscles, tendons, and ligaments were examined to ensure their integrity. There was no need for tenomyoplasty or _____[Blank 9]. Once the surgery was completed, the surgical incision was _____[Blank 10], the wrist was bandaged, and the arm was placed in a long cast to immobilize the wrist and elbow joints. The patient left the operation room in good and stable condition. The patient was discharged from the hospital on the following day. He was scheduled for his first follow

up visit in 3 weeks. At that time, the cast will be replaced with a removable wrist _____[Blank 11] and the patient will be referred to a physiotherapy clinic. Timely rehabilitation is extremely important in these types of fractures to reduce _____[Blank 12] and prevent from _____[Blank 13] and muscle _____[Blank 14].

Michael Porter, MD, Orthopedic Surgery

Note: Report samples (H5P and Pressbooks) are to encourage learners to identify correct medical terminology and do not represent the Association for Health Documentation Integrity (AHDI) formatting standards.

Check your answers:²

Activity source: MUSCULOSKELETAL SYSTEM – OPERATIVE REPORT by Saeedha Akram and Heather Scudder, from *Building a Medical Terminology Foundation* by Kimberlee Carter and Marie Rutherford, licensed under CC BY- 4.0. /Text version added.

Image Descriptions

Figure 13.8 image description: This multi-part image shows different types of movements that are possible by different joints in the body. Labels read (from top, left): a and b angular movements: flexion and extension at the shoulders and knees, c) angular movements: flexion and extension of the neck (arrows pointing left and right to indicate movement). Labels (from bottom, left) read: d) angular movements: flexion and extension of the vertical column, e) angular movements abduction, adduction, and circumduction of the upper limb at the shoulder, f) rotation of the head, neck, and lower limb. [Return to Figure 13.8].

Attribution

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Notes

1. chondromalacia, 2. x-rays, 3. arthritis, 4. Orthopedic, 5. arthroscopy, 6. total hip arthroplasty, 7. femoral, 8. tendinitis
1. orthopedic, 2. supination, 3. Colles, 4. carpal, 5. tenomyoplasty, 5. sterilized, 6. aligned, 7. fluoroscopy, 8. tenorrhaphy, 9. sutured, 10. splint, 11. arthralgia, 12. akinesia, 13. atrophy

13.4 - Skeletal Diseases, Disorders and Diagnostic Testing

Common Diseases and Disorders

Osteoporosis

Health Canada (2018) describes **osteoporosis** as bone loss that causes bones to become weak and thin over time. This weakness can lead to fractures from simple movements and occurs often in the wrist, shoulder, spine, and hip. To learn more about osteoporosis, please visit the Osteoporosis Health Canada website [New Tab] (<https://www.canada.ca/en/public-health/services/chronic-diseases/osteoporosis.html>).

Arthritis

Arthritis often presents as **edema**, **arthralgia**, and **ankylosis** (Centers for Disease Control and Prevention, 2019). Common types of arthritis are **osteoarthritis** (OA), rheumatoid arthritis (RA), **fibromyalgia**, gout, and lupus. To learn more about arthritis, visit the CDC's Arthritis Basics webpage [New Tab] (<https://www.cdc.gov/arthritis/basics/types.html>).

Osteoarthritis

Osteoarthritis is the most common form of arthritis and, according to the Arthritis Society, affects Canadians more than the combination of all other types of arthritis. The breakdown of cartilage and bone occurs over time when joints are exposed to heavy workloads either through occupation, obesity, and/or prior injury to a joint. Common symptoms are pain, stiffness, and aching that worsens over time. While there is no cure, symptoms can be managed through exercise, medications and, in severe cases, joint replacements (Arthritis Society, 2020).

Rheumatoid arthritis

The CDC describes **rheumatoid arthritis (RA)** as an autoimmune and inflammatory disease. Autoimmune diseases are disorders in which the immune system overreacts and begins to attack itself. In the case of RA, inflammation of the joint tissues of the hands, wrists and knees is painful and debilitating. Treatments may include immunosuppressive drugs and anti-inflammatory drugs (Betts et al., 2013). RA can also affect other tissues throughout the body and cause problems in organs such as the lungs, heart, and eyes. RA can affect children, and in this case, it is referred to as **juvenile rheumatoid arthritis** (Centers for Disease Control and Prevention, 2022).

Gout

According to the Arthritis Society, gout is an inflammatory arthritis caused when the immune system attacks the crystals that form when uric acid builds up in a joint. Gout has periods of **exacerbation** and remission and is commonly treated through lifestyle changes and medication. While any joint can be affected, it is common in the lower extremities and most often in the big toe (Choy & MacMullan, 2017). To learn more about the causes and treatments, please visit the Arthritis Society's web page about gout [New Tab] ([https://arthritis.ca/about-arthritis/arthritis-types-\(a-z\)/types/gout](https://arthritis.ca/about-arthritis/arthritis-types-(a-z)/types/gout)).

Myasthenia Gravis

The National Institute of Neurological Disorders and Strokes describes **myasthenia gravis** as a “**chronic** autoimmune neuromuscular disorder that causes weakness in the skeletal muscle” (Office of Communications and Public Liaison, 2020). To learn more, visit the National Institute of Neurological Disorders and Stroke's page on Myasthenia Gravis [New Tab] (<https://www.ninds.nih.gov/health-information/disorders/myasthenia-gravis>).

Fibromyalgia

Fibromyalgia is a challenging disease to diagnose, since symptoms manifest differently and are similar to other diseases. Symptoms may include chronic fatigue, gastrointestinal problems, headaches, and increased pain sensitivity. Historically, fibromyalgia was often misdiagnosed or dismissed as not real. According to The National Institute of Arthritis and Musculoskeletal and Skin Disease, there is agreement on the definition and treatment for fibromyalgia, but it is recommended to find a specialist who is familiar with fibromyalgia (National Institute of Arthritis and Musculoskeletal and Skin Diseases, 2021). To learn more about the diagnosis and treatment for fibromyalgia, please visit the National Institute of Arthritis and Musculoskeletal and Skin Diseases' fibromyalgia web page [New Tab] (<https://www.niams.nih.gov/health-topics/fibromyalgia>).

Osteomyelitis

Osteomyelitis is a bone infection caused when staphylococcus bacteria travels through the blood stream from an infection in one part of the body to the bone. Staphylococcus bacteria is found on the skin and it can transfer to the bone through a wound and/or surgical contamination. The risk increases as people age or if their immune system is compromised (Mayo Clinic Staff, 2022). To learn more about the causes, symptoms and treatments for osteomyelitis, please visit the Mayo Clinic's osteomyelitis web page [New Tab] (<https://www.mayoclinic.org/diseases-conditions/osteomyelitis/symptoms-causes/syc-20375913>).

Disorders of the Curvature of the Spine

Developmental anomalies, pathological changes, or obesity can enhance the normal vertebral column curves, resulting in the development of abnormal or excessive curvatures (see Figure 13.10). Disorders associated with the curvature of the spine include:

- **Kyphosis:** Also referred to as humpback, is an excessive posterior curvature of the thoracic region. This can develop when osteoporosis causes weakening and erosion of the anterior portions of the upper thoracic vertebrae, resulting in their gradual collapse (see Figure 13.11).
- **Lordosis:** Also referred to as swayback, is an excessive anterior curvature of the lumbar region and is most commonly associated with obesity or late pregnancy. The accumulation of body weight in the abdominal region results in an anterior shift in the line of gravity that carries the weight of the body. This causes an anterior tilt of the pelvis and a pronounced enhancement of the lumbar curve.
- **Scoliosis:** An abnormal lateral curvature accompanied by twisting of the vertebral column. Scoliosis is the most common vertebral abnormality among girls. The cause is usually unknown, but it may result from weakness of the back muscles, defects such as differential growth rates in the right and left sides of the vertebral column, or differences in the length of the lower limbs. When present, scoliosis tends to get worse during adolescent growth spurts. Although most individuals do not require treatment, a back brace may be recommended for growing children. In extreme cases, surgery may be required (Betts et al., 2013).

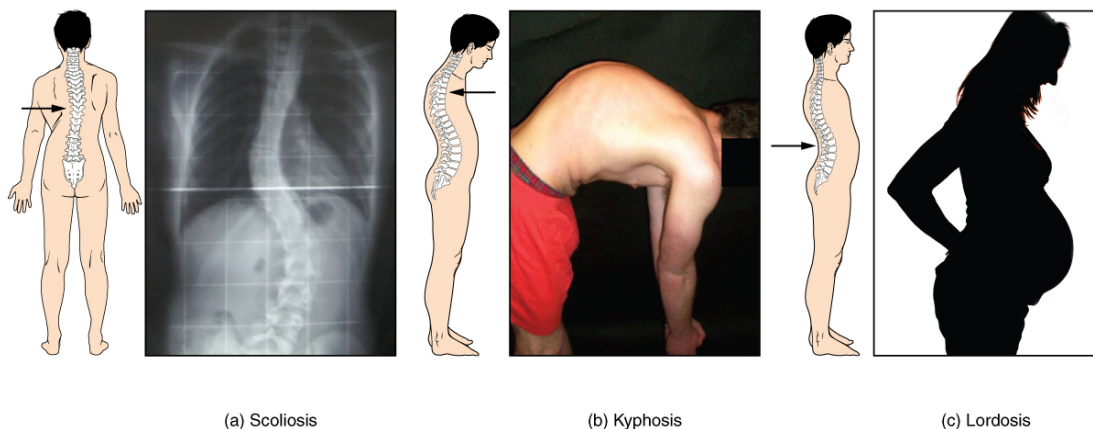


Figure 13.10 Abnormal Curvatures of the Vertebral Column. (a) Scoliosis is an abnormal lateral bending of the vertebral column. (b) An excessive curvature of the upper thoracic vertebral column is called kyphosis. (c) Lordosis is an excessive curvature in the lumbar region of the vertebral column. From Betts et al., 2013. Licensed under CC BY 4.0. [Fig. 13.10 Image description.]

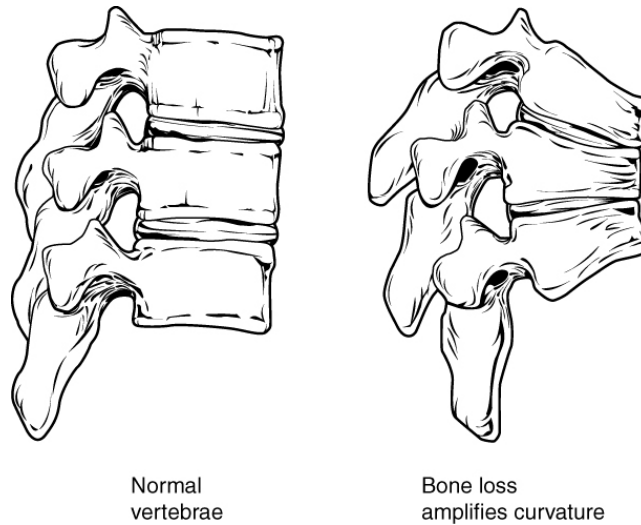


Figure 13.11. Osteoporosis. Osteoporosis is an age-related disorder that causes the gradual loss of bone density and strength. When the thoracic vertebrae are affected, there can be a gradual collapse of the vertebrae. This results in kyphosis, an excessive curvature of the thoracic region. From Betts et al., 2013. Licensed under CC BY 4.0. [Fig. 13.11 Image description.]

Fractures

A **fracture** is a broken bone. It will heal whether or not a physician resets it in its anatomical position. If the bone is not reset correctly, the healing process will keep the bone in its deformed position. **Crepitation or crepitus** is the creaking or popping sound that is heard when fractured bones move against each other. Fractures are classified by their complexity, location, and other features (see Figure 13.12). Some fractures may be described using more than one term because it may have features of more than one type (e.g., an open transverse fracture) (Betts et al., 2013; Cleveland Clinic, 2022).

Types of fractures include:

- **Closed or simple:** bones are broken but does not protrude the skin
- **Open or compound:** bones are broken and pierce through the skin
- **Transverse;** bone is broken straight across
- **Spiral:** bone has twisted apart
- **Comminuted:** bones are broken and crushed into pieces
- **Greenstick:** bones are partially broken; occurs mainly in children
- **Oblique:** bones are broken at an angle
- **Colles:** bones are broken and occur at the wrist or distal radius
- **Stress:** small crack in a bone

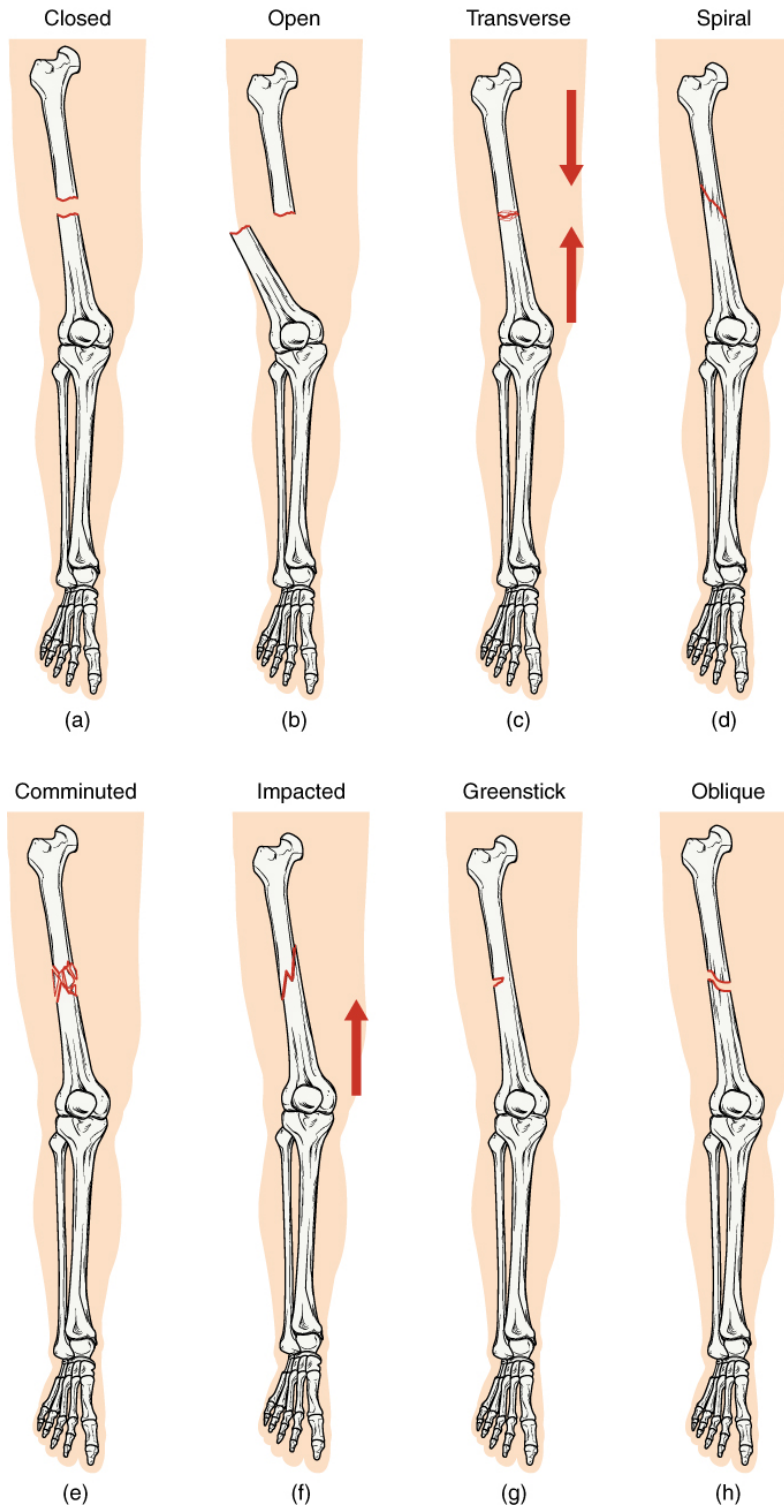


Figure 13.12. Types of Fractures. Compare healthy bone with different types of fractures: (a) closed fracture, (b) open fracture, (c) transverse fracture, (d) spiral fracture, (e) comminuted fracture, (f) impacted fracture, (g) greenstick fracture, and (h) oblique fracture. From Betts et al., 2013. Licensed under CC BY 4.0. [Fig. 13.12 Image description.]

Bone Cancer

There are three types of primary bone cancers: osteosarcoma, Ewing Sarcoma, and chondrosarcoma. These are considered primary cancers because they originate in the bones. Osteosarcoma and Ewing Sarcoma are cancers found in children, teenagers, and young adults. Ewing Sarcoma is considered to be the more aggressive of the two cancers since it tends to **metastasize** quickly. Osteosarcoma is the most common type of bone cancer and it begins in the tissues of growing bones. Chondrosarcoma is a slow-growing bone cancer that affects adults and rarely metastasizes (Government of Canada, 2013). To learn more, visit the Public Health Agency of Canada's web page on bone cancer [New Tab] (<https://www.canada.ca/en/public-health/services/chronic-diseases/cancer/bone-cancer.html>).

Diagnostic Procedures

Common diagnostic procedures related specifically to the skeletal system include x-rays, bone mineral density testing, and arthroscopy.

- **X-rays** are common diagnostic tests used to confirm or rule out fractures and broken bones. The radiation dose is low so it is considered a safe diagnostic test (Ontario Association of Radiologist, 2020).
- **Dual x-ray absorptiometry (BMD)**, also called a bone mineral density test, is a test to determine osteoporosis by measuring the amount of bone mineral in a particular amount of bone (Radiology Info, 2022).
- **Arthroscopy** is a common procedure performed by orthopedic surgeons to view the inside of a joint to diagnose and/or repair joint problems. The patient is given a local anesthetic and the surgeon inserts an **arthroscope** through an incision in the skin. Depending on what the surgeon finds, a repair of the joint may take place during the procedure (Mayo Clinic Staff, 2022).

Medical Specialties Related to the Skeletal System

Orthopedic Surgeon

Orthopedic Surgeons are medical doctors who complete an additional 5-years of specialized training in the prevention, diagnosis, treatment and surgery of disorders and diseases related to the musculoskeletal systems (Canadian Medical Association, 2019). For more details, please visit the Canadian Medical Association's page on Orthopedic Surgery [PDF] (<https://www.cma.ca/sites/default/files/2019-01/orthopedic-surgery-e.pdf>).

Rheumatologist

Rheumatologists are medical doctors who have additional training as internists with a sub-specialty in rheumatology. Many rheumatology disorders have an underlying autoimmune disorders. Consequently, rheumatologists are interested in autoimmune disorders and their impact on multiple body systems including the musculoskeletal systems (Canadian Medical Association, 2019). For more details, please follow the link to the Canadian Medical Association's page on Rheumatology [PDF] (<https://www.cma.ca/sites/default/files/2019-01/rheumatology-e.pdf>).

Doctor of Chiropractic (DC)/Chiropractor

A Doctor of Chiropractic (DC) is regulated and licensed by each province in Canada. Chiropractors have seven years of university education, a supervised internship, and national examinations. Chiropractors are trained in the prevention, assessment and treatment of the spine, muscular system and nervous system. Chiropractors focus on spinal adjustments, nutrition, and preventing injury without the use of pharmaceuticals or surgical procedures (Cleveland Clinic, 2022). To learn more, visit the Cleveland Clinic's page on Chiropractic adjustment [New Tab] (<https://my.clevelandclinic.org/health/treatments/21033-chiropractic-adjustment>).

Physiotherapist

A physiotherapist in Canada has a Master's degree in physiotherapy and has successfully completed a national Physiotherapy Competency Examination (PCE). Physiotherapists use an evidenced-based approach when assessing and designing treatment plans for their clients. Treatments may include exercises, massage, joint manipulation, and occupational retraining (Canadian Physiotherapy Association, n.d.). To learn more, please visit the Canadian Physiotherapy Association website [New Tab] (<https://physiotherapy.ca/advocacy/about-physiotherapy-in-canada/>).

Image Descriptions

Figure 13.10 image description: This image shows the changes to the abnormal curves of the vertebral columns in different diseases. The left panel shows the change in the curve of the vertebral column in scoliosis, the middle panel shows the change in the curve of the vertebral column in kyphosis, and the right panel shows the change in the curve of the vertebral column in lordosis. [Return to Figure 13.10].

Figure 13.11 image description: This figure shows the changes to the spine in osteoporosis. The left panel shows the structure of normal vertebrae and the right panel shows the curved vertebrae in osteoporosis. [Return to Figure 13.11].

Figure 13.12 image description: In this illustration, each type of fracture is shown on the right femur from an anterior view. In the closed fracture, the femur is broken in the middle of the shaft with the upper and lower

halves of the bone completely separated. However, the two halves of the bones are still aligned in that the broken edges are still facing each other. In an open fracture, the femur is broken in the middle of the shaft with the upper and lower halves of the bone completely separated. Unlike the closed fracture, in the open fracture, the two bone halves are misaligned. The lower half is turned laterally and it has protruded through the skin of the thigh. The broken ends no longer line up with each other. In a transverse fracture, the bone has a crack entirely through its width, however, the broken ends are not separated. The crack is perpendicular to the long axis of the bone. Arrows indicate that this is usually caused by compression of the bone in a superior-inferior direction. A spiral fracture travels diagonally through the diameter of the bone. In a comminuted fracture, the bone has several connecting cracks at its middle. It is possible that the bone could splinter into several small pieces at the site of the comminuted fracture. In an impacted fracture, the crack zig zags throughout the width of the bone like a lightning bolt. An arrow indicates that these are usually caused by an impact that pushes the femur up into the body. A greenstick fracture is a small crack that does not extend through the entire width of the bone. The oblique fracture shown here is travelling diagonally through the shaft of the femur at about a thirty degree angle. [Return to Figure 13.12].

Attribution

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Vocabulary & Check Your Knowledge

Skeletal System Vocabulary

Amphiarthrosis

Joints with some movement.

Ankylosis

Abnormal condition of stiffness.

Appendicular Skeleton

Consists of all the bones in the upper and lower limbs.

Arthralgia

Painful joint(s).

Arthritis

Inflammation of the joints.

Articulations

Also known as joints. It is where bones meet bones or bones meet bones.

Autoimmune Diseases/Disorders

Autoimmune diseases are disorders in which the immune system overreacts and begins to attack itself.

Axial Skeleton

Forms the vertical, central axis of the body and includes all bones of the head, neck, chest, and back.

Chronic

A condition that lasts a long time with periods of remission and exacerbation.

Diarthrosis

Freely moveable joints.

Edema

Swelling.

Hematopoiesis

The process in which the body produces blood.

Osteoarthritis

Inflammation of bones and joints.

Osteoporosis

Abnormal condition of bones that are porous.

Synarthrosis

Joints with no movements.

Skeletal System Glossary Reinforcement Activity

Skeletal System Glossary Reinforcement Activity (Text version)

1. Joints with some movement are called _____[Blank 1].
 - a. Amphiarthrosis
 - b. Diarthrosis
 - c. Synarthrosis
2. The skeleton that consists of all the bones in the upper and lower limbs is called _____[Blank 2].
 - a. Appendicular Skeleton
 - b. Articulations
 - c. Axial Skeleton
3. A condition that lasts a long time with periods of remission and exacerbation is called _____[Blank 3].
 - a. Chronic
 - b. Edema
 - c. Hematopoiesis
4. Forward curvature of the lower lumbar spine is called _____[Blank 4].
 - a. Scoliosis
 - b. Lordosis
 - c. Kyphosis
5. Comminuted fractures are _____[Blank 5].
 - a. bones that are broken but do not protrude the skin
 - b. bones that are broken and crushed into pieces

- c. bones that are broken and pierce through the skin

Check your answers:¹

Activity source: Skeletal System Glossary Reinforcement Activity by Kimberlee Carter, from *Building a Medical Terminology Foundation* by Kimberlee Carter and Marie Rutherford, licensed under CC BY 4.0.

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Notes

1. 1. a) Amphiarthrosis, 2. a) Appendicular Skeleton, 3. a) Chronic, 4. b) Lordosis, 5. b) bones that are broken and crushed into pieces.

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