

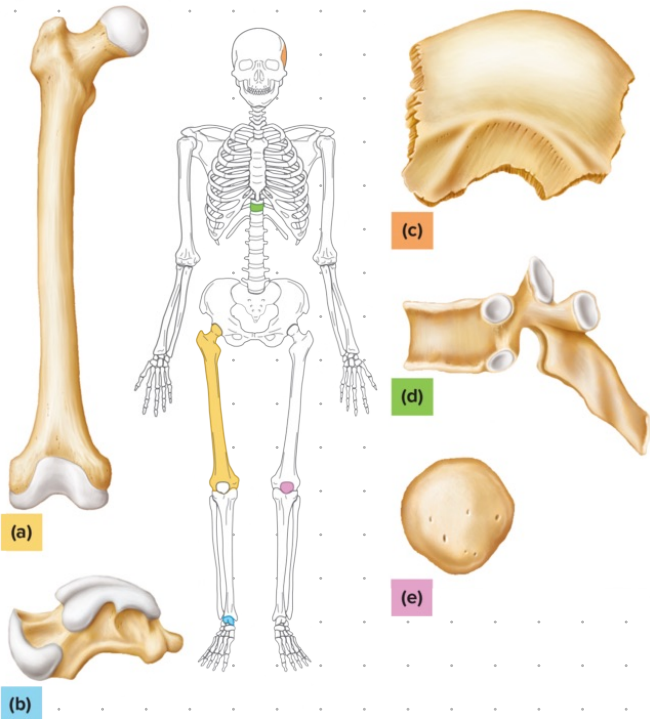


Chapter 7.1

- "skeleton" is greek & latin for "dried framework"
- living bones are wrapped in connective tissues w a blood & nerve supply
- 2 major skeletal system divisions: axial & appendicular

CHAPTER 7.2

- bones may be classified by shapes: long, short, flat, or irregular



- **long bones** have longitudinal axes & expanded ends
ex: forearm & thigh bones (a)
- **short bones** have equal length & width;
ex: wrist & ankle bones (b)
- sesamoid bone (round bone) is a special short bone: usually nodular & embedded in a tendon adjacent to a joint where tendon is compressed
ex: patella
- **flat bones** are platelike w broad surfaces
ex: ribs, scapulae, some skull bones (c)
- **irregular bones** have a variety of shapes, most are connected to several bones
ex: backbone vertebrae, many facial bones (d)

- at each end of a long bone is an expanded part called: **epiphysis** which forms a joint w another bone
- articular cartilage**: hyaline cartilage that covers the ends of bones in synovial joints
- diaphysis**: long bone shaft
- metaphysis**: the widening part of bone between diaphysis & epiphysis

→ bone is enclosed by tough, vascular covering of dense connective tissue called the **periosteum**

→ periosteum helps form & repair bone tissue

compact bone: dense bone tissue in which cells are organized in osteons w/o apparent spaces;

cortical bone

spongy bone: bone that consists of bars & plates separated by irregular spaces; **cancellous bone**

trabecula: branching bony plate that separates irregular spaces within spongy bone

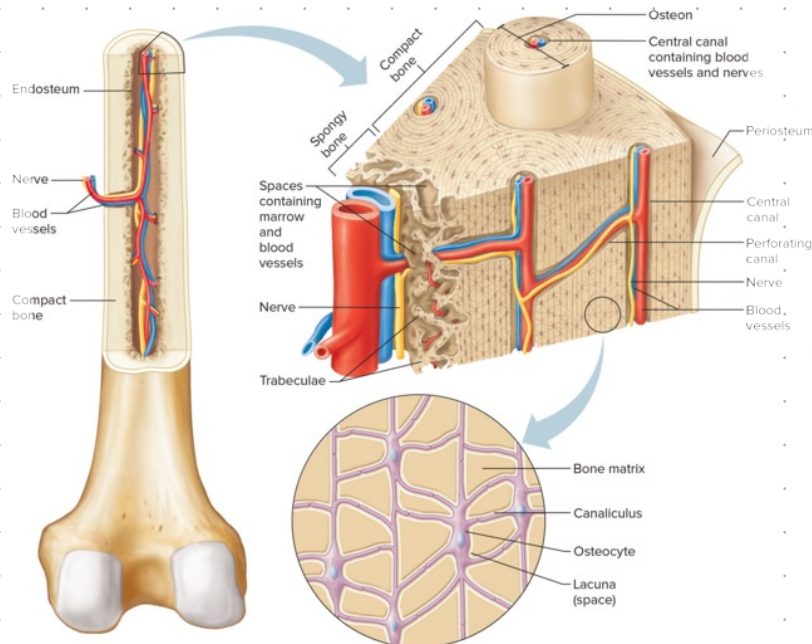
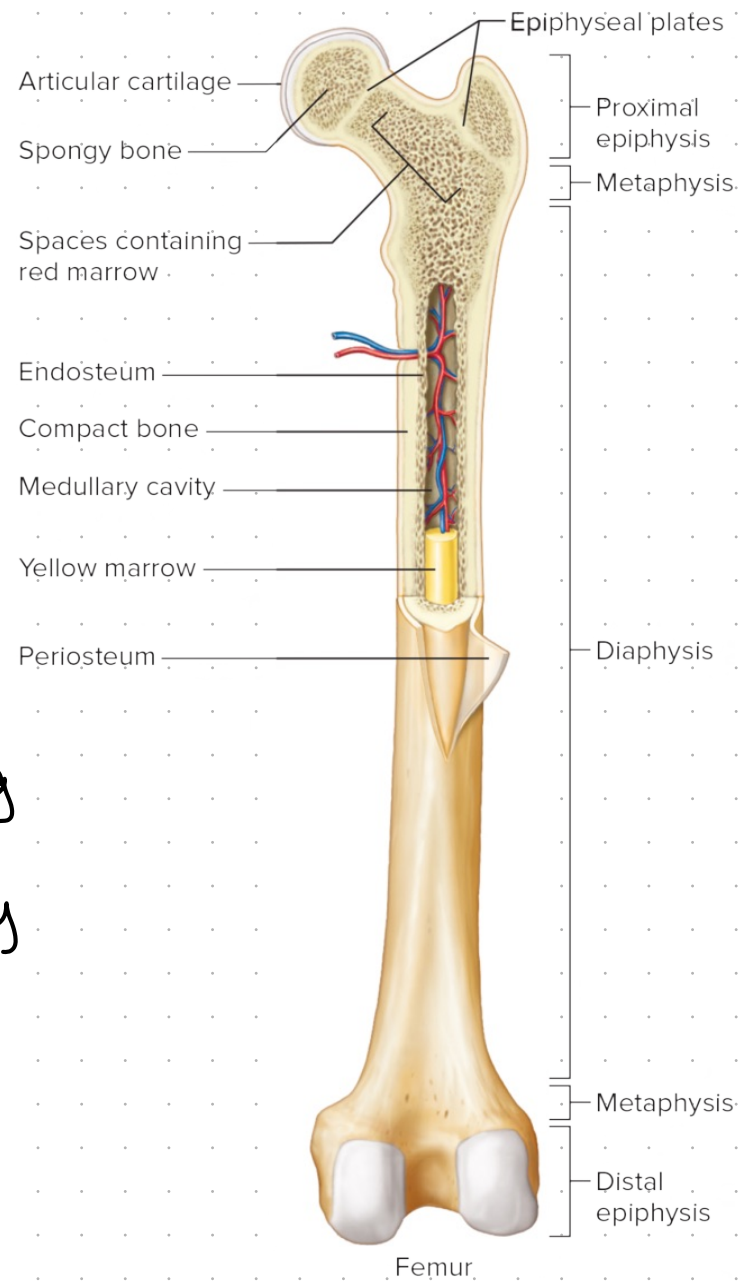
medullary cavity: cavity containing red/yellow marrow w/in diaphysis of a long bone

endosteum: tissue lining the medullary cavity in a bone

marrow: connective tissue w/in bone spaces that includes blood-forming stem cells

osteocytes: mature bone cell

→ in compact bone the osteocytes & layers of extracellular matrix called **lamellae** are clustered around a central canal forming a cylinder-shaped unit called an **osteon**



→ central canals extend longitudinally through bone tissue & transverse **perforating canals** connect center canals

Chapter 7.3

hematopoiesis: process of blood cell formation

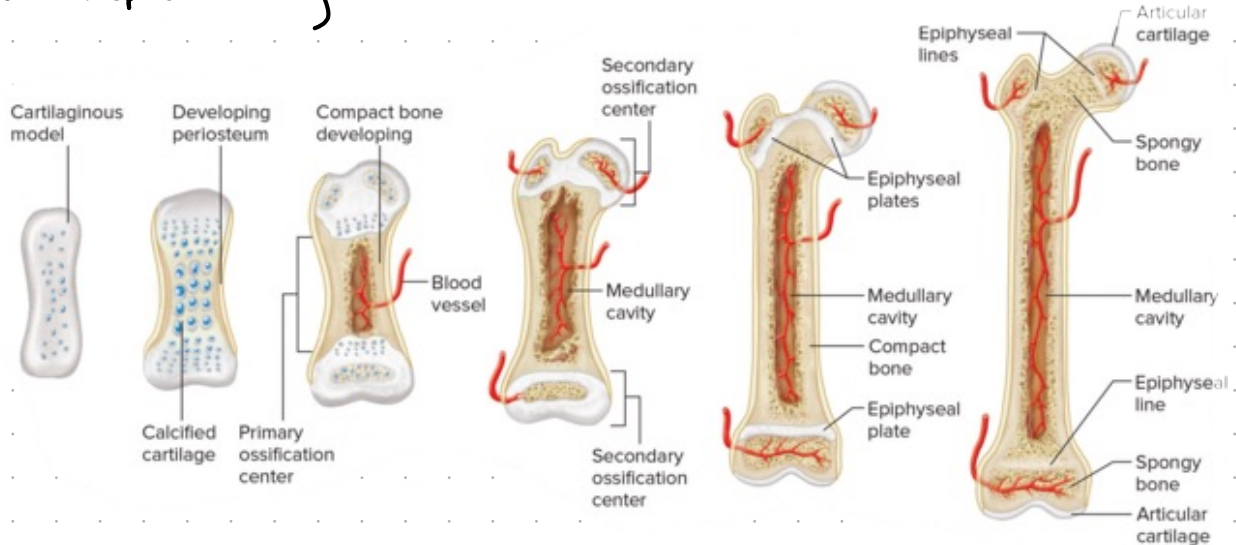
- red blood cells, white blood cells, & blood platelets form in red marrow
- yellow marrow stores fat & does not produce blood cells

- inorganic mineral salts in extracellular bone matrix account for $\approx 70\%$ of the matrix by weight & are mostly small crystals of calcium phosphate called hydroxyapatite.

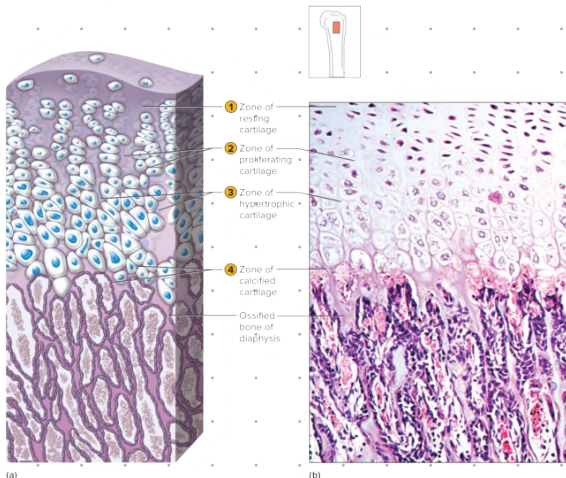
CHAPTER 7.4

intramembranous bones: bones that originate w/in sheetlike layers of connective tissues

endochondral bones: bones that begin as masses of hyaline cartilage & are later replaced by bone



↑ endochondral ossification ↓

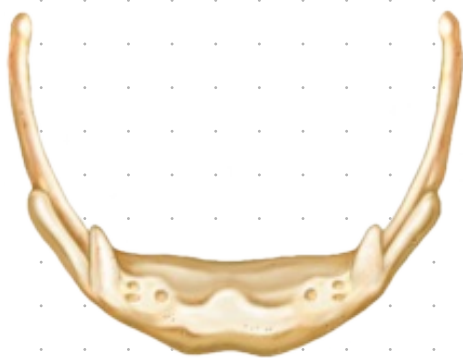
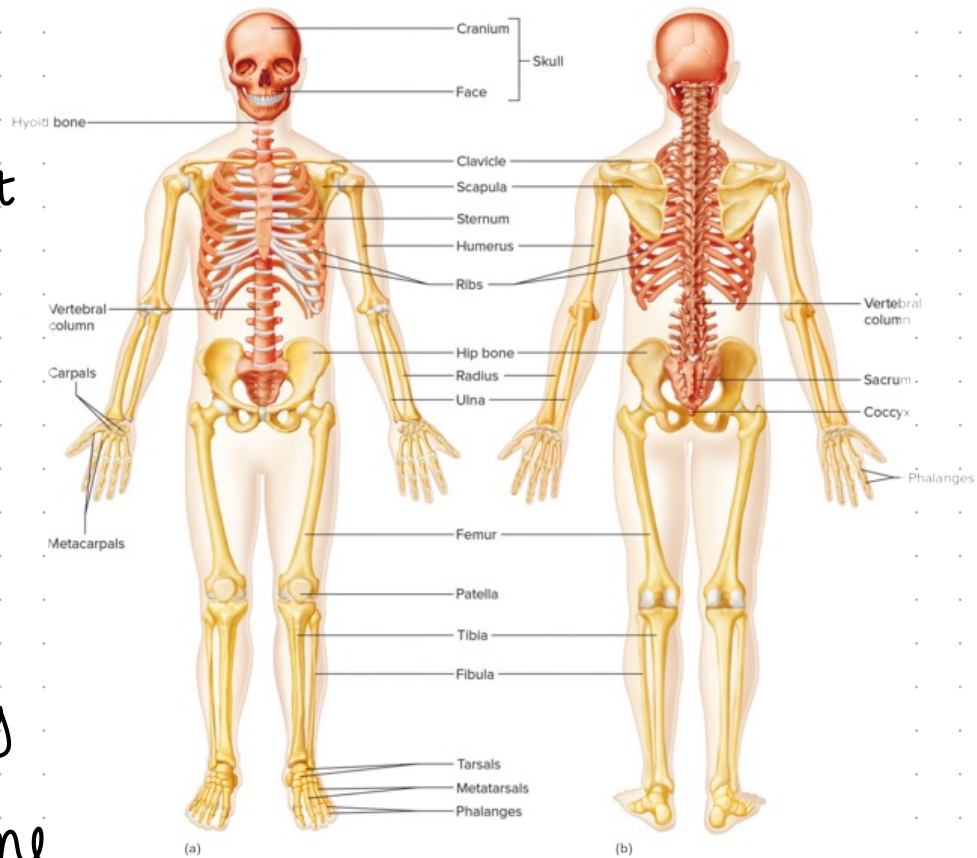


In a long bone, the diaphysis is separated from the epiphysis by an epiphyseal plate. The cartilaginous cells of the epiphyseal plate form 4 layers, each of which may be several cells thick.

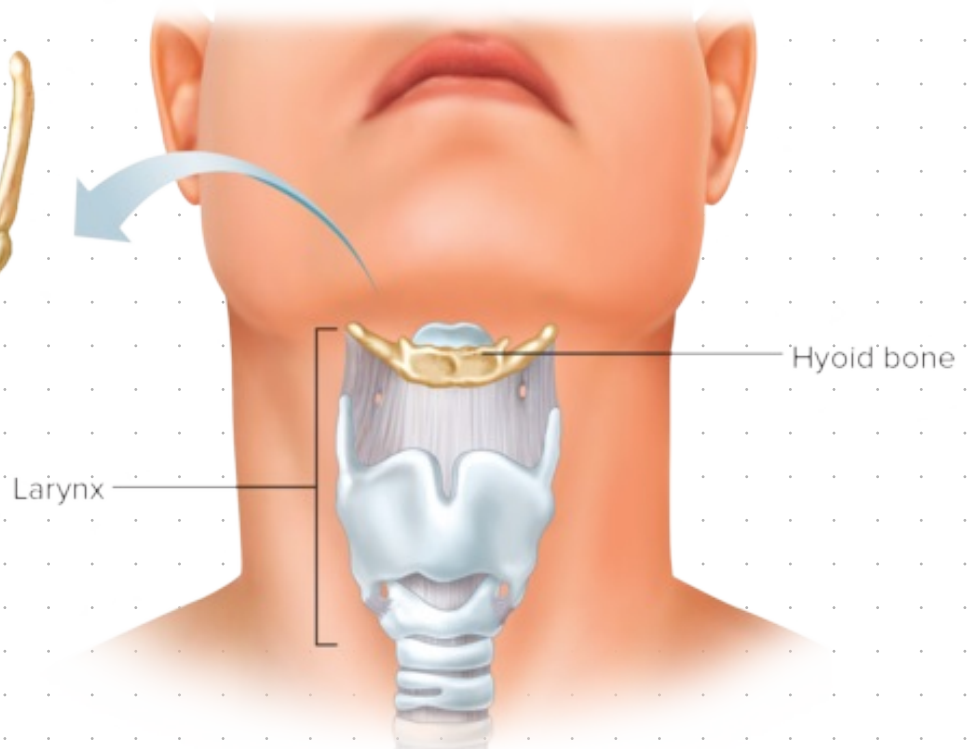
Chapter 7.5

The **axial skeleton** is the bony & cartilaginous parts that support & protect the organs of the head, neck, & trunk.

- The **skull** is composed of the **cranium** & **facial bones**.
- The **middle ear bones** transfer sound vibrations to hearing receptors.
- The **hyoid bone** is located in the neck between the lower jaw & larynx; it does not articulate w any other bones but is in a fixed position by muscles & ligaments. The hyoid bone supports the tongue & is an attachment for certain muscles that help move the tongue during swallowing. It can be felt approximately a finger's width above the anterior prominence of the larynx.



Hyoid bone



vertebral column: 24 vertebrae found in the posterior side of the body that house & protect the spinal cord

→ vertebrae are separated by **intervertebral discs**

pectoral girdle: part of the skeleton that supports & attaches the upper limbs

→ pectoral girdle is formed by a **scapula** (shoulder blade) & a **clavicle** (collarbone)

pelvic girdle: part of skeleton to which lower limbs attach

→ pelvic girdle formed by 2 hip bones attached to each other anteriorly & to sacrum posteriorly

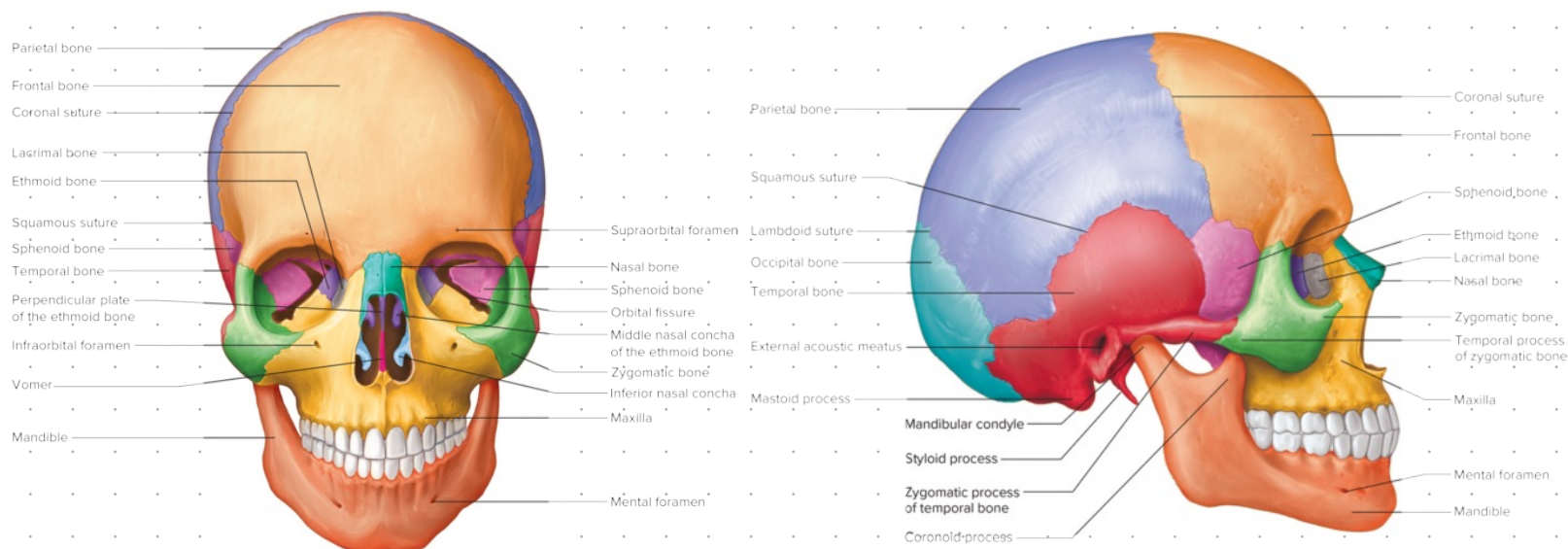
Terms used to describe skeletal structures

Term	Definition	Example
condyle	rounded process that usually articulates w another bone	occipital condyle of the occipital bone
crest	narrow, ridgelike projection	iliac crest of ilium
epicondyle	projection situated above a condyle	medial epicondyle of the humerus
facet	small, nearly flat surface	costal facet of a thoracic vertebra
fissure	cleft/groove	inferior orbital fissure in orbit of the eye
fontanel	soft spot in the skull where membranes cover space between bones	anterior fontanel between frontal & parietal bones
foramen	opening through a bone that usually serves as a passageway for blood vessels, nerves, / ligaments	foramen magnum of the occipital bone
fossa	deep pit/depression	olecranon fossa of the humerus
fovea	tiny pit/depression	fovea capitis of femur
head	enlargement on the end of a bone	head of humerus

linea	narrow ridge	linea aspera of femur
meatus	tubelike passageway w/in a bone	external acoustic meatus of the temporal bone
process	prominent projection on a bone	mastoid process of the temporal bone
ramus	branch/similar extension	ramus of the mandible
sinus	cavity w/in a bone	frontal sinus of the frontal bone
spine	thornlike projection	spine of scapula
sulcus	furrow/groove	intertubercular sulcus of the humerus
suture	interlocking line of union between bones	lambdoid suture between occipital & parietal bones
trochanter	relatively large process	greater trochanter of the femur
tubercle	knoblike process	tubercle of a rib
tuberosity	knoblike process usually larger than a tubercle	radial tuberosity of the radius

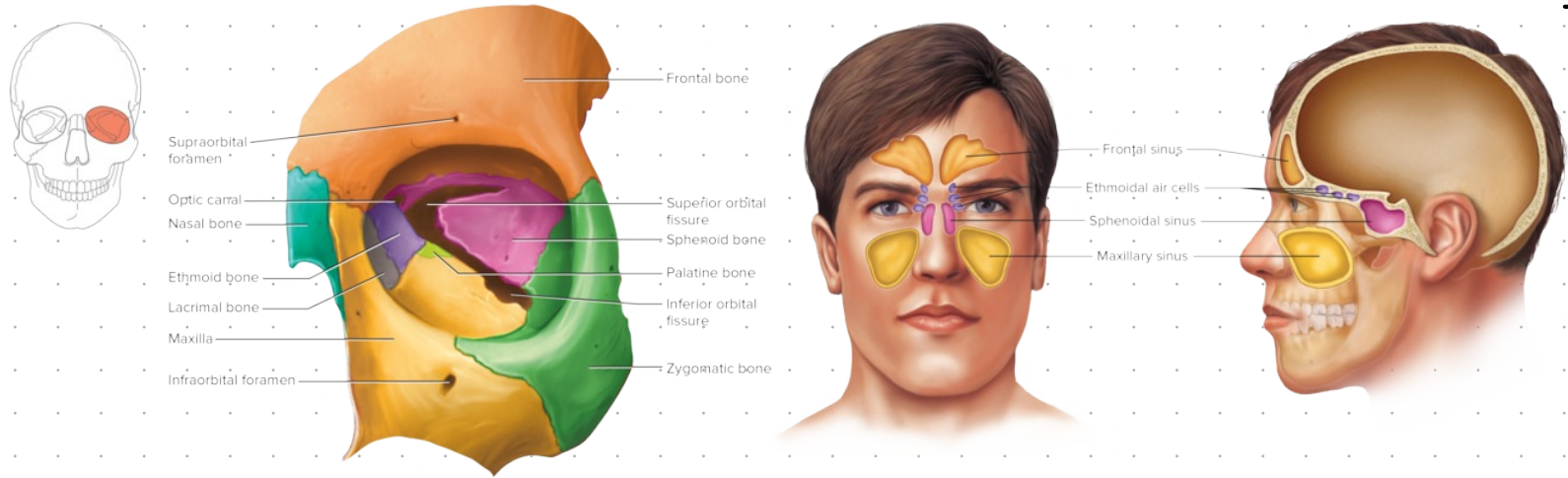
CHAPTER 7.6

→ human skull has 22 bones



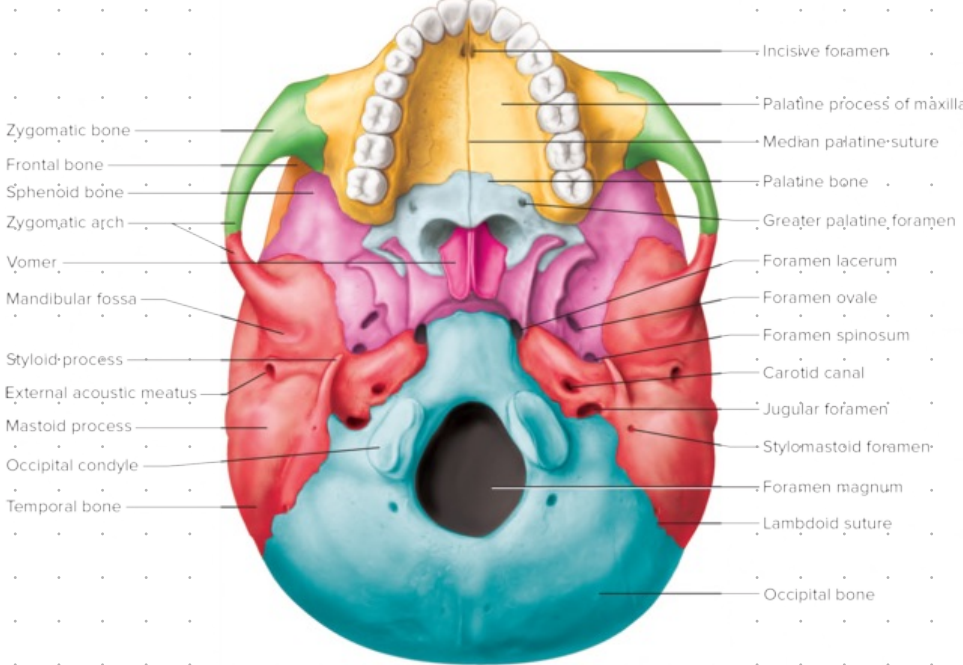
Cranium: encloses & protects the brain, formed by 8 skull bones, brain case

Paranasal sinus: any of the several air-filled cavities in a cranial/facial bone lined w mucous membrane & connected to nasal cavity

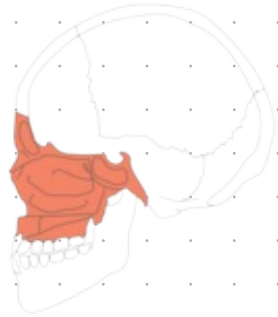


Cranial Bones

Name	Description	Special Features
Frontal (1)	forms forehead	supraorbital foramen, frontal sinuses
Parietal (2)	side walls & roof of cranium	fused at midline along sagittal suture
Occipital (1)	back of skull & base of cranium	foramen magnum, occipital condyles
Temporal (2)	side walls & floor of cranium	external acoustic meatus, mandibular fossa, mastoid process, styloid process, zygomatic process
Sphenoid (1)	parts of cranium base, sides of skull, floors & sides of orbits	sella turcica, sphenoid sinuses
Ethmoid (1)	parts of roof & walls of nasal cavity, cranium floor, orbit walls	Cribriform plates, perpendicular plate, superior & middle nasal conchae, ethmoidal air cells, crista galli

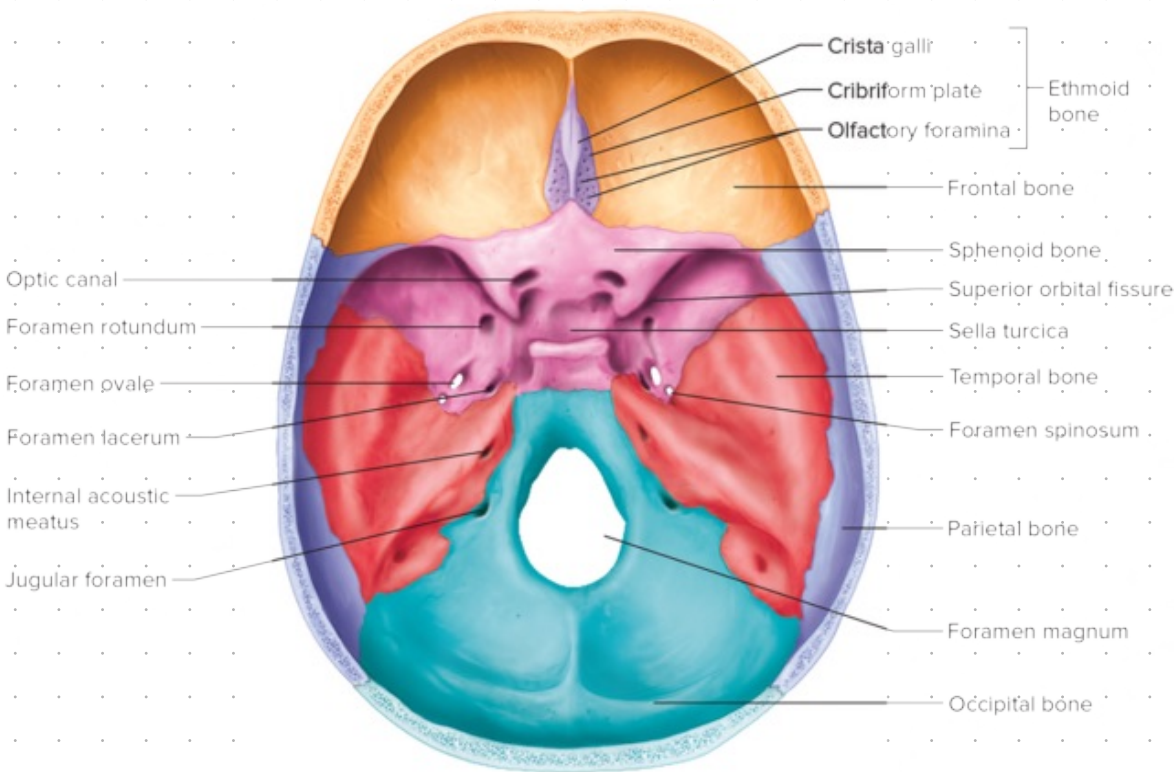
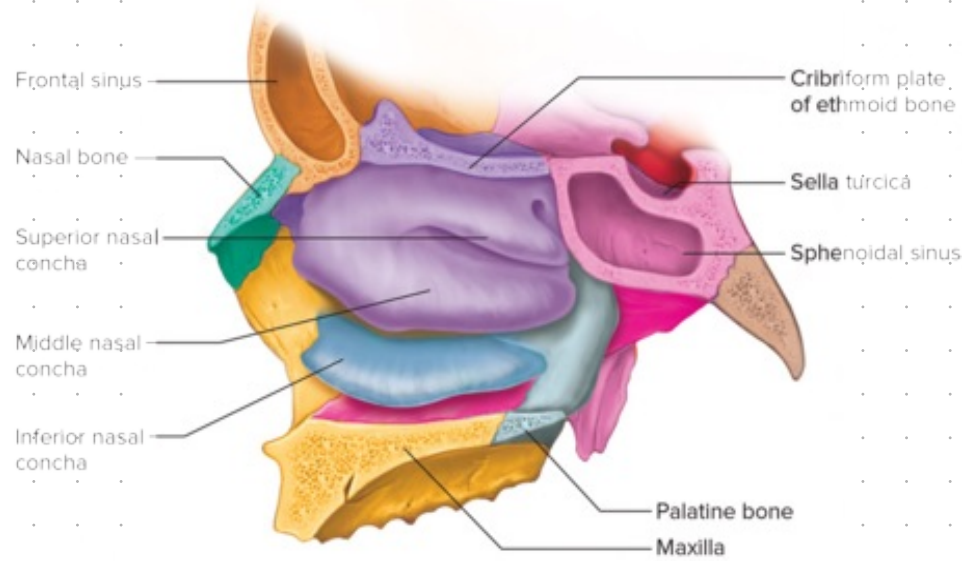


Inferior view of the skull



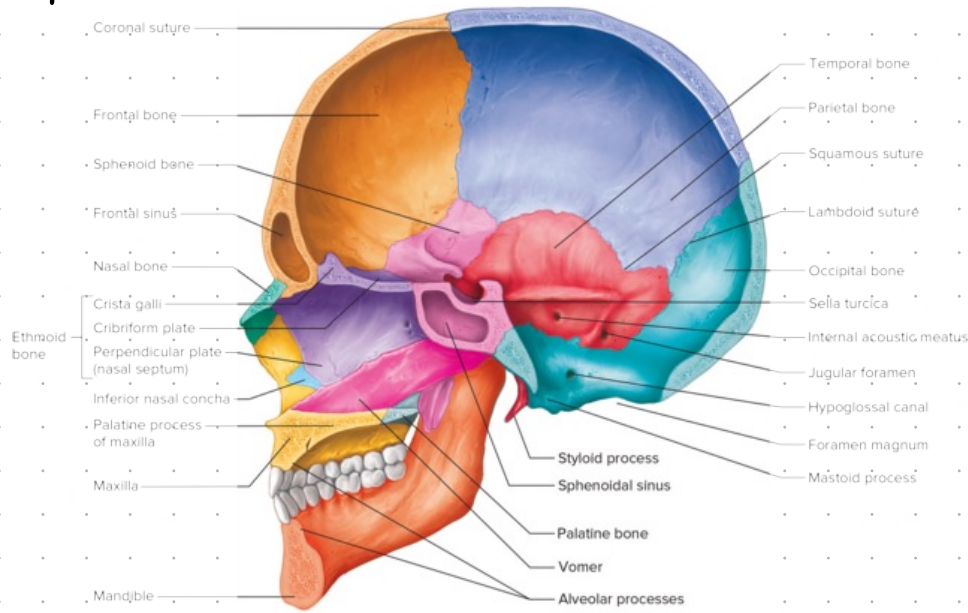
Midsagittal section

Lateral view of the nasal cavity



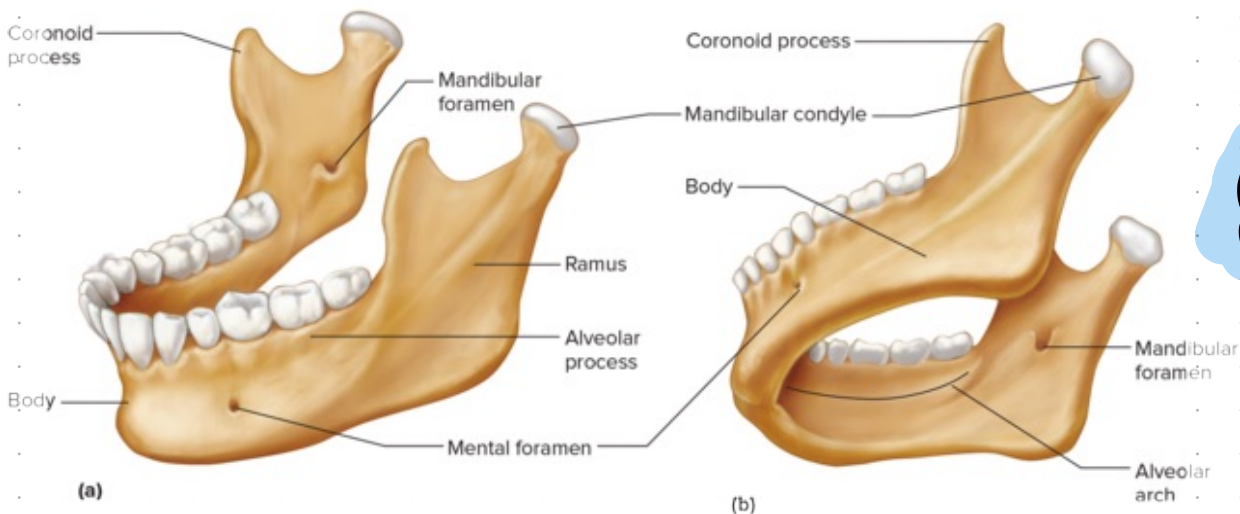
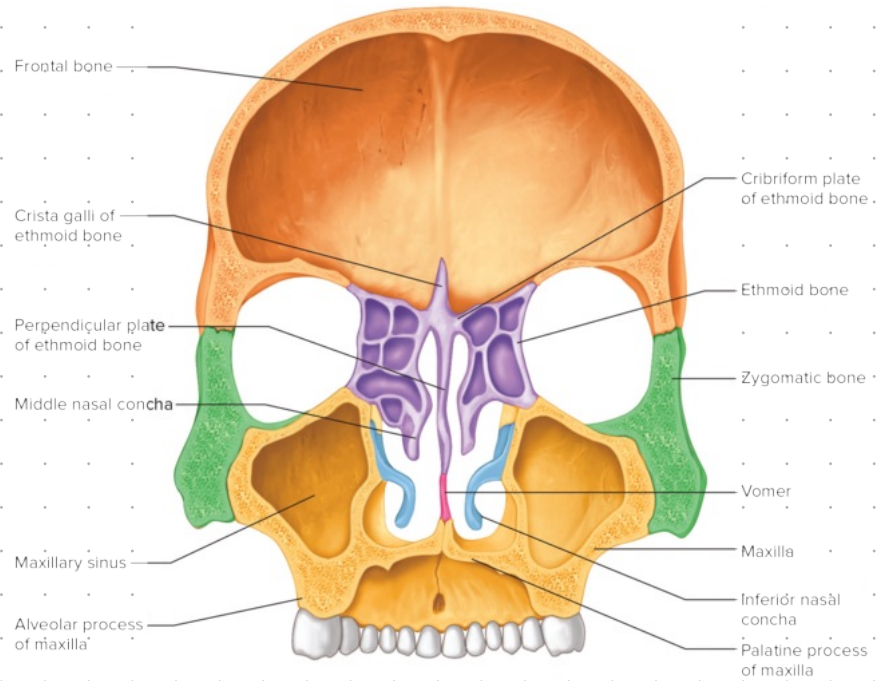
Floor of the cranial cavity, viewed from above

The **facial skeleton** consists of 13 immovable bones & a moveable lower jawbone. In addition to forming the basic face shape, these bones provide attachments for muscles that move the jaw & control facial expressions.



Sagittal section of the skull

Frontal section of the skull (posterior view)

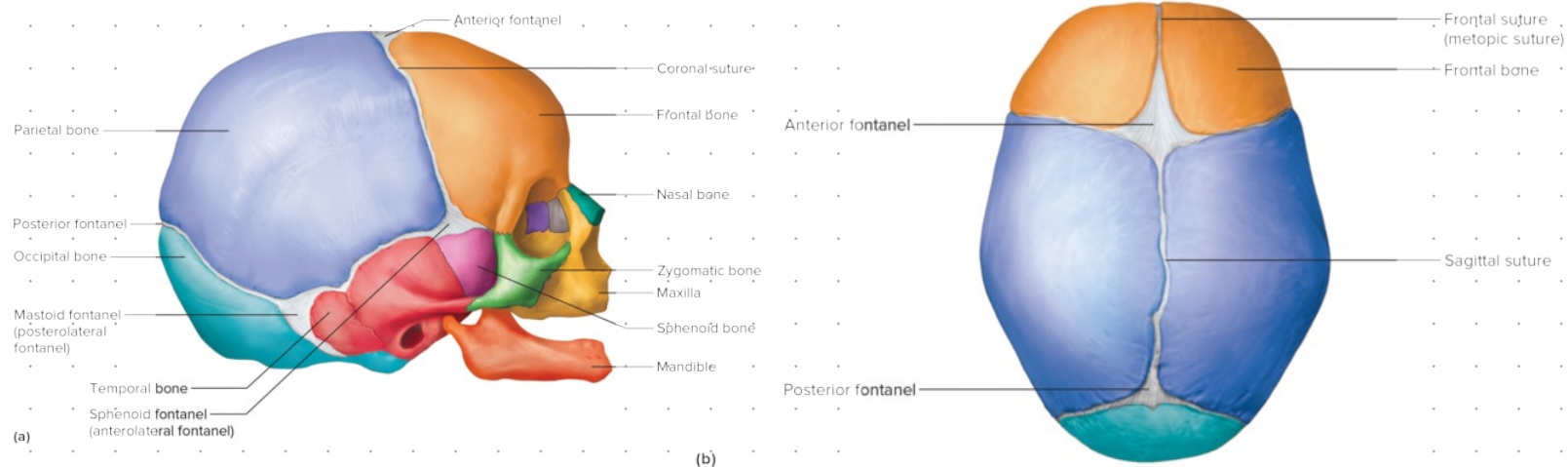


Mandible
(a) left lateral view
(b) inferior view

Bones of the facial skeleton

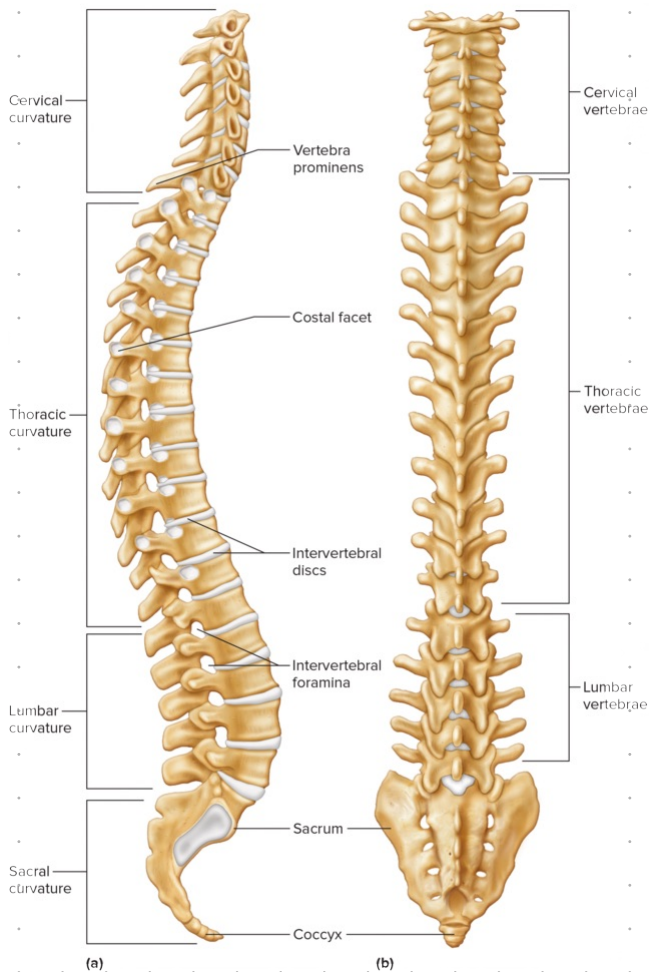
Name	Description	Special features
Maxilla (2)	upper jaw, anterior roof of mouth, orbit floors, & sides & floor of nasal cavity	alveolar processes, maxillary sinuses, palatine process
Palatine (2)	posterior roof of mouth & floor & lateral walls of nasal cavity	
Zygomatic (2)	prominences of cheeks & lateral walls & floors of orbits	temporal process
Lacrimal (2)	part of medial walls of orbits	groove that leads from orbit to nasal cavity
Nasal (2)	bridge of nose	
Vomer (1)	interior portion of nasal septum	
Inferior nasal concha (2)	extend into nasal cavity from its lateral walls	
Mandible (1)	lower jaw	body, ramus, mandibular condyle, coronoid process, alveolar processes, mandibular foramen, mental foramen

fontanel: membranous region between certain developing cranial bones in the skull of a fetus/infant

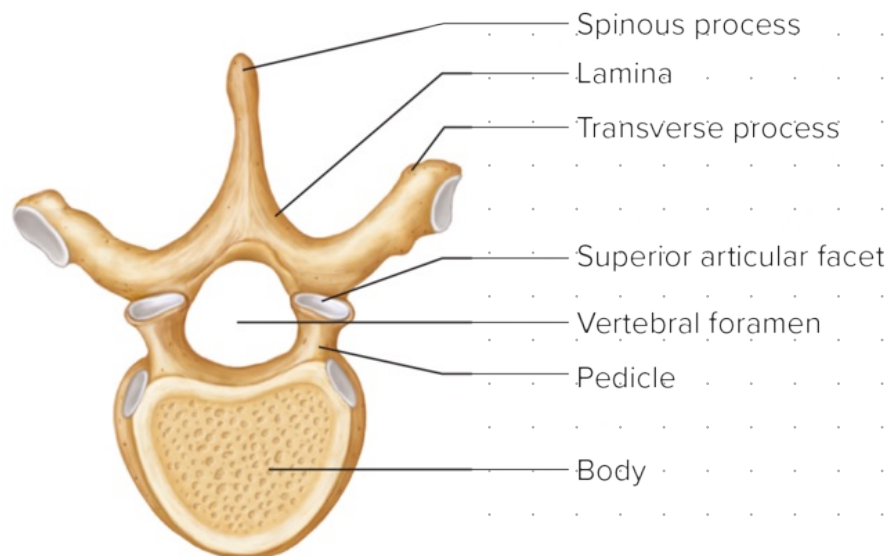
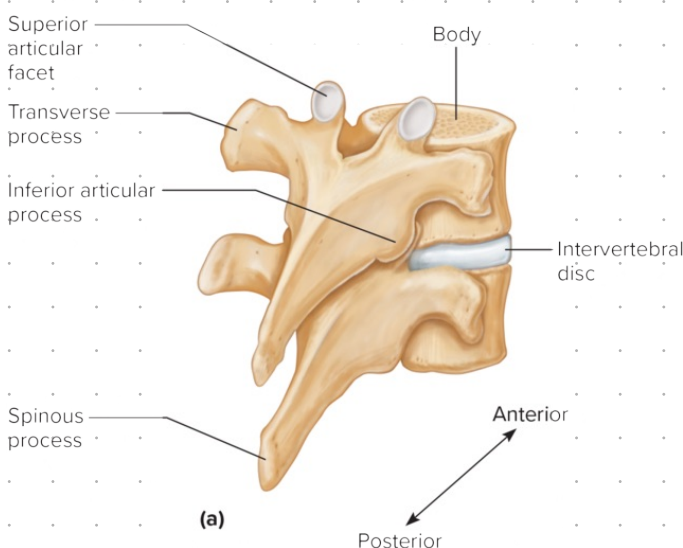


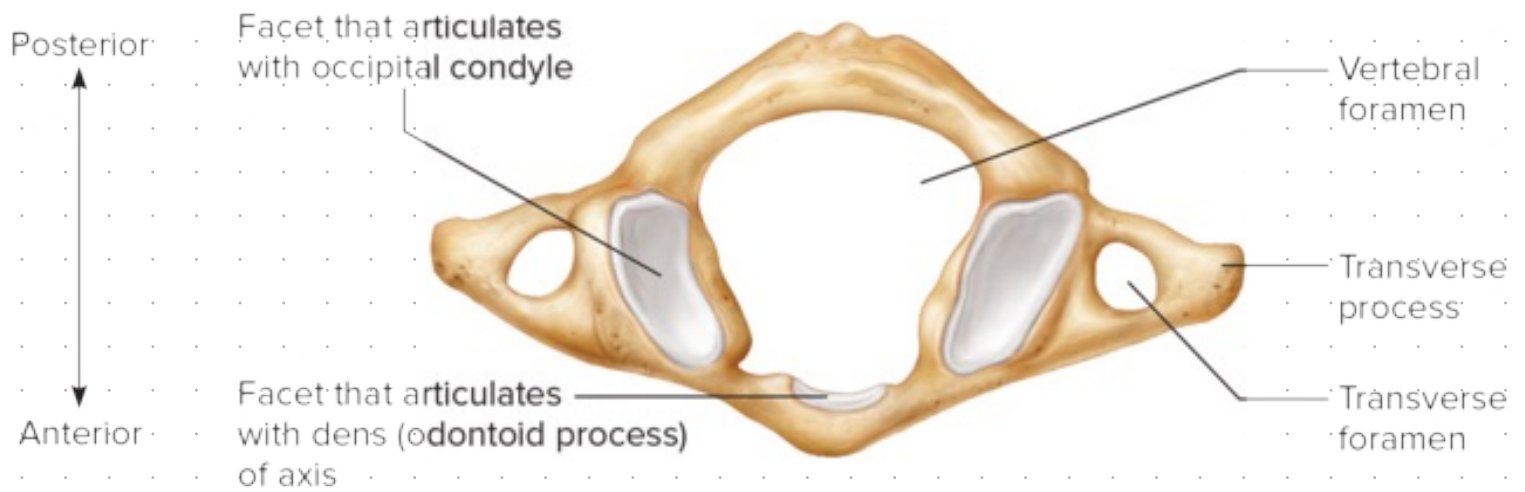
CHAPTER 7.7

The **vertebral column** extends from the skull to the pelvis & forms the vertical axis of the skeleton. It is composed of many bony parts called **vertebrae** separated by masses of fibrocartilage called **intervertebral discs** & connected to one another by ligaments. The vertebral column supports the head & the trunk of the body, yet is flexible enough to permit movements, such as bending forward, backward, or to the side & turning or rotating on the central axis. It also protects the spinal cord.

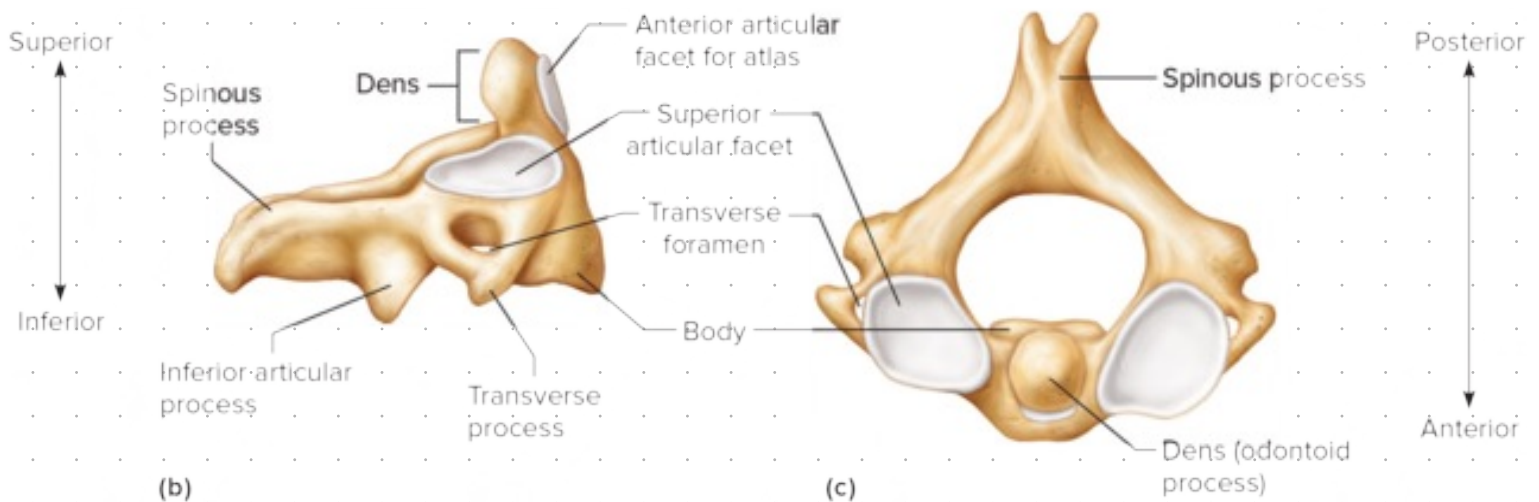


- infants have **33** bones in the vertebral column
- adults have **26** bones in the vertebral column
- the **thoracic & sacral curvatures** are concave anteriorly & are called **primary curves**
- the **cervical curvature** in neck & **lumbar curvature** in lower back are convex anteriorly & are called **secondary curves**





(a)



(b)

(c)

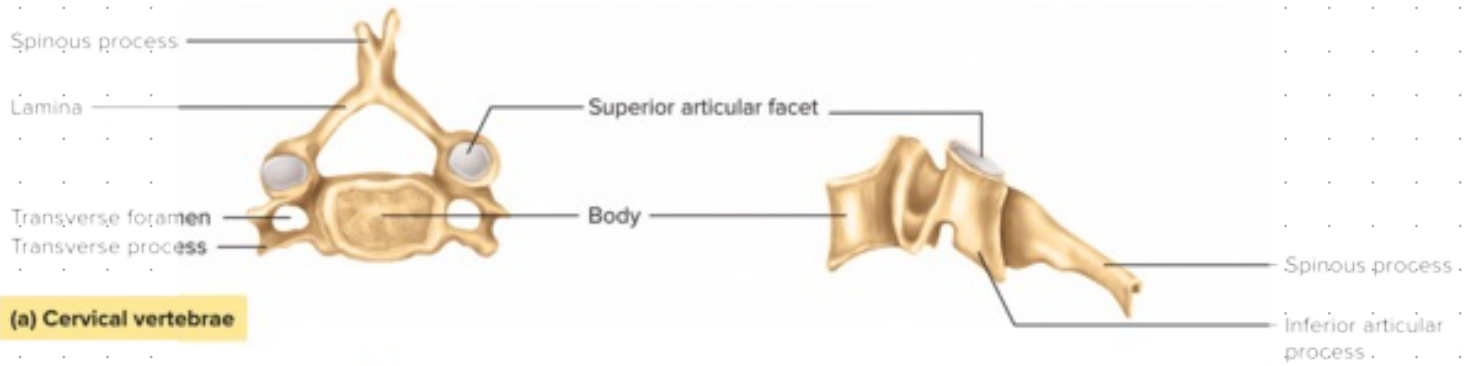
- (a) superior view of the atlas
- (b) right lateral view
- (c) superior view of the axis

- 12 **thoracic vertebrae** are larger than those in the cervical region
- thoracic vertebrae, except for T11-T12, have 2 **costal facets** that articulate w ribs
- one costal facet articulates w the rib tubercle, second articulates w the rib head

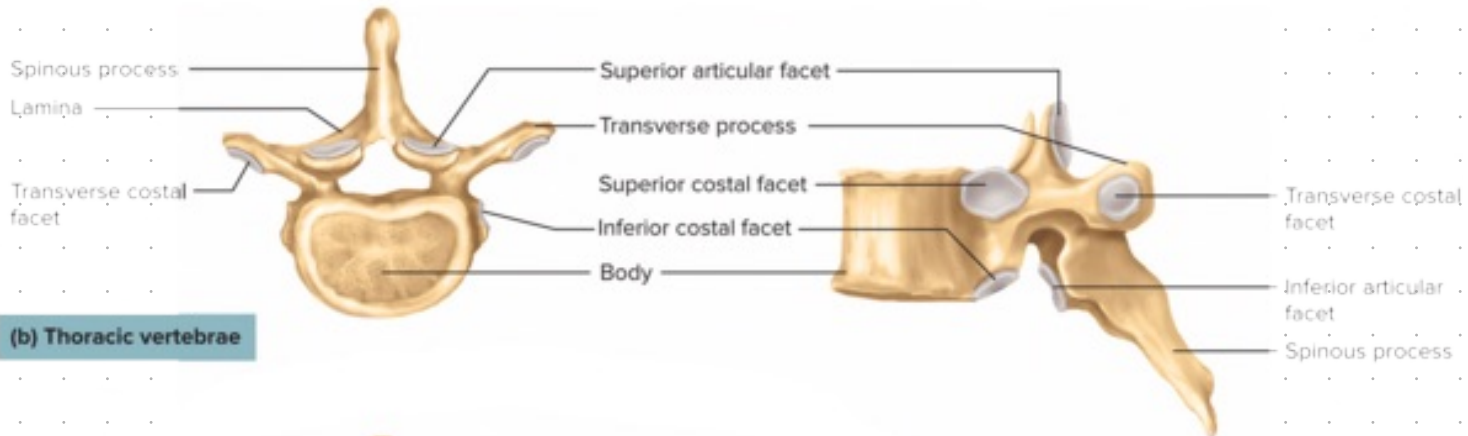


Superior views

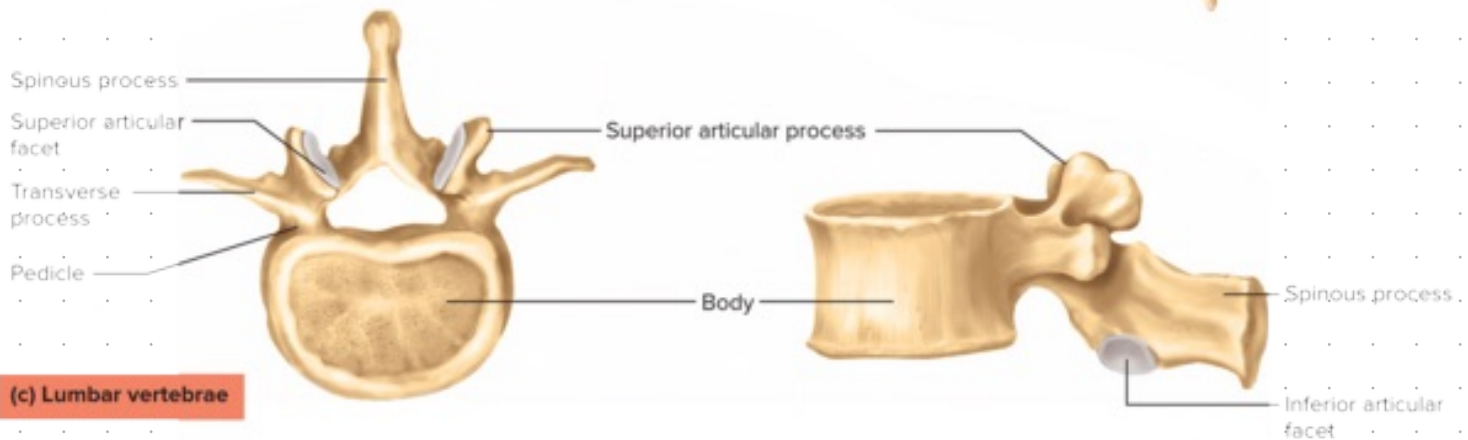
Lateral views



(a) Cervical vertebrae

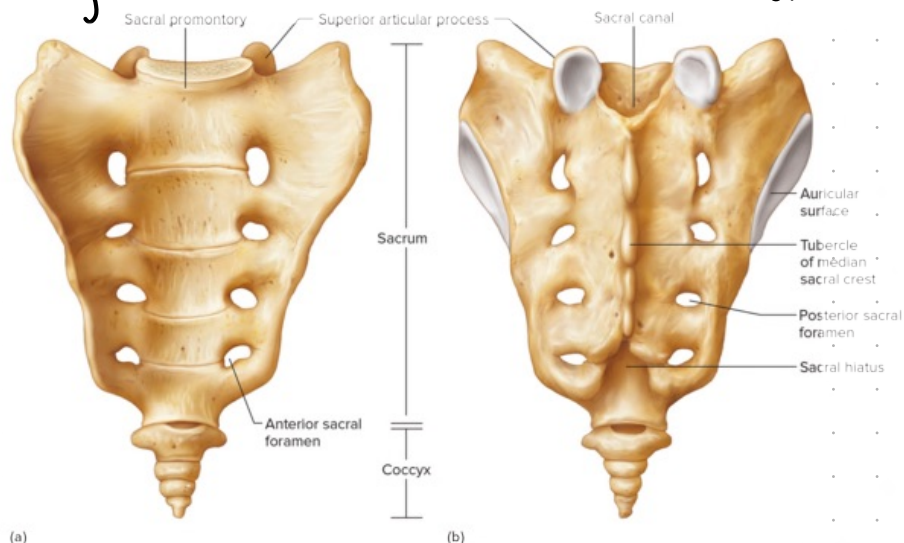


(b) Thoracic vertebrae



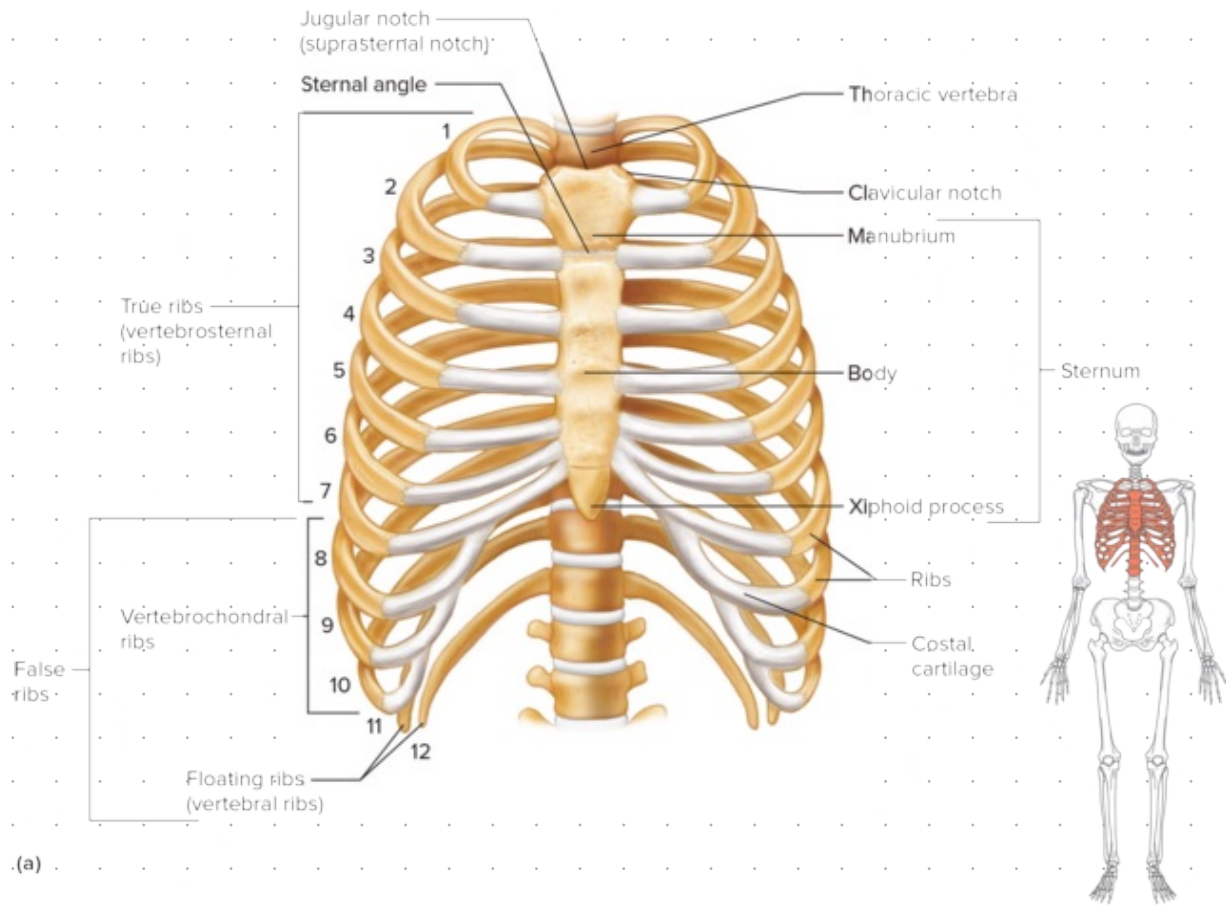
(c) Lumbar vertebrae

- 5 **lumbar vertebrae** in the small of the back (loin) support more weight than the superior vertebrae & have larger, stronger bodies
- **sacrum** is a triangular structure at the base of vertebral column

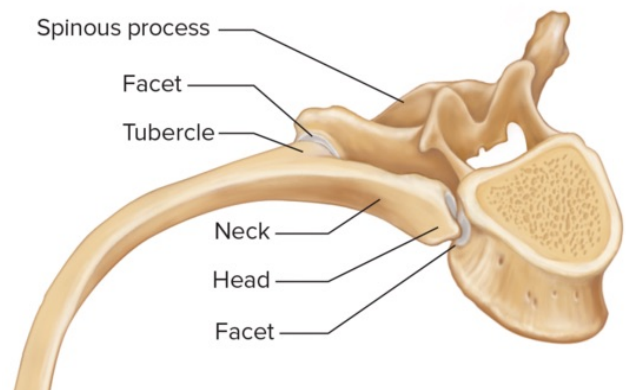
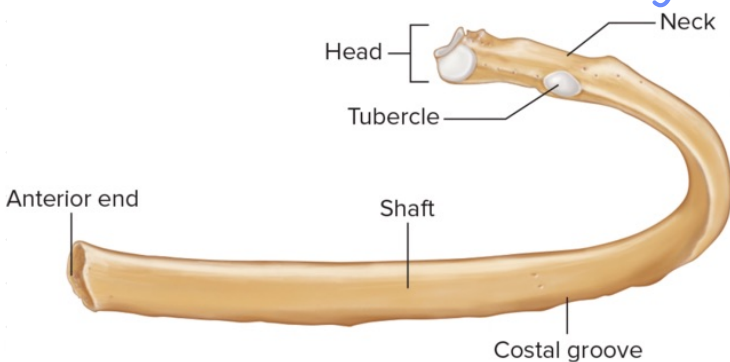


- **spinous processes** of fused bones form a ridge of tubercles called the **median sacral crest**
- nerves & blood vessels pass through rows of openings called **posterior sacral foramina**, located to sides of tubercles
- **coccyx** is typically composed of 4 vertebrae that fuse between 25-30
- in older adults the coccyx may fuse to the sacrum

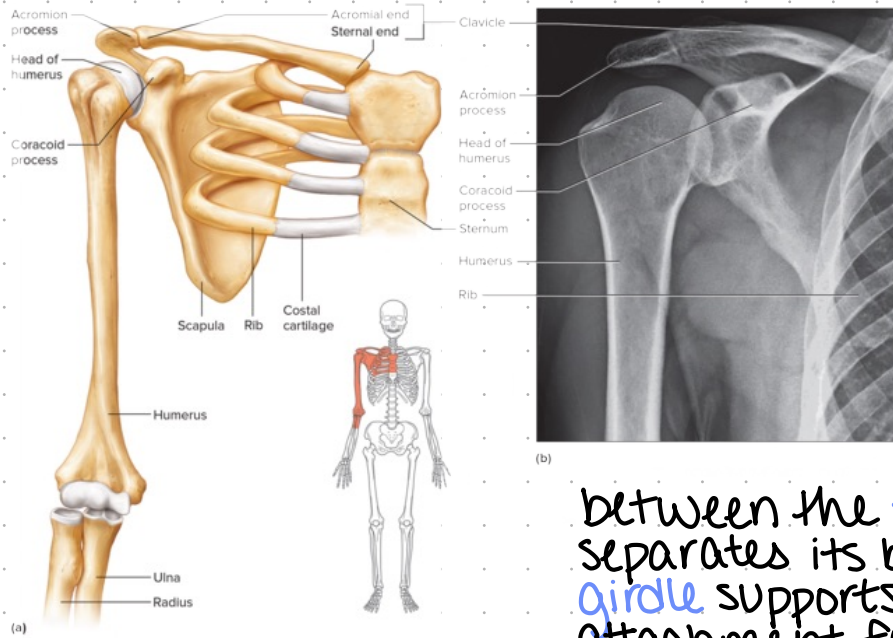
Chapter 7.8



- usually 24 ribs, some people may have more
- first 7 rib pairs: **true ribs**, joined to sternum by costal cartilage
- last 5 pairs of ribs: **false ribs**, their cartilage does not reach sternum
- lower 2/3 pairs are **floating ribs**



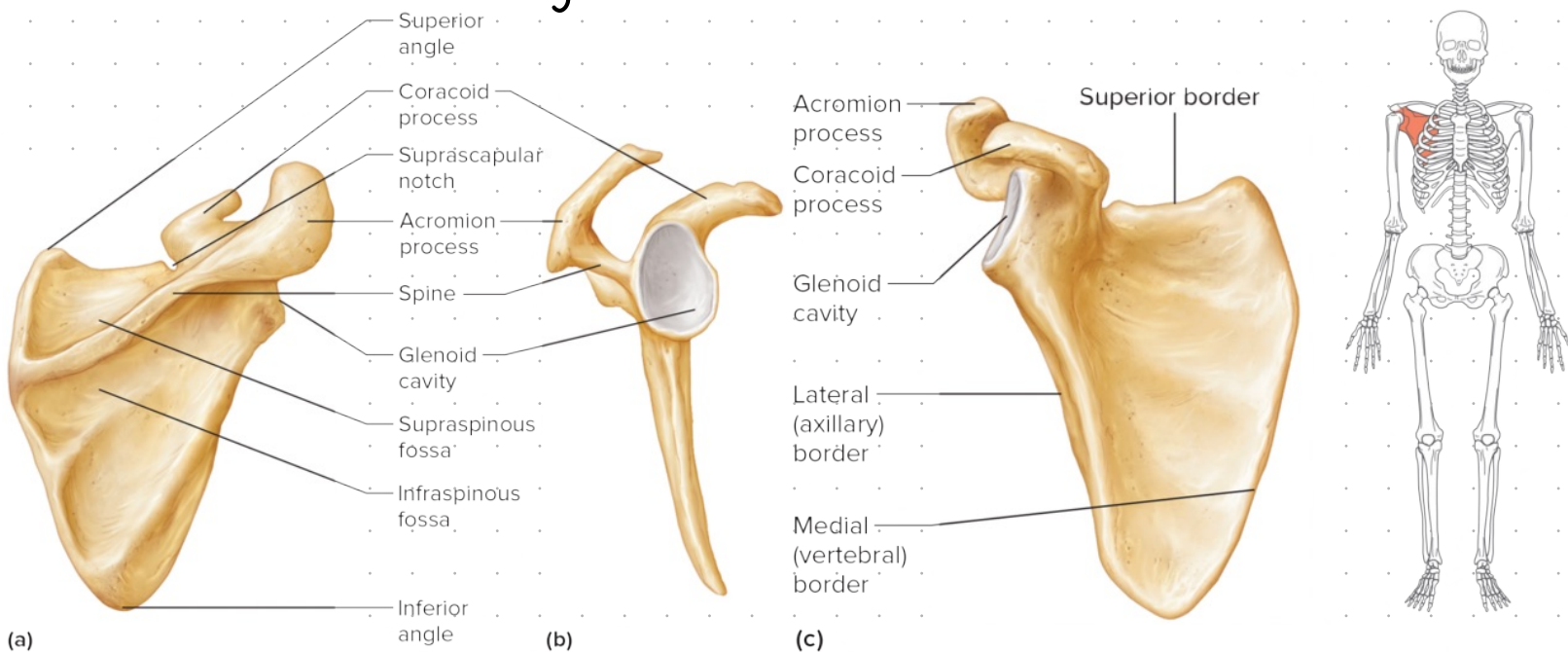
Chapter 7.9



Each **pectoral girdle** (shoulder girdle) is 2 parts - an anterior bone called the **clavicle**, & a **scapula** on the posterior portion. Although the word **girdle** suggests a ring-shaped structure, the **pectoral girdle** is an incomplete ring. It is open in the back

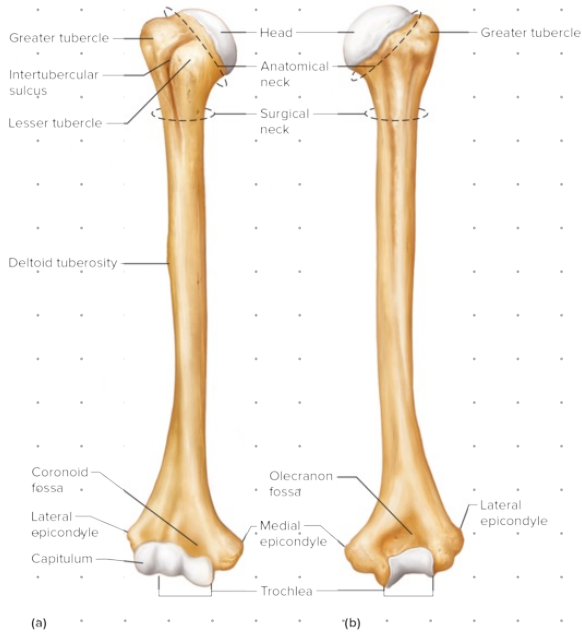
between the **scapulae**, & the sternum separates its bones in front. The **pectoral girdle** supports the upper limbs & is an attachment for several muscles that move them.

→ scapula is broad, triangular, & located on each side of upper back

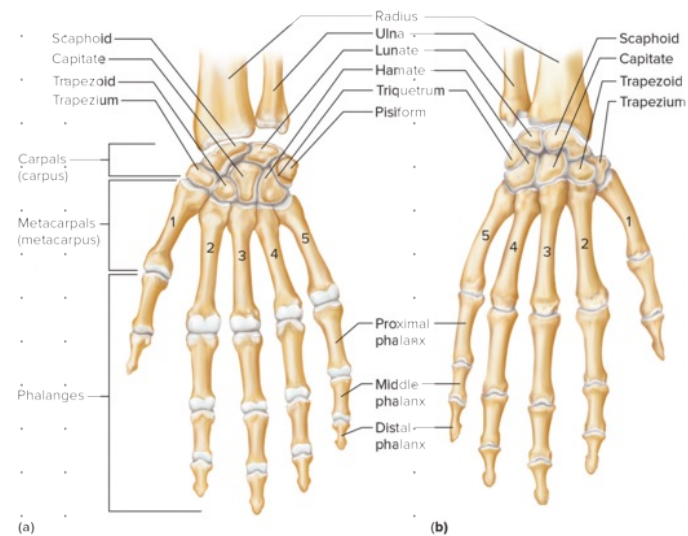
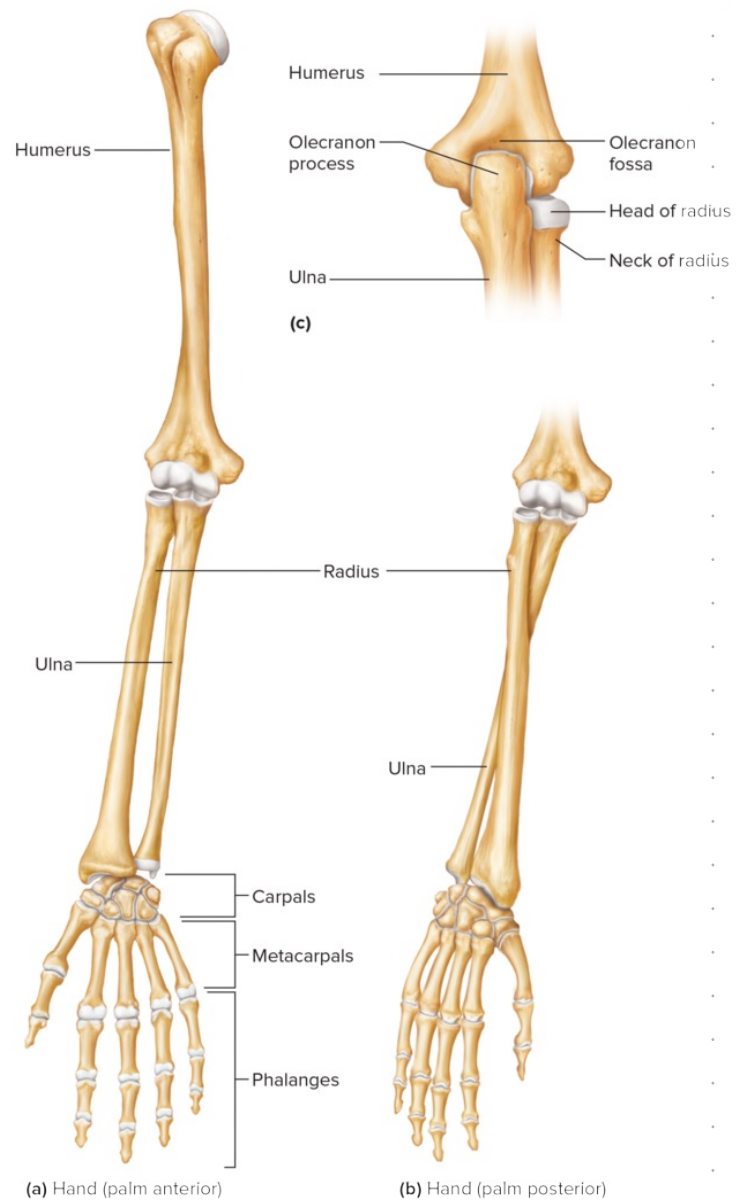
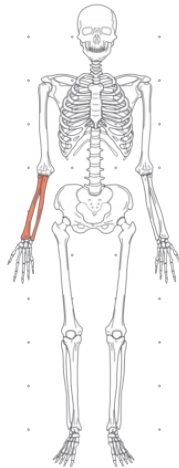
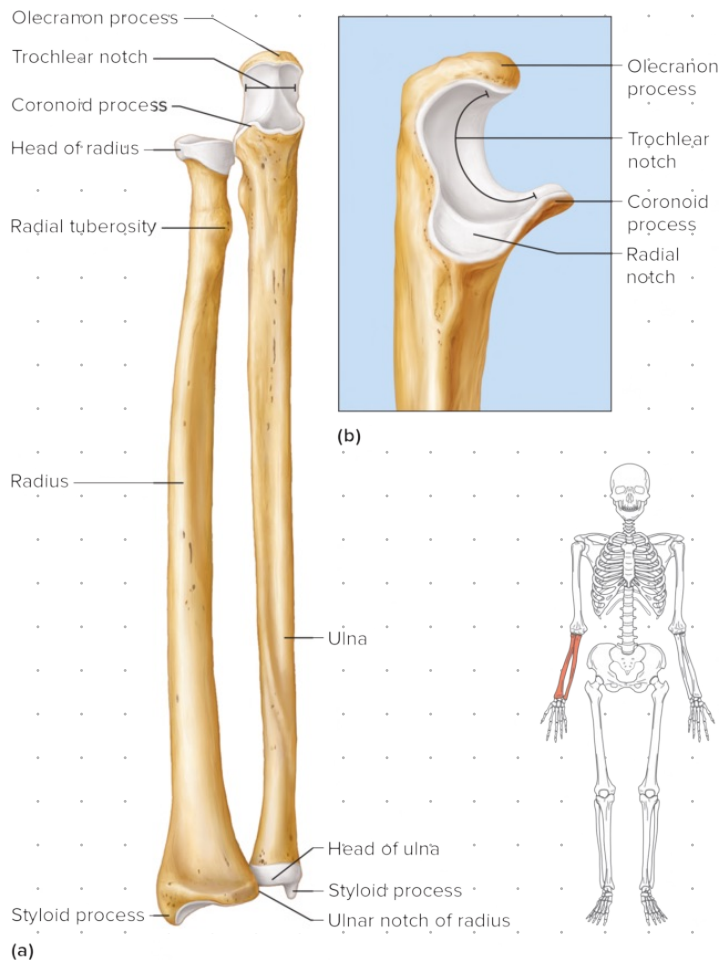


The scapula has 3 borders. The **superior border** is on the superior edge. The **axillary**, or **lateral**, **border** is directed toward the upper limb. The **vertebral**, or **medial**, **border** is closest to the vertebral column, about 5 cm away.

CHAPTER 7.10



→ humerus is a long bone that extends from scapula to elbow

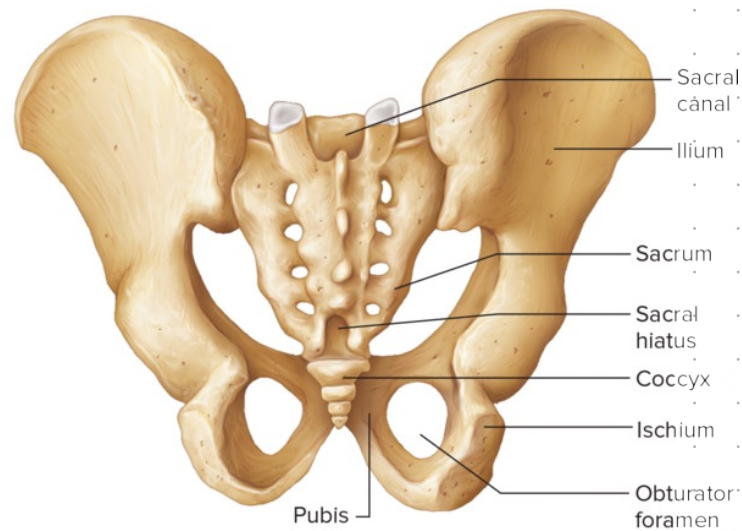
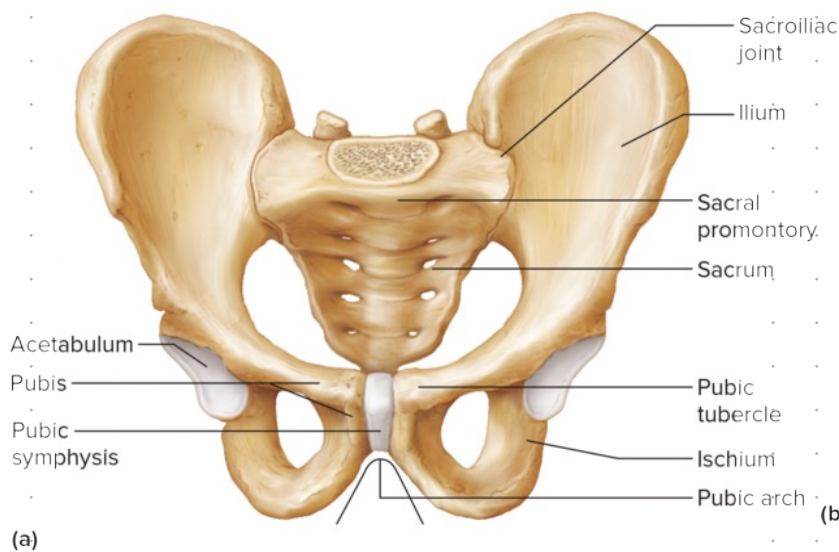


Bones of the Pectoral Girdle & Upper Limbs

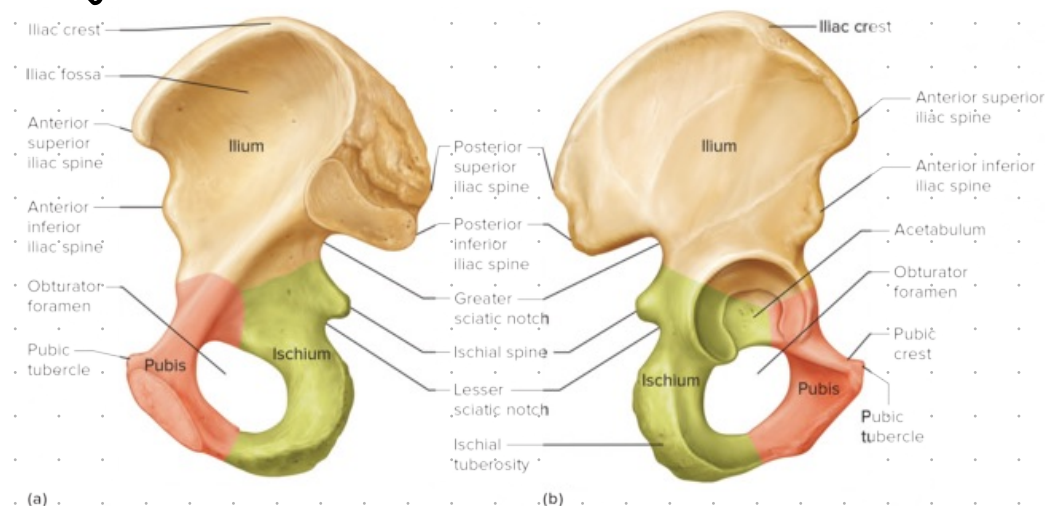
Name	Location	Special Features
Clavicle (2)	base of neck between sternum & scapula	sternal end, acromial end
Scapula (2)	upper back, forms part of shoulder	body, spine, acromion process, coracoid process, glenoid cavity
Humerus (2)	arm, between scapula & elbow	head, greater & lesser tubercle, intertubercle sulcus, anatomical neck, surgical neck, deltoid tuberosity, capitulum, trochlea, medial epicondyle, coronoid & olecranon fossa
Radius (2)	lateral side of forearm, between elbow & wrist	head, radial tuberosity, styloid process, ulnar notch
Ulna (2)	medial side of forearm, between elbow & wrist	trochlear notch, olecranon & coronoid process, head, styloid process, radial notch
Carpal (16)	wrist	2 rows of 4 bones each
Metacarpal (10)	palm	1 bone in line w each finger & thumb
Phalanx (28)	finger	3 phalanges in each finger; 2 phalanges in each thumb

Chapter 7.11

The **pelvic girdle** consists of 2 hip bones, also known as **coxal bones** (*os coxae*), or **innominate** bones. They articulate w each other anteriorly & w the sacrum posteriorly. The sacrum, coccyx, & pelvic girdle form the bowl-shaped **pelvis**. The pelvic girdle supports the trunk; provides attachments for lower limbs; & protects the urinary bladder, the distal end of the large intestine, & the internal reproductive organs. The body's weight is transmitted through the pelvic girdle to the lower limbs.

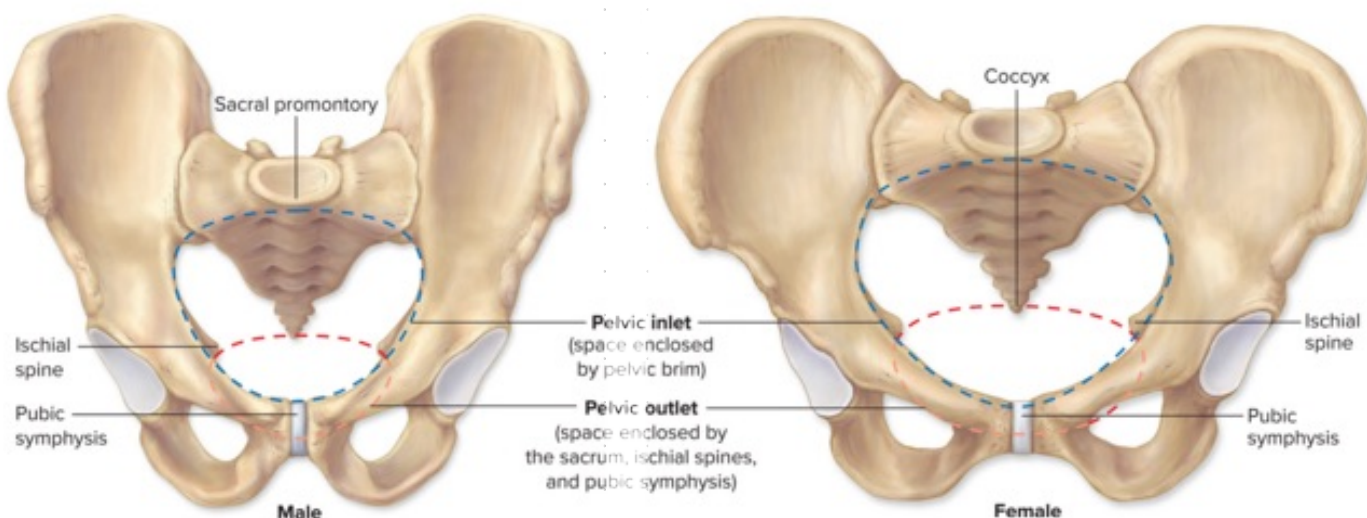


Each hip bone develops from 3 parts - an ilium, ischium, & a pubis. These parts fuse in the region of a cup-shaped cavity called a **acetabulum**. This depression, on the lateral surface of the hip bone, receives the rounded head of the femur/thigh bone.



The **ilium**, the largest & most superior portion of the hip bone, flares outward, forming the prominence of the hip. The margin of this prominence is the **iliac crest**. The smooth, concave surface on the anterior aspect of the ilium is the **iliac fossa**. The **ischium** forms the

posterior & inferior region of the hip bone. The **pubis** constitutes the anterior & inferior region of the hip bone.

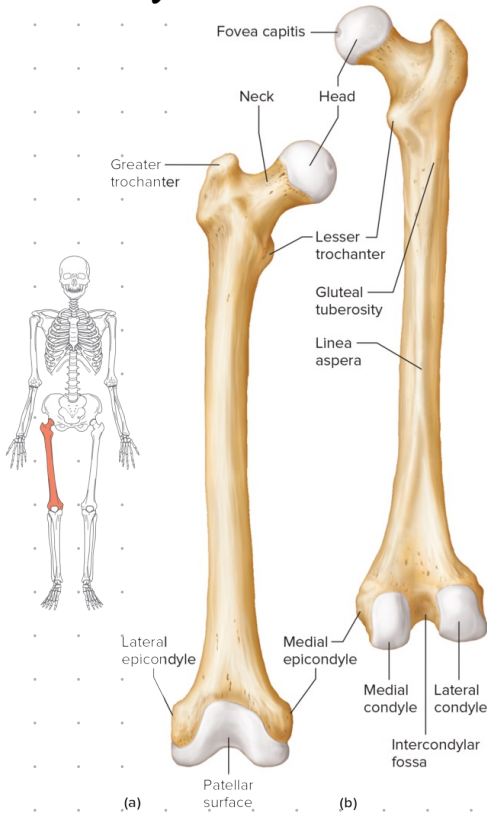


- if a line was drawn on each side of the pelvis from sacral promontory down & anteriorly to upper margin of the symphysis pubis: the pelvic brim
- false pelvis is bounded posteriorly by lumbar vertebrae
- false pelvis helps support abdominal organs
- true pelvis bounded posteriorly by sacrum & coccyx & laterally & anteriorly by lower ilium, ischium, & pubis bones

Differences Between Male & Female Skeletons

Part	Male	Female
Skull	larger, heavier, more conspicuous muscle attachment	smaller, more delicate, less evidence of muscle attachment
Mastoid process	larger	smaller
Supraorbital ridge	more prominent	less prominent
chin	more square	more pointed
jaw angle	angle of ramus about 90°	angle of ramus $>125^\circ$
forehead	shorter	taller
orbit	superior border thicker, blunt edge	superior border thinner, sharp edge
parietal bones	less bulbous	more bulbous
Pelvis	hip bones heavier, thicker, more evidence of muscle attachment	hip bones lighter, less evidence of muscle attachment
obturator foramen	more oval	more triangular
acetabulum	larger	smaller
pubic arch	narrow, sharper angle	broader, flatter angle
sacrum	narrow, sacral promontory projects more forward, sacral curvature bends less sharply posteriorly	wide, sacral curvature bends sharply posteriorly
Coccyx	less movable	more movable
cavity	narrow, long, more funnel-shaped	wide, distance between ischial spines & ischial tuberosities is greater

Chapter 7.12



Femur

- thigh bone
- longest bone in the body
- extends from hip to knee

Patella

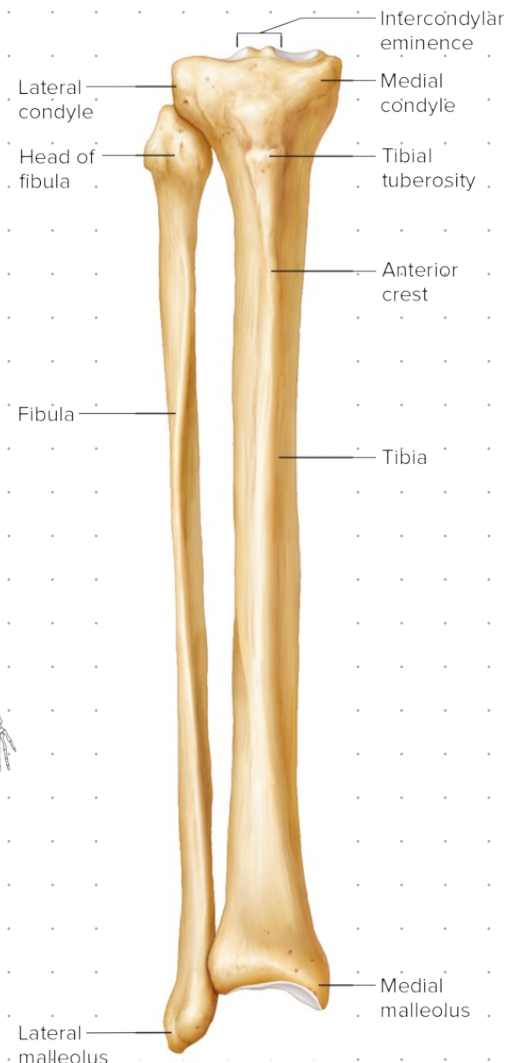
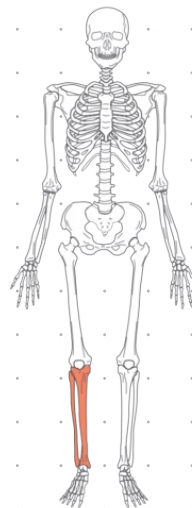
- kneecap
- controls the angle at which the tendon continues toward the tibia

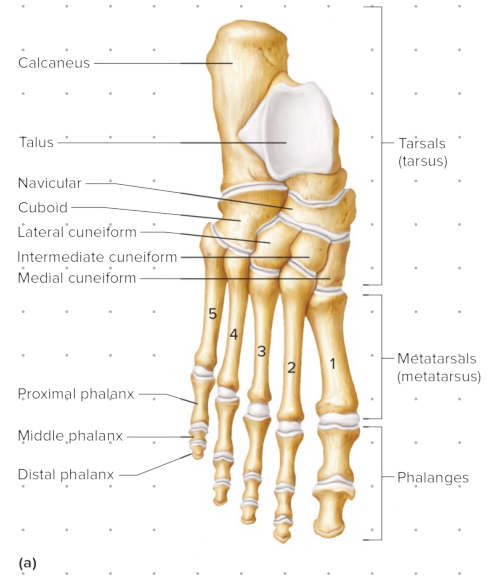
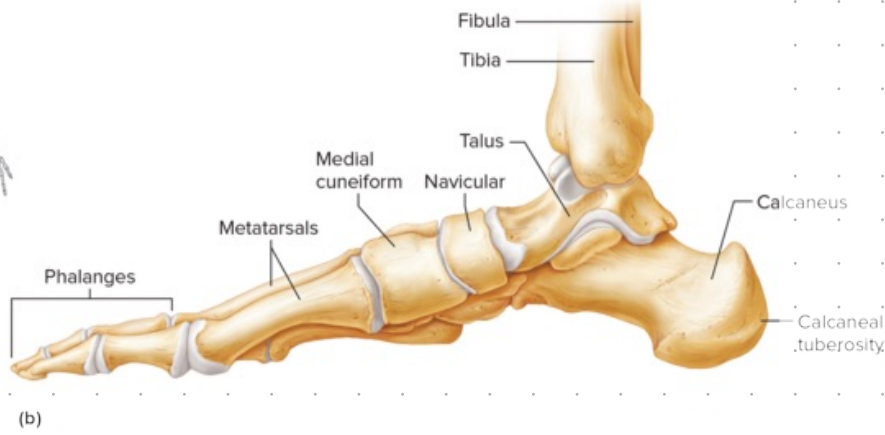
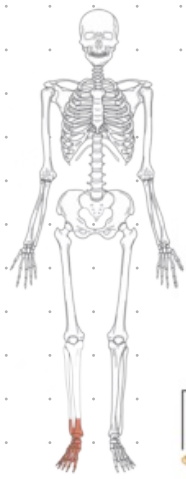
Tibia

- shin bone
- larger of 2 leg bones
- on medial side

Fibula

- long & slender
- located on lateral side of tibia
- does not enter knee joint
- does not bear any weight





- **calcaneus** is largest tarsal/heel bone
- calcaneus supports body weight & provides attachment for muscles to move the foot

Bones of the Pelvic Girdle & Lower Limbs

Name	Location	Special Features
Hip bone (2)	Hip, articulating w other hip bone anteriorly & w the sacrum posteriorly	ilium, iliac crest, ant. sup. iliac spine, ischium, ischial tuberosity, ischial spine, obturator foramen, acetabulum, pubis
Femur (2)	thigh, between hip & knee	head, fovea capitis, neck, greater trochanter, lesser trochanter, linea aspera, lateral condyle, medial condyle, gluteal tub., intercondylar fossa
Patella (2)	Ant. knee surface	flat sesamoid bone w/in tendon
Tibia (2)	medial leg side, between knee & ankle	medial con., lateral con., tibial tub., ant. crest, medial malleolus, intercondylar fossa
Fibula (2)	lat. leg side, between knee & ankle	head, lat. malleolus
Tarsal (14)	ankle	freely movable talus articulates w leg bones, calcaneus forms heel base, 5 other tarsals bound toget.
Metatarsal (10)	instep	1 bone aligned w each toe, bound by ligaments to form arches
Phalanx (28)	toe	3 phalanges in each toe, 2 phal. in great toe

CHAPTER 7.13

- around age 30, the body begins to shorten at $\approx 1/16"$ per year
- osteoclasts begin to outnumber osteoblasts. the bone is eaten away in the remodeling process faster than it's being replaced
- around age 35, we begin to lose bone mass
- compact bone loss begins around age 40
- bone loss is slow & steady in males but females' is linked to hormones
- first decade of menopause females lose 15-20% of trabecular bone. 2-3x the rate loss than males

Possible reasons for falls among older adults

- overall fragility
- decreased muscle strength
- decreased coordination
- medication side effects
- slowed reaction time due to joint stiffening
- poor vision &/or hearing
- disease (cancer, infection, arthritis)