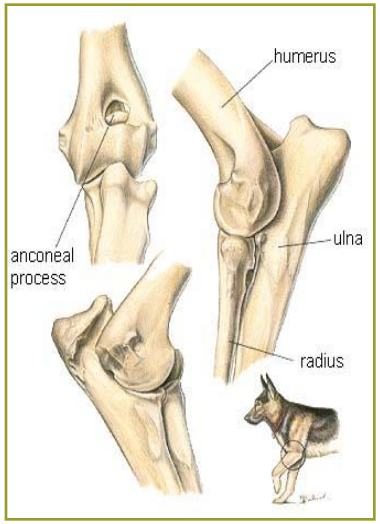
Animal Anatomy and Physiology 1

Webinar Chapter 6

Skeletal System

The Skeleton System
Chapter 6



Pages 153-190

Comparative Anatomy?

Textbook Learning Objectives

Chapter 6 – Page 153

- List the cell types that comprise bone and describe the function of each cell type
- List the functions of bone
- Differentiate between cancellous and compact bone
- Describe the process of endochondral bone formation and growth
- Describe the process of intramembranous bone formation
- List and describe the four bone shapes
- Differentiate between yellow and red bone marrow
- List and define the terms used to describe shape and surface features of bone
- List the components of the axial and appendicular skeletons
- Name the internal and external bones of the face and cranium
- List the divisions of the spinal column
- Describe the structure of the ribs and sternum
- Name the bones of the thoracic and pelvic limbs
- List and describe the three classifications of joints

Bone

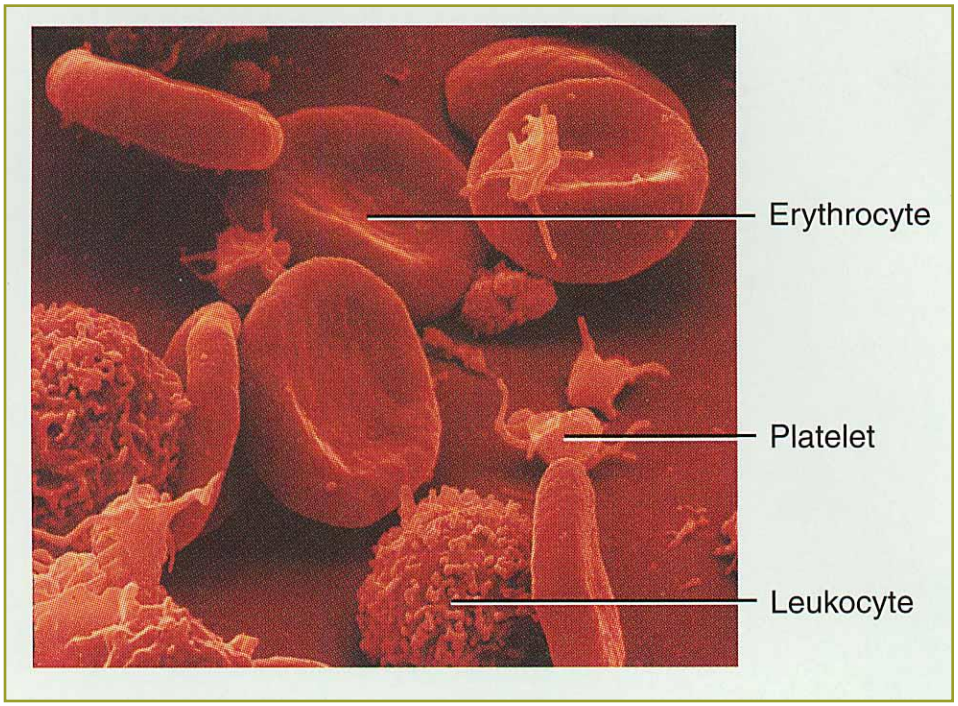
- **Second hardest** substance in the body
  - What is #1?
- Connective tissue, composed of cells embedded in a *matrix*
  - Matrix is made up of collagen fibers embedded in a protein and polysaccharides

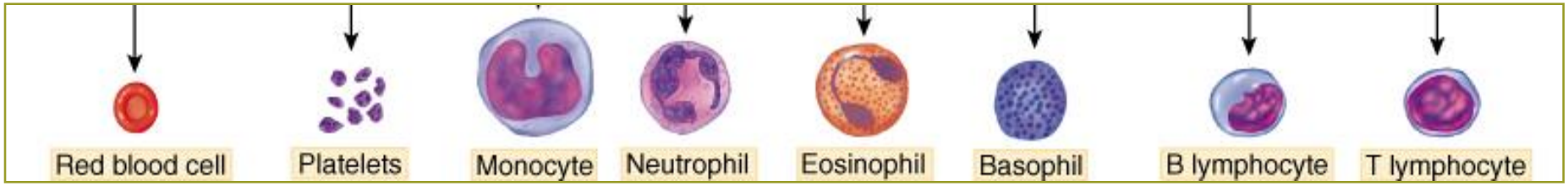
Bone

- Characteristics of bone
  - **Secret of Life!!!**
- Weight of bone
  - 1/3 organic
    - Collagen (protein)
  - 2/3 inorganic salts
    - Calcium (Ca)
    - Phosphorus (P)
    - Magnesium (Mg)

Functions of Bones

- Support
- Protection
- Leverage
- Storage
  - Calcium
- Blood cell formation
  - Hematopoiesis





Bone Cells

- **Osteoblasts**: cells that produce bone
  - Harden matrix through **ossification**
- Once surrounded by bone, osteoblasts are called **osteocytes**
- **Osteoclasts**: remodel/remove bone

Blood Supply to Bone

- Volkmann canals*:* channels through bone matrix that contain blood vessels
  - Blood vessels in the Volkmann canals join with blood vessels in the haversian systems.
- **Nutrient foramina**: channels in many large bones
  - Contain large blood vessels, lymph vessels, and nerves

Bone Histology

Figures 6-1 & 6-2, Pages 155-156

Two types of bone

- **Cancellous** bone: light and spongy
  - Red bone marrow
- **Compact** bone: dense and heavy

Cancellous Bone

Figure 6-1B, Page 155

- Tiny "spicules" of bone that appear randomly arranged
- Spaces between the spicules contain **bone marrow**

Bone Marrow

- Fills the spaces within bones
- Two types:
  1. **Red** bone marrow
  2. **Yellow** bone marrow

Red Bone Marrow

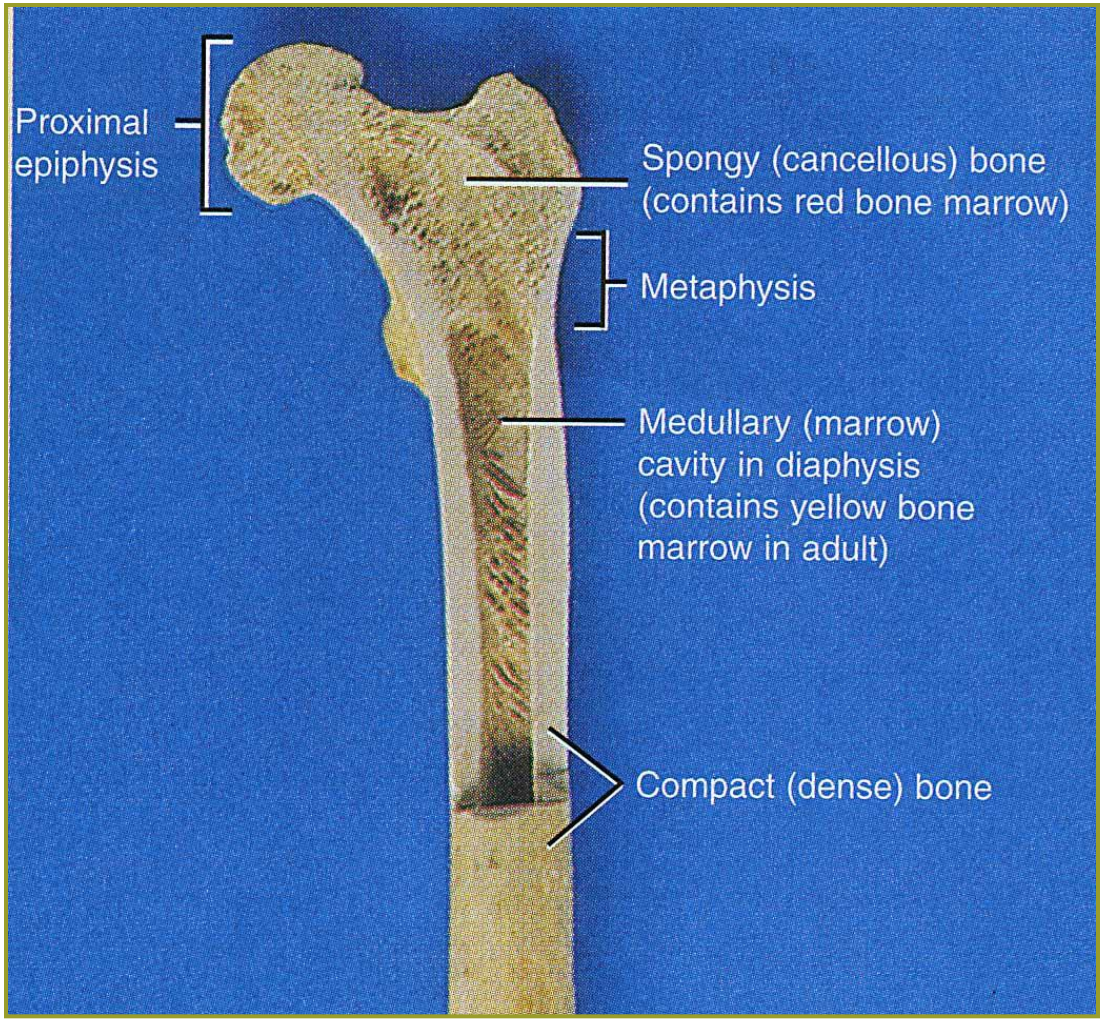
- **Forms blood cells**
- **Majority of the bone marrow of young animals**
- Only a small portion of the marrow of older animals
- Confined to a few specific locations in older animals

Yellow Bone Marrow

- Consists primarily of **adipose** connective tissue
- **Most common type of marrow in adult animals**
- Can revert to red bone marrow if needed

Bone Marrow

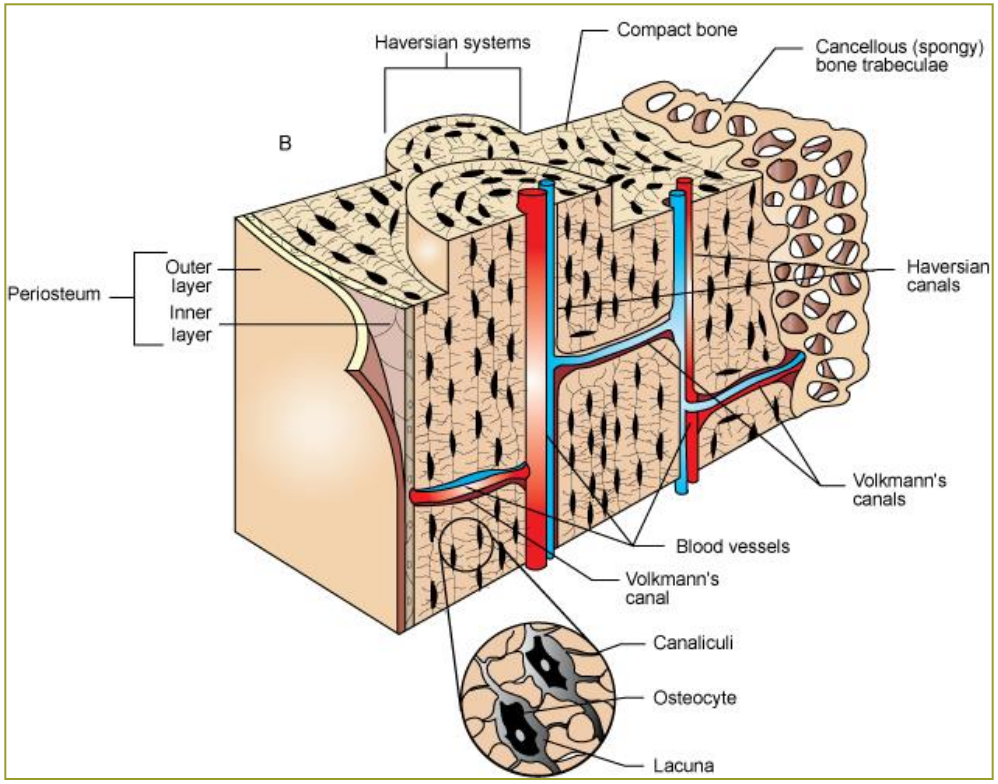
- Red marrow
- Yellow marrow



Compact Bone

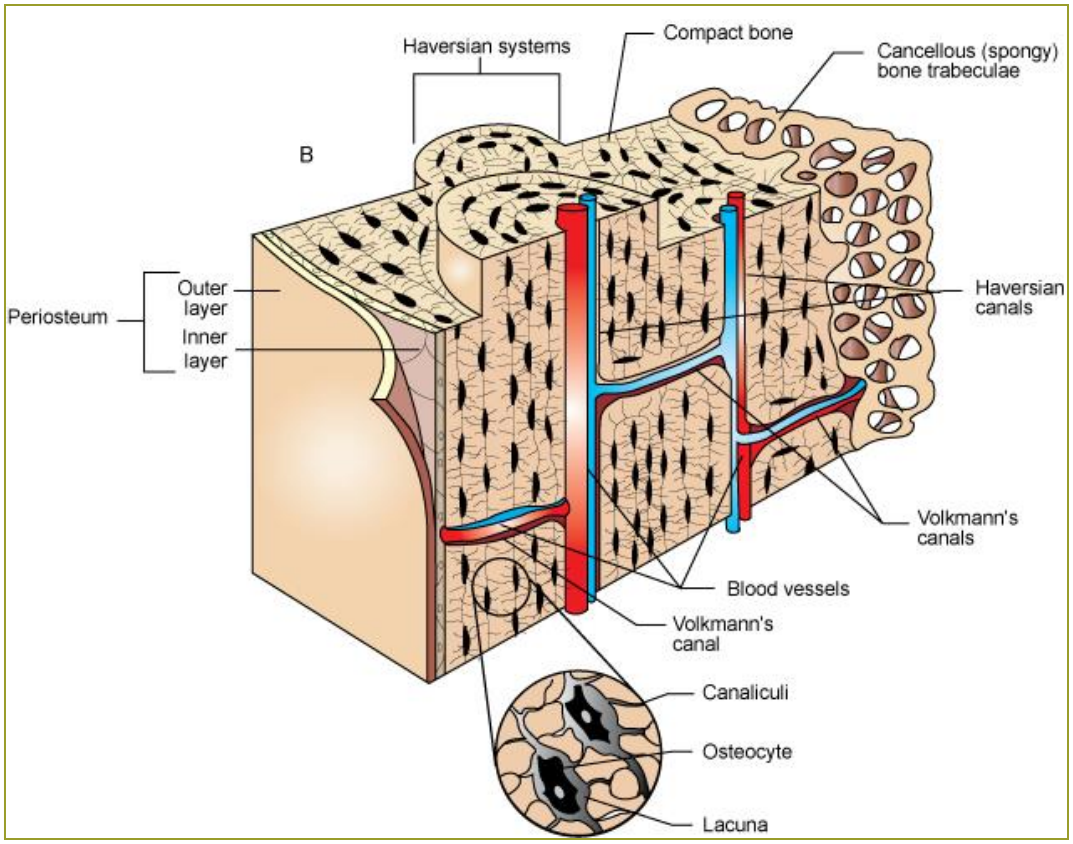
Figure 6-2, Page 156

- **Shafts** of long bones
- **Outside layer** of all bones
- Composed of **haversian systems** that run lengthwise with the bone



Haversian Systems

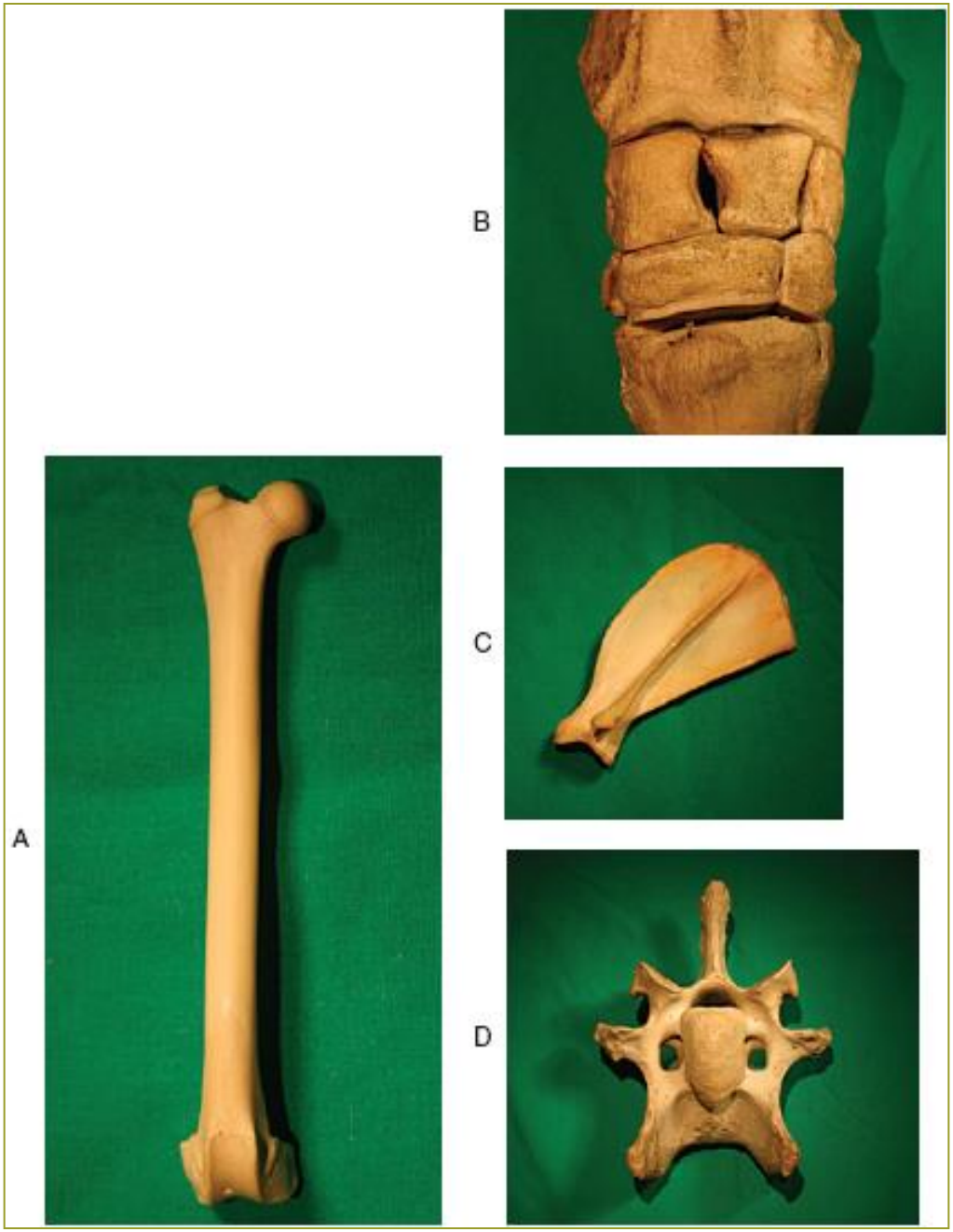
- Concentric layers of ossified bone matrix arranged around a **central canal**
  - Blood and lymph vessels and nerves



Bone Shapes

Figure 6-5, Page 159

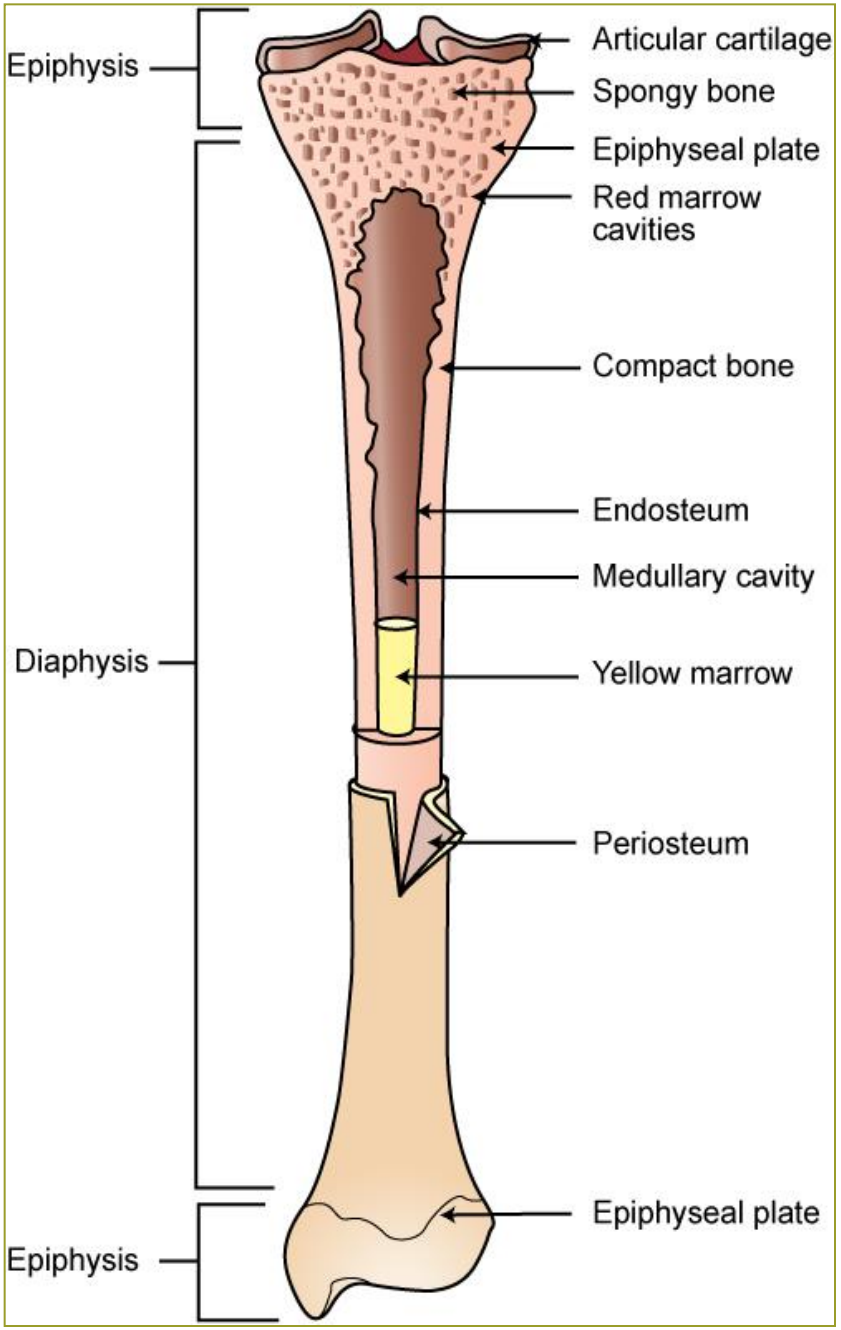
- Long bones
  - Femur, humerus
- Short bones
  - Carpal, tarsal bones
- Flat bones
  - Scapula
- Irregular bones
  - Sesamoid bones
  - Vertebrae



Anatomy of a Long Bone

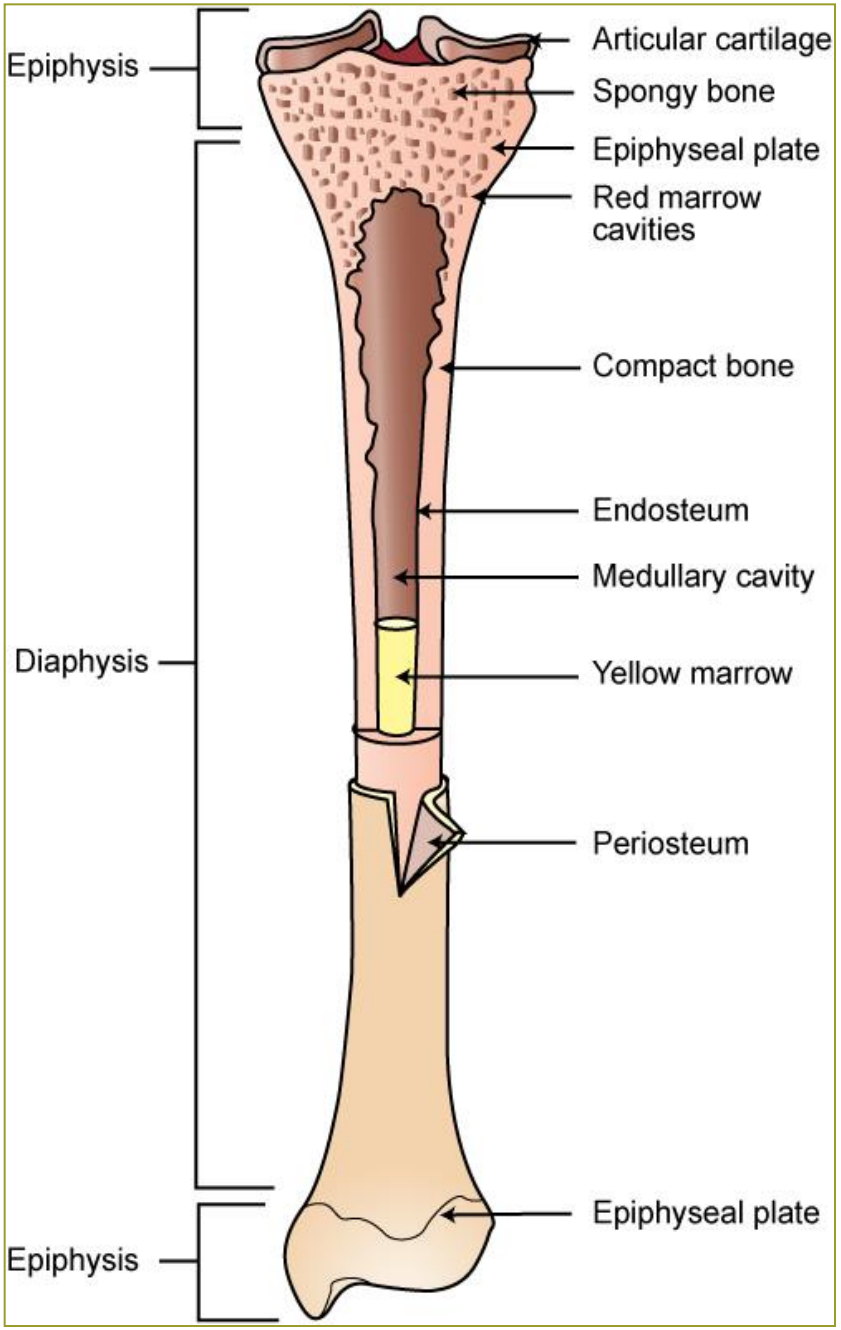
Figure 6-3, Page 157

- **Epiphyseal plates**: cartilage located between diaphysis and epiphyses of bone
  - Sites where new bone develops to allow long bones to lengthen



Anatomy of a Long Bone

- **Epiphysis**
  - Articular cartilage
  - Spongy bone
  - Epiphyseal plate
- **Diaphysis**
  - Compact bone
  - Periosteum
  - Endosteum
  - Medullary cavity



Epiphyseal Plates in Young Animals

Figure 6-4, Page 158

Bone Membranes

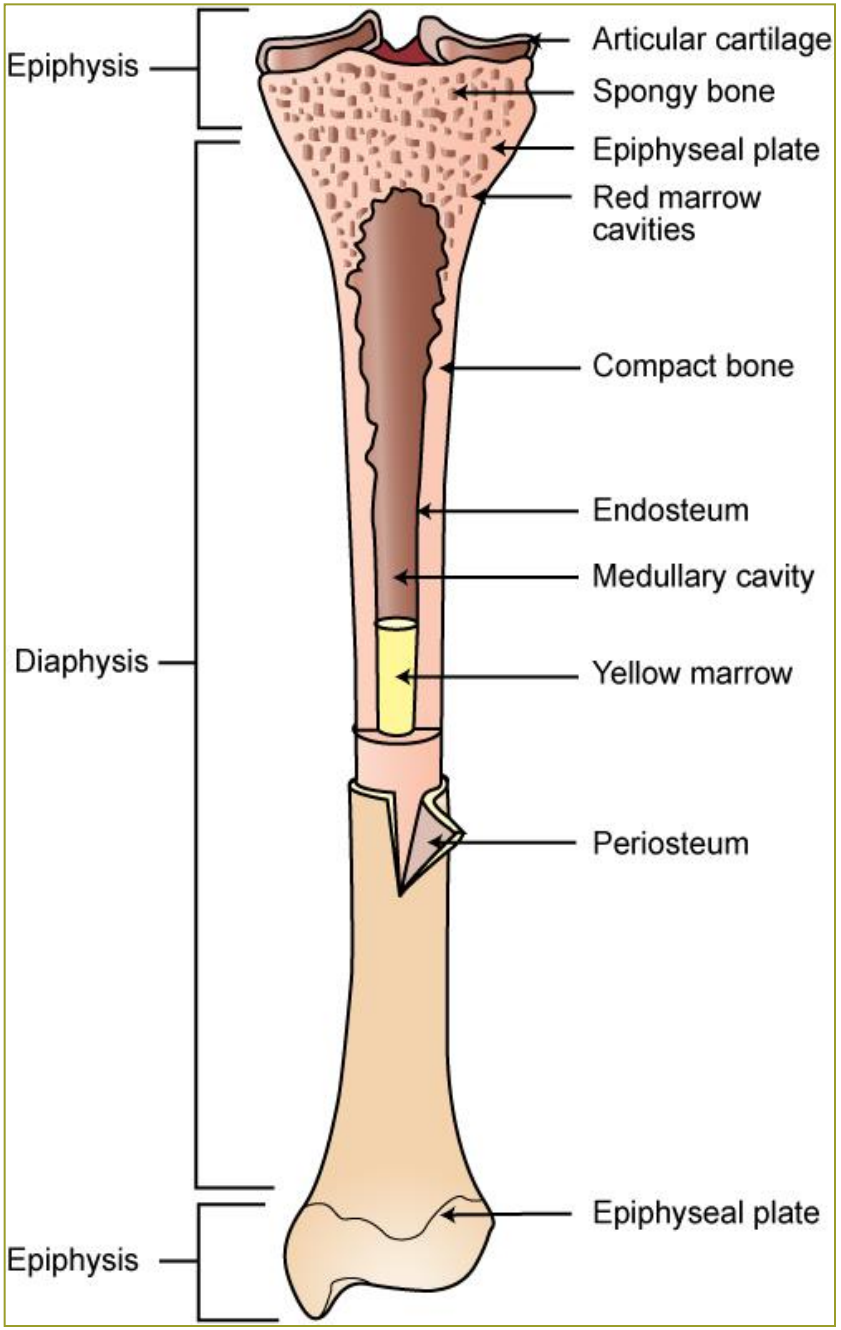
- **Periosteum**: membrane that covers outer surfaces of bones
  - Outer layer is composed of fibrous tissue
  - Inner layer contains osteoblasts
  - **Not present on articular surfaces**
- **Endosteum**: membrane that lines the hollow interior surfaces of bones
  - Also contains osteoblasts

Long Bone Growth

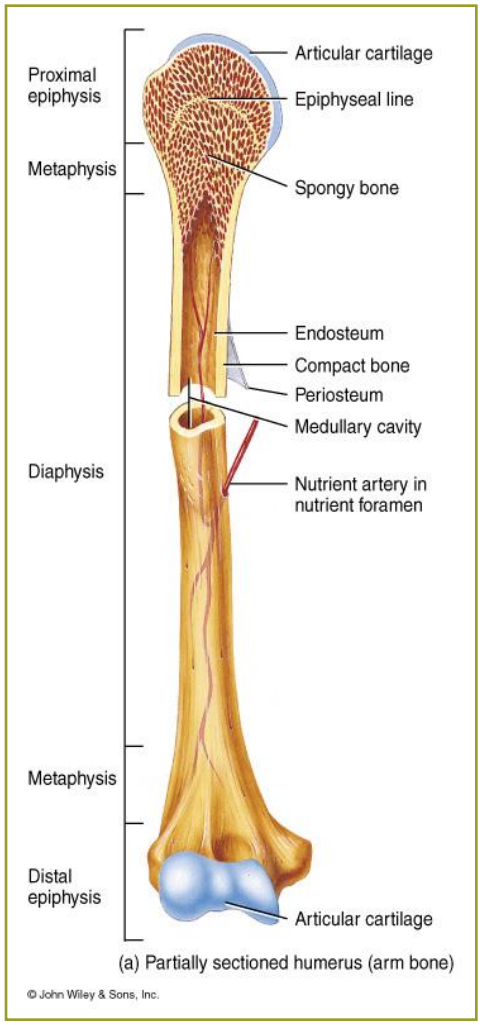
- **Primary** growth center: bones develop in the diaphyses
  - Cartilage rod
- Cartilage is removed as bone is created
- **Secondary** growth centers: develop in the epiphyses of the bone

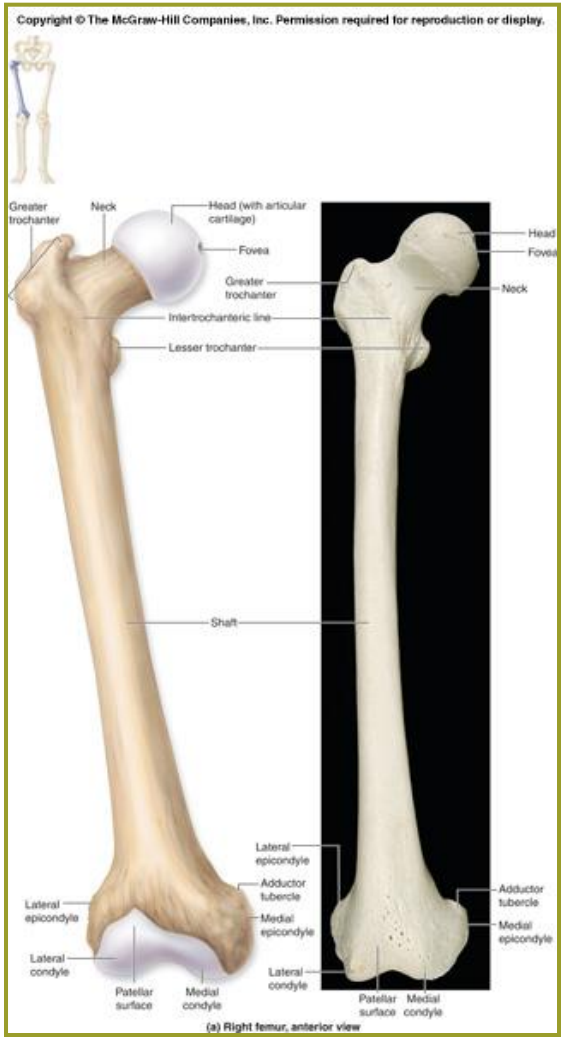
Ossification

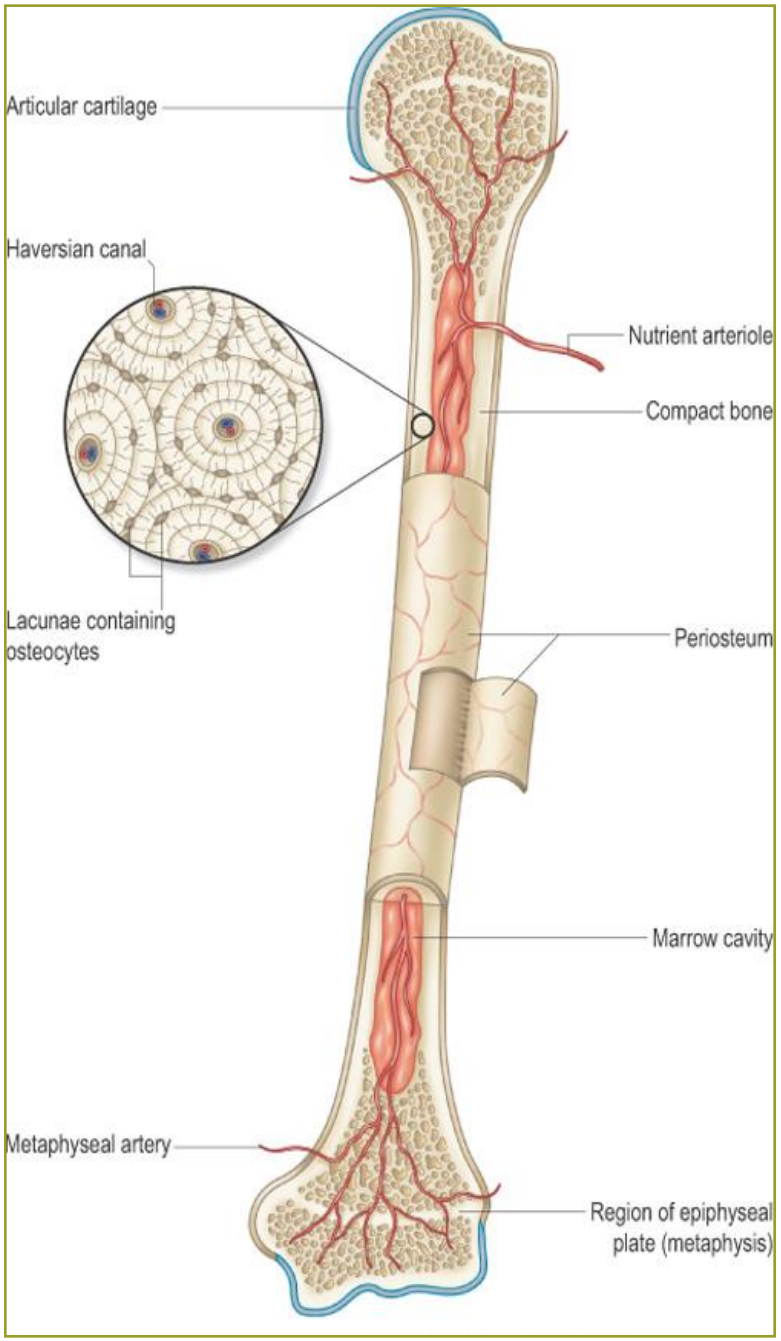
- When the bone has reached its full size, the epiphyseal plates completely **ossify**

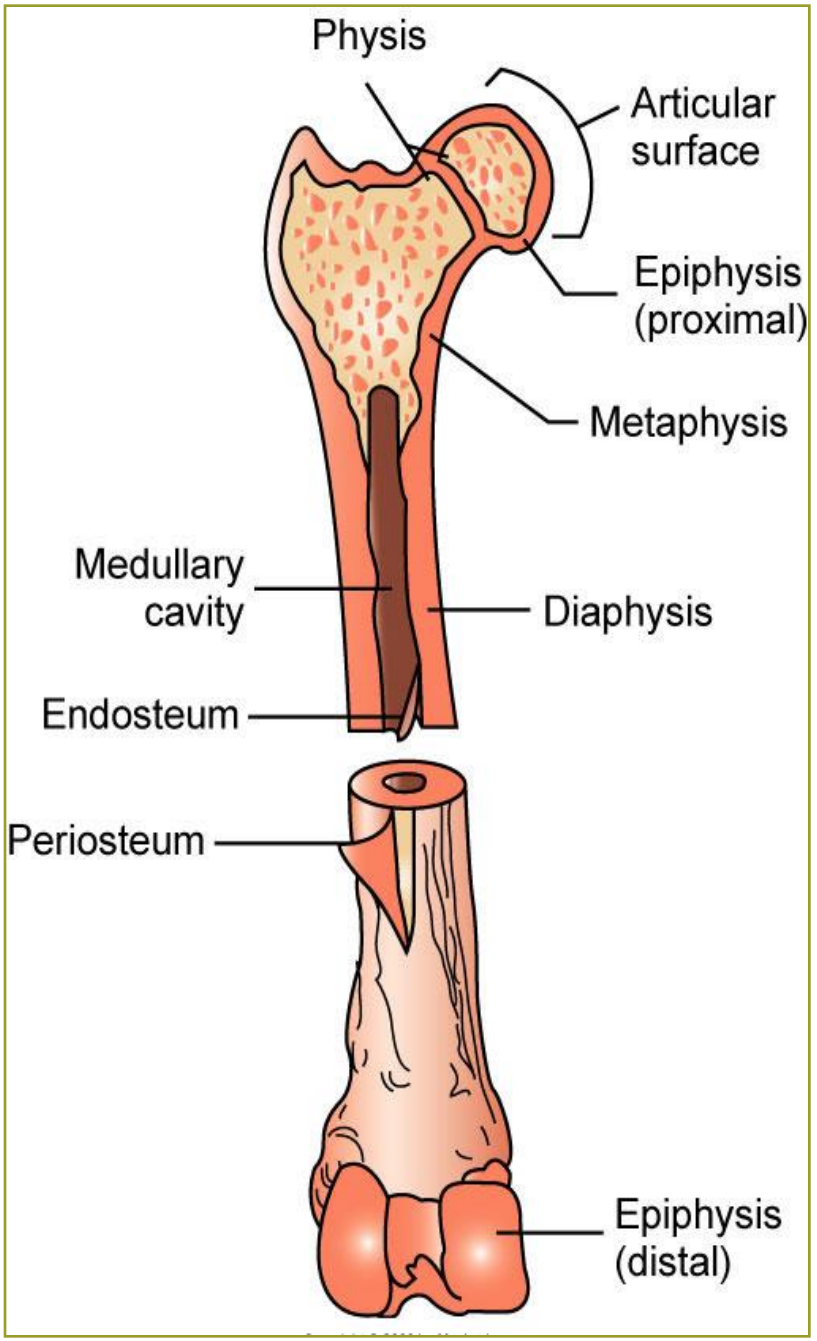


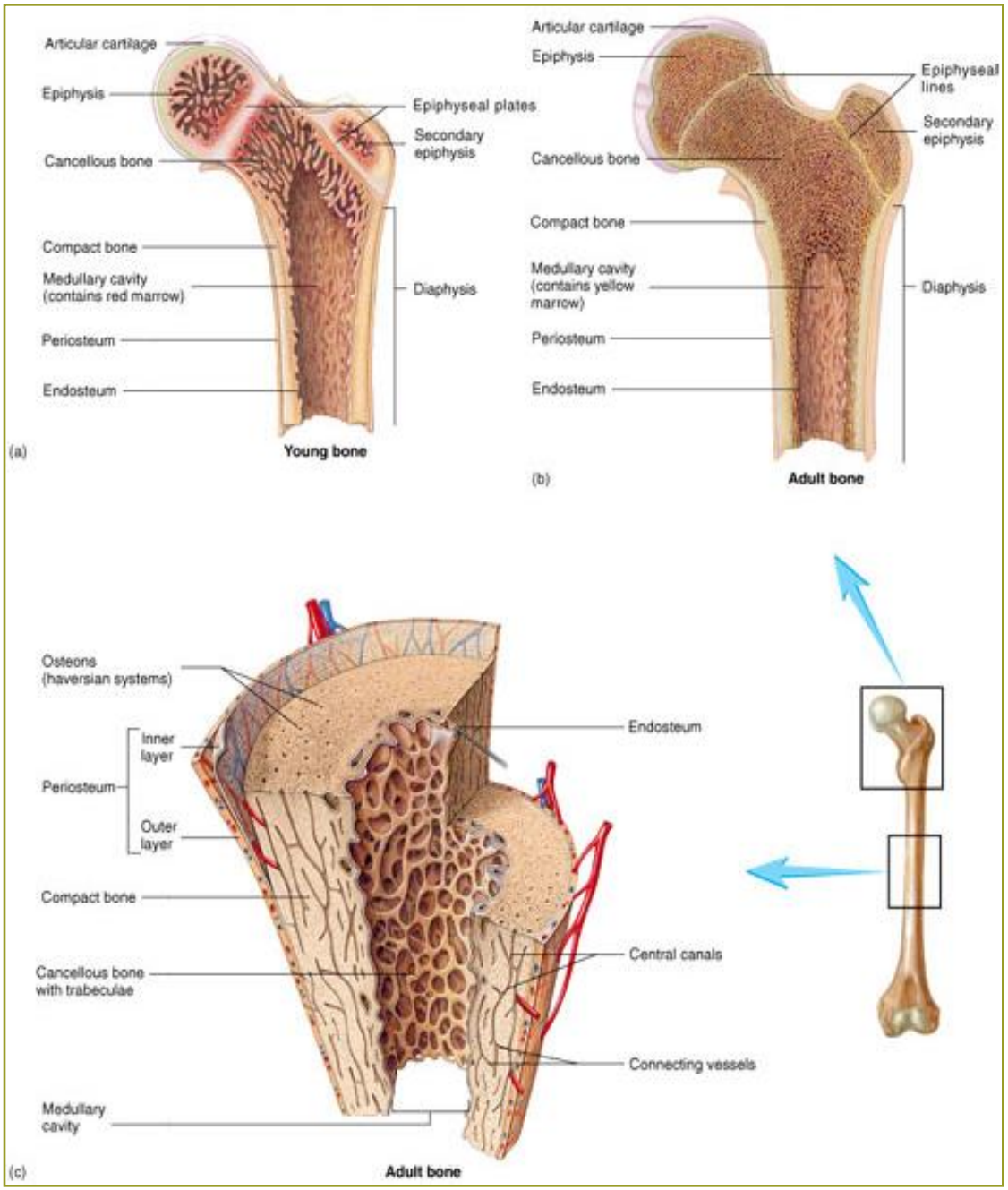
Long Bone Anatomy Review






Articular cartilage
Haversian canal
Nutrient arteriole
Compact bone
Lacunae containing osteocytes
Periosteum
Marrow cavity
Metaphyseal artery
Region of epiphyseal plate (metaphysis)


Physis
Articular surface
Epiphysis (proximal)
Metaphysis
Medullary cavity
Diaphysis
Endosteum
Periosteum
Epiphysis (distal)

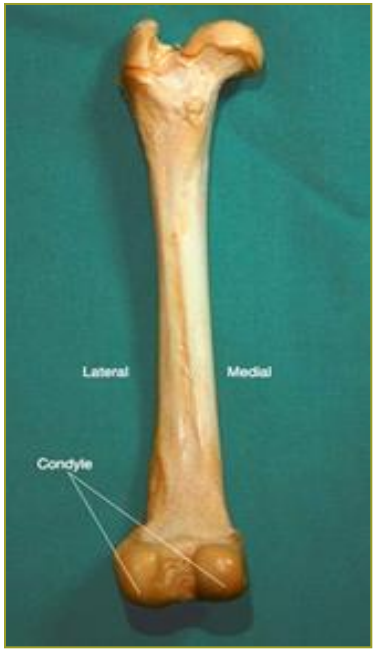

Articular cartilage
Epiphysis
Epiphyseal plates
Secondary epiphysis
Cancellous bone
Compact bone
Medullary cavity (contains red marrow)
Diaphysis
Periosteum
Endosteum
(a)
Young bone
Articular cartilage
Epiphysis
Epiphyseal lines
Secondary epiphysis
Cancellous bone
Compact bone
Medullary cavity (contains yellow marrow)
Diaphysis
Periosteum
Endosteum
(b)
Adult bone
Osteons (haversian systems)
Inner layer
Periosteum
Outer layer
Endosteum
Compact bone
Central canals
Cancellous bone with trabeculae
Connecting vessels
Medullary cavity
(c)
Adult bone

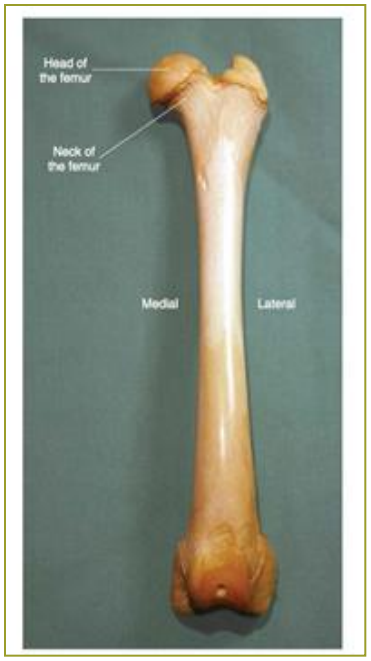
Bones “Bumps & Grooves”

Articular Surfaces

Bassert Lab Manual, Pages 103-104

- **Condyle**: large, round articular surface
- **Head**: spherical articular surface on the proximal end of a long bone
  - Joins with the shaft of the bone at the neck region
- **Facet**: flat articular surface





Processes

Bassert Lab Manual
Page 108

- Projections off a bone surface
- Name depends on location
- Examples:
  - Spinous process of a vertebra
  - Trochanter on the femur
  - Tuberosity on the ischium
  - Spine on the scapula
  - Wing on the atlas

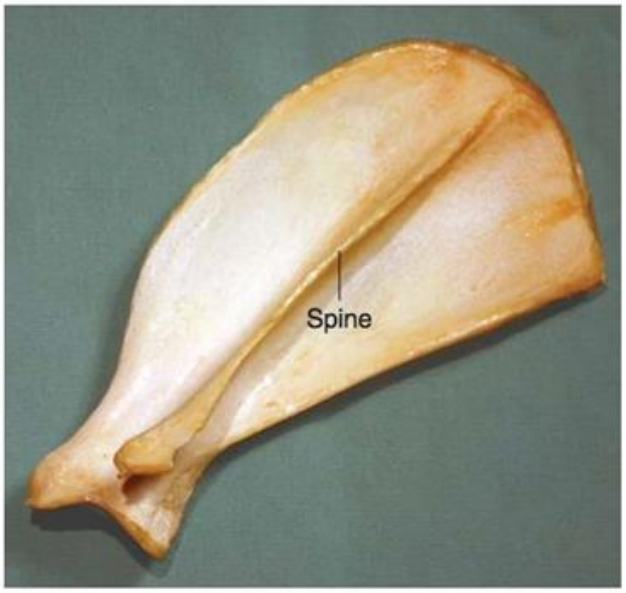


Figure 6-26 **Spine of the Canine Scapula.** The spine runs along the lateral surface.

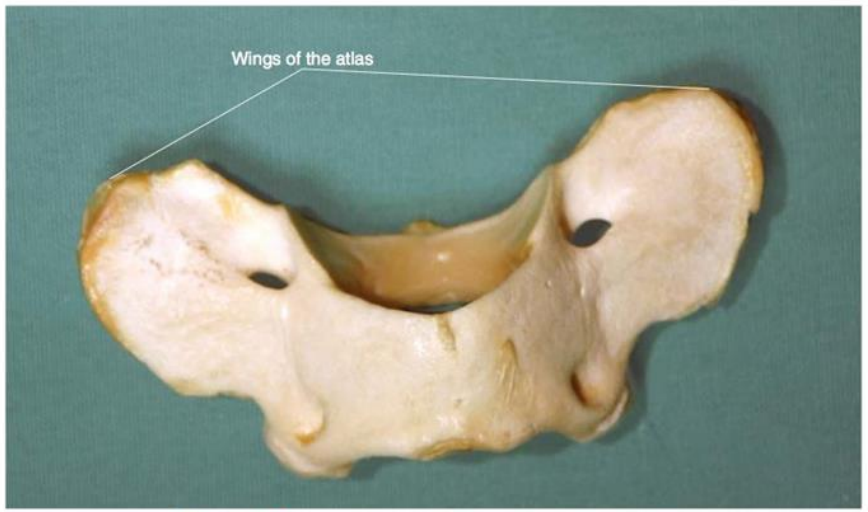
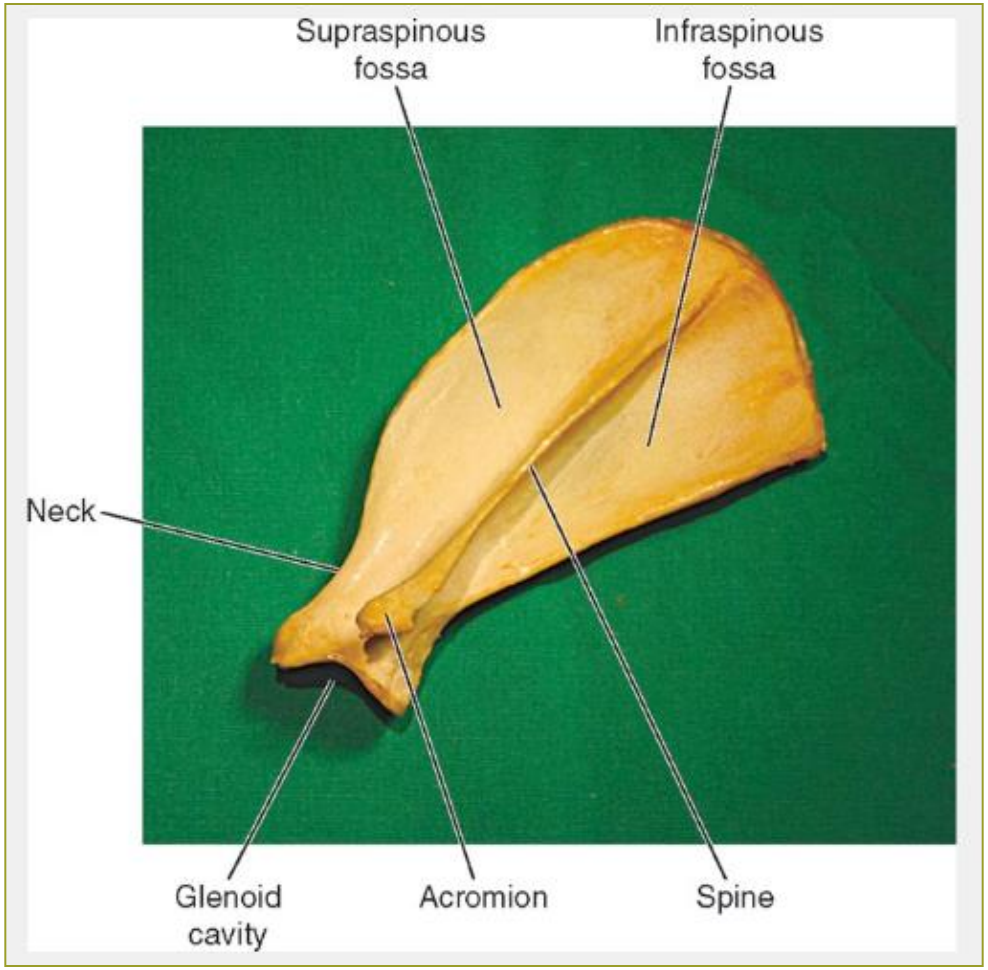


Figure 6-27 Wings of the Atlas (First Cervical) Vertebra.

Bone Holes and Grooves

Figure 6-24, Page 175

- **Foramen**: hole in a bone; may contain blood vessels, nerves
- **Fossa**: depressed area on the surface of a bone



Examples of Processes and a Foramen

Bassert Lab Manual, Pages 102, 108

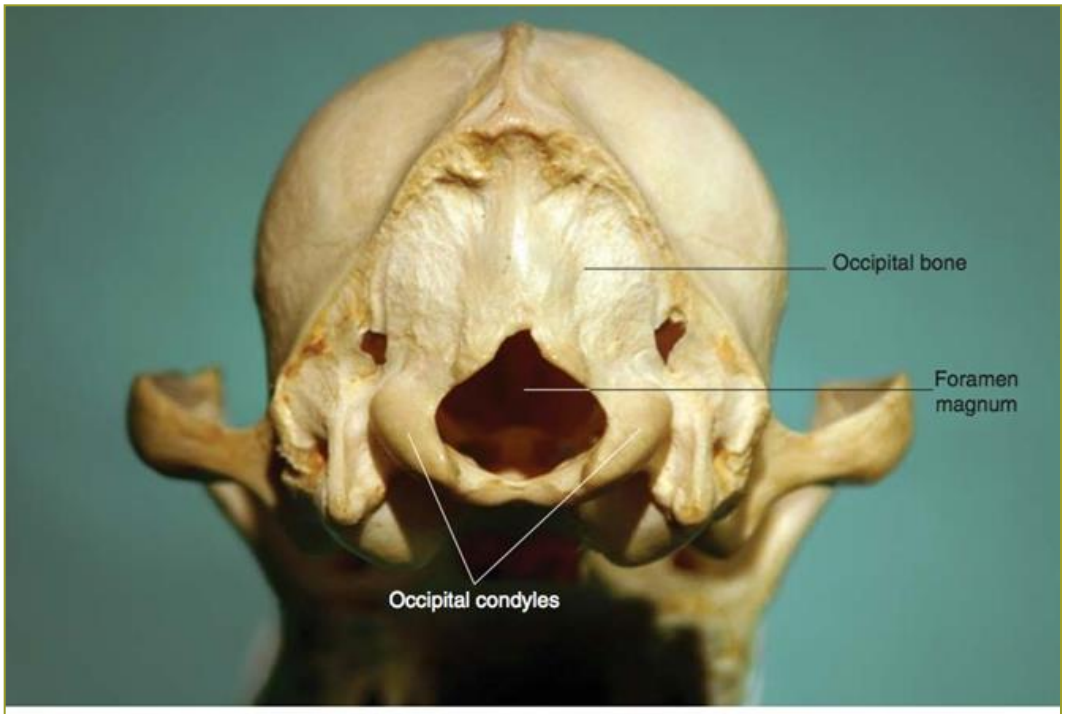
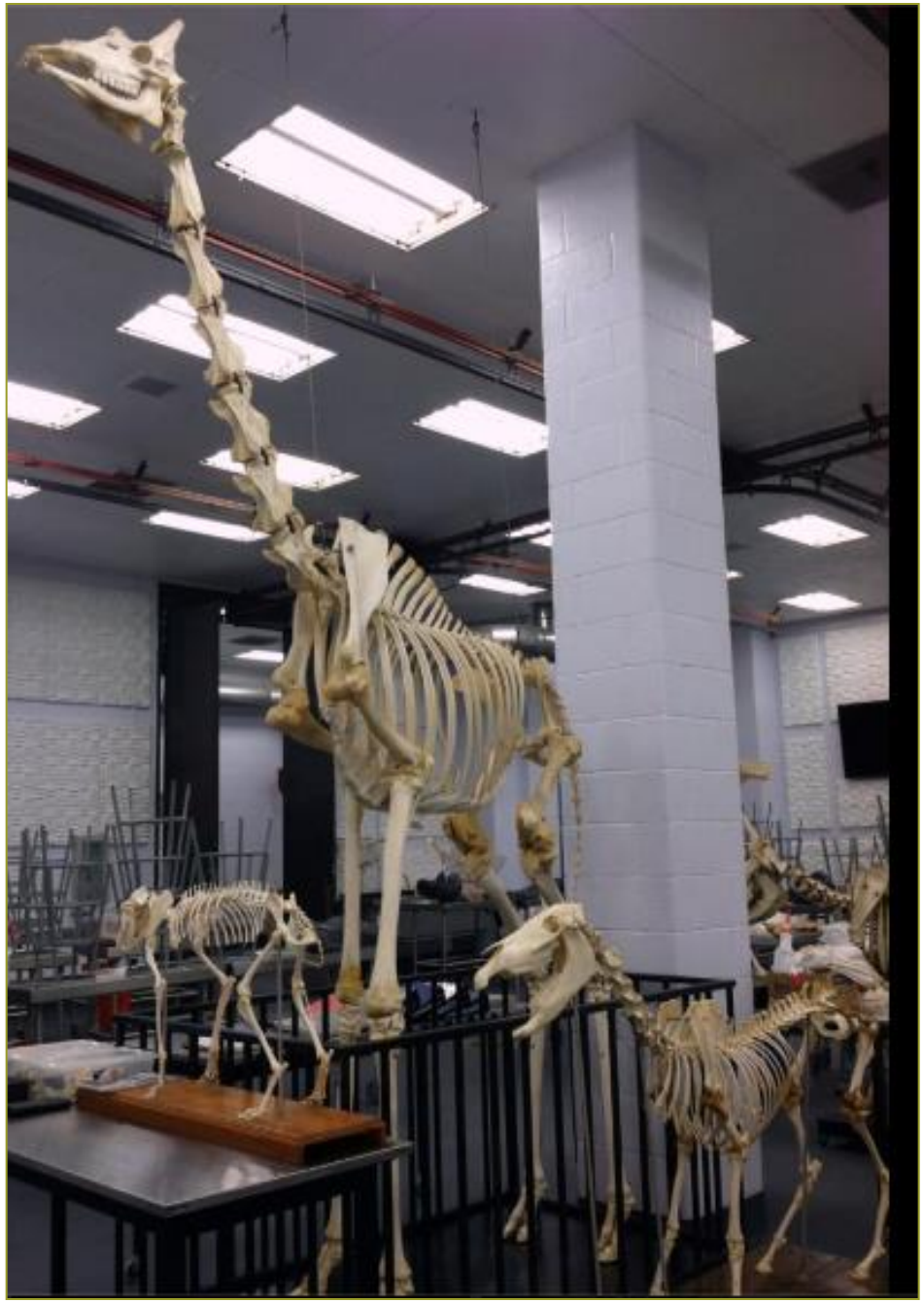


Figure 6-13 The Condyles of the Occipital Bone in the Canine Skull. These articular surfaces are where the skull joins the spinal column. It connects the head to the neck. (This joint is the one your mother meant when she said you would lose your head if it wasn't attached.)

The Skeleton

Osteology



Topic 5

Compare and contrast the axial skeleton with the appendicular skeleton

Axial vs. Appendicular Skeleton

- Axial skeleton
  - Bones of the head and trunk
  - Bones of “the main body mass”
- Appendicular Skeleton
  - Bones of the limbs (extremities)

Axial Skelton

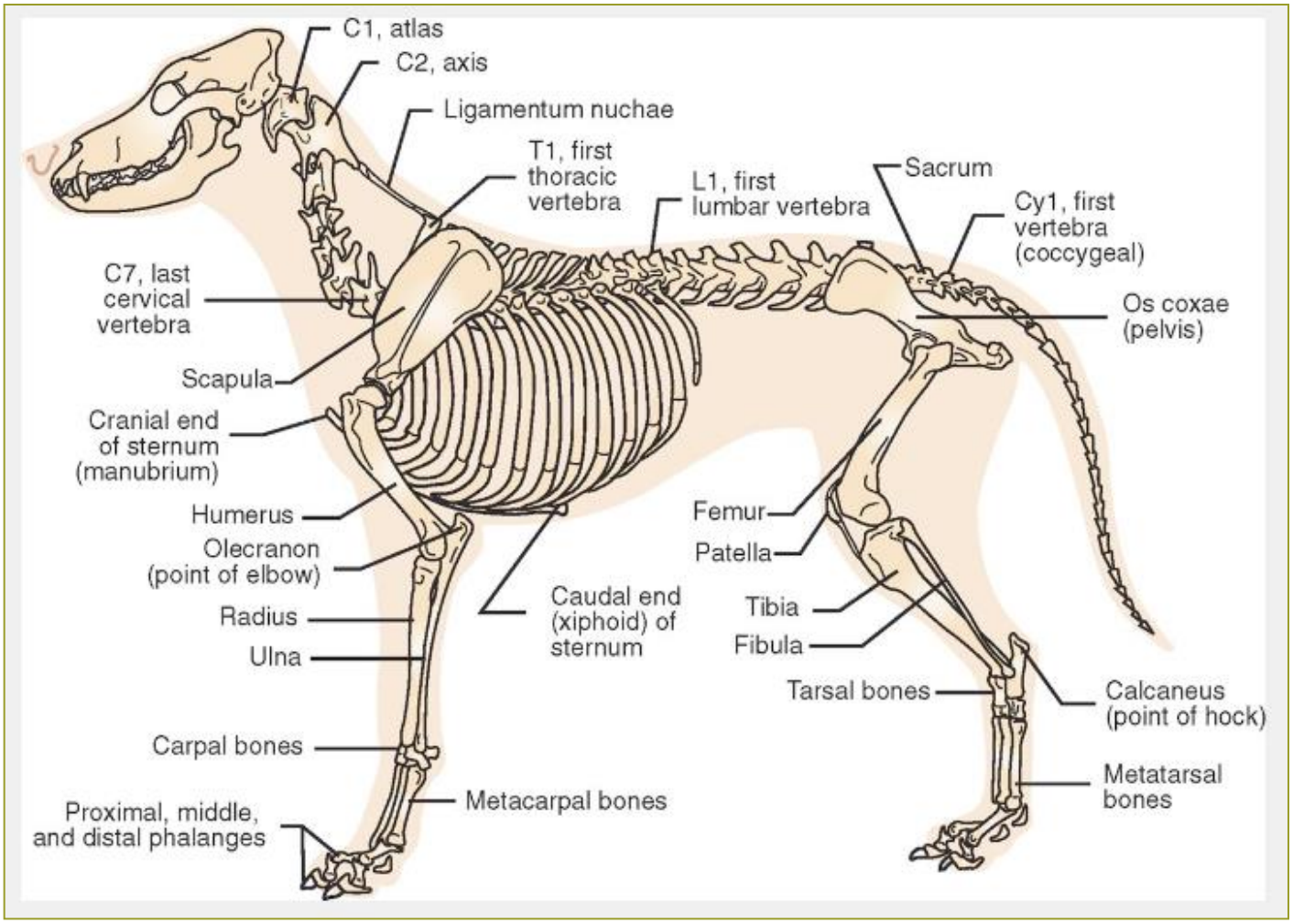
Bassert Lab Manual, Page 111

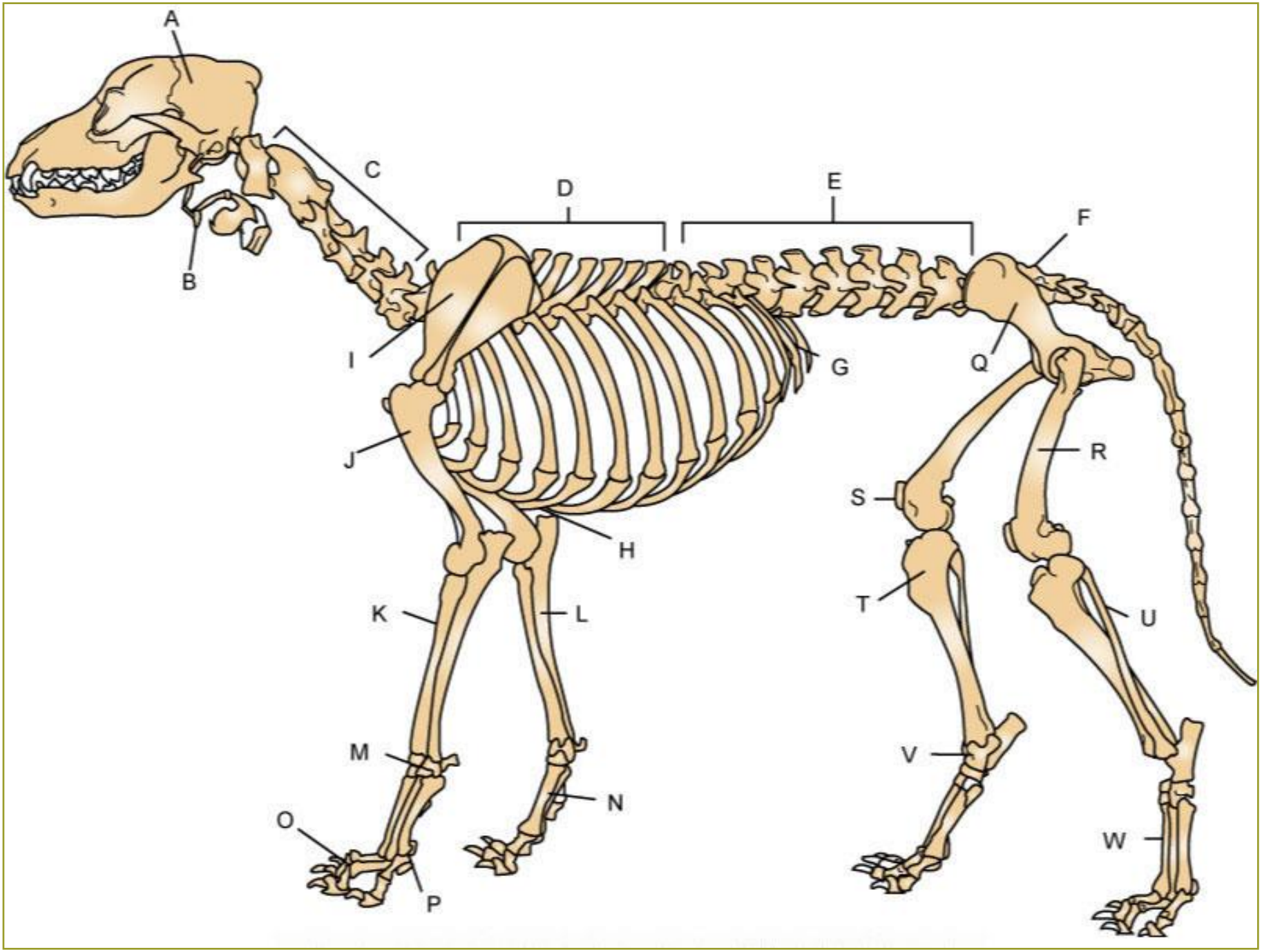
- Skull
- Hyoid bone
- Spinal column
- Ribs
- Sternum

Figure 6-32 Feline Skeleton With the Bones of the Axial Skeleton Highlighted.

Canine Skeleton

Figure 6-8, Page 163

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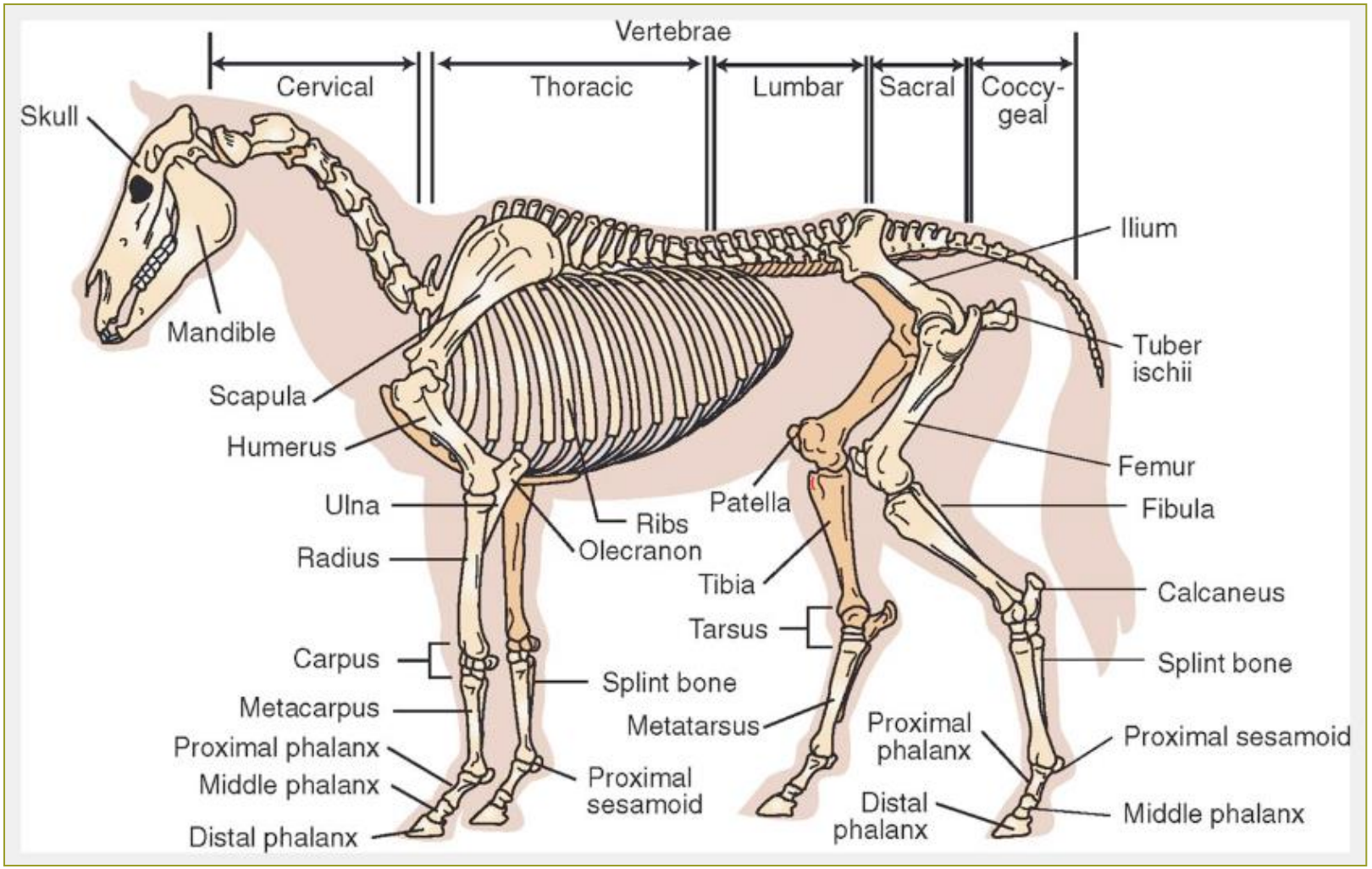
Equine Skeleton

Figure 6-7, Page 163



Appendicular Skeleton

Thoracic Limb (Foreleg)

Pelvic Limb (Rear Leg)

Axial Skelton

Bassert Lab Manual, Page 120

Figure 6-48 Feline Skeleton With the Bones of the Appendicular Skeleton Highlighted.

Thoracic Limb (Proximal to Distal)

- Scapula
- Humerus
- Radius
- Ulna
- Carpal bones (Carpus)
- Metacarpal Bones
- Phalanges

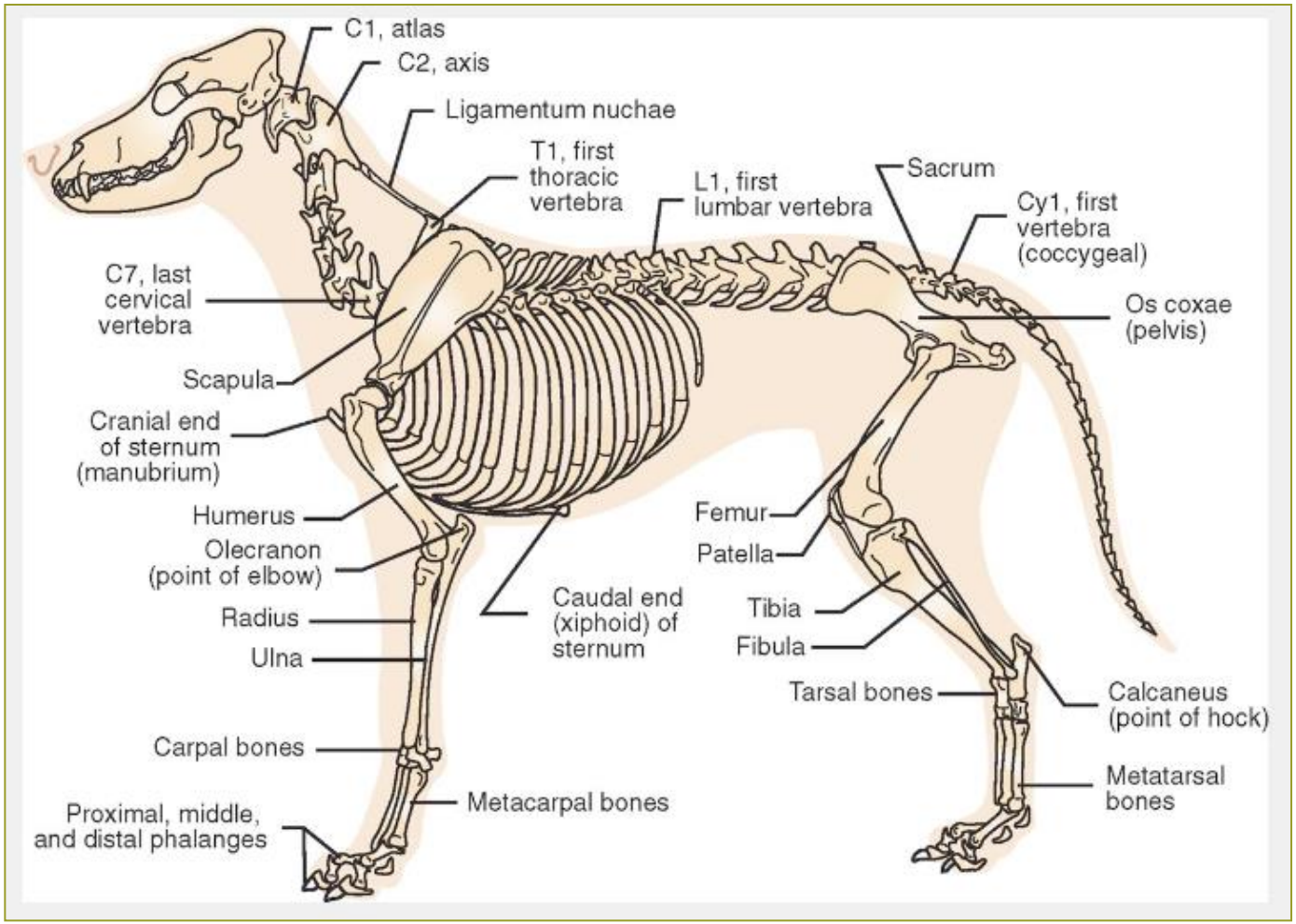
Pelvic Limb (Proximal to Distal)

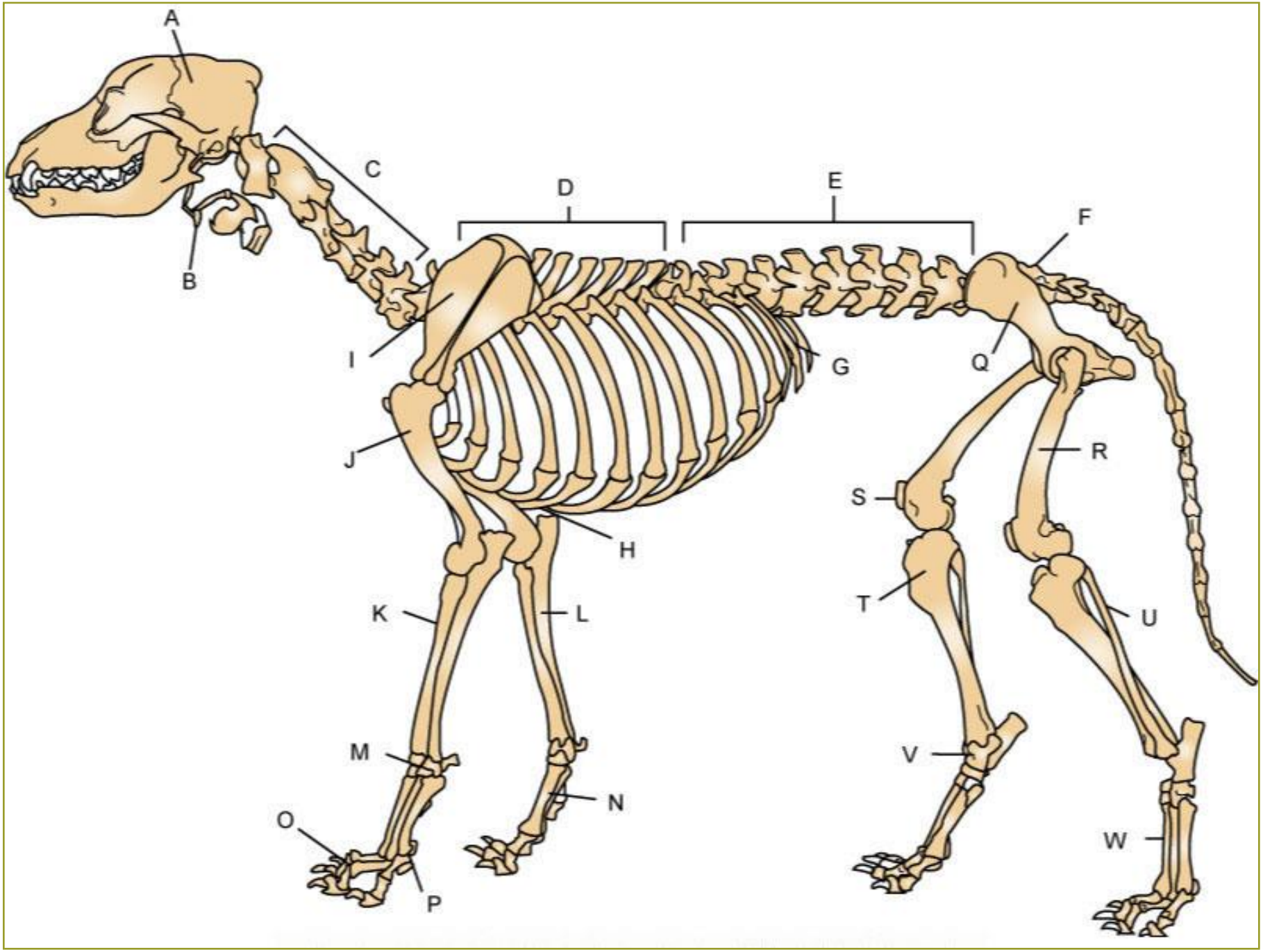
Connected to axial skeleton at **sacroiliac joint**

- Pelvis
- Femur
- Tibia
- Fibula
- Tarsal bones (tarsus)
- Metatarsal bones
- Phalanges

Canine Skeleton

Figure 6-8, Page 163

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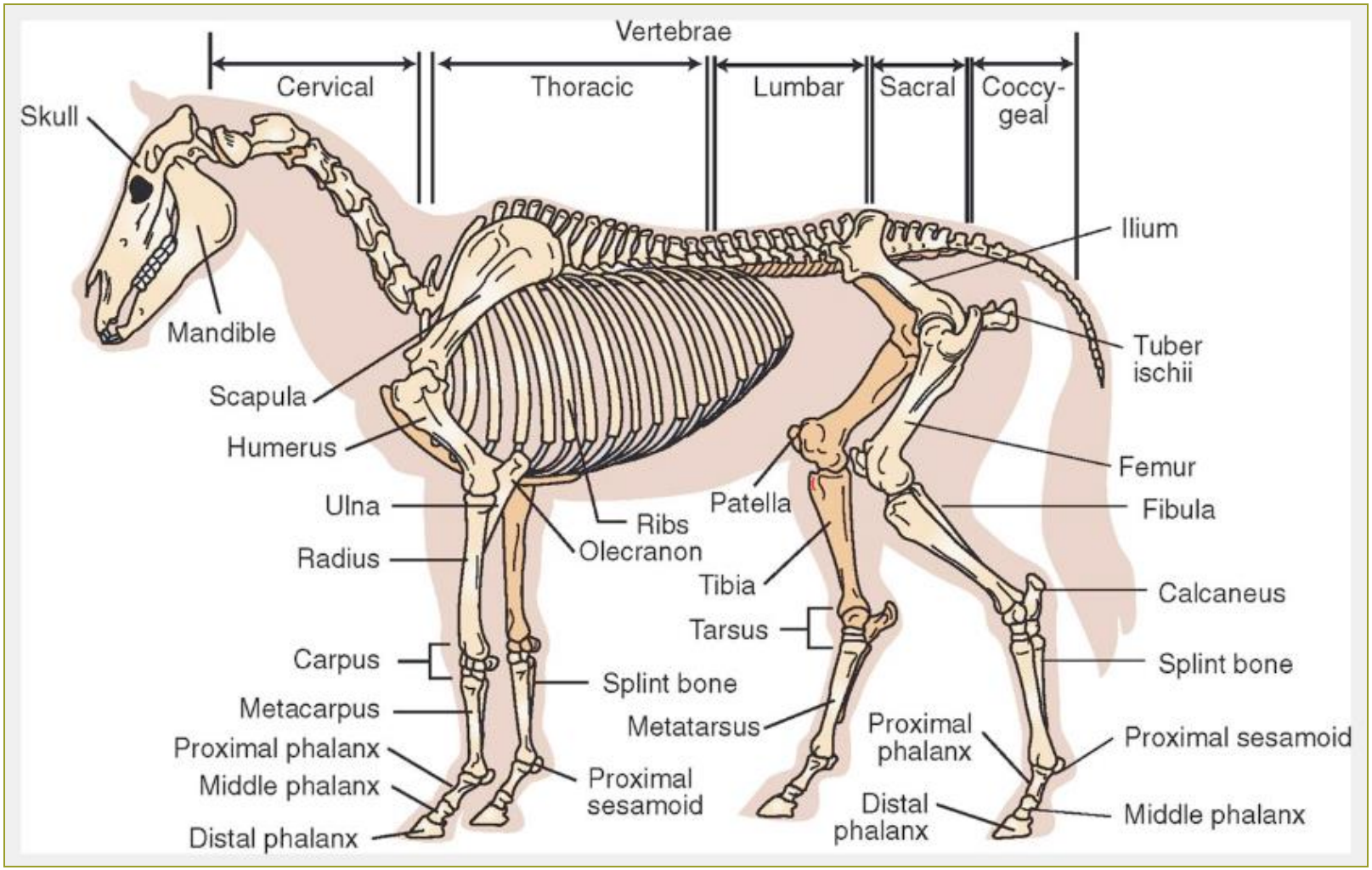
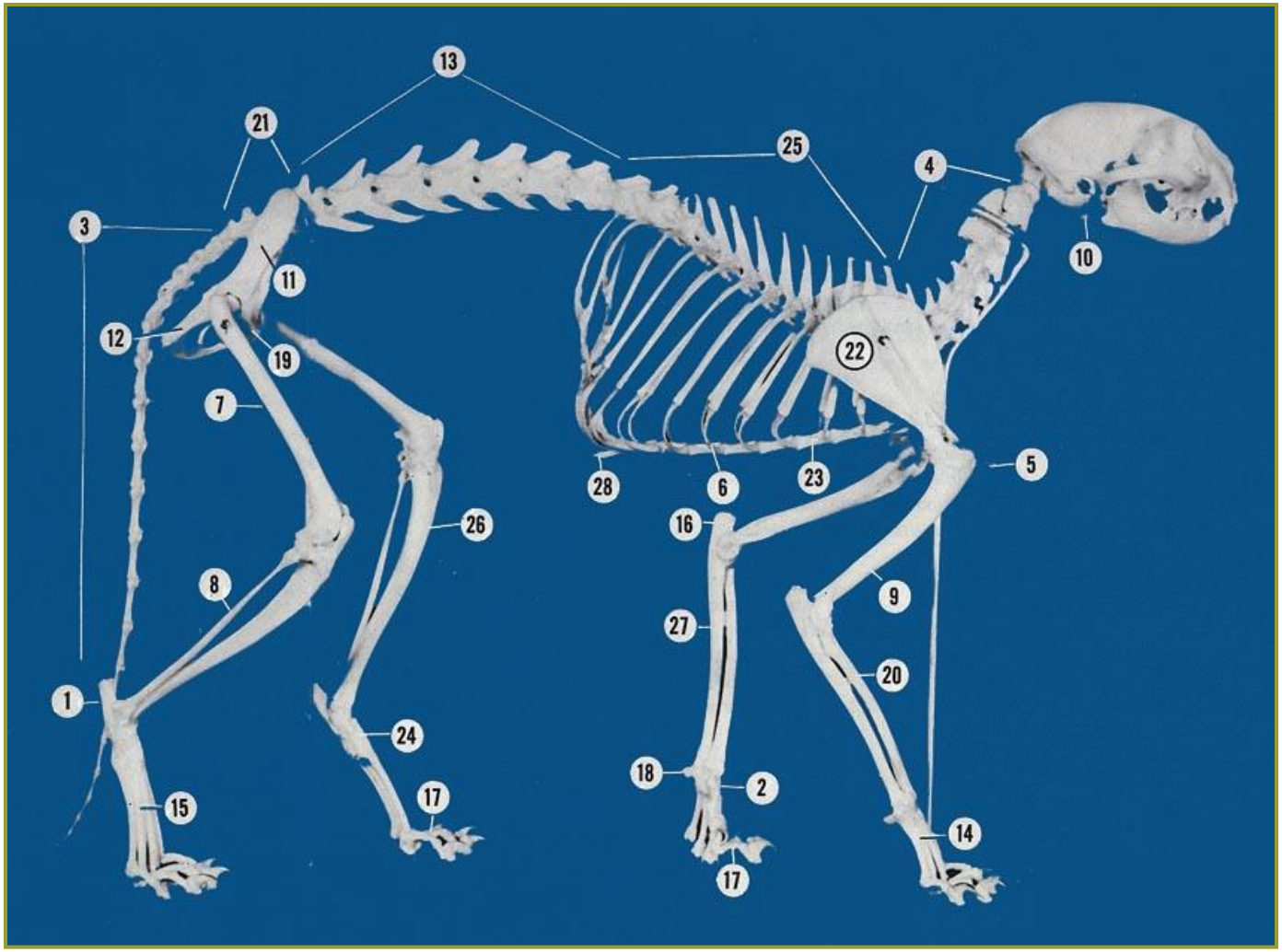
Equine Skeleton

Figure 6-7, Page 163





1. calcaneus
2. carpals
3. caudal vertebrae
4. cervical vertebrae
5. clavicle
6. costal cartilage #5
7. femur
8. fibula
9. humerus
10. hyoid apparatus
11. ilium
12. ischium
13. lumbar vertebrae
14. metacarpals
15. metatarsals
16. olecranon
17. phalanges
18. pisiform bone
19. pubis
20. radius
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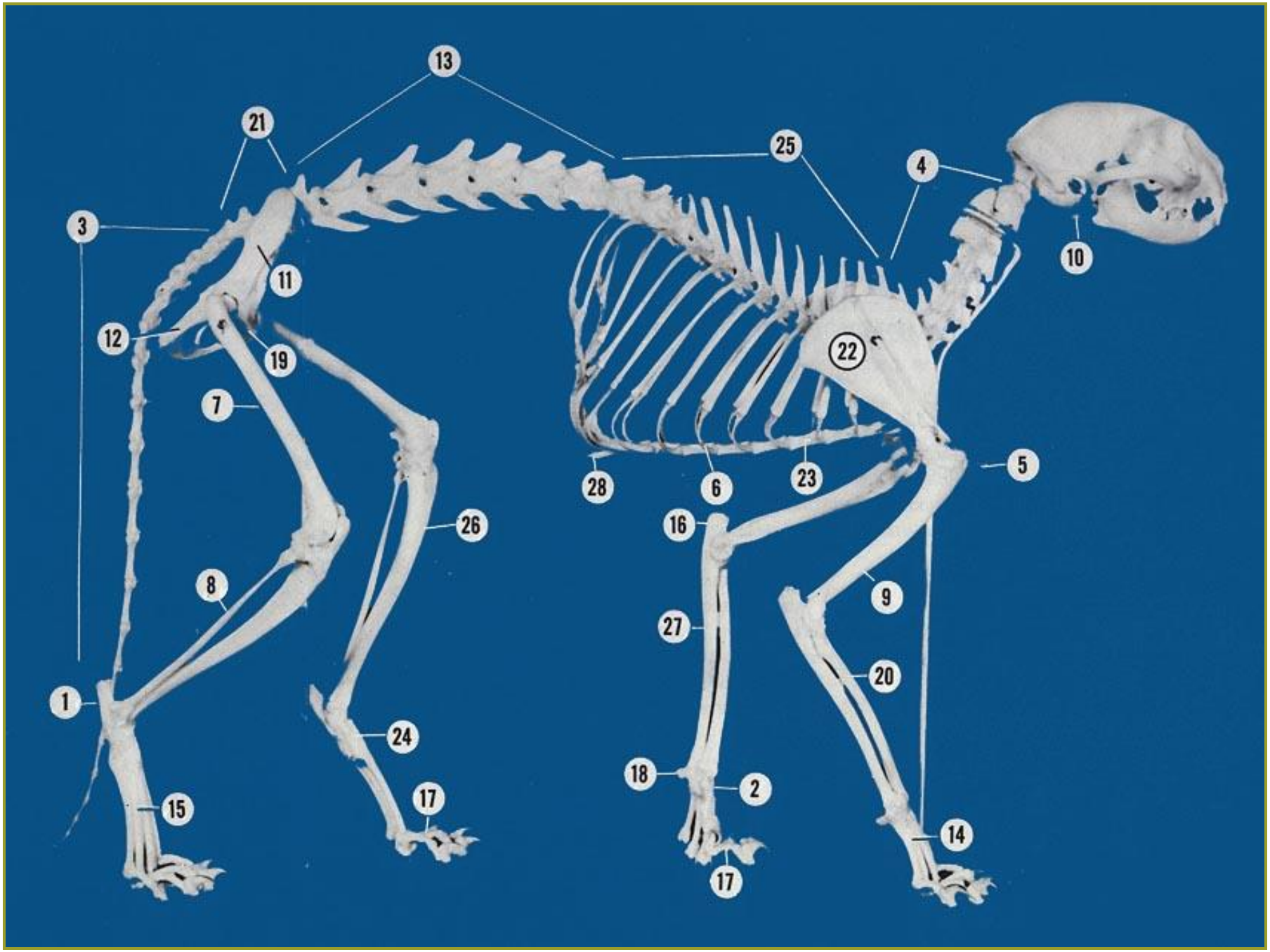
22. scapula
23. sternebra
24. tarsals
25. thoracic vertebrae
26. tibia
27. ulna

28. xiphoid process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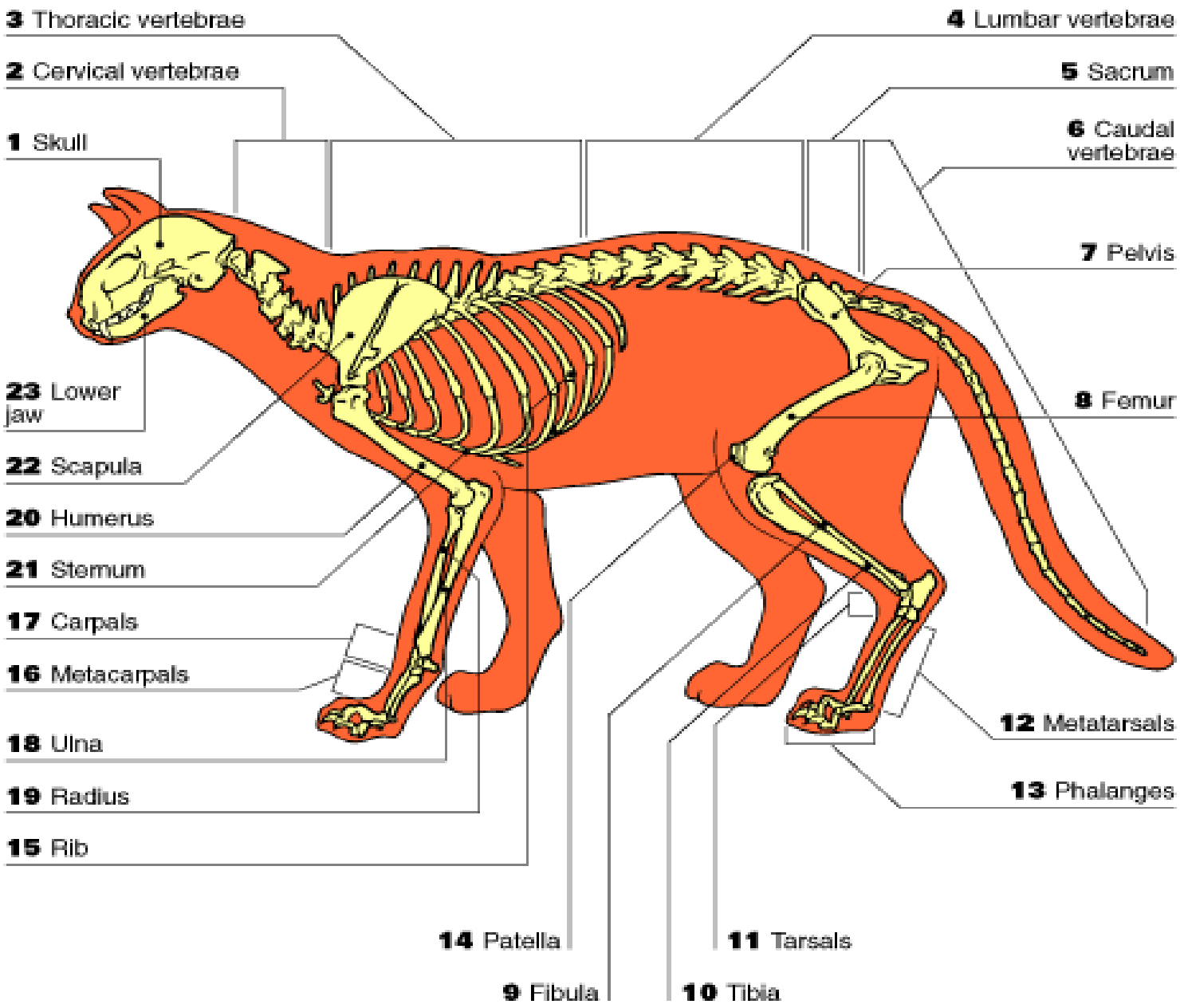
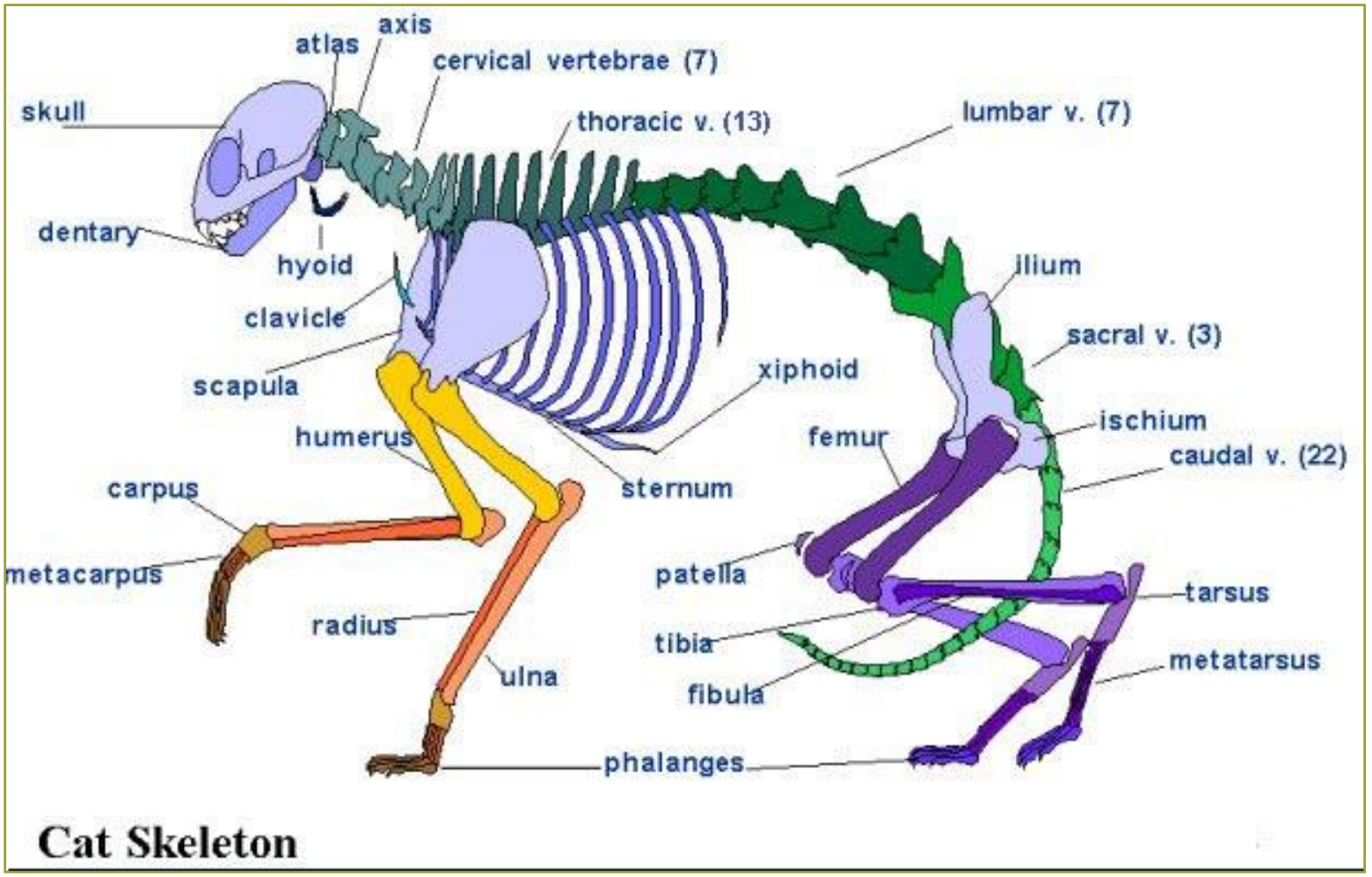

3 Thoracic vertebrae
4 Lumbar vertebrae
2 Cervical vertebrae
5 Sacrum
1 Skull
6 Caudal vertebrae
7 Pelvis
23 Lower jaw
8 Femur
22 Scapula
20 Humerus
21 Sternum
17 Carpals
16 Metacarpals
12 Metatarsals
18 Ulna
13 Phalanges
19 Radius
15 Rib
14 Patella
11 Tarsals
9 Fibula
10 Tibia

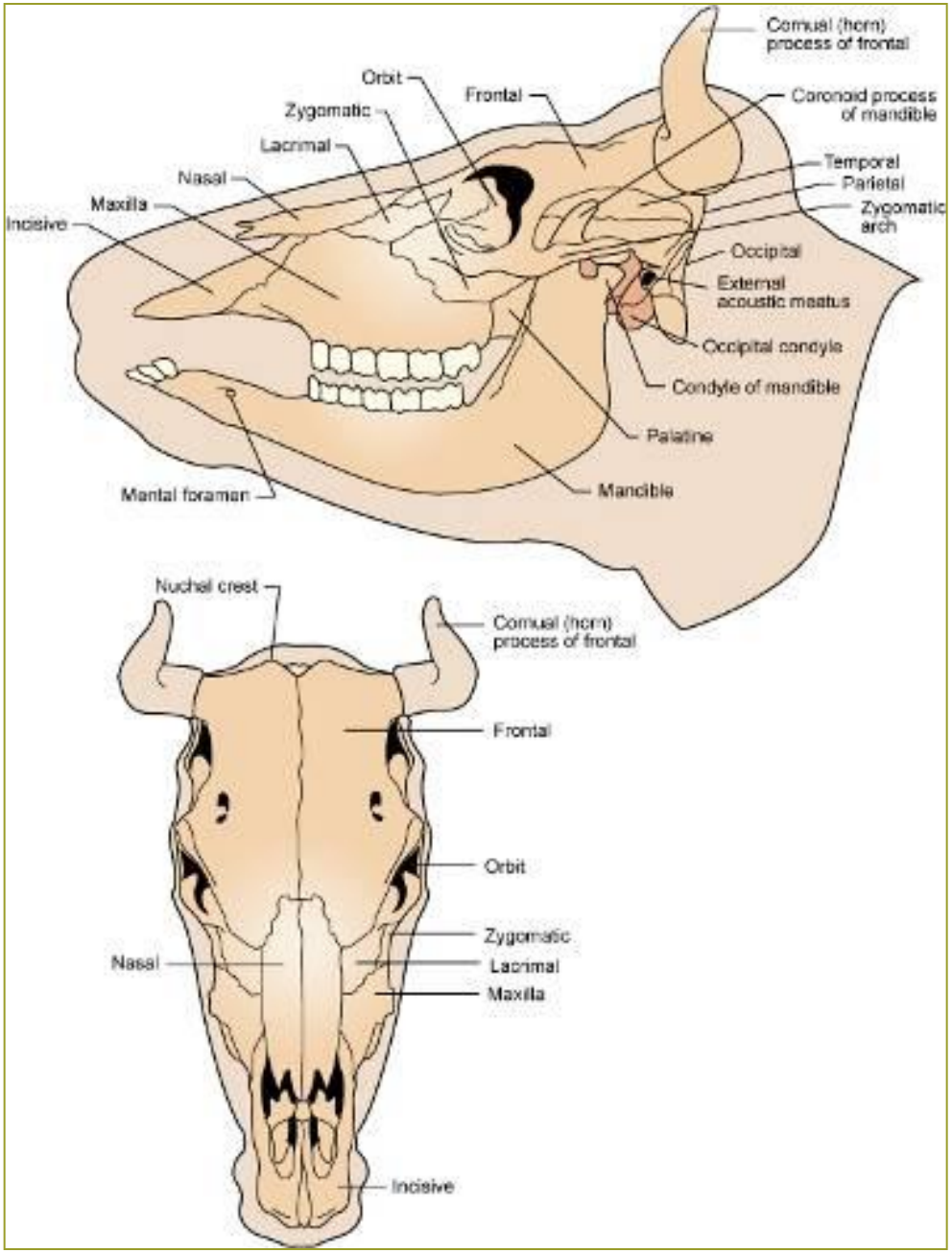
Comparative Anatomy – Dog Skeleton vs. Cat Skeleton



Skull

Figure 6-10, Page 165

- Usually consists of 37 or 38 separate bones
- Most of the skull bones are joints called **sutures**
- The **mandible** is connected to the rest of the skull by a synovial joint



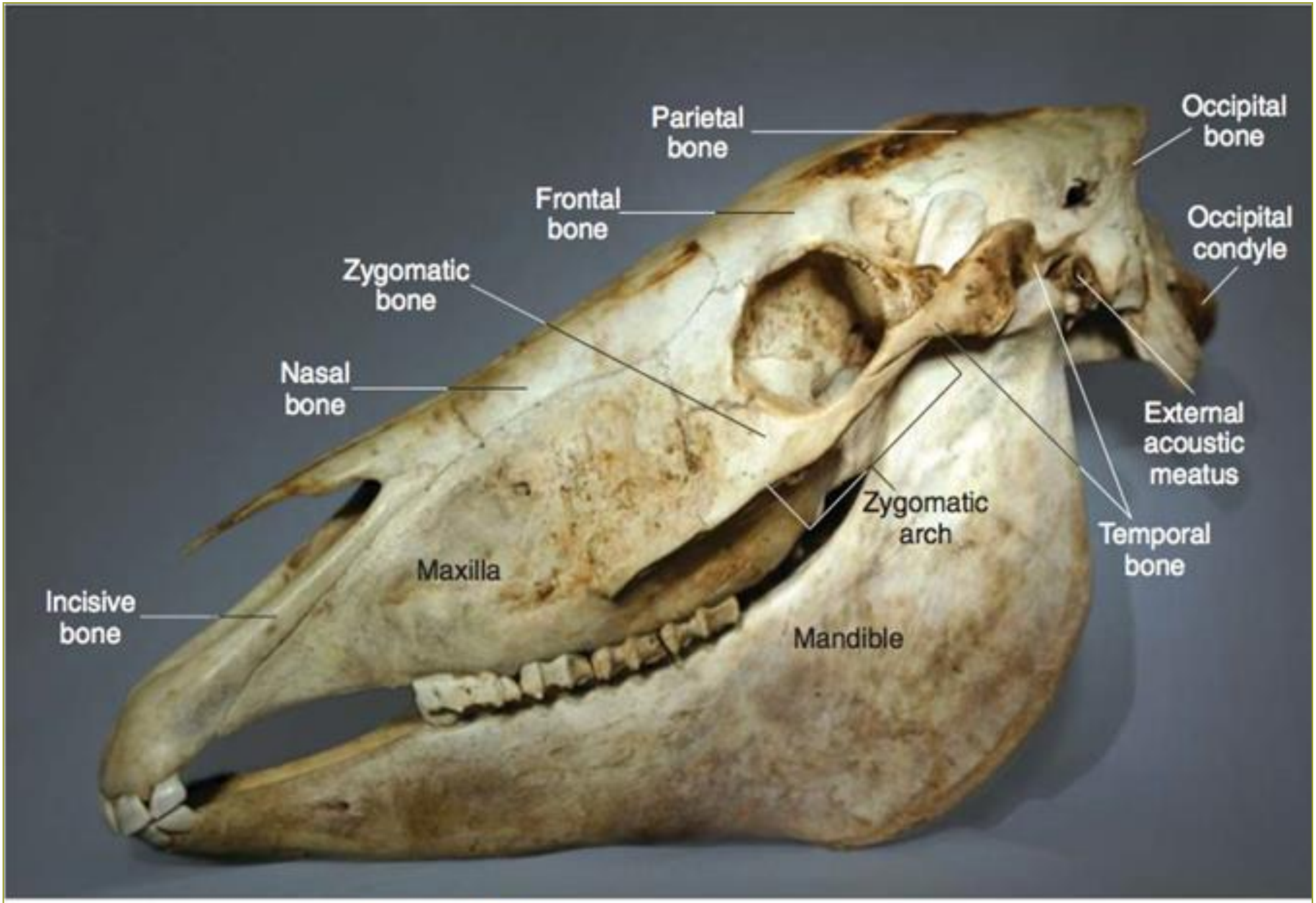


Figure 6-37 Lateral View of an Equine Skull.

Skull Bones to Know

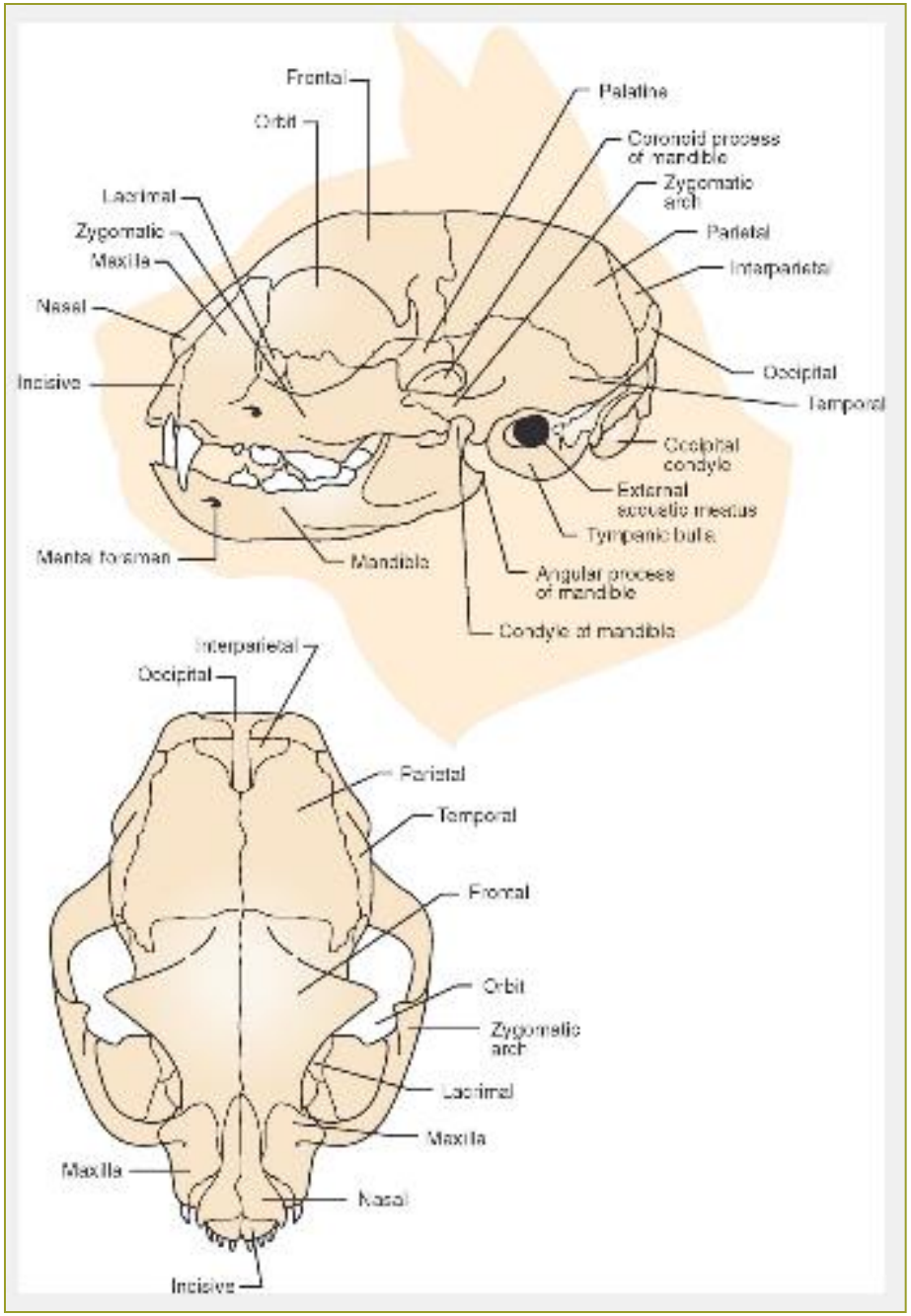
Figures 6-11 & 6-12, Pages 166 & 167

- Occipital Bone (protuberance)
- Foramen Magnum
- Zygomatic Arch (2 bones)
- Maxilla
- Mandible
- Tympanic Bulla
- Mental Foramen

Cat Skull

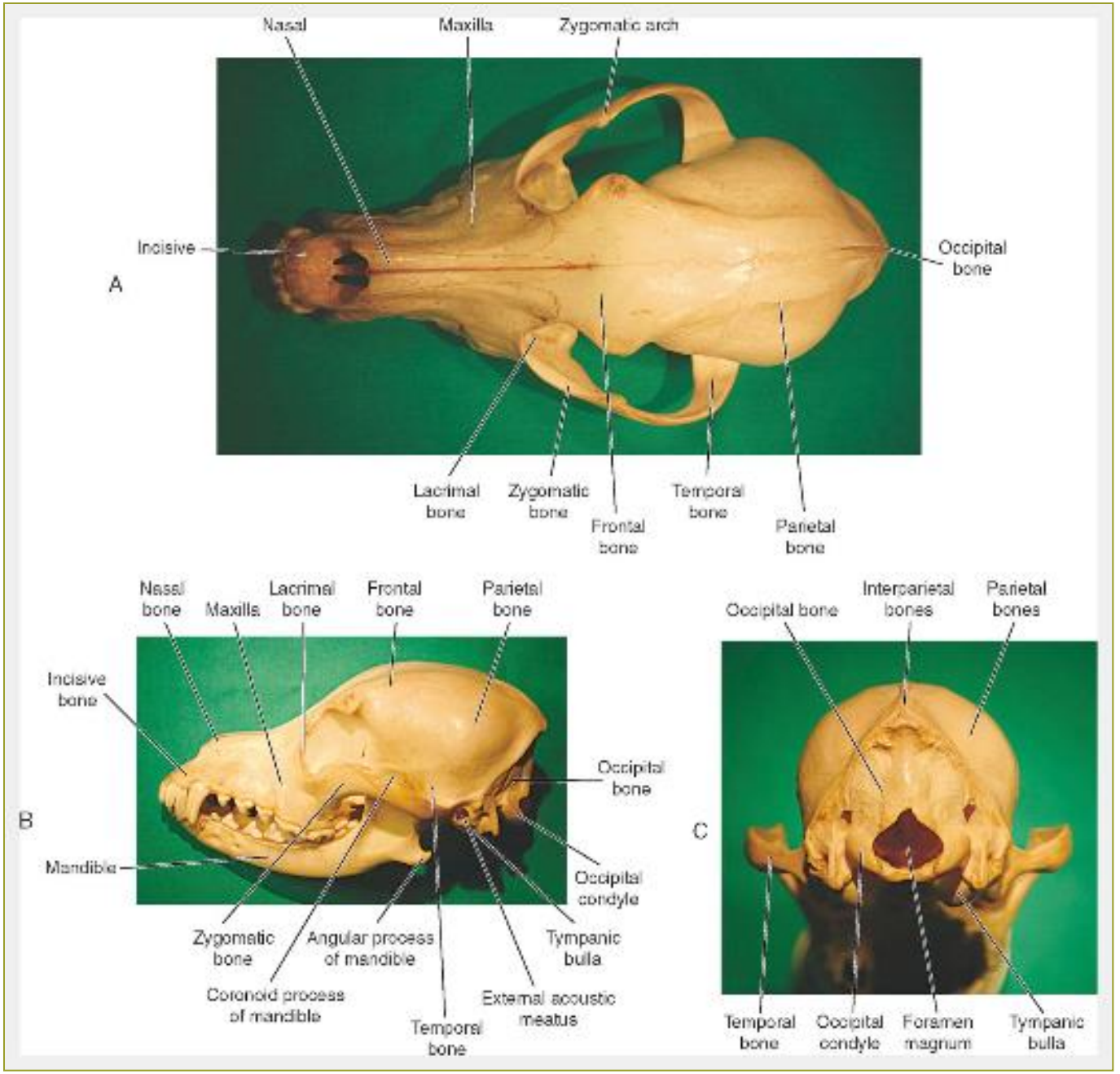
Figure 6-11, Page 166

- Zygomatic Arch (2 bones)
- Maxilla
- Mandible
- Tympanic Bulla
- Mental Foramen



Dog Skull

Figure 6-12, Page 167



How the Dog Skull Looks on X-rays

Bassert Lab Manual, Page 117

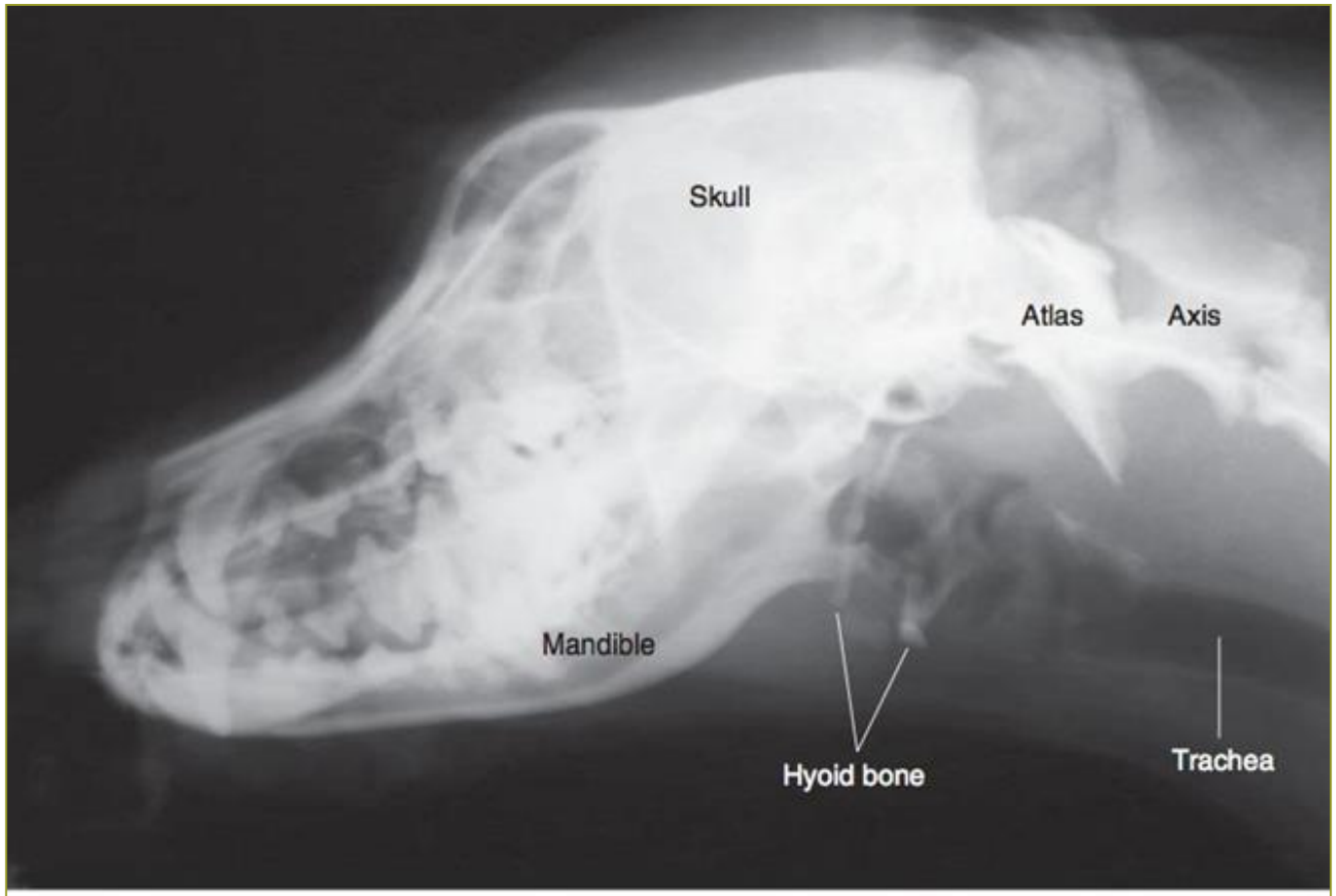
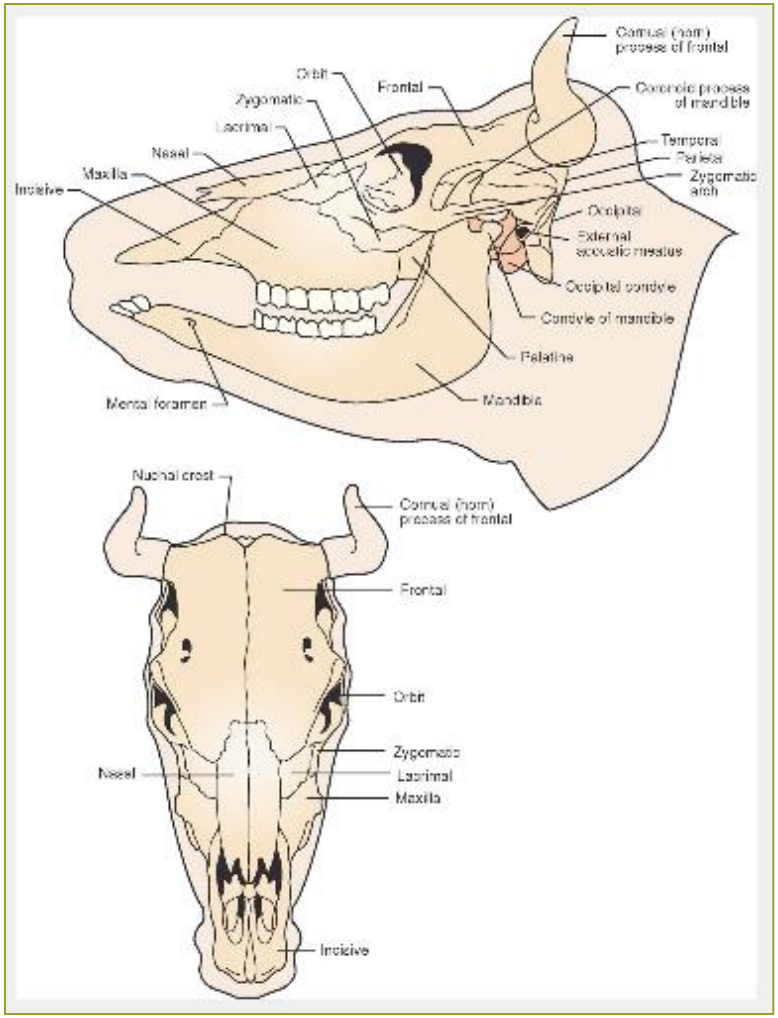
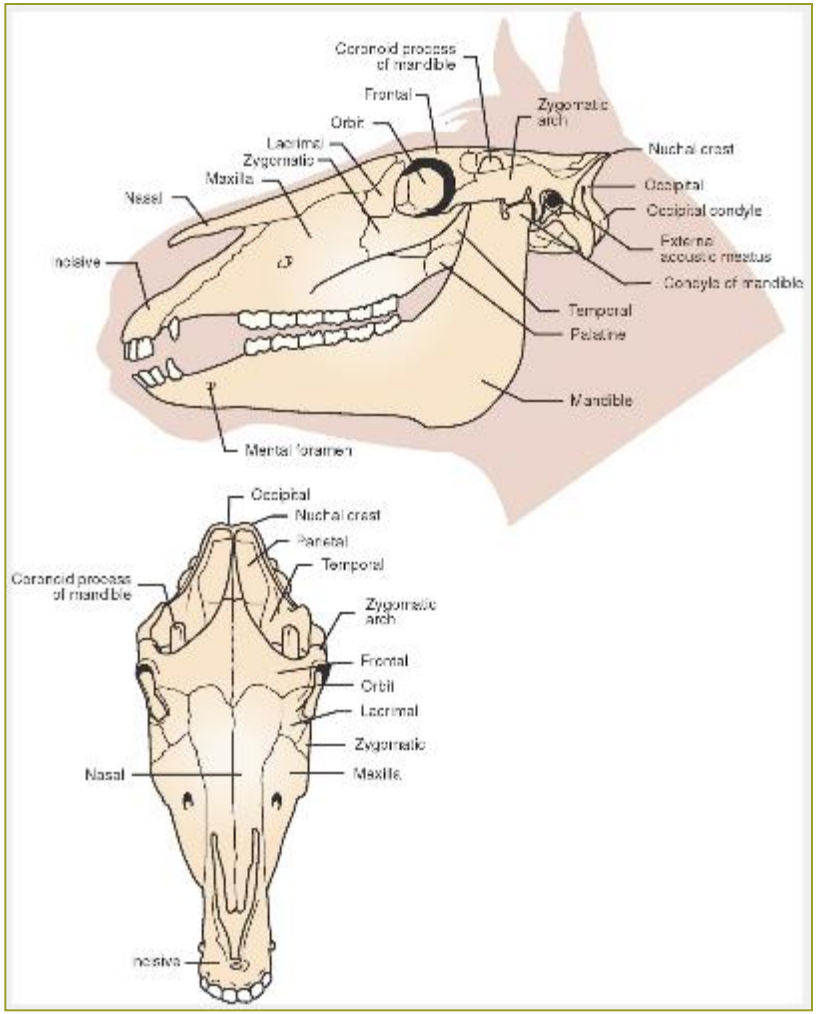


Figure 6-39 Skull Radiograph Showing Hyoid bone.

Horse vs. Cow

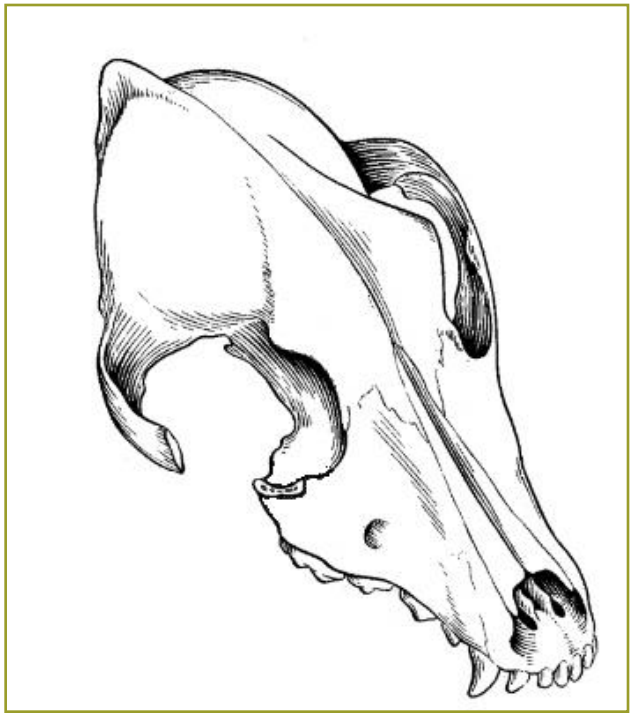
Figures 6-9 & 6-10, Pages 164 & 165

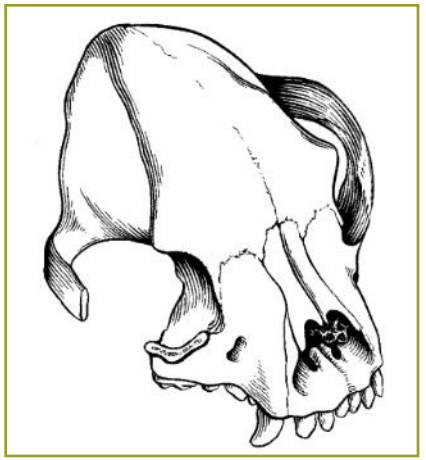


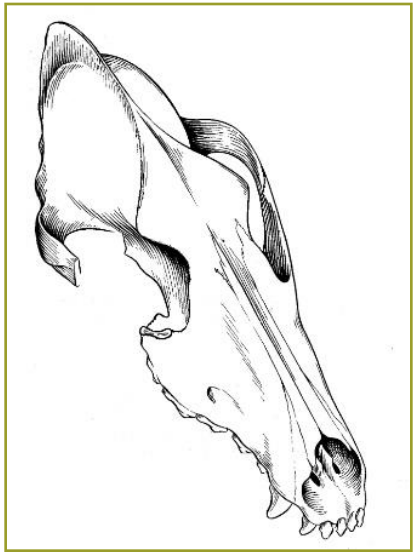


Skull – Head Shapes

- **Secret of Life!!!**
- Dolichocephalic
- Mesaticephalic
- Brachycephalic







Other Bones of Axial Skeleton

Bassert Lab Manual, Page 119

- Hyoid bone
- Vertebrae
- Ribs
- Sternum

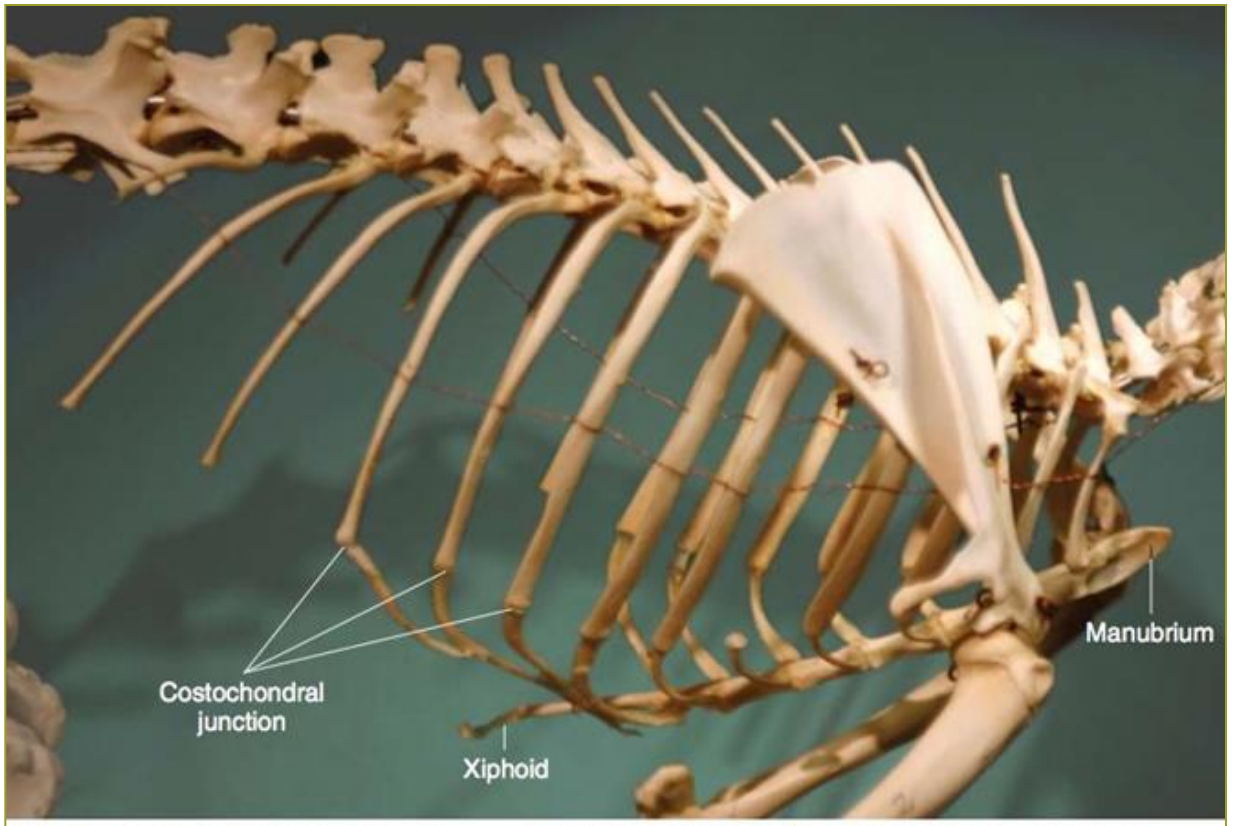
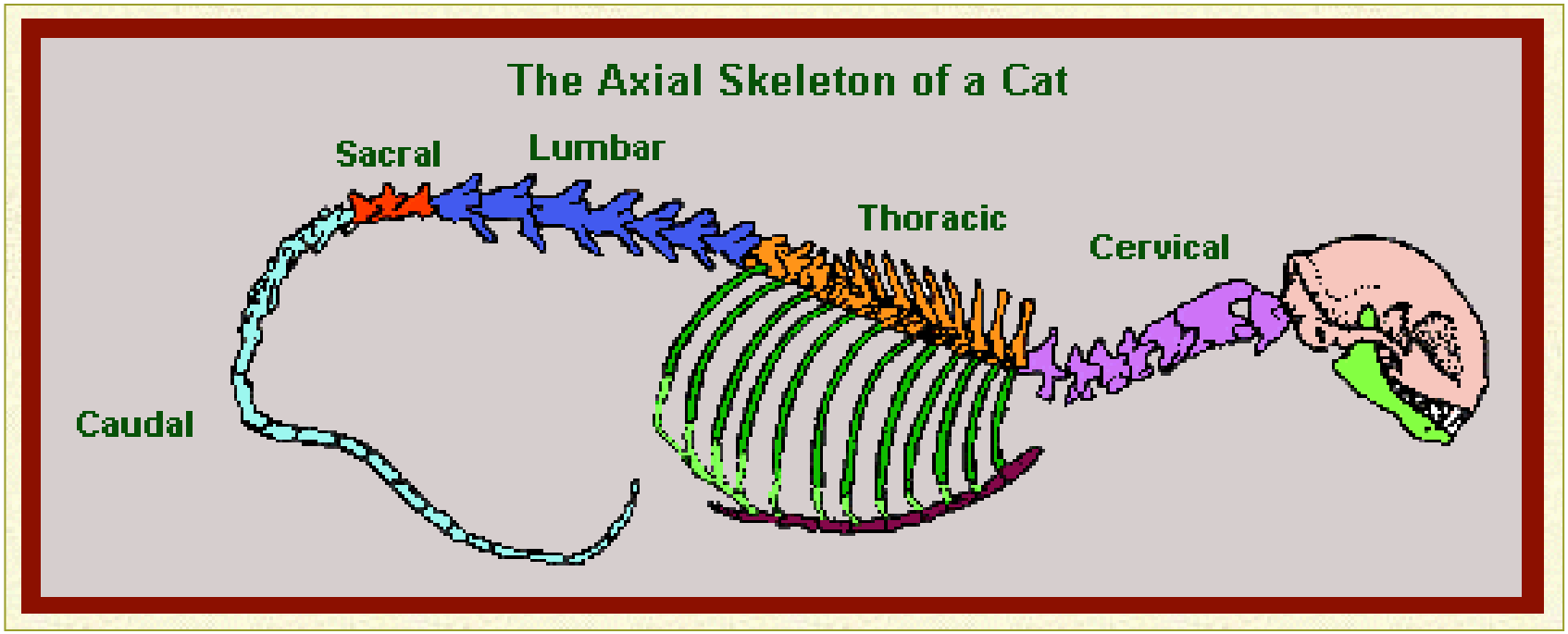
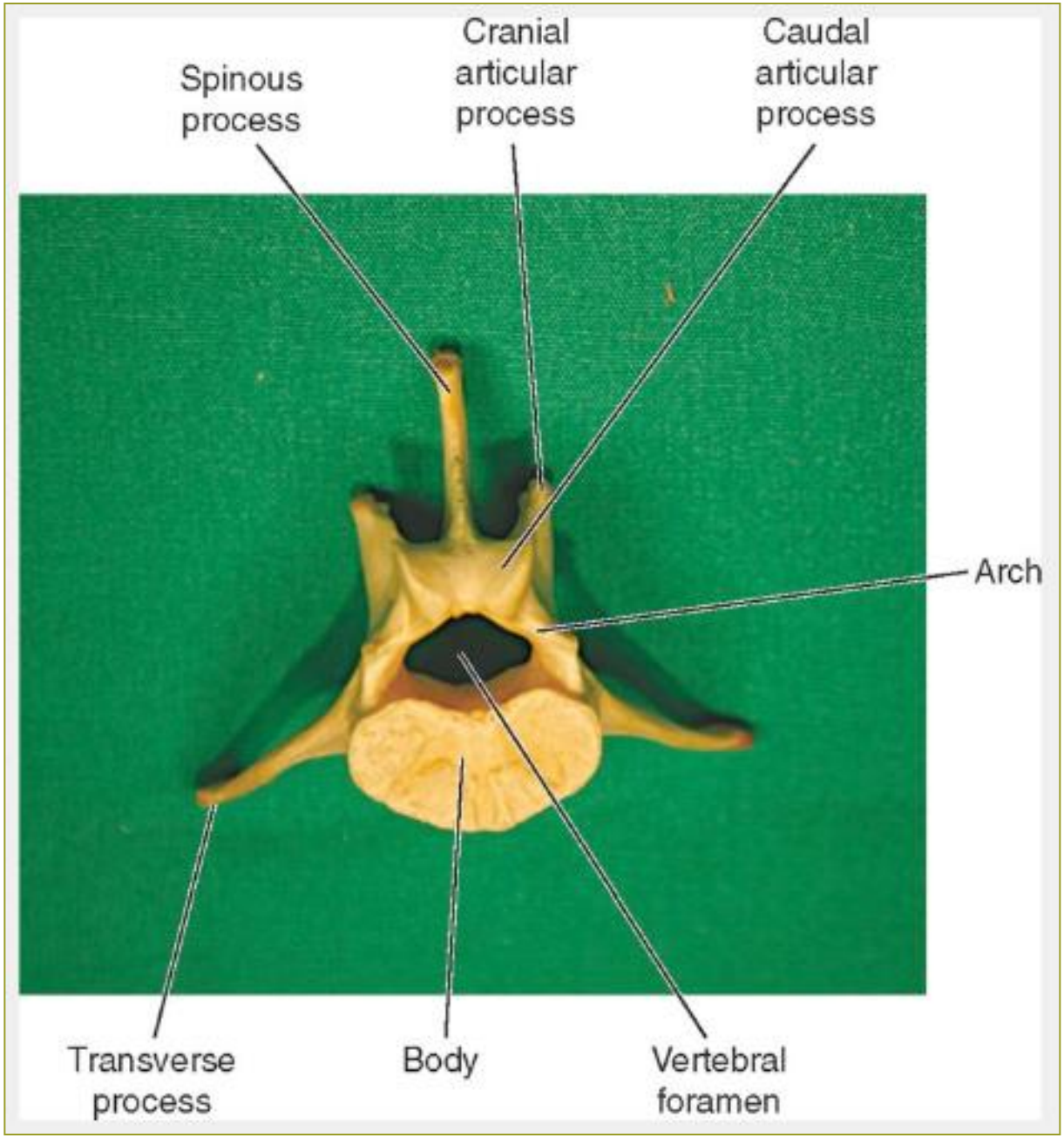


Figure 6-44 **Rabbit Rib Cage, Sternum, and Thoracic Vertebrae.** The point at which the bony part of the rib meets the cartilaginous part of the rib is the costochondral junction. Some of the costal cartilages join the sternum, and other costal cartilages attach to the costal cartilage of the ribs in front.


The Axial Skeleton of a Cat
Sacral
Lumbar
Thoracic
Cervical
Caudal

Anatomy of the Vertebrae

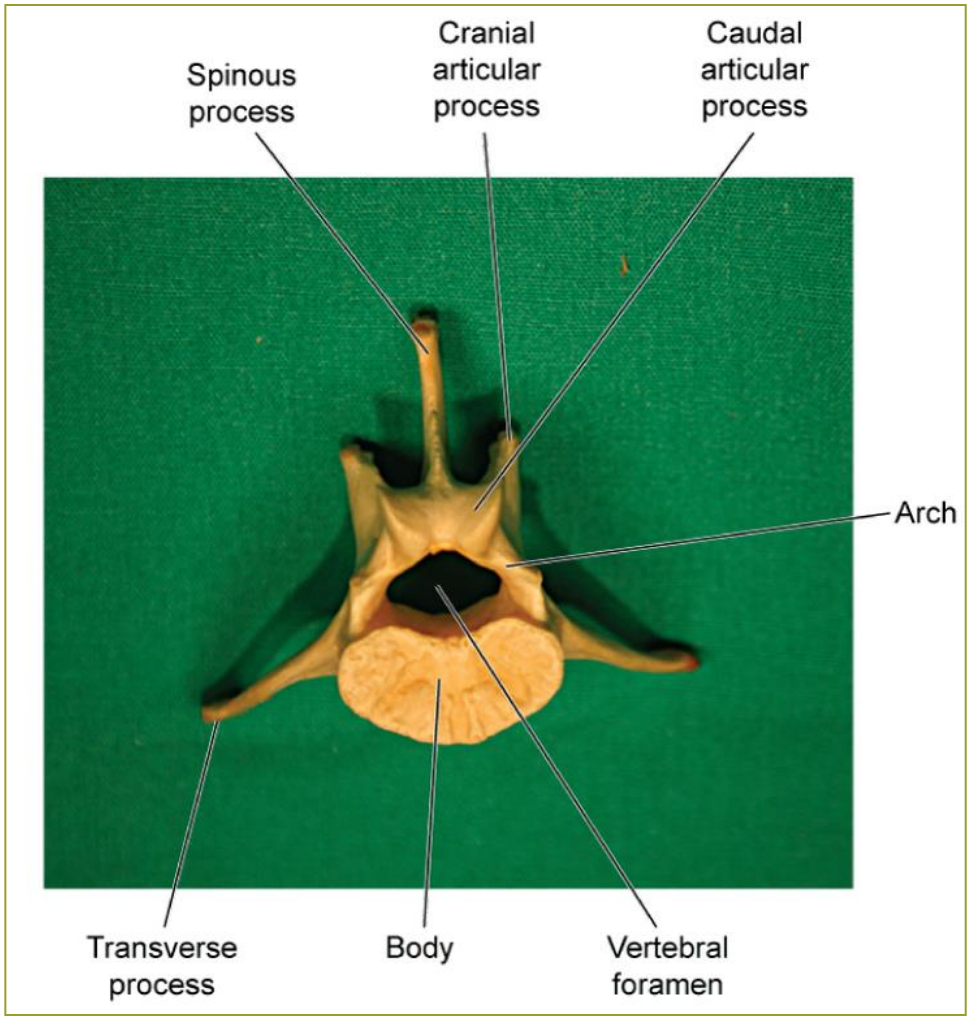
Figure 6-16, Page 170



Vertebrae Anatomy Review

Figure 6-16, Page 170

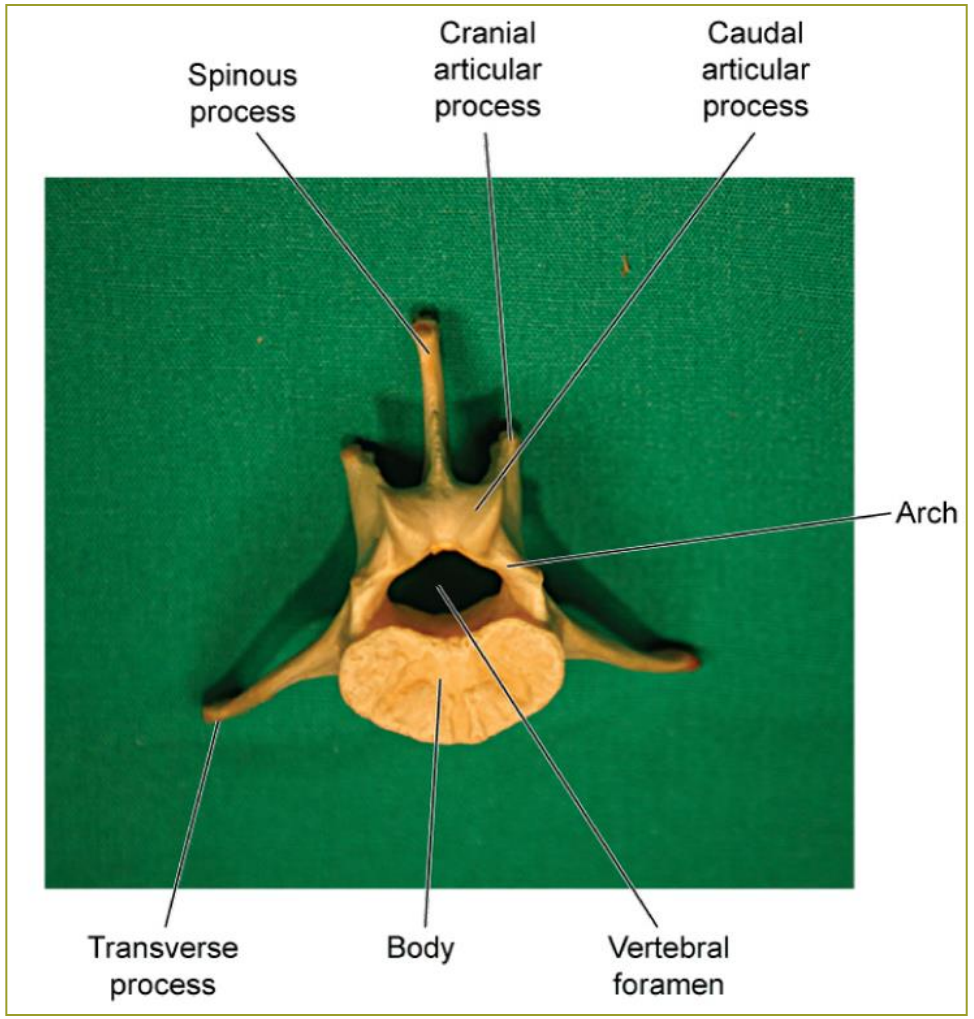
- Consist of a **body**, an **arch**, and **processes**
- **Intervertebral disks**: cartilage separating bodies of adjacent vertebrae



Vertebrae Anatomy Review

Figure 6-16, Page 170

- **Vertebral foramina** line up to form the **spinal canal**
- Vertebrae usually contain several processes
  - Spinous process
  - Transverse processes
  - Articular processes



One More Time! ☺

Bassert Lab Manual, Page 117

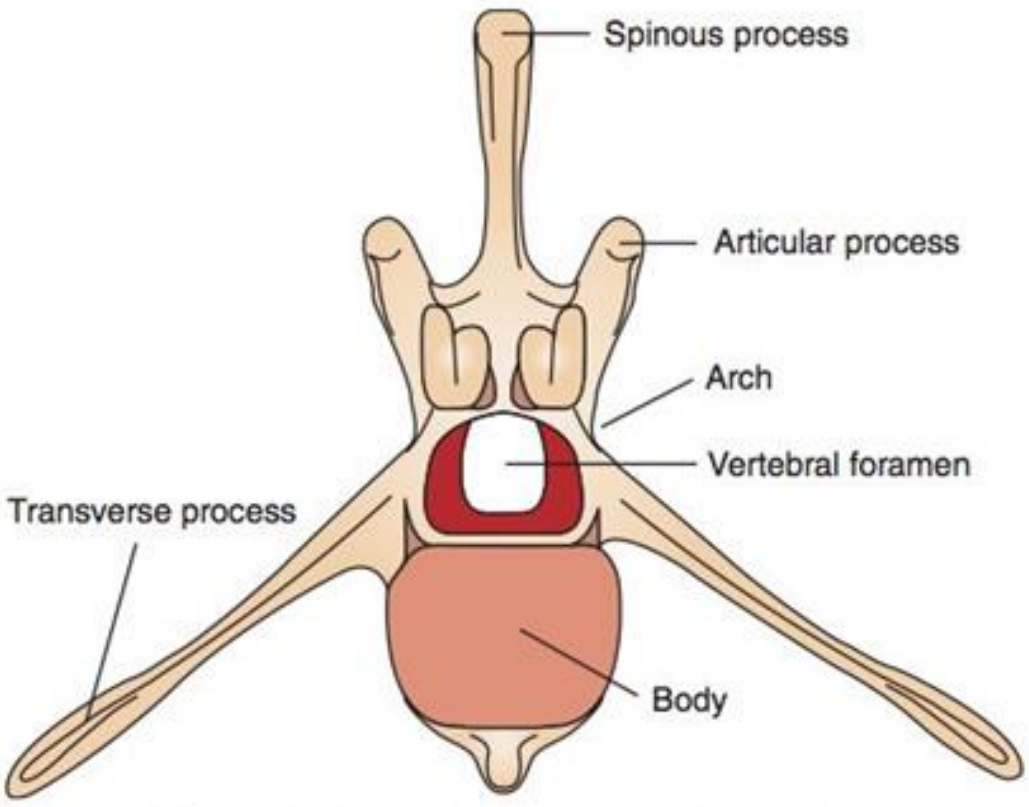
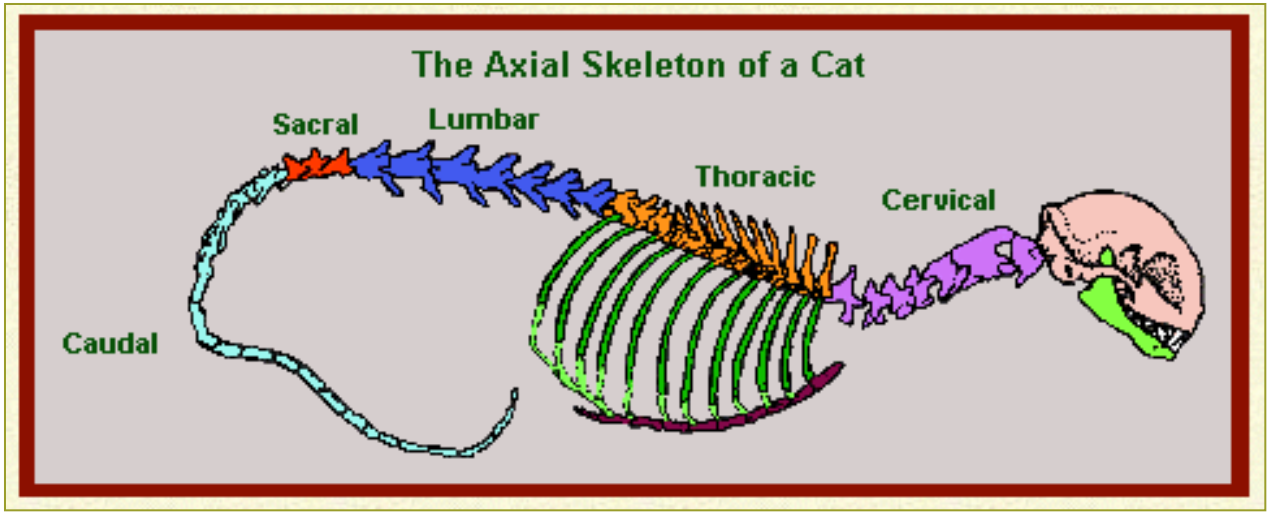


Figure 6-40 Basic Anatomy of Vertebra.

Types of Vertebrae

- Cervical (C1-C7)
- Thoracic (T1-T13)
- Lumbar (L1-L7)
- Sacral (S1-3)
- Coccygeal (many!)



Vertebral Formulas

Table 6-2, page 170

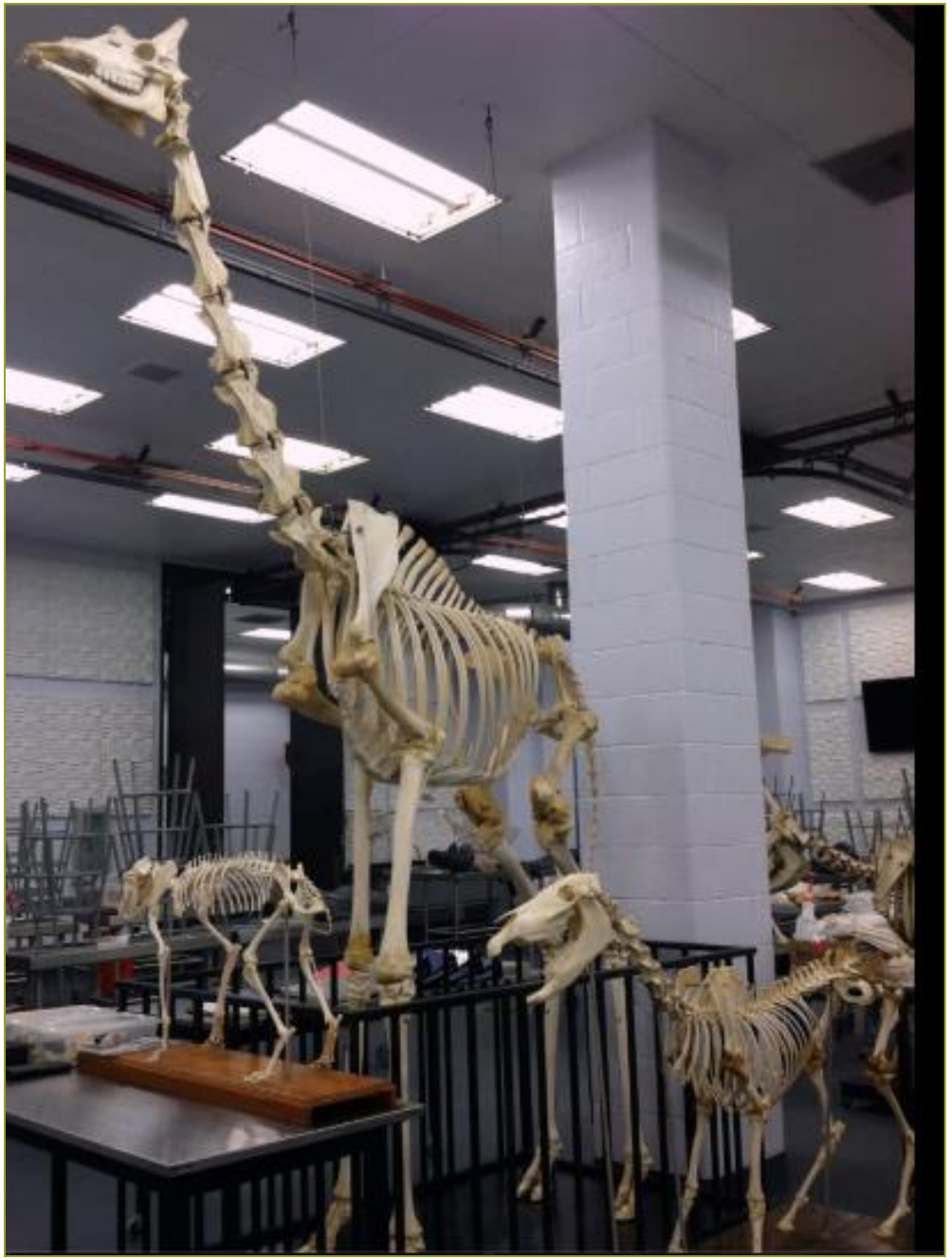
TABLE 6-2 Vertebral Formulas for Some Common Species

	Cervical	Thoracic	Lumbar	Sacral	Coccygeal
Cat	7	13	7	3	5–23
Cattle	7	13	6	5	18–20
Dog	7	13	7	3	20–23
Goat	7	13	7	5	16–18
Horse	7	18	6	5	15–21
Human	7	12	5	5	4–5
Pig	7	14-15	6-7	4	20–23
Sheep	7	13	6-7	4	16–18

Soooooooooo….. How Many Cervical Vertebrae in a Giraffe?

What do you think? ☺

The Answer – Consistency in Nature! ☺



Types of Vertebrae

Cervical

Thoracic

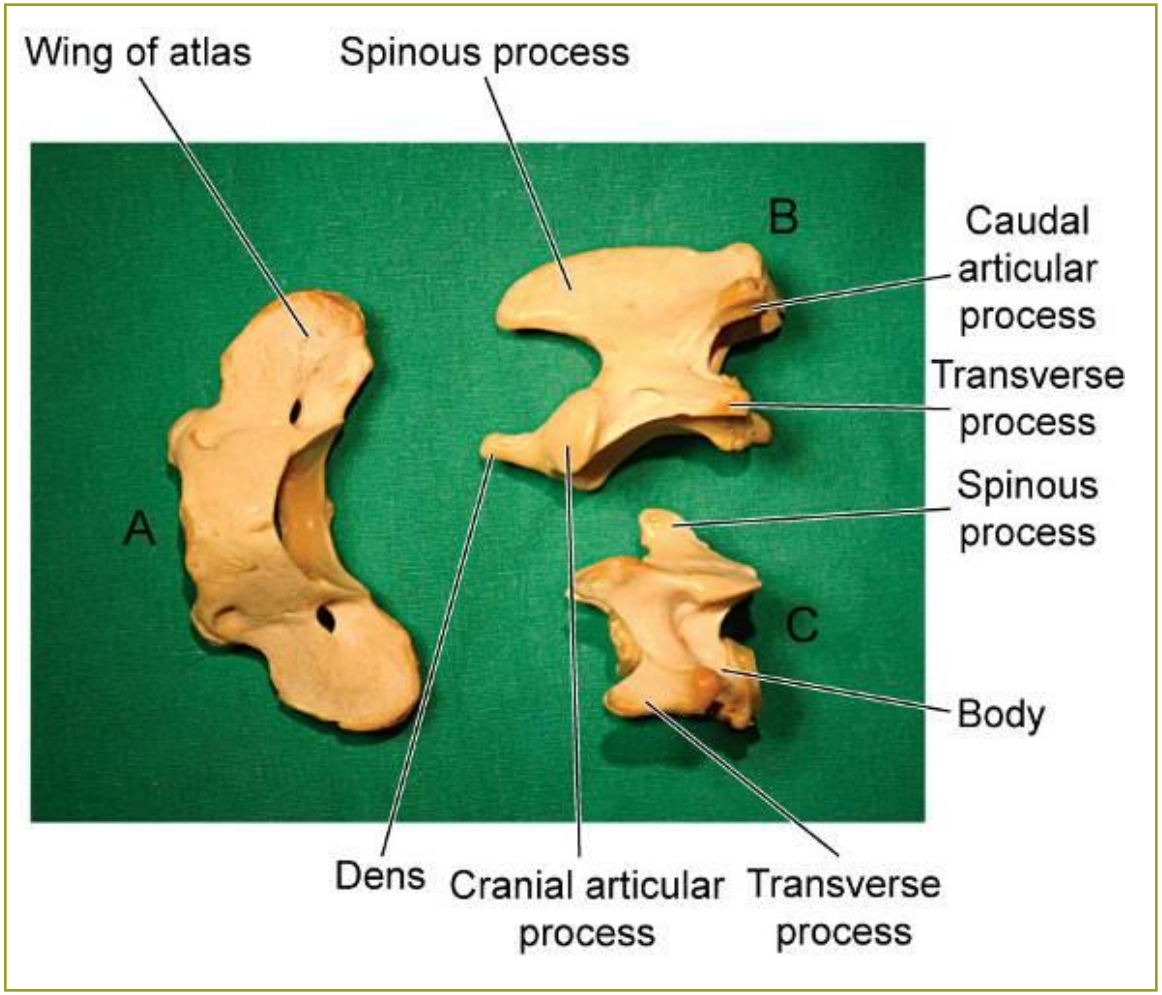
Lumbar

Sacral

Coccygeal

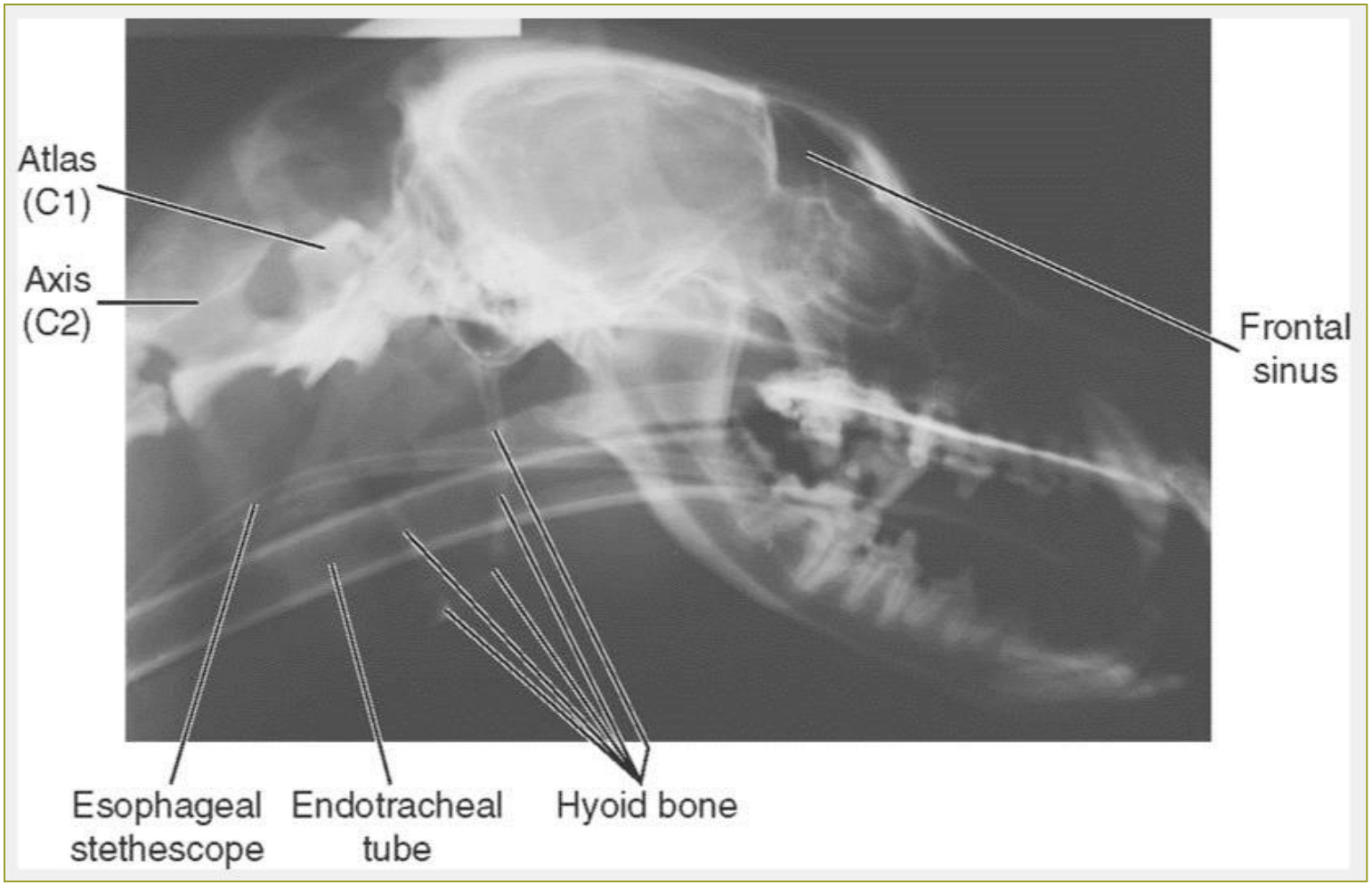
Cervical Vertebrae – 7 of them

Figure 6-17, Page 171



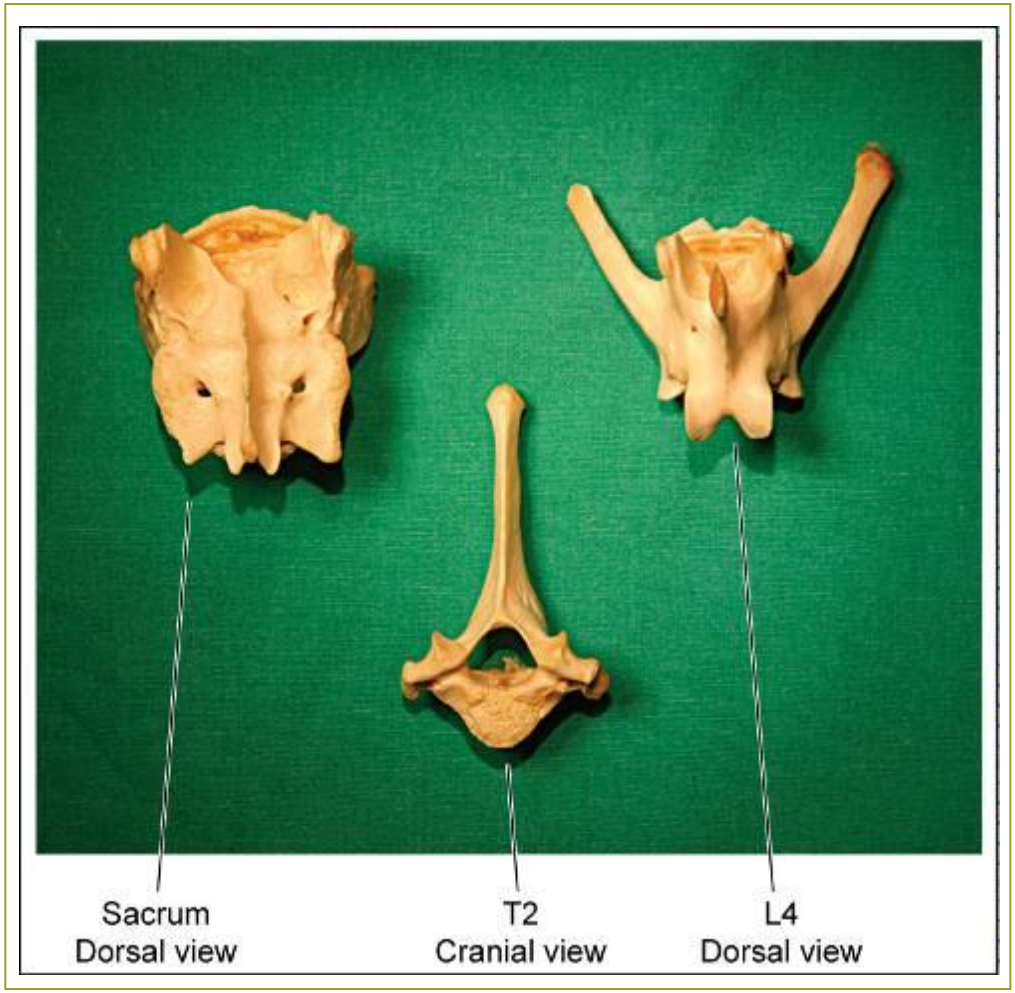
Cervical Vertebrae

Figure 6-15, Page 170



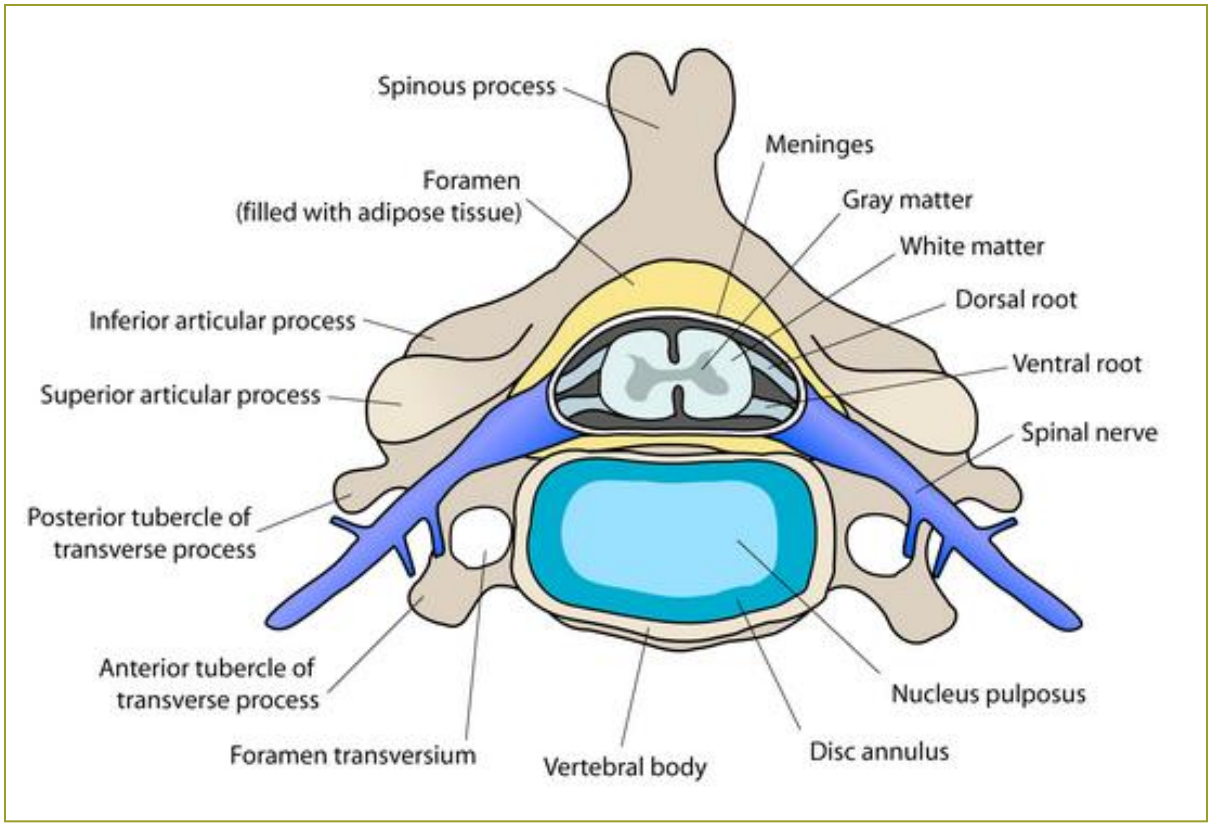
Thoracic, Lumbar, Sacral Vertebrae

Figure 6-18, Page 171



Intervertebral Disks

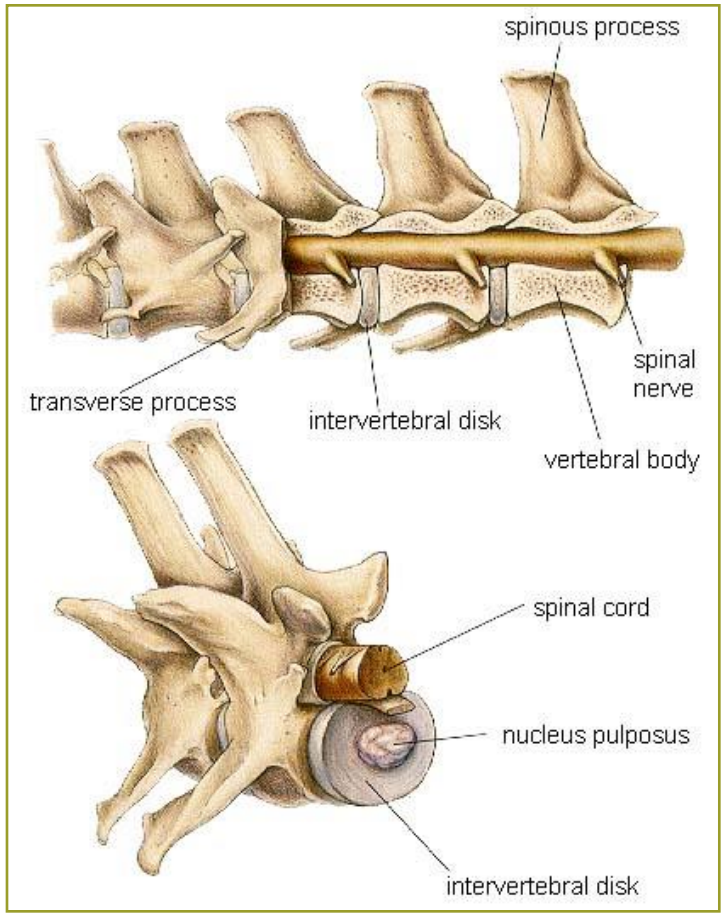
- **Between** vertebral bodies
- **Ventral** to spinal cord
- Annulus fibrosus
- Nucleus pulposus



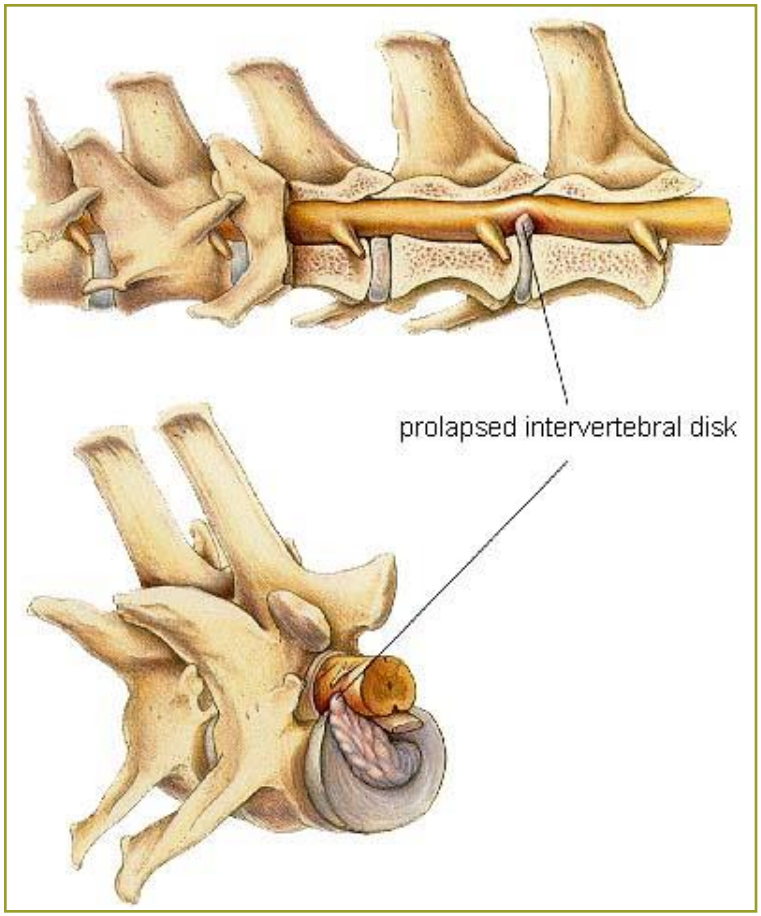
Intervertebral Disk Disease

Clinical Application, Page 172

Normal



Ruptured



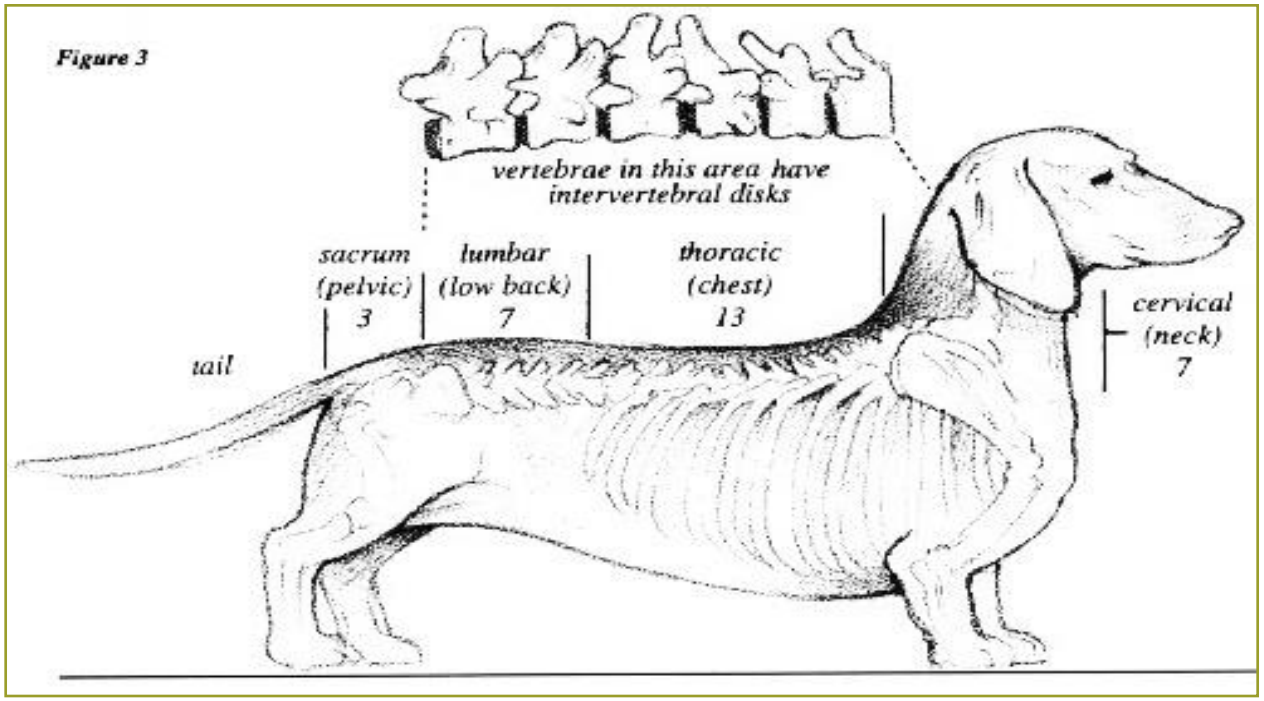
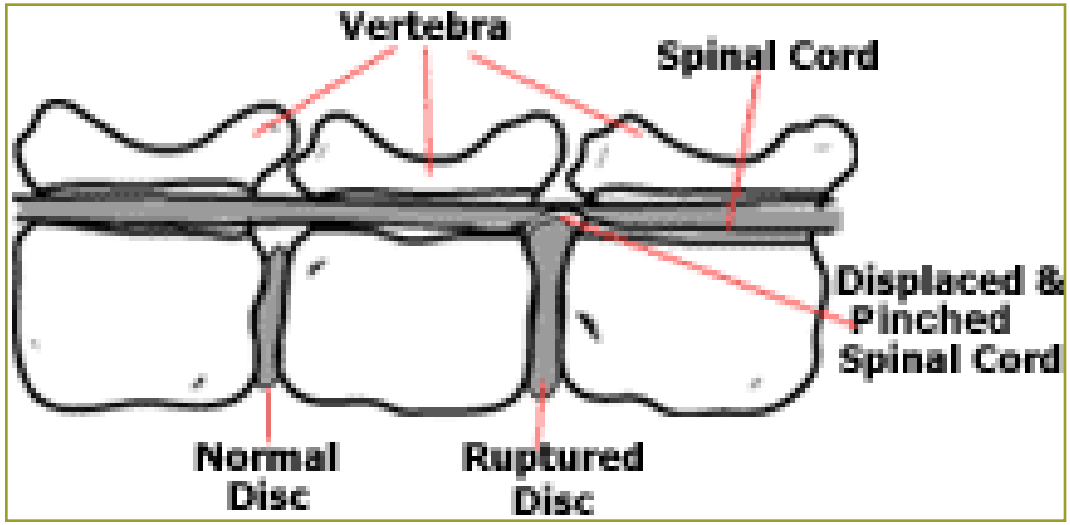
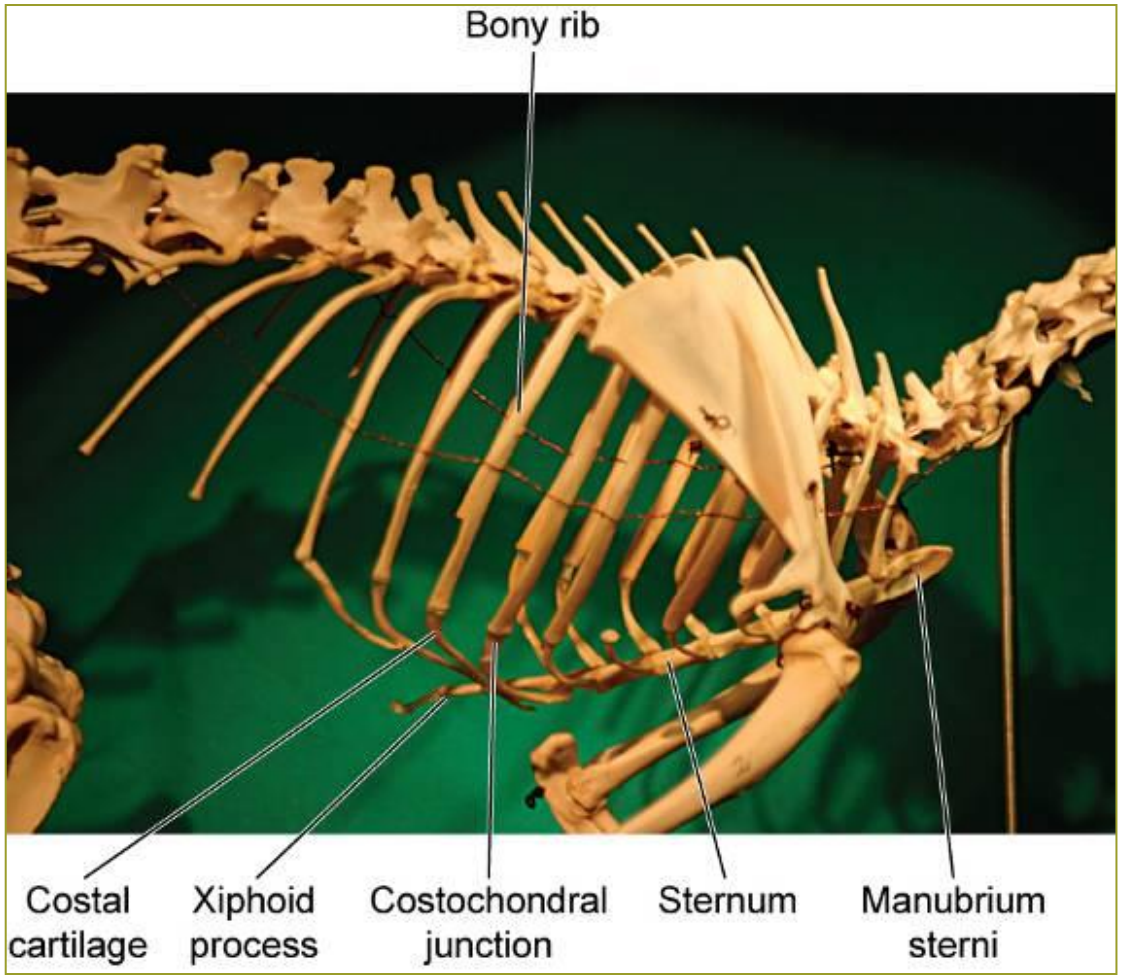


Figure 3
vertebrae in this area have intervertebral disks
sacrum (pelvic) 3
lumbar (low back) 7
thoracic (chest) 13
cervical (neck) 7
tail


Vertebra
Spinal Cord
Displaced & Pinched Spinal Cord
Normal Disc
Ruptured Disc

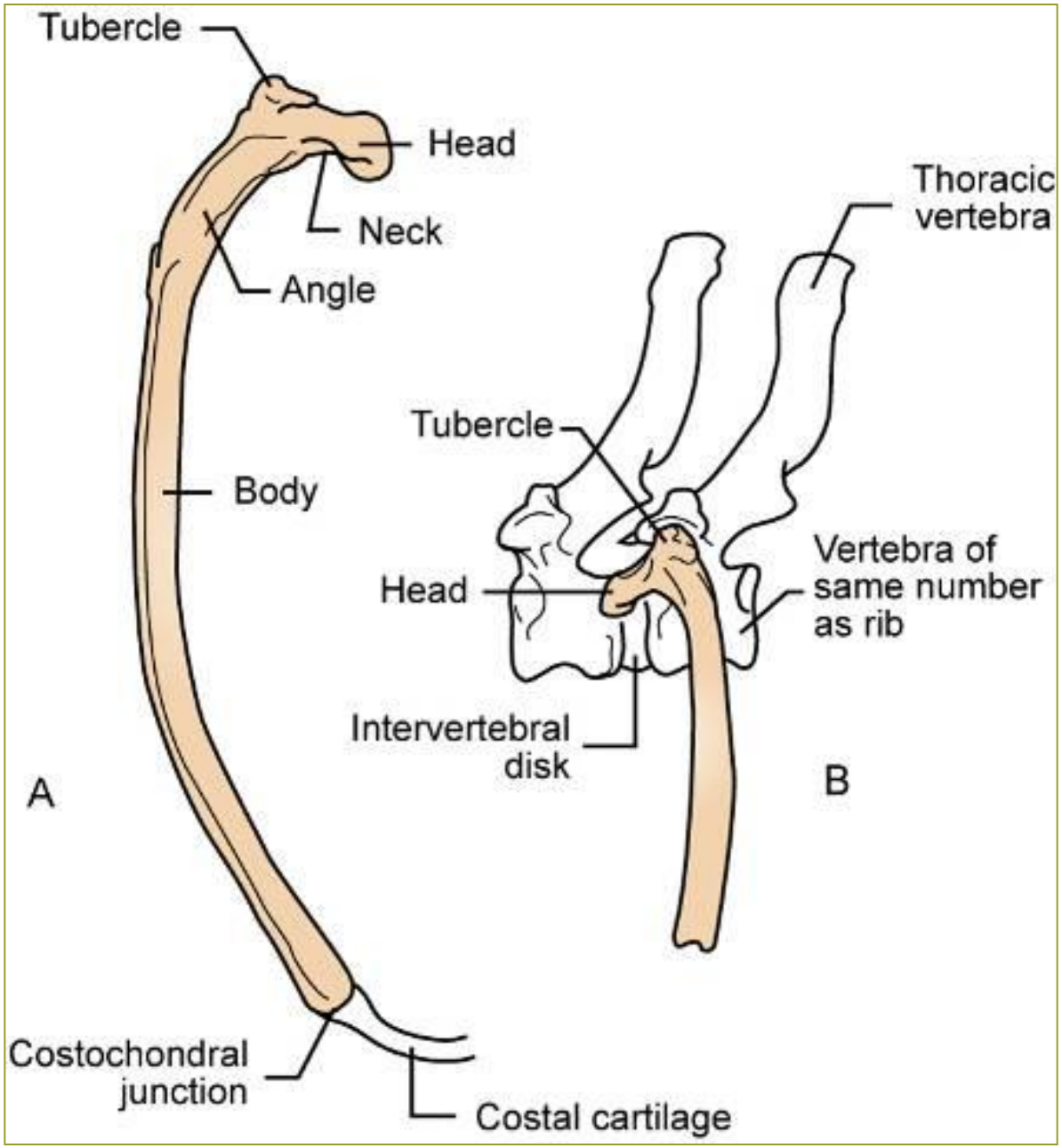
Bones of the Animal Ribs and Sternum



Ribs

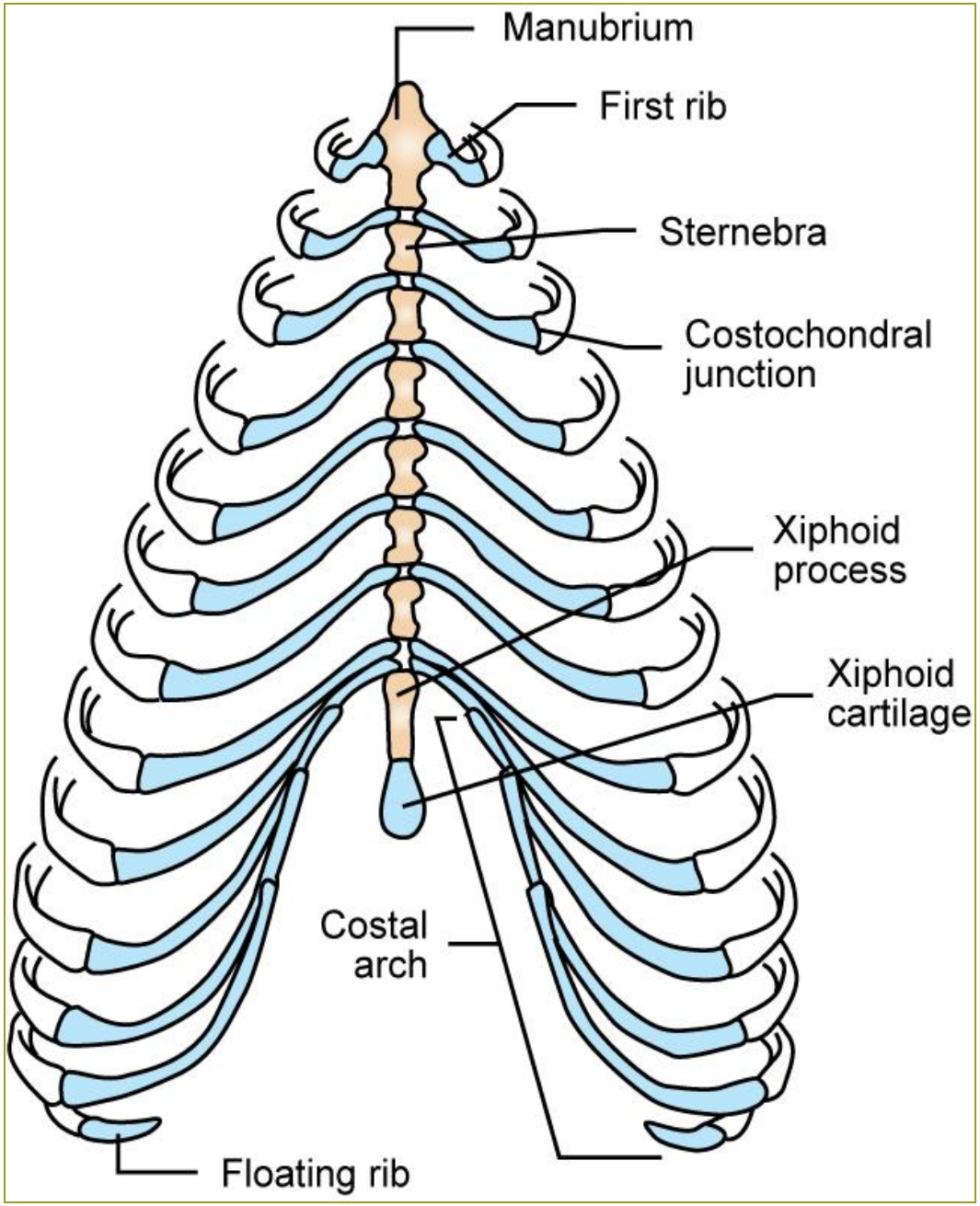
Figure 6-22, Page 174

- Flat bones that form lateral walls of the thorax
- Dorsal heads of the ribs articulate with thoracic vertebrae



Rib Types

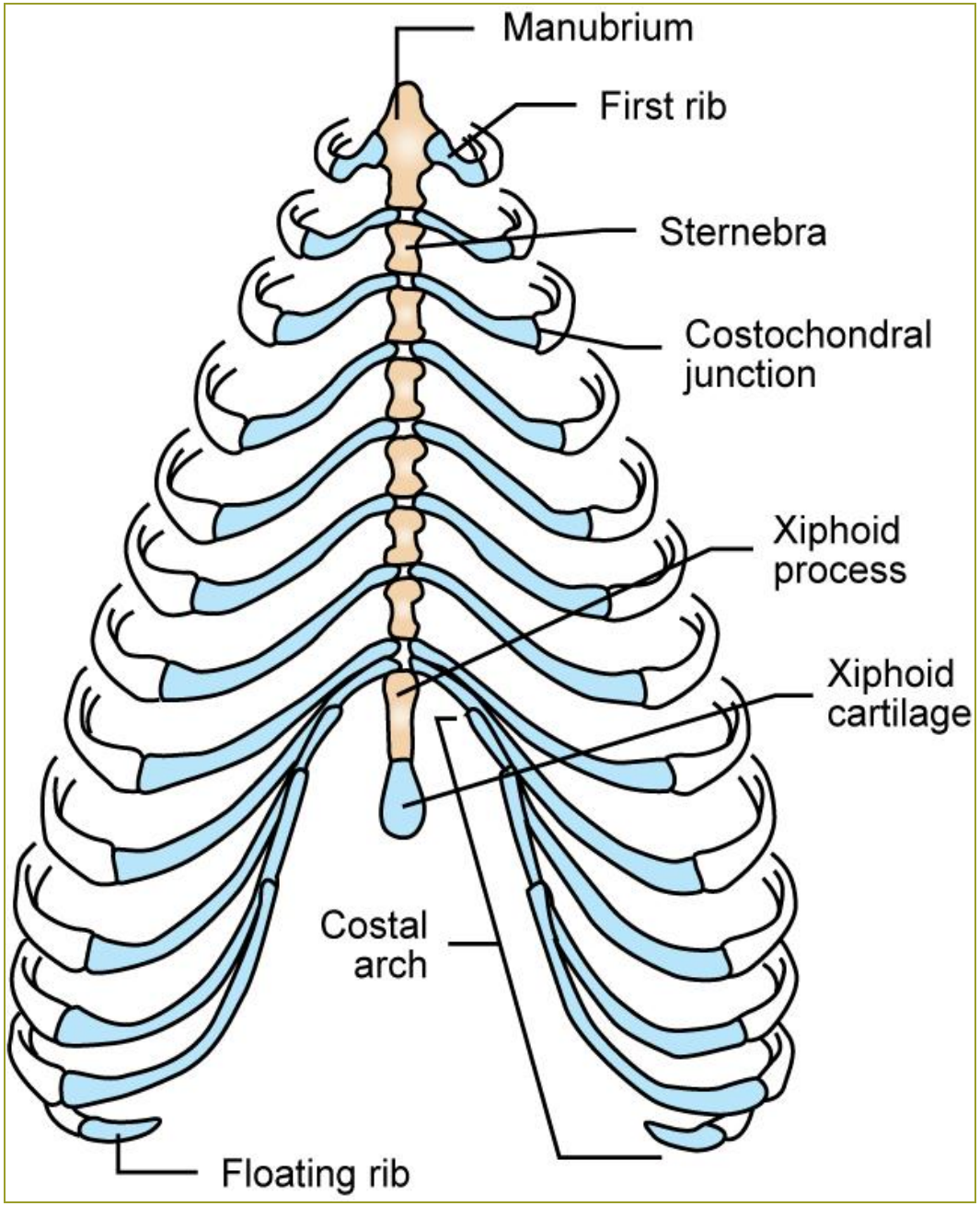
- True ribs
  - Attach directly to sternum (9)
- False ribs
  - Fuse to form costal arch (3)
- Floating ribs
  - No ventral attachment (1)



Ribs

Figure 6-23, Page 174

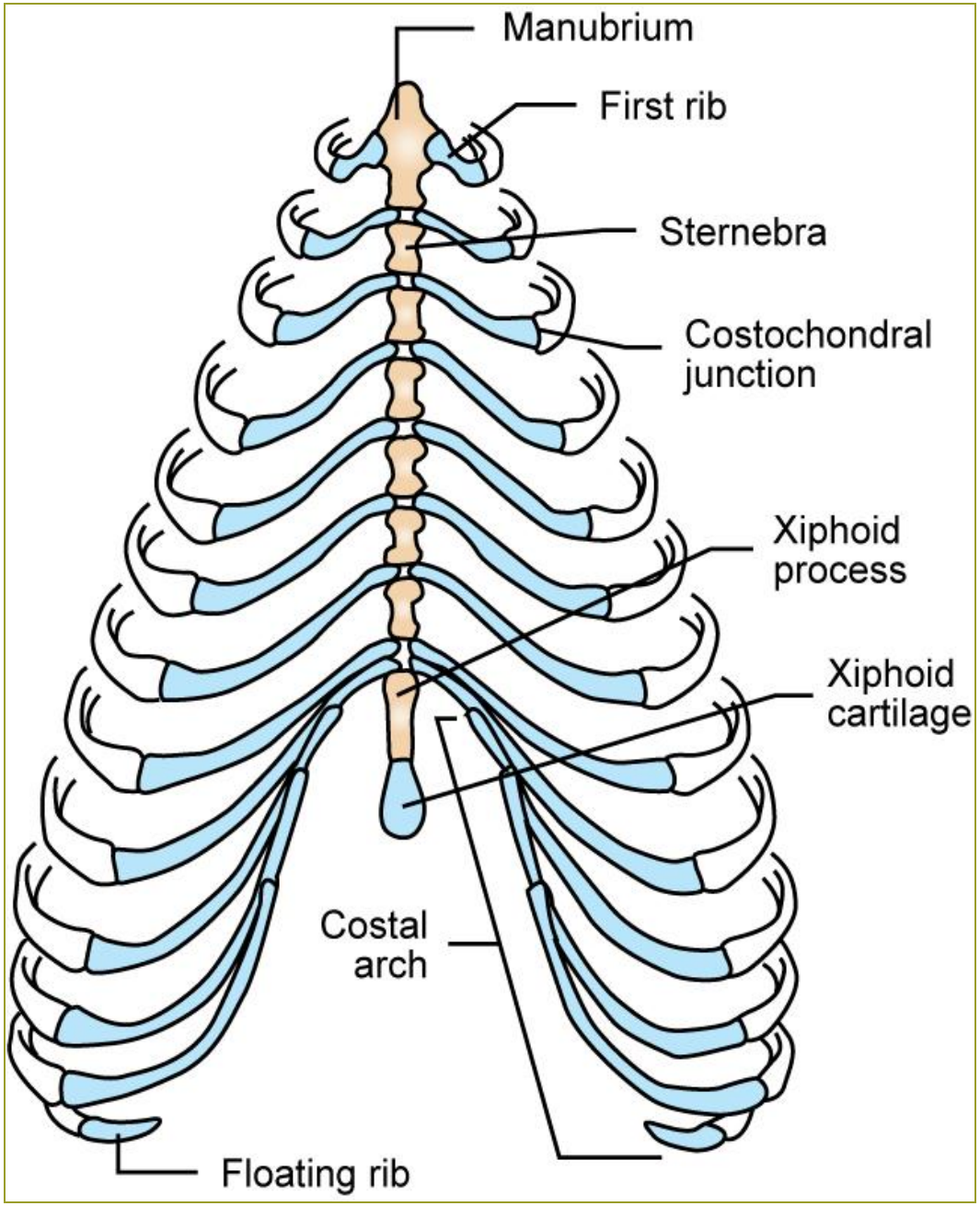
- Attached to thoracic vertebrae dorsally
- Costal cartilage
- Costo-chondral junction
- Costal arch



Sternum

Figure 6-23, Page 174

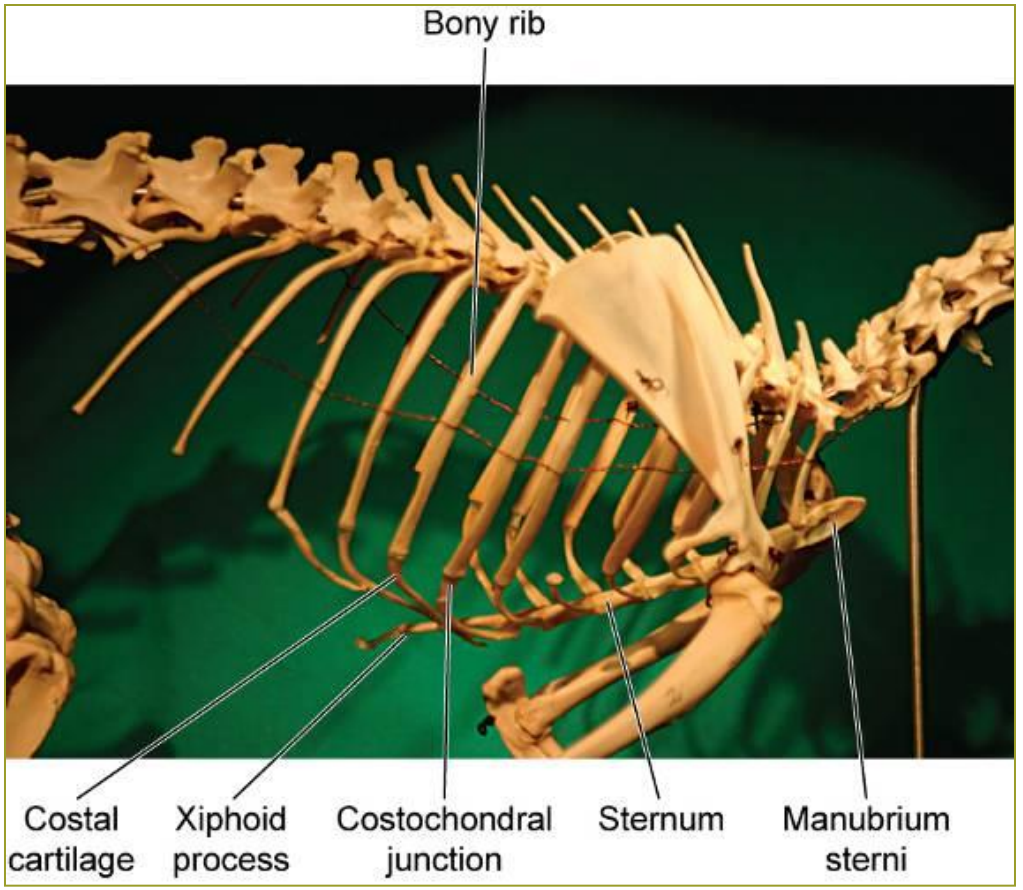
- Costal Cartilage: ventral ends of ribs meet sternum
- Manubrium
- Xiphoid
  - Process
  - Cartilage



Sternum

Figure 6-21, Page 173

- Breastbone – forms floor of thorax
  - Composed of sternebrae
- Manubrium – most cranial sternebra
- Xiphoid process – most caudal sternebra



Canine Sternum

Bassert Lab Manual, Page 120

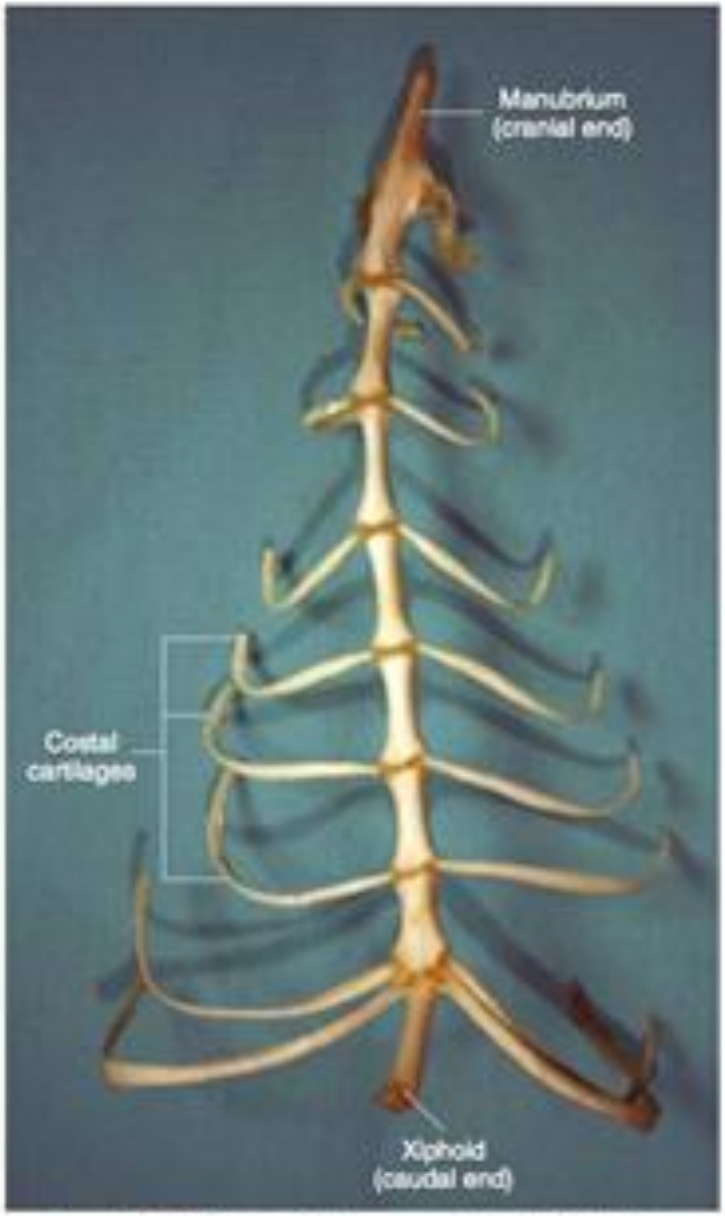


Figure 6–47 Canine Sternum and Costal Cartilages.

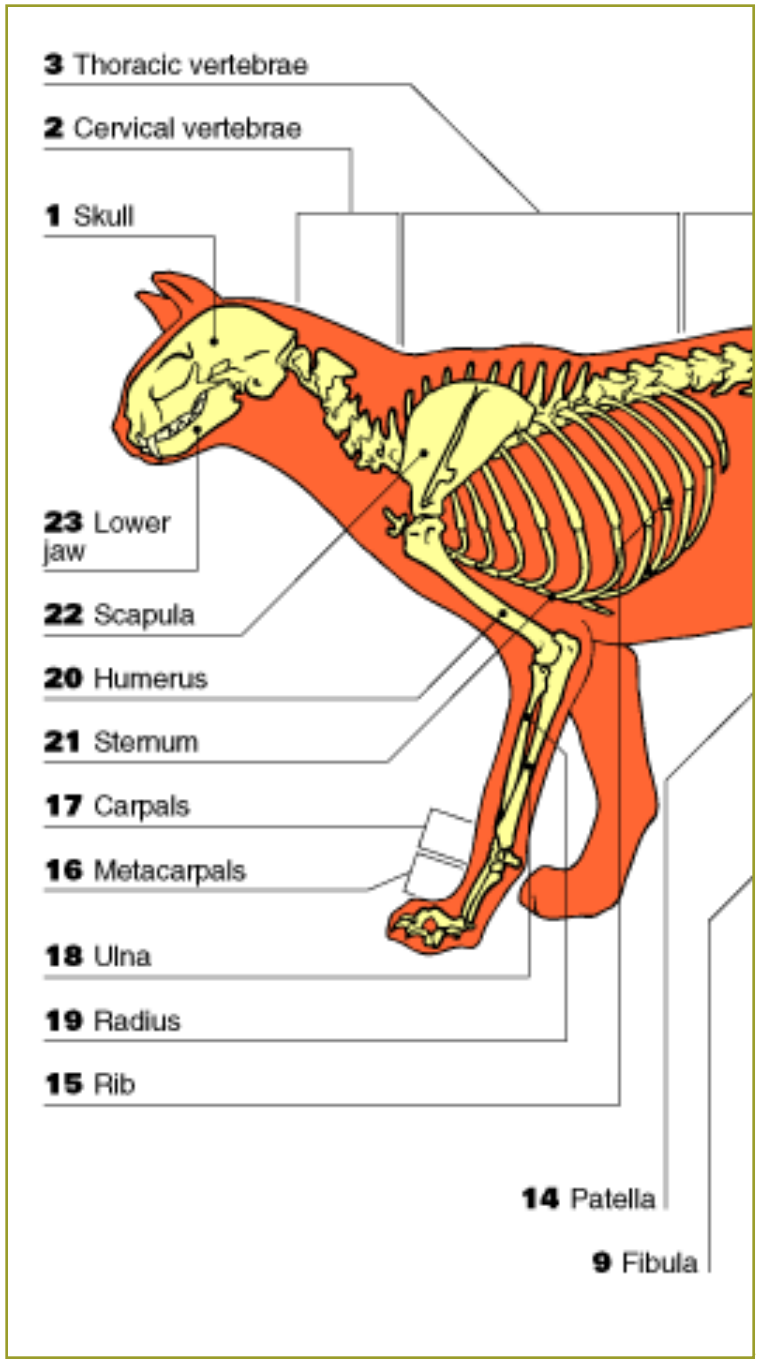
Appendicular Skeleton

Thoracic Limb (Foreleg)

Pelvic Limb (Rear Leg)

Thoracic Limb (Proximal to Distal)

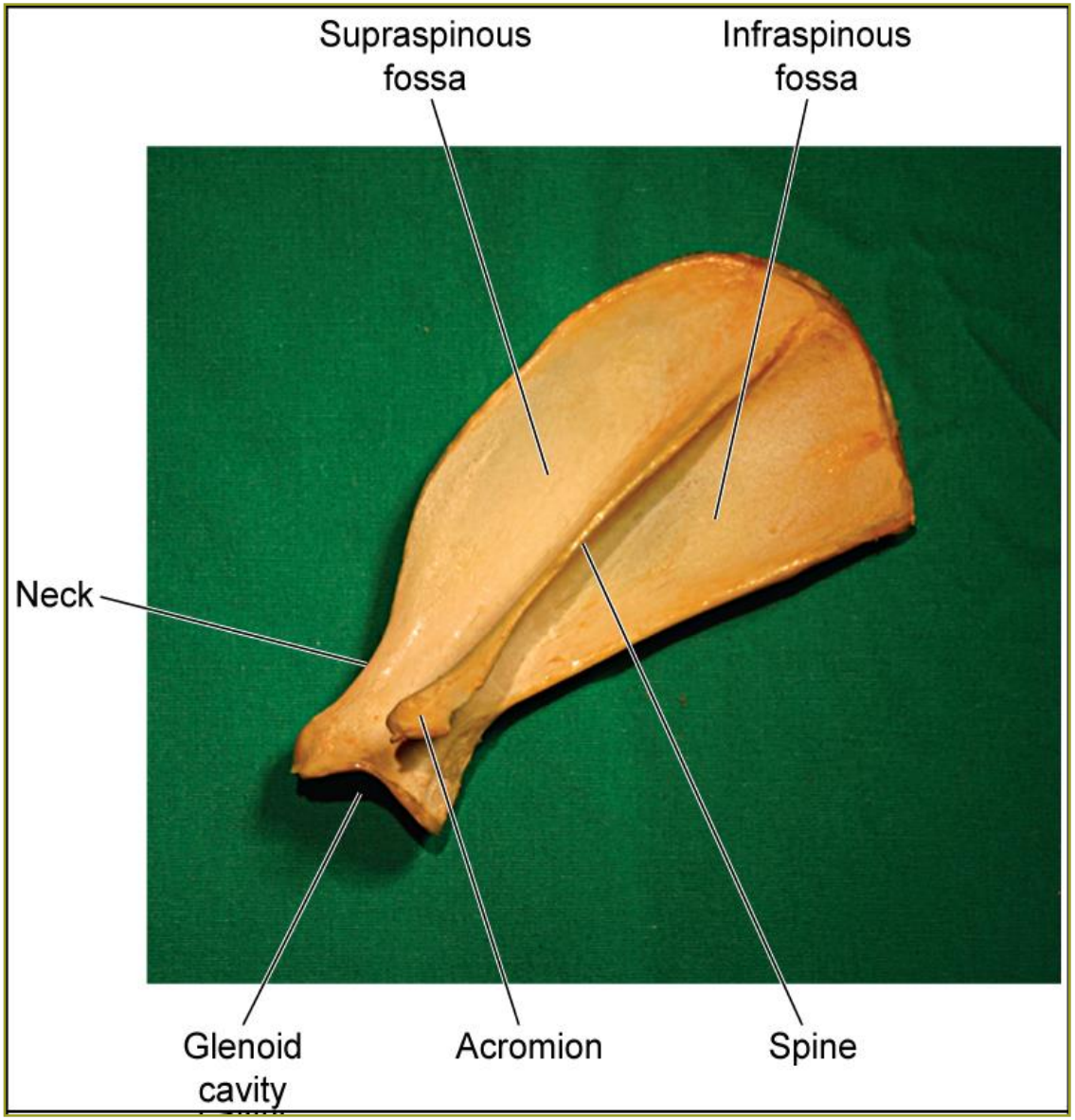
- Scapula
  - Glenoid cavity
- Humerus
- Radius
- Ulna
  - Olecranon
- Carpal bones (Carpus)
- Metacarpal Bones
- Phalanges



Scapula

Figure 6-24, Page 175

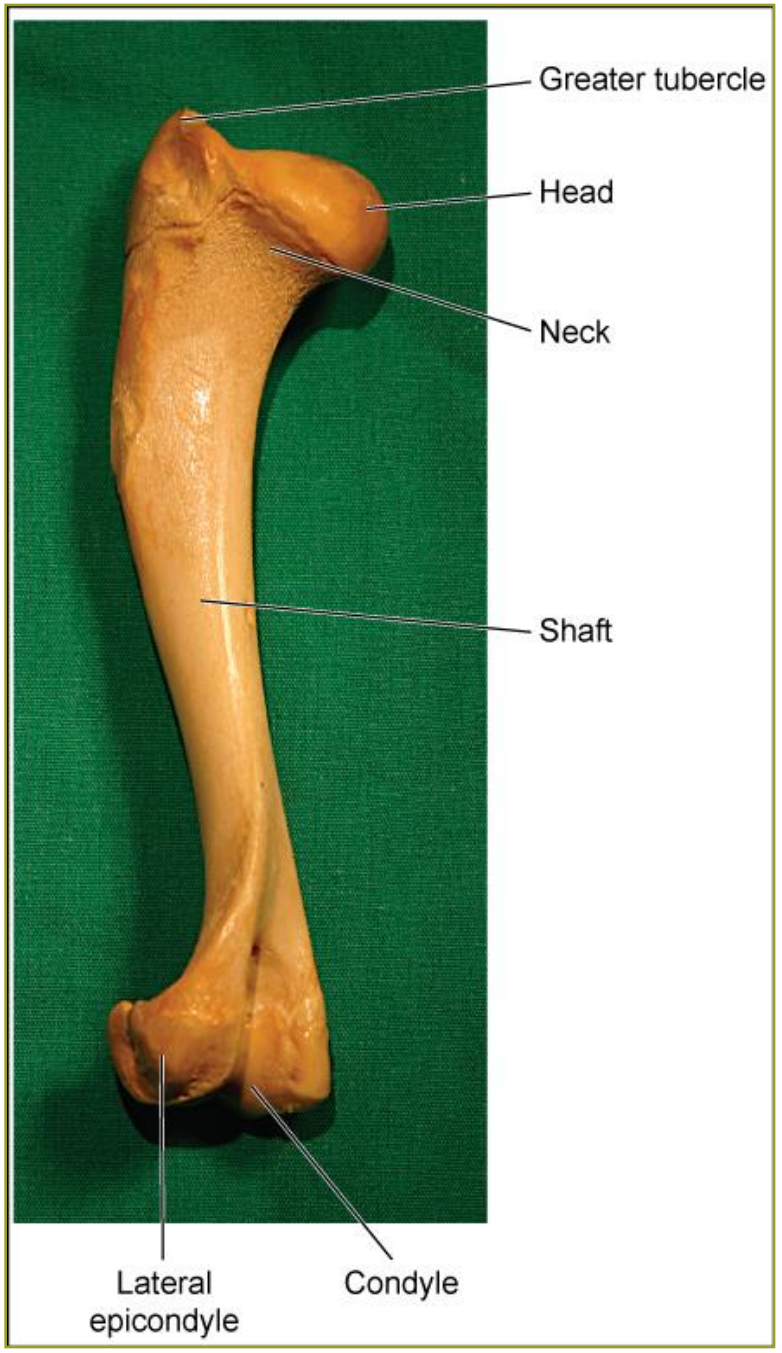
- Flat, triangular bone
- Forms portion of shoulder joint
- Spine of scapula: longitudinal ridge on lateral surface
- Glenoid cavity: shallow, concave articular surface



Humerus

Figure 6-25, Page 175

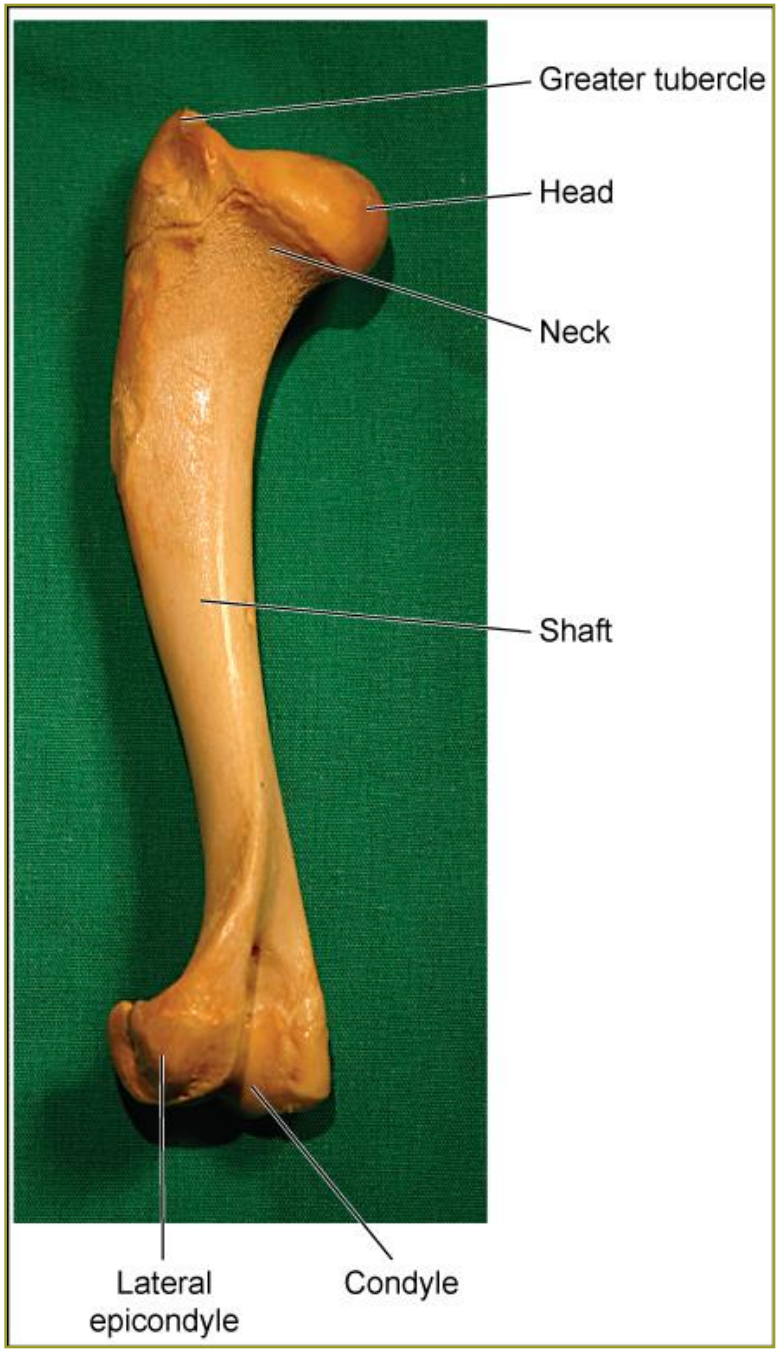
- Long bone of **brachium** (proximal foreleg)
- Forms portion of **shoulder joint** and **elbow joint**
- **Tubercles**: processes where shoulder muscles attach



Humerus

Figure 6-25, Page 175

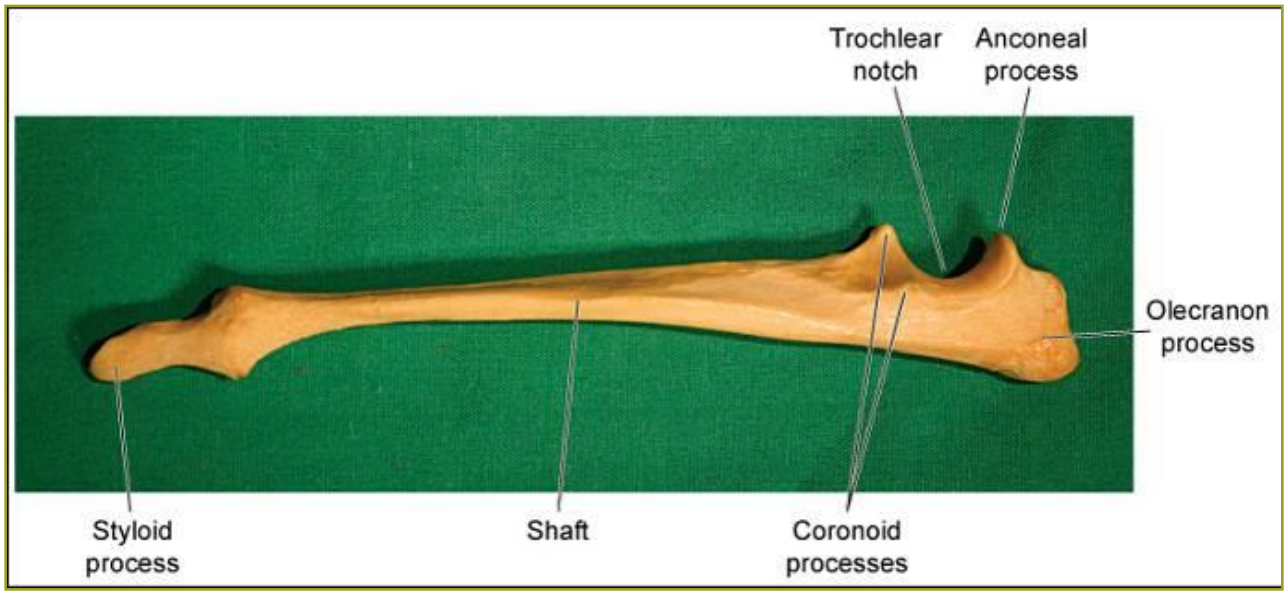
- Condyles: articular surfaces
- Olecranon fossa: indentation above condyle
- Epicondyles: non-articular



Ulna

Figure 6-26, Page 176

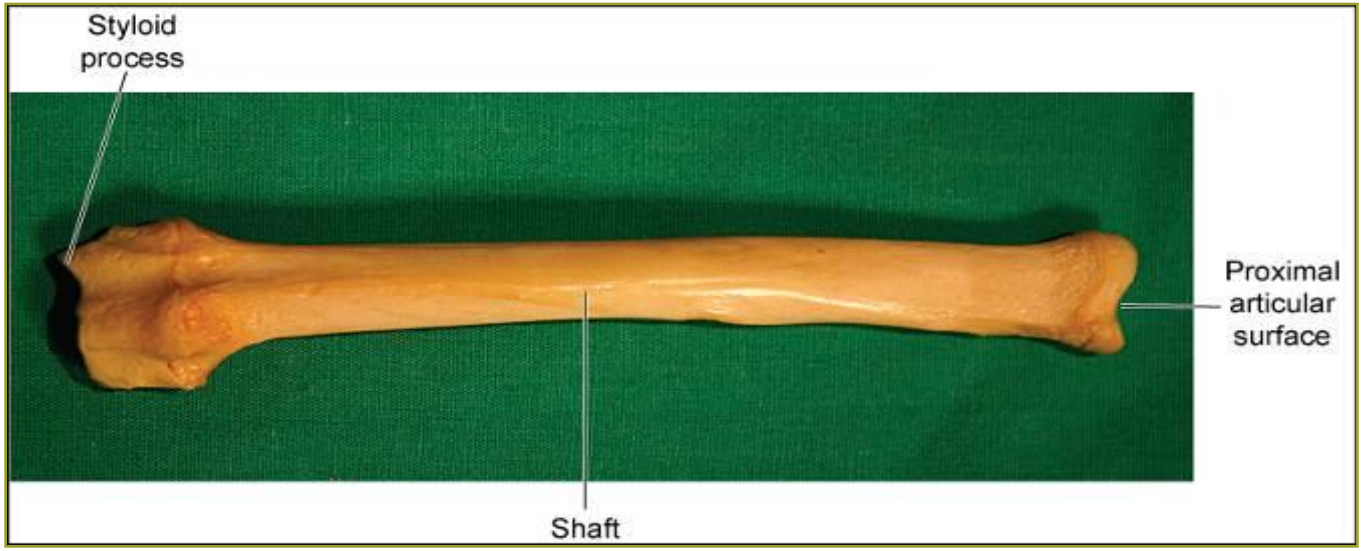
- Olecranon process
  - Point of the elbow
  - Site for tendon attachment of triceps brachii muscle
- Anconeal and coronoid processes



Radius

Figure 6-27, Page 177

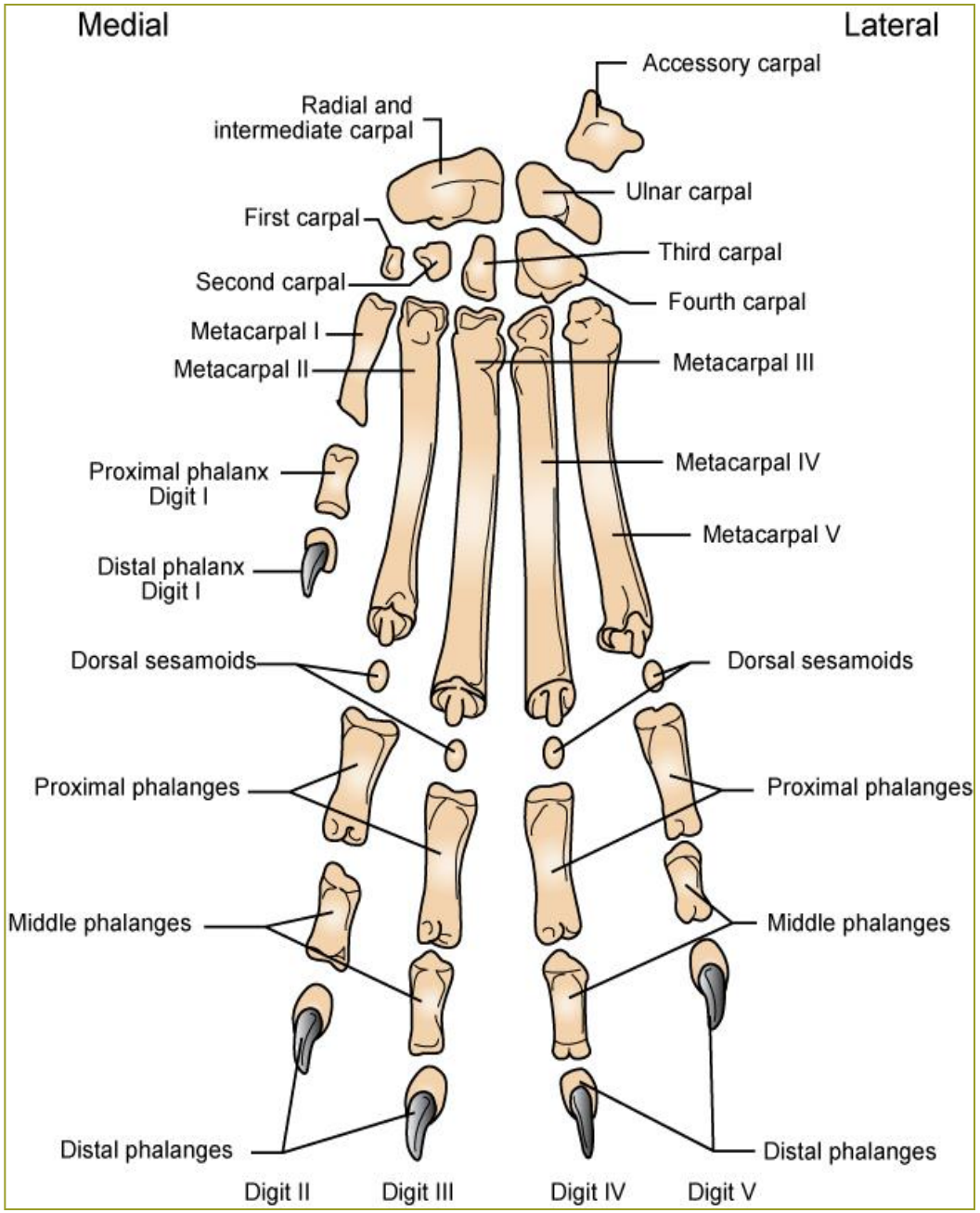
- Main weight-bearing bone of **antebrachium** (distal foreleg)
- Articulates with humerus and ulna
- Styloid process articulates with carpus



Carpus (Wrist)

Figure 6-30, Page 179

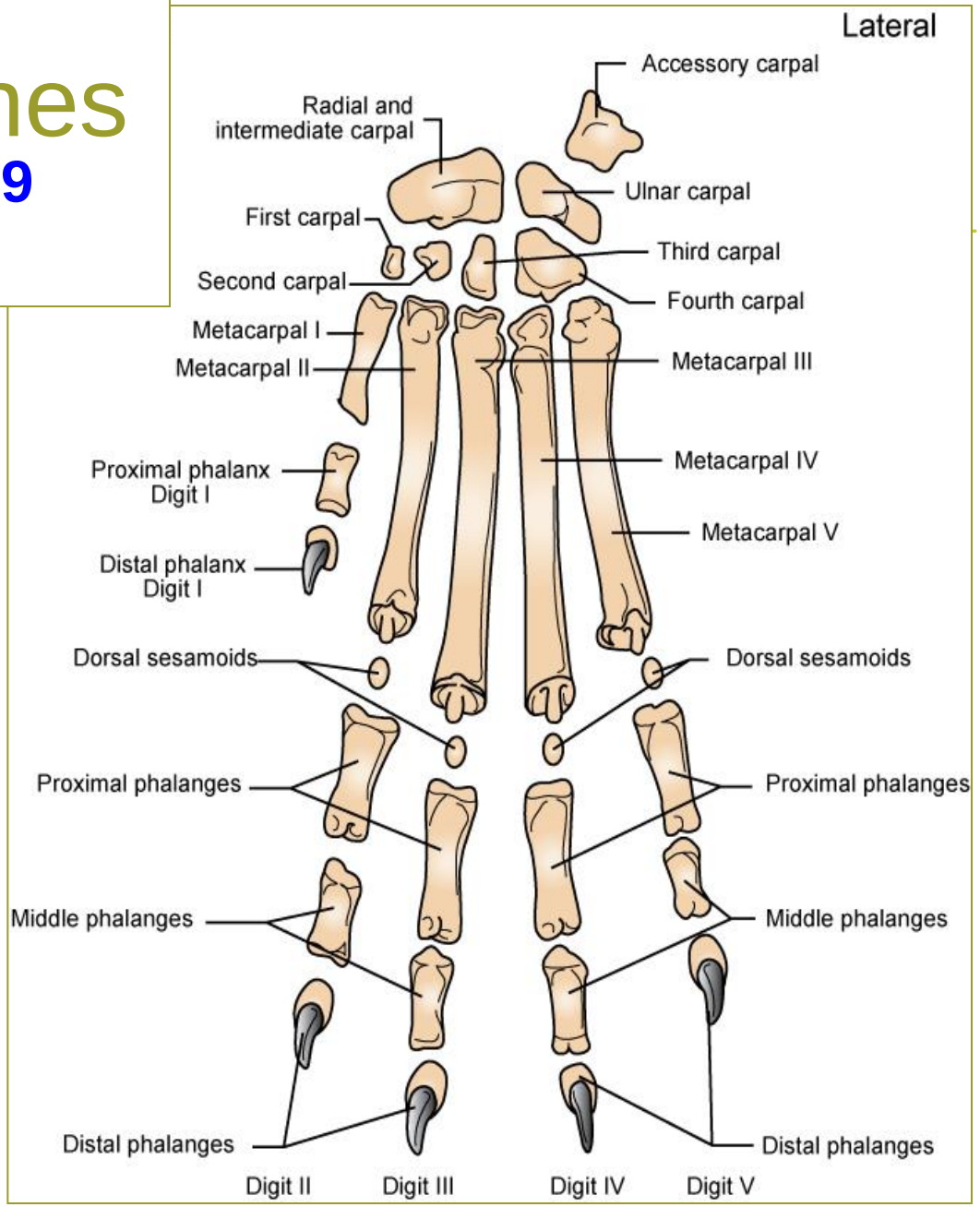
- AKA "carpal joint"
- Two rows of carpal bones
- Proximal row bones are named
- Distal row bones are numbered medial to lateral



Metacarpal Bones

Figure 6-30, Page 179

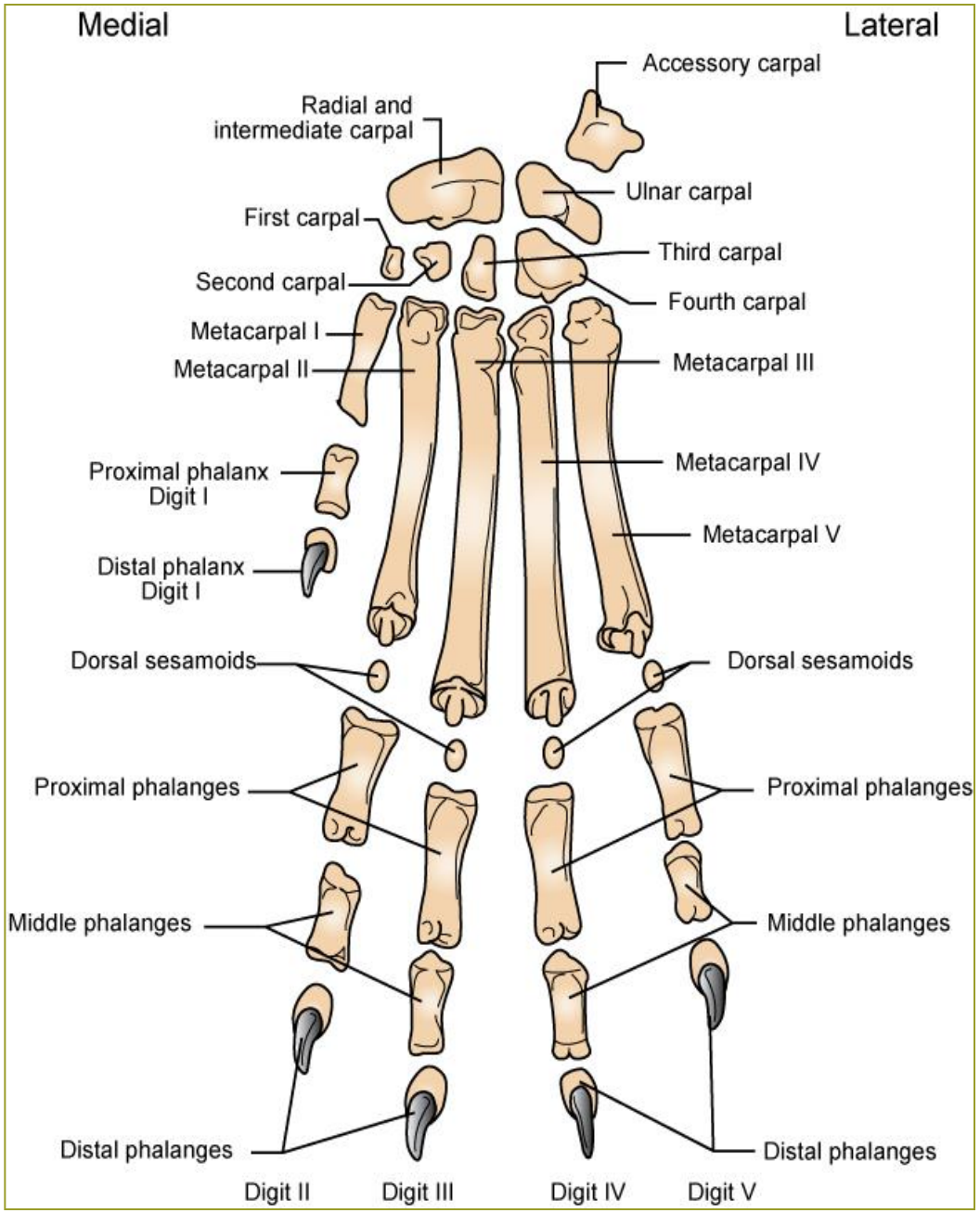
- Extend distally from distal carpal bones to proximal phalanges
- Dogs & cats – 5 digits
  - Numbered medial to lateral
  - Metacarpal & Digit I: dewclaw



Phalanges

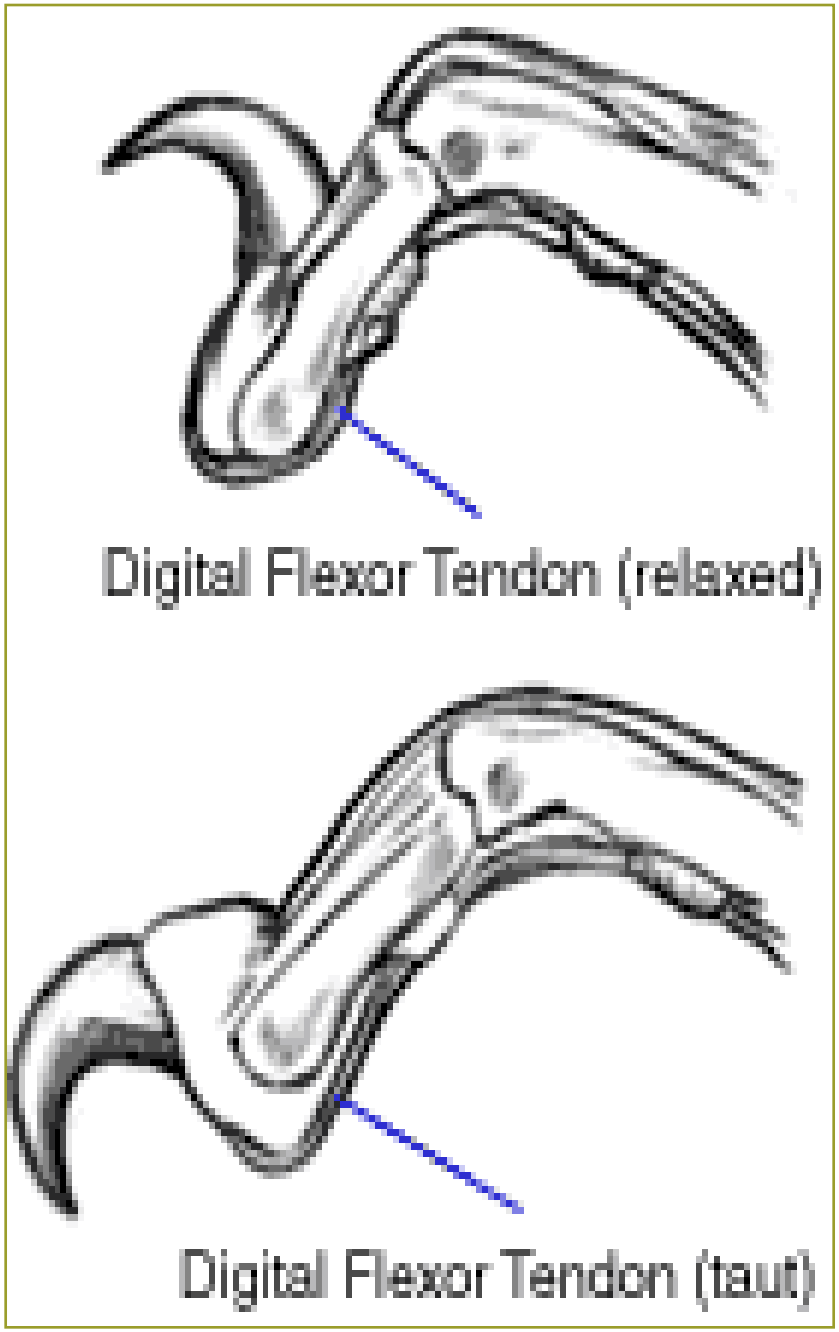
Figure 6-30, Page 179

- 1 digit = 3 phalanges
- Digit I (dewclaw): one proximal and one distal phalanx
- Digits II to V: proximal, middle, and distal phalanx
  - Ungual process – is surrounded by claw on distal phalanx



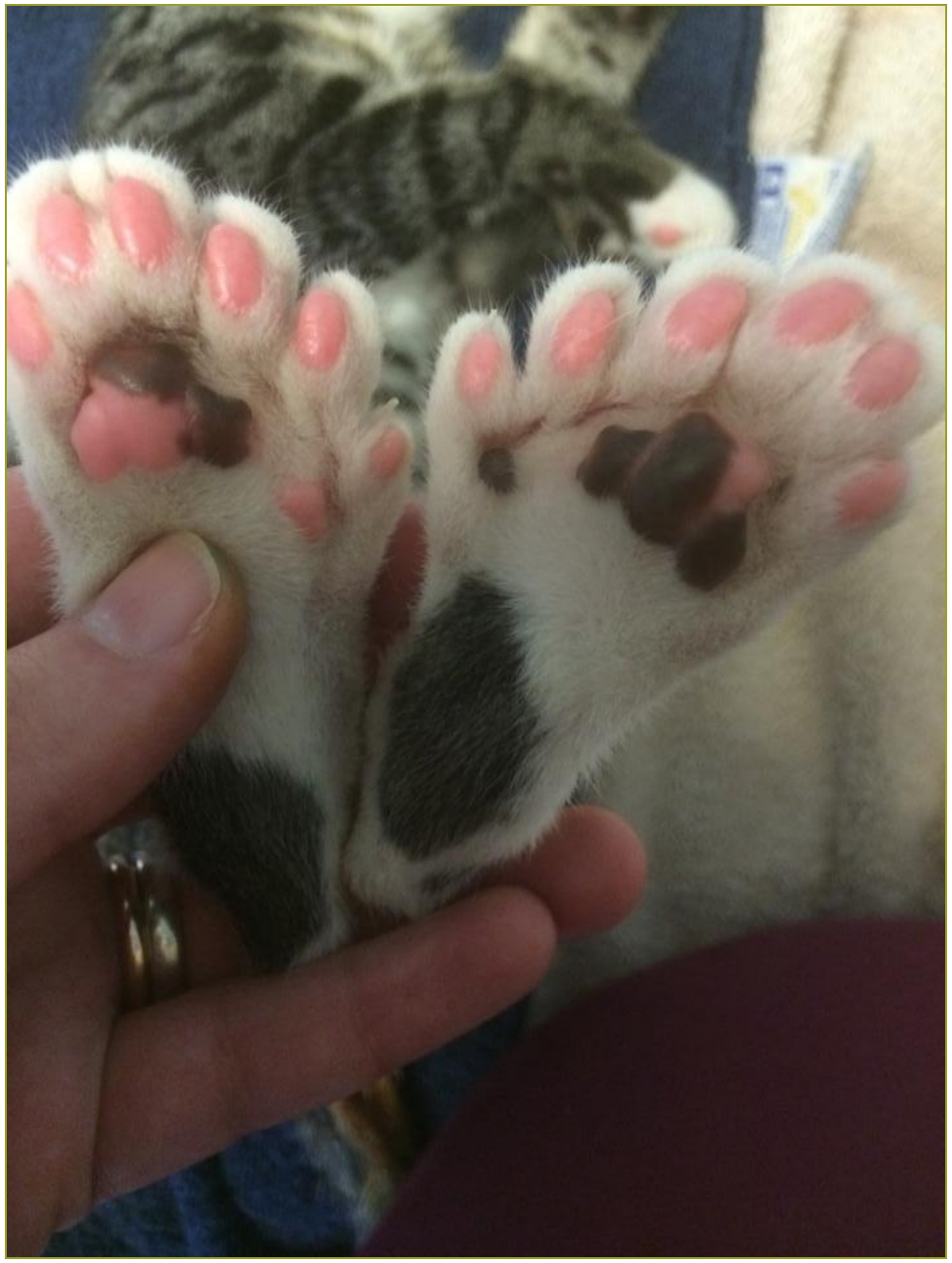
Review Digits/Phalanges

- Each **digit** has 3 phalanges
  - Proximal
  - Middle
  - Distal
- Equine
  - Navicular bone (distal sesamoid)
- Feline – retractable claw



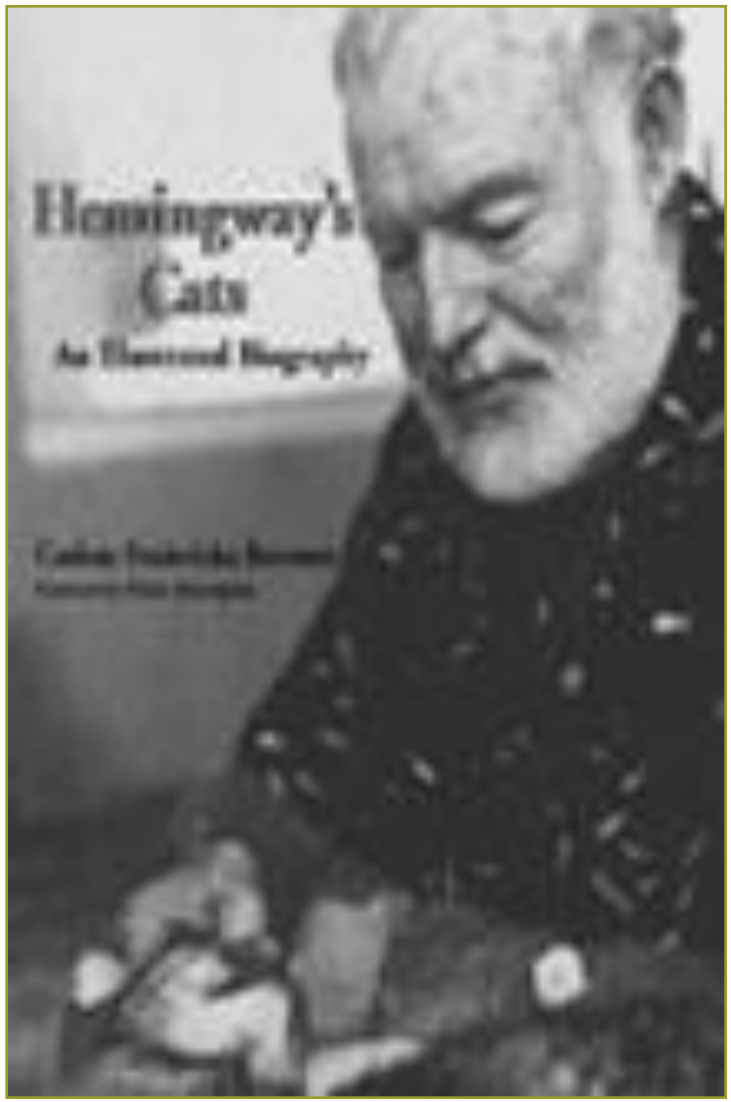
Polydactyly

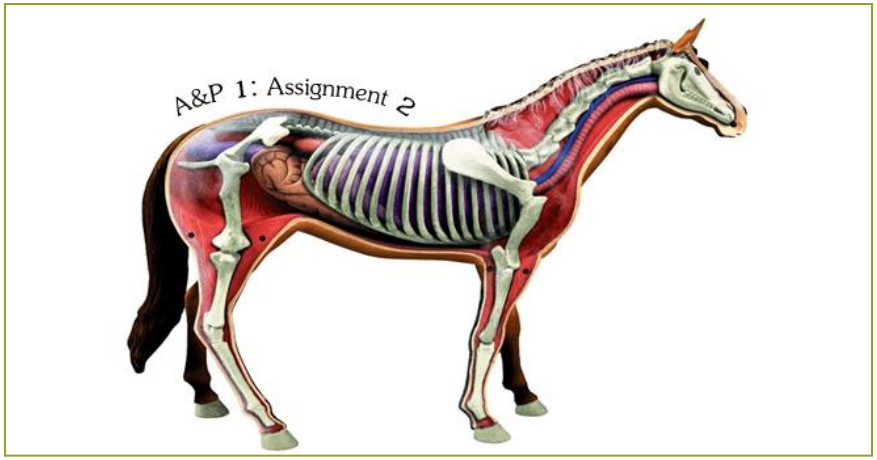
- Common in cats
- Genetic dominant



Hemingway Cats

http://www.hemingwayhome.com/cats/





Some Comparative Anatomy

Equine

Bovine

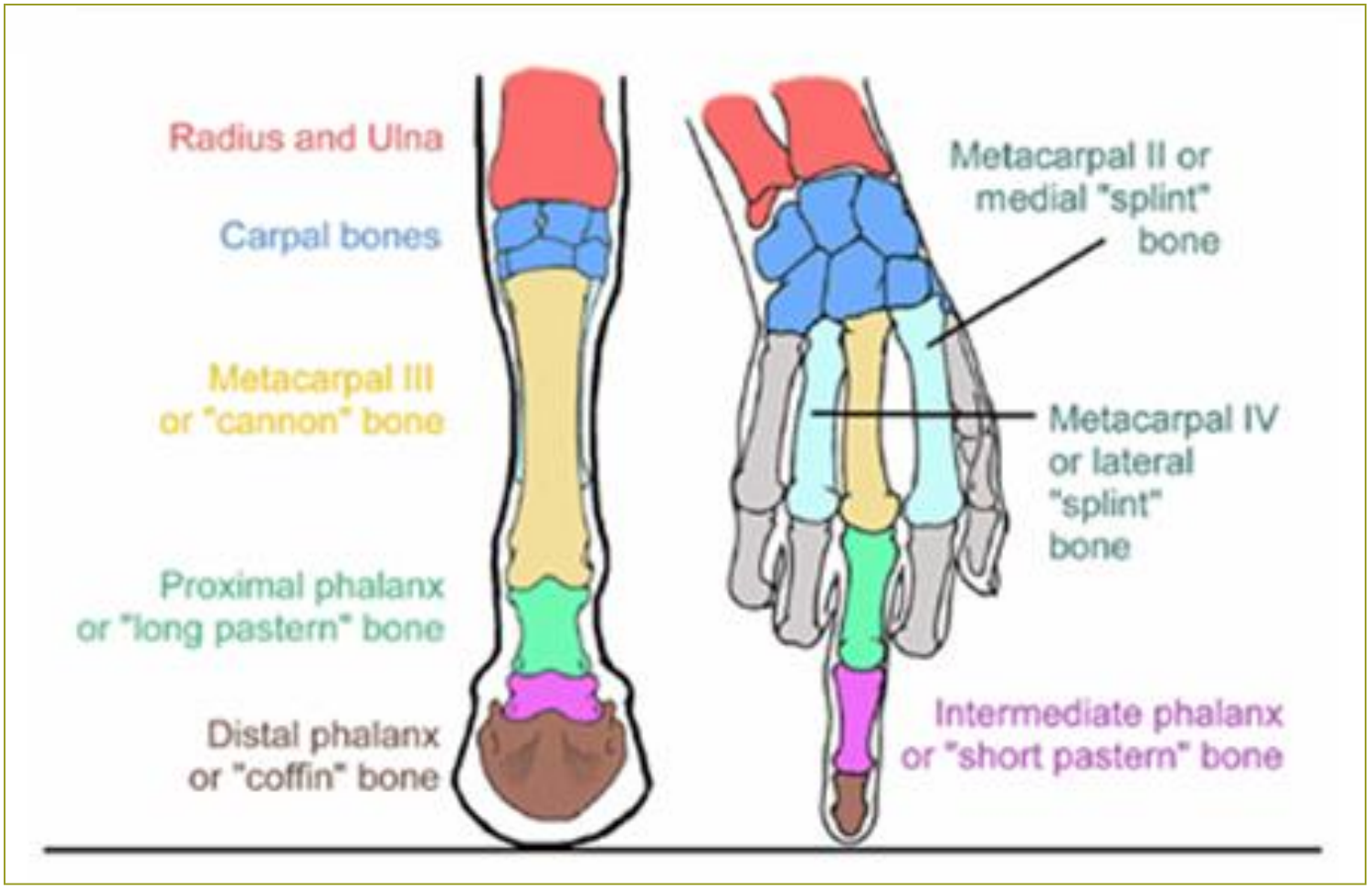
Avian

Equine and Bovine Scapula to Carpus

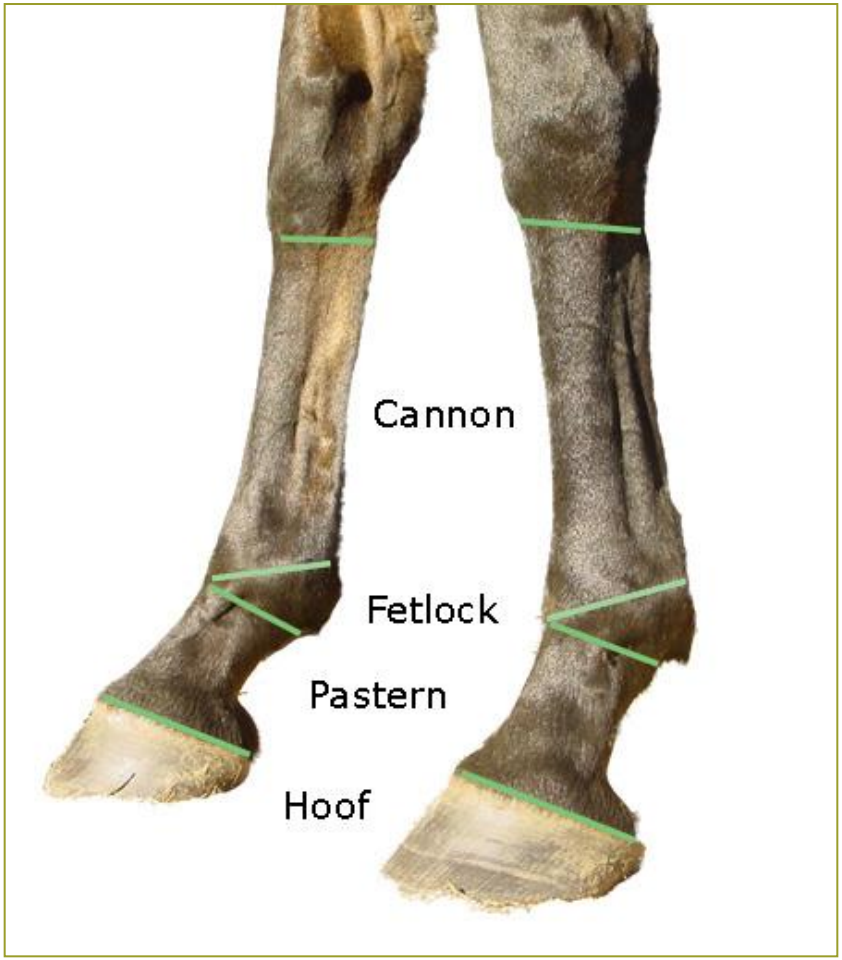
Very similar to dog and cat

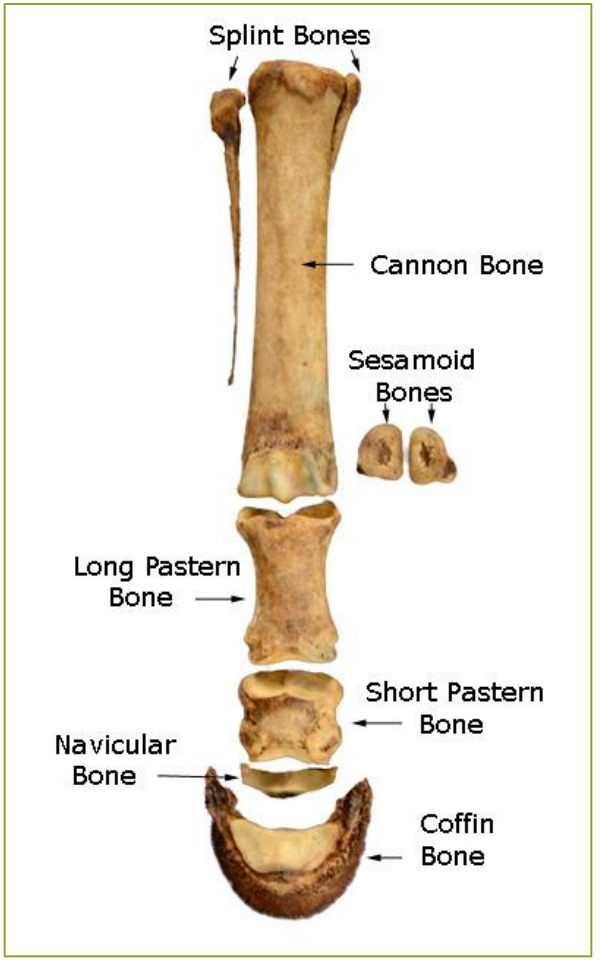
Radius and ulna fused

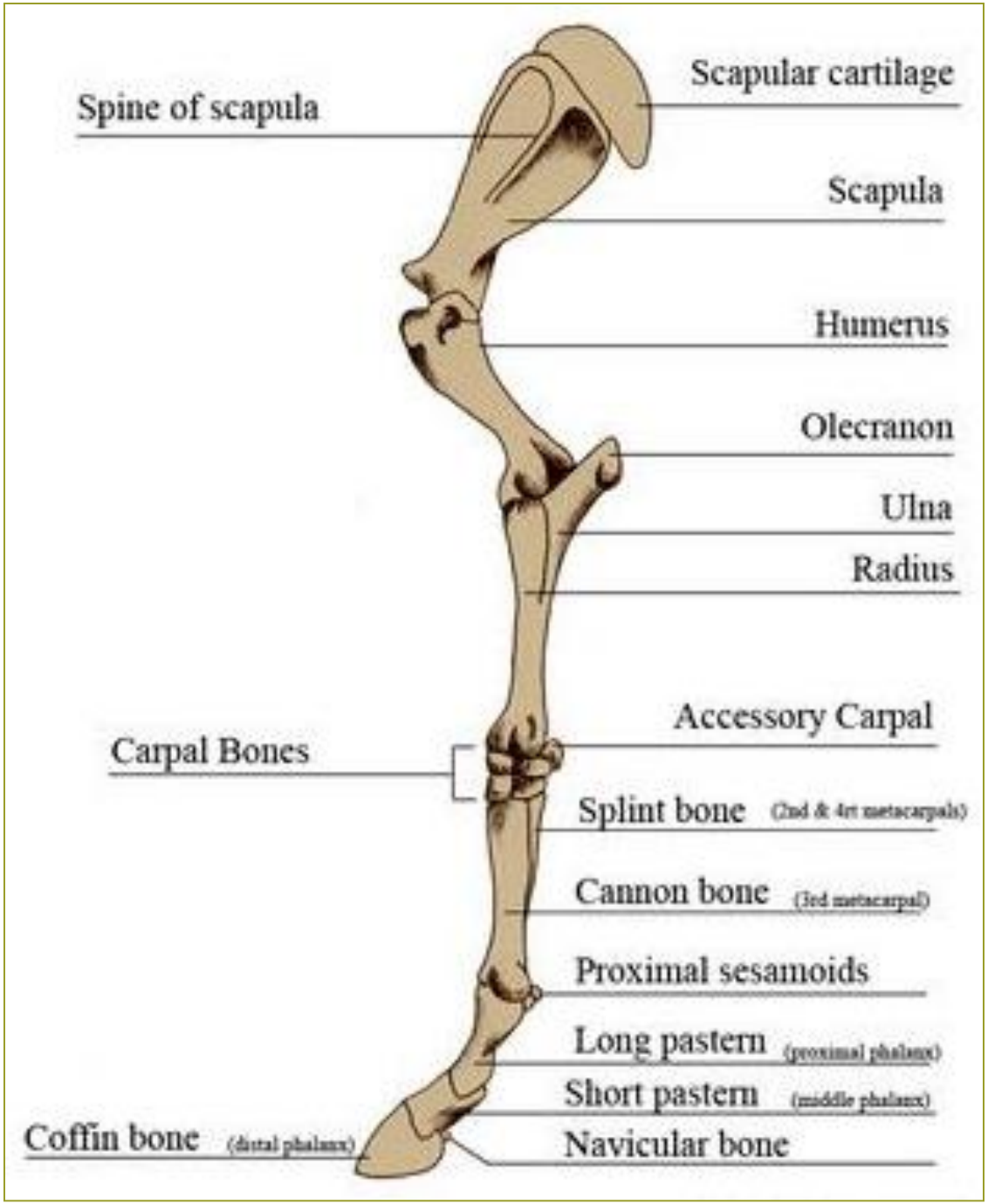
Horse Walks on Digit III



Bone Names on Horse Extremities

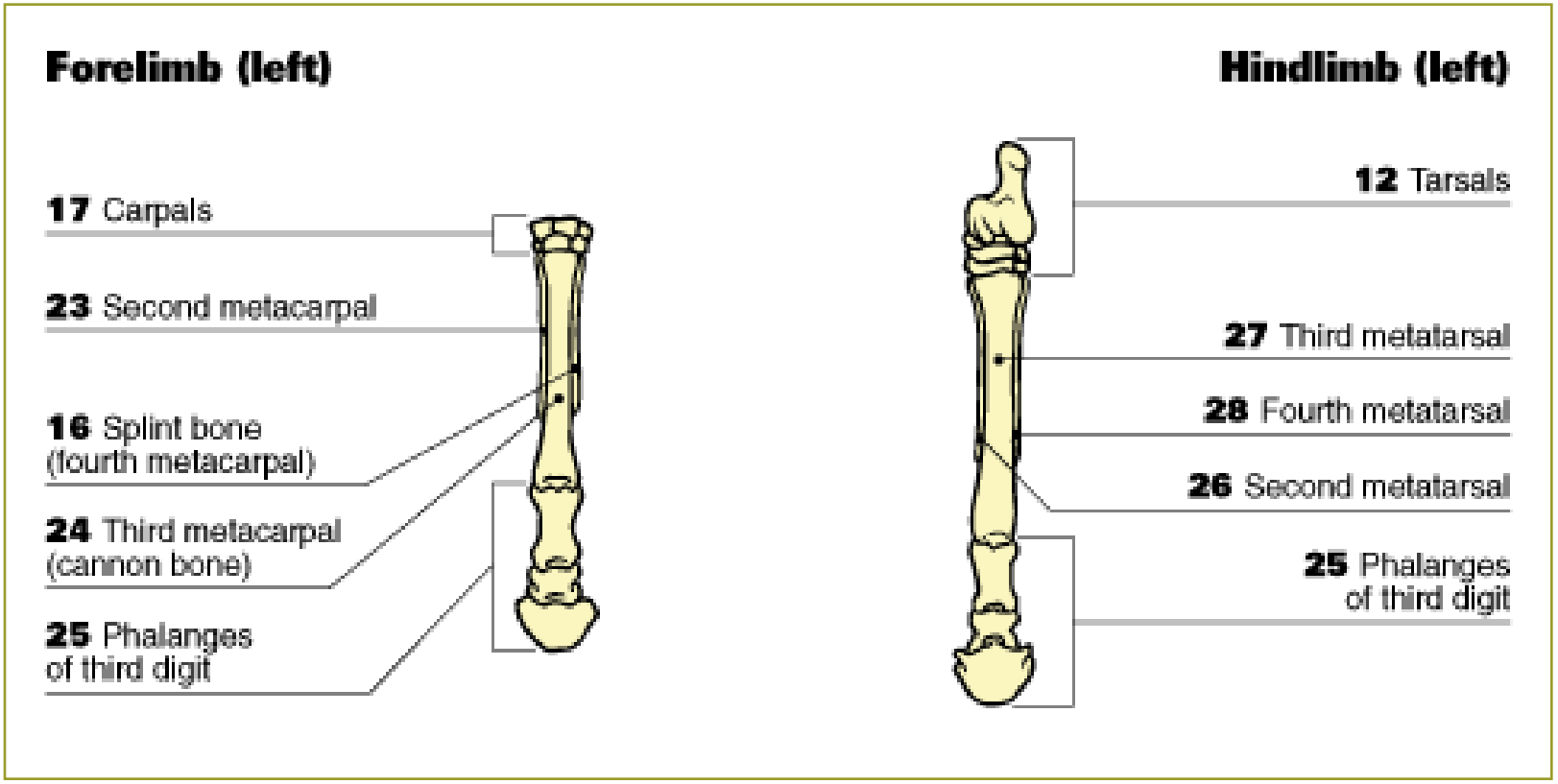





Spine of scapula
Scapular cartilage
Scapula
Humerus
Olecranon
Ulna
Radius
Accessory Carpal
Carpal Bones
Splint bone (2nd & 4rt metacarpals)
Cannon bone (3rd metacarpal)
Proximal sesamoids
Long pastern (proximal phalanx)
Short pastern (middle phalanx)
Coffin bone (distal phalanx)
Navicular bone

Equine (Horse) Limbs

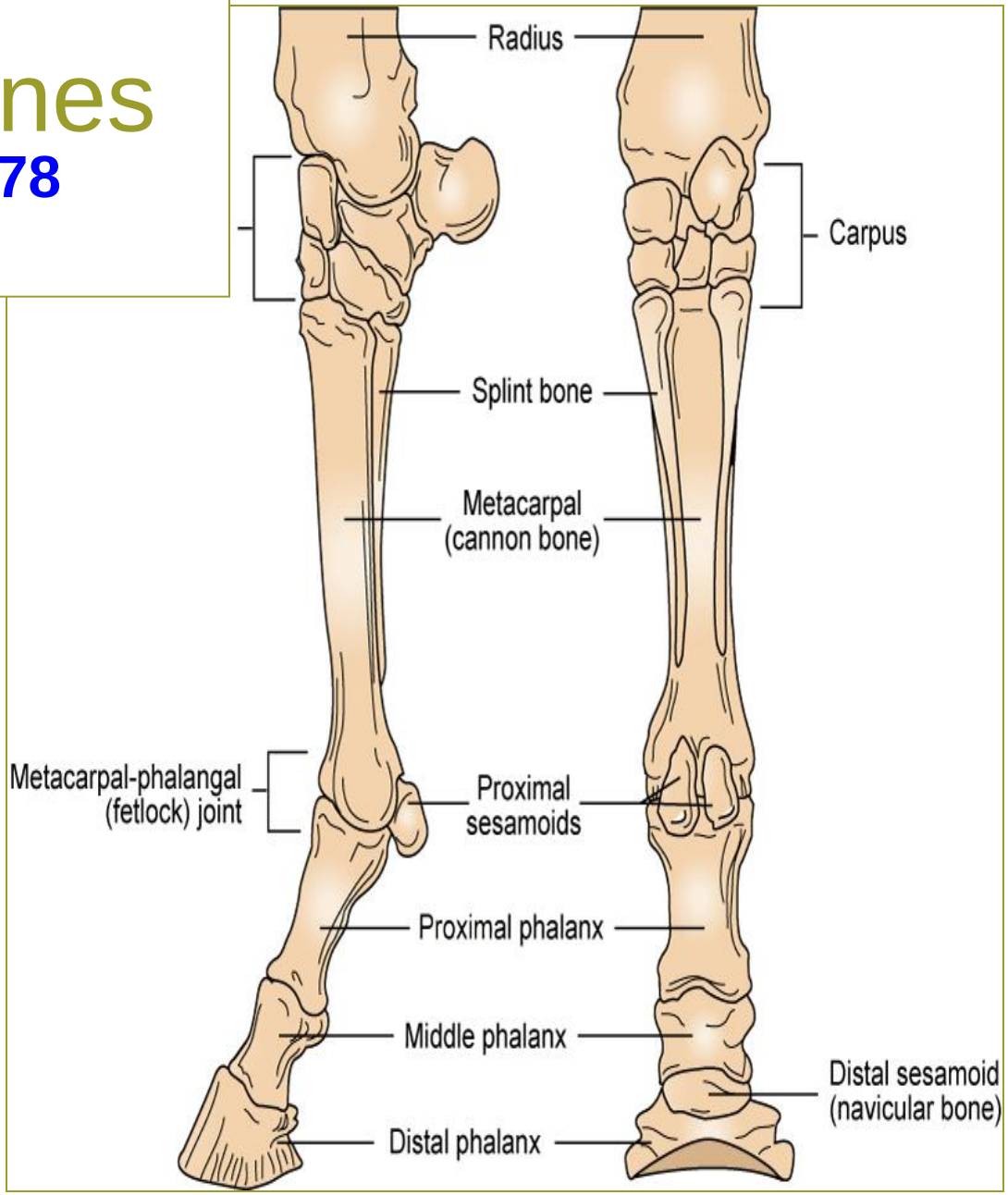
- Distal to Carpus and Tarsus



Metacarpal Bones

Figure 6-29, Page 178

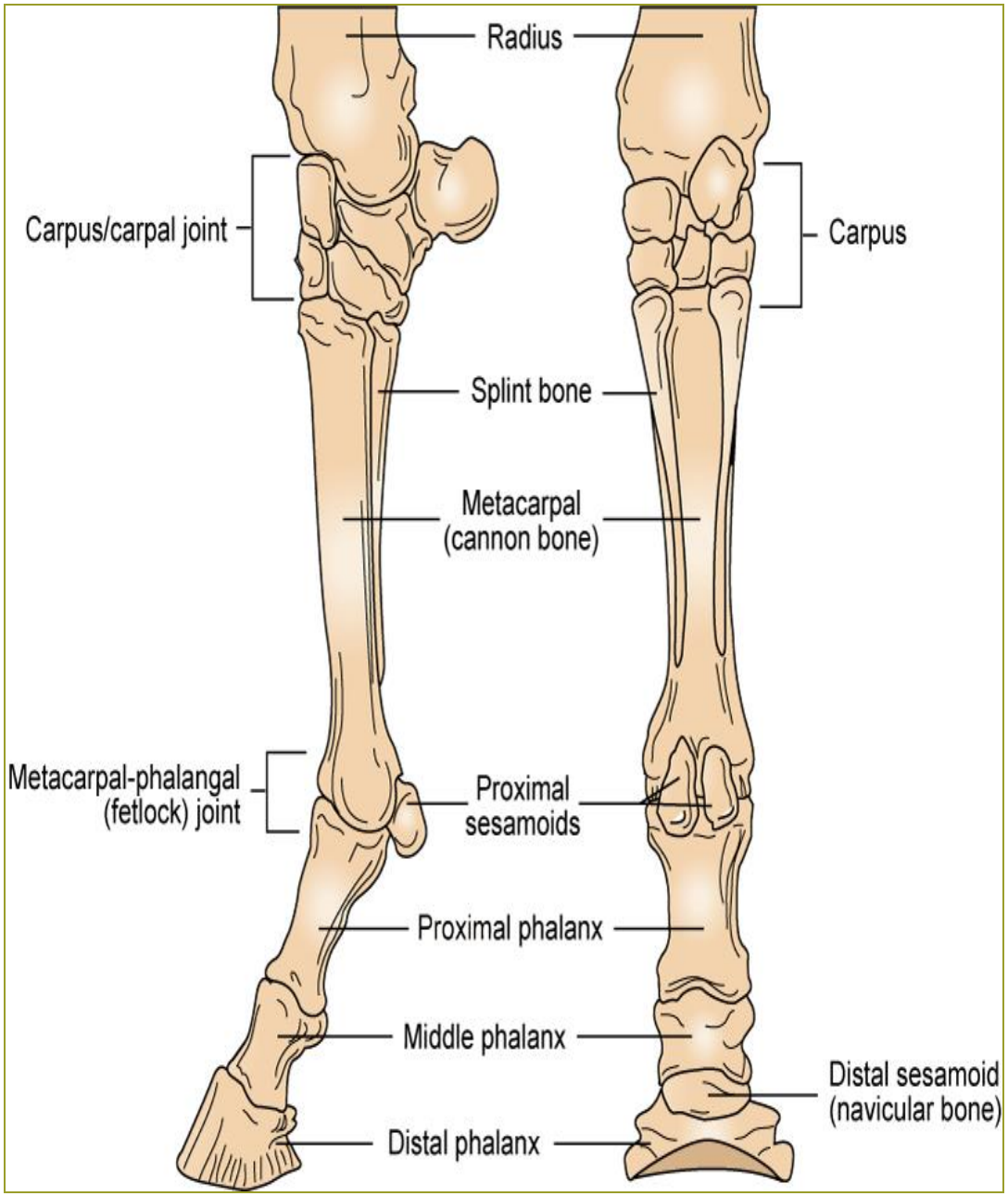
- One large metacarpal bone (III) (cannon bone)
- Two smaller vestigial metacarpal bones (II & IV) (splint bones)
  - Non weight-bearing



Phalanges

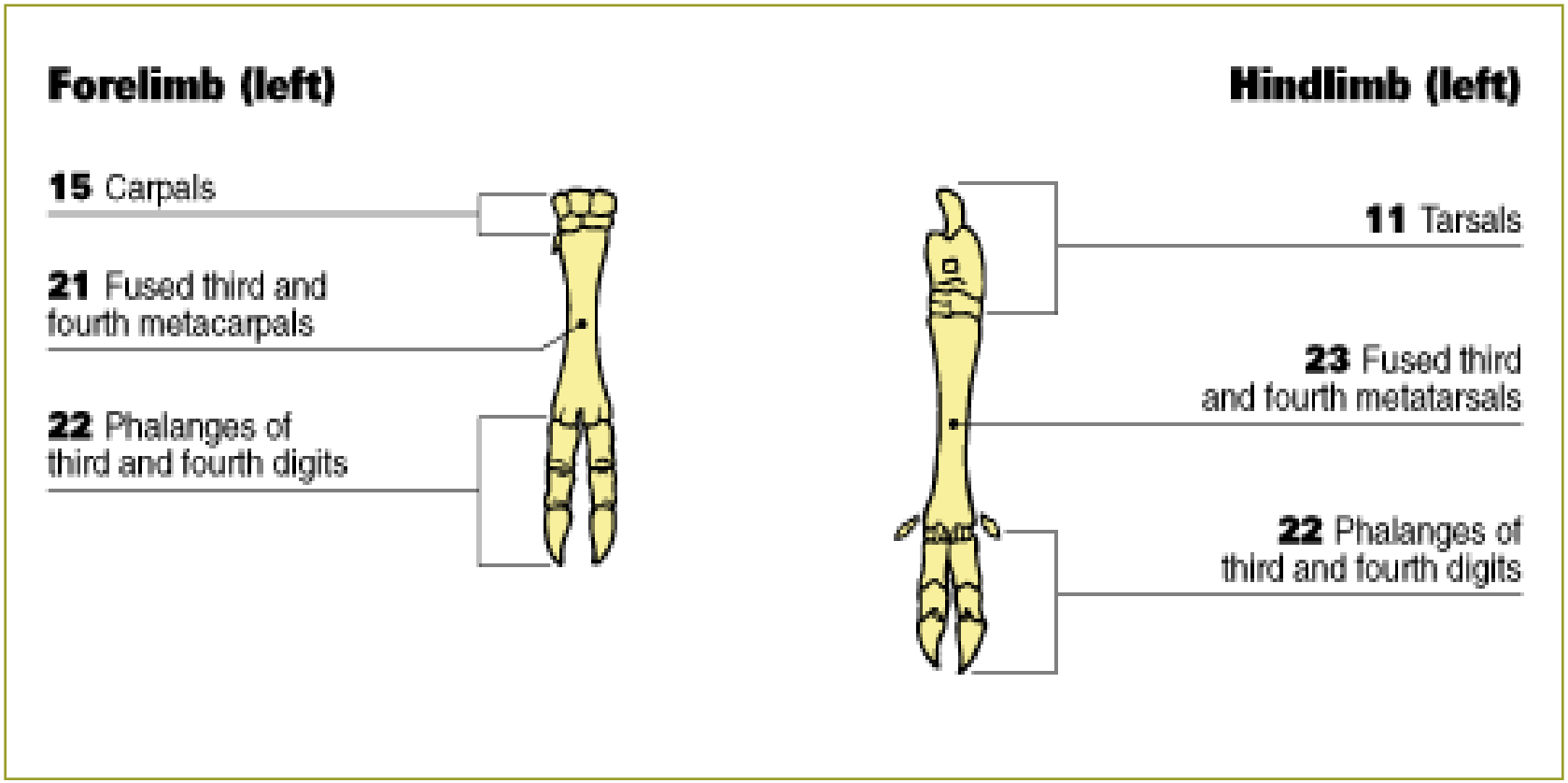
Figure 6-29, Page 178

- 1 **digit** (III) with 3 phalanges
  1. Proximal phalanx (long **pastern** bone)
  2. Middle phalanx (short **pastern** bone)
  3. Distal phalanx (**coffin bone**)
- Also have sesamoid bones



Bovine Limbs

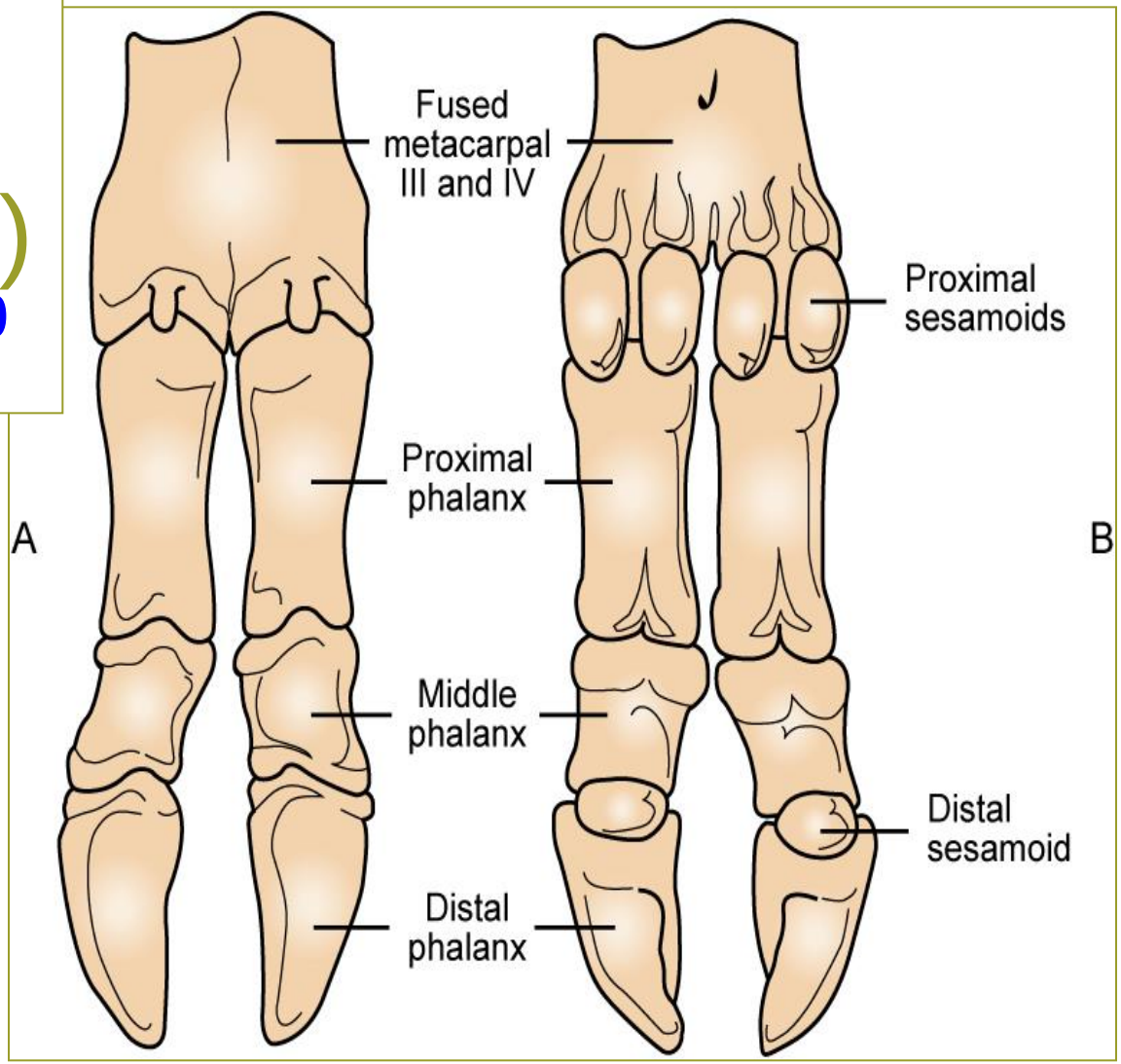
- Distal to Carpus and Tarsus



Metacarpal Bones Bovine (Cattle)

Figure 6-32, Page 180

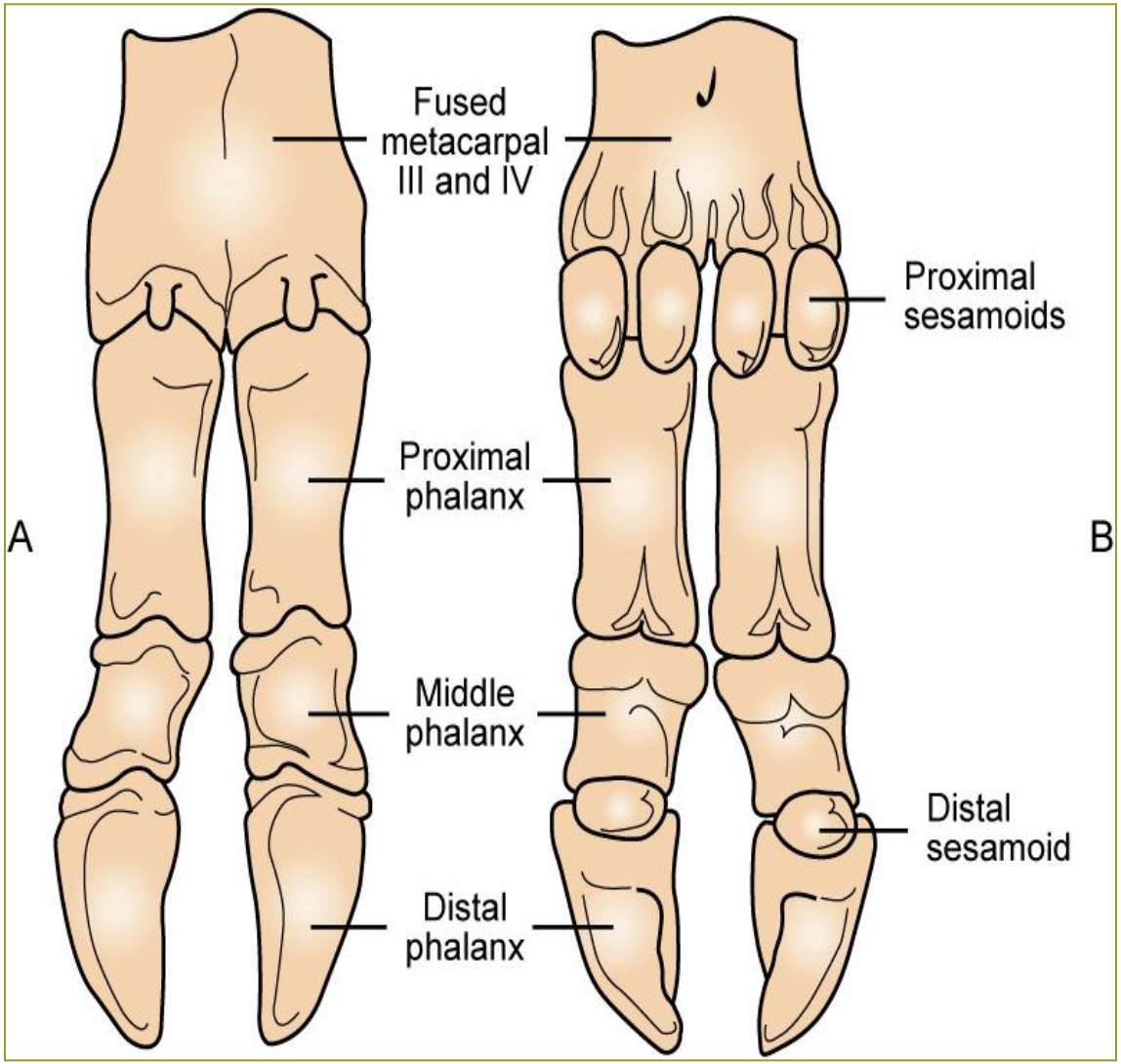
- Two **fused** metacarpal bones (III & IV)



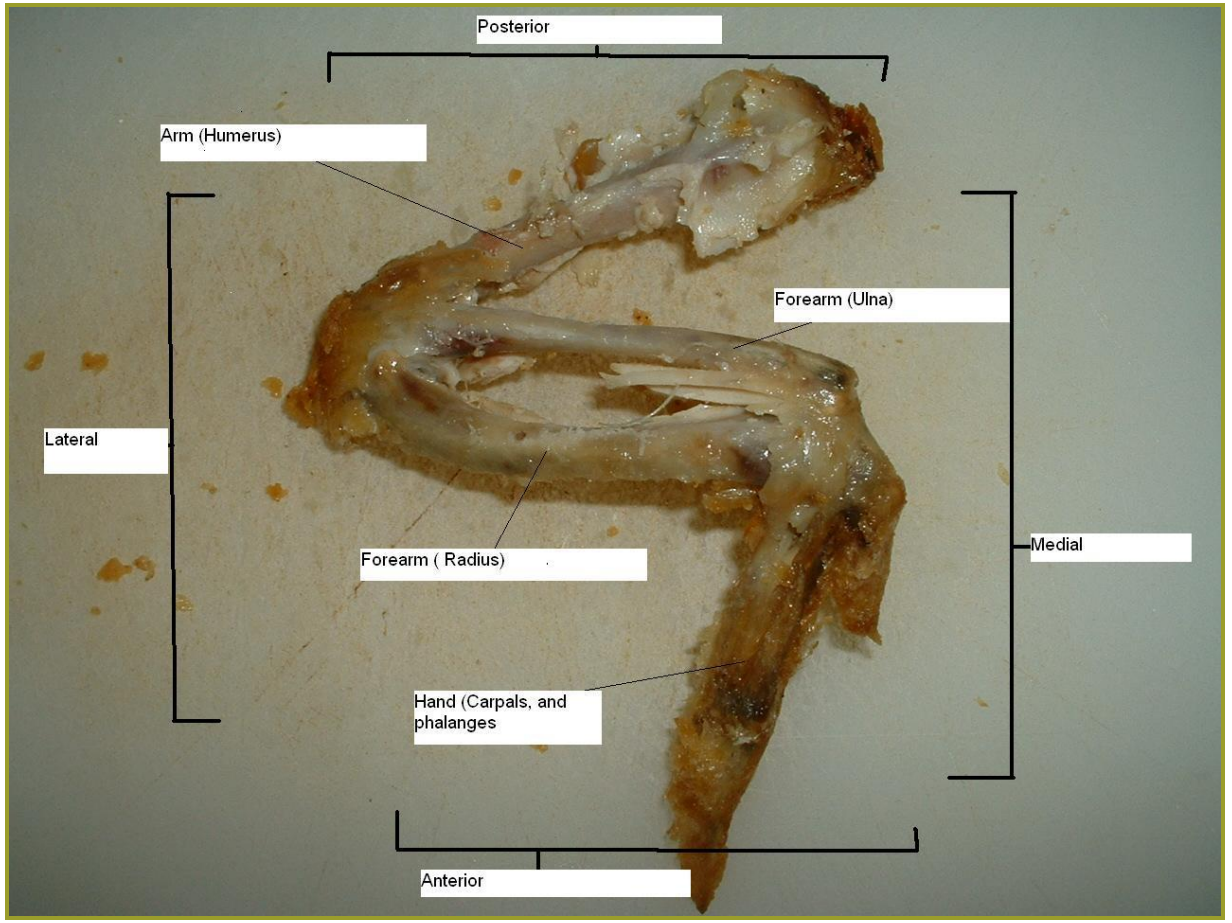
Phalanges

Figure 6-32, Page 180

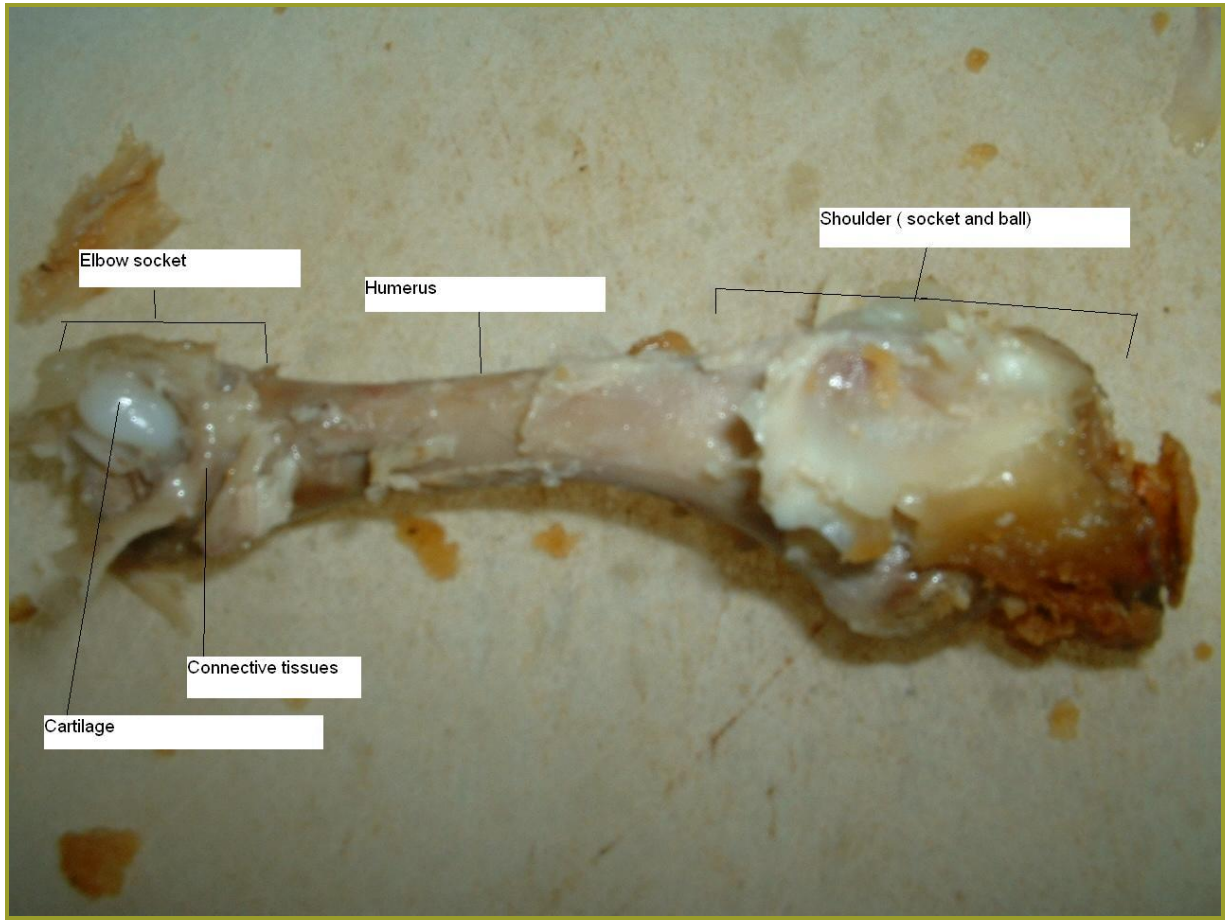
- Four digits on each limb
- Two support weight (III & IV), two are vestigial (**dewclaws**)
- Each digit has a proximal, middle, and distal phalanx
- Also proximal, distal sesamoid bones



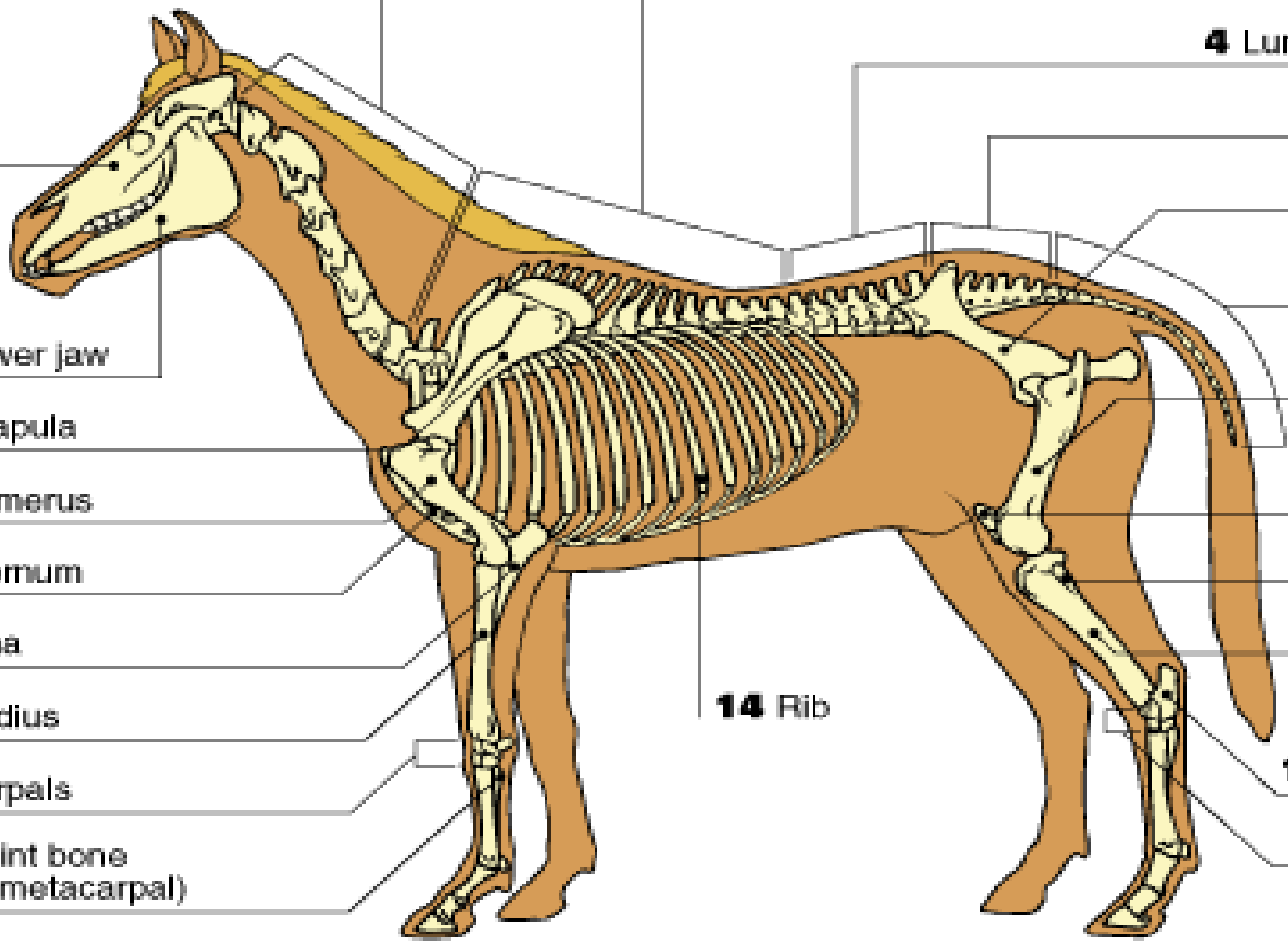
Chicken Wing (Forelimb)



Chicken Wing (Forelimb)

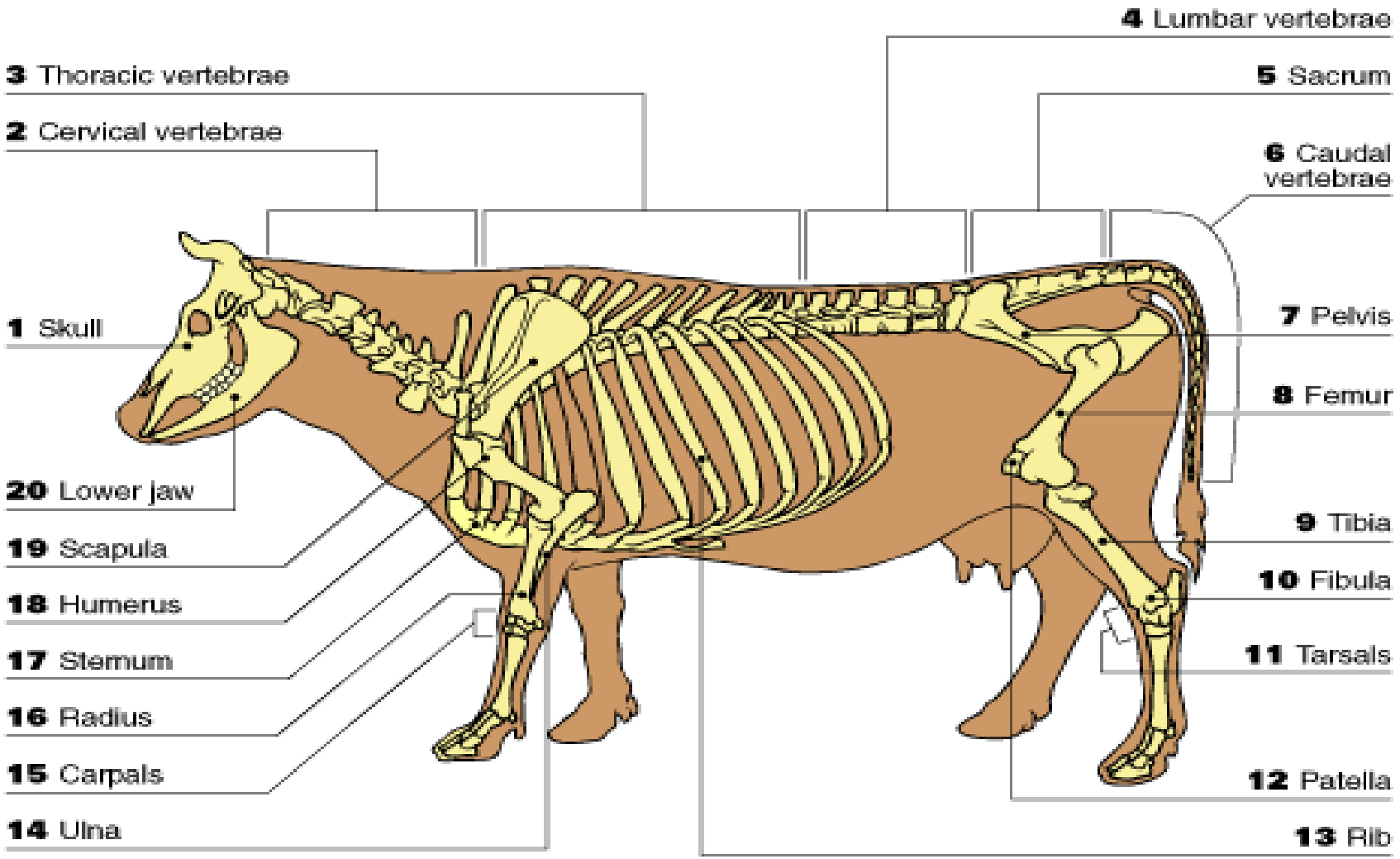


Whole skeleton



3 Thoracic vertebrae
2 Cervical vertebrae
1 Skull
22 Lower jaw
21 Scapula
20 Humerus
19 Sternum
15 Ulna
18 Radius
17 Carpals
16 Splint bone (fourth metacarpal)
14 Rib
4 Lumbar vertebrae
5 Sacrum
7 Pelvis
6 Caudal vertebrae
8 Femur
13 Patella
9 Fibula
10 Tibia
11 Calcaneum
12 Tarsals

Whole skeleton



Review

Bassert Lab Manual, Page 140

Exercise 8: Label the Bones of the Horse Foot from Proximal to Distal

_____ 1.

_____ 2.

_____ 3.

_____ 4.

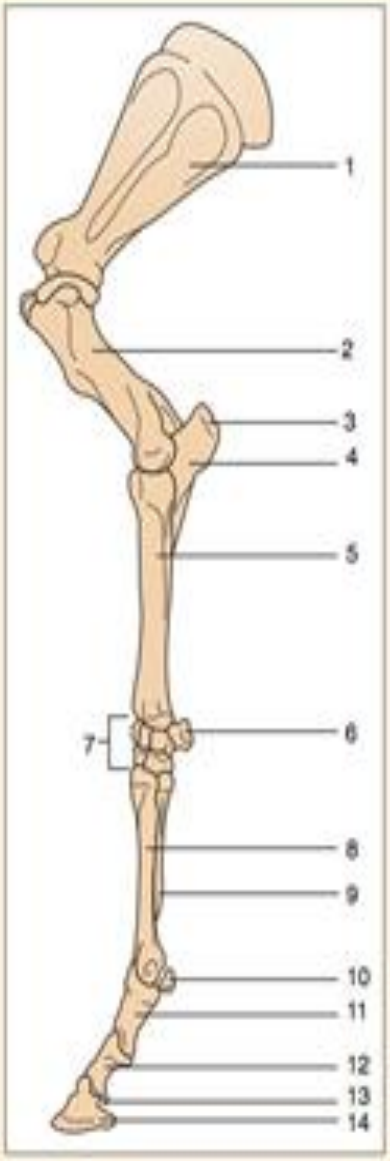
_____ 5.

Review

Bassert Lab Manual, Page 141

Exercise 9: Label the Bones or Processes of the Equine Thoracic Limb

_____ 1.
_____ 2.
_____ 3. (Name the process)
_____ 4. (Name the bone)
_____ 5.
_____ 6. (Name the bone—be specific)
_____ 7. (Name the joint)
_____ 8.
_____ 9.
_____ 10.
_____ 11.
_____ 12.
_____ 13.
_____ 14.

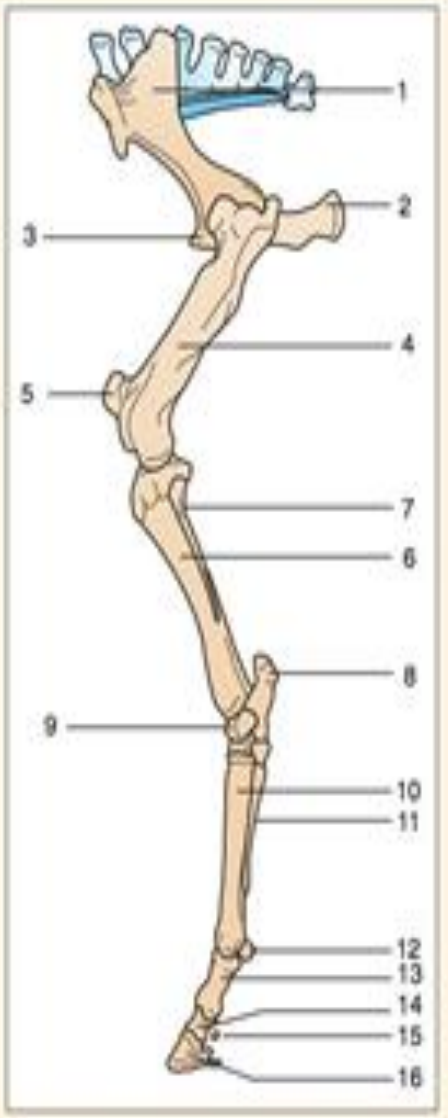


Review

Bassert Lab Manual, Page 142

Exercise 10: Label the Indicated Bones, Joints, or Processes of the Equine Pelvic Limb

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____ (Name the process)
9. _____ (Name the joint)
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____

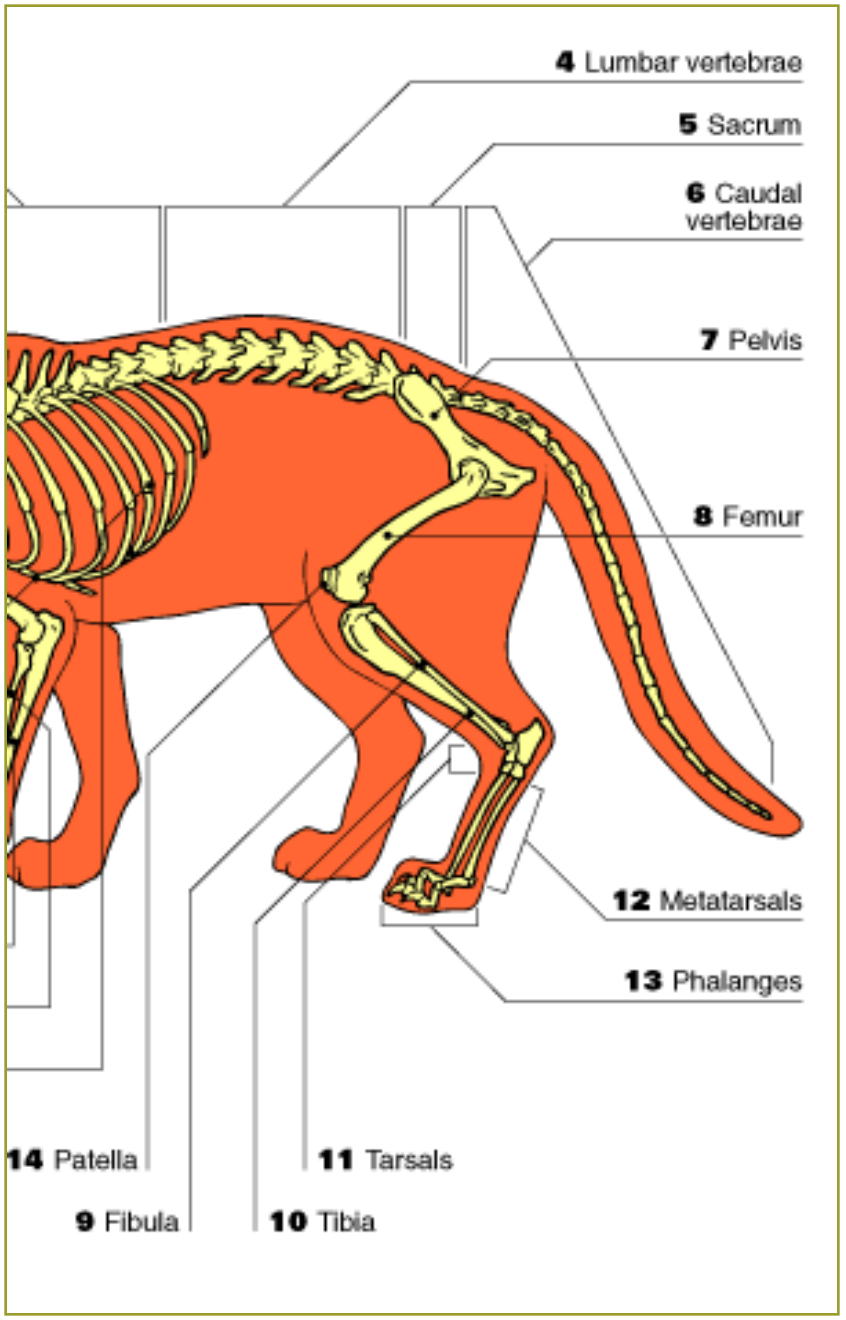


Pelvic Limb
(Proximal to Distal)

Connected to axial skeleton at sacroiliac joint

Pelvic Limb Proximal to Knee

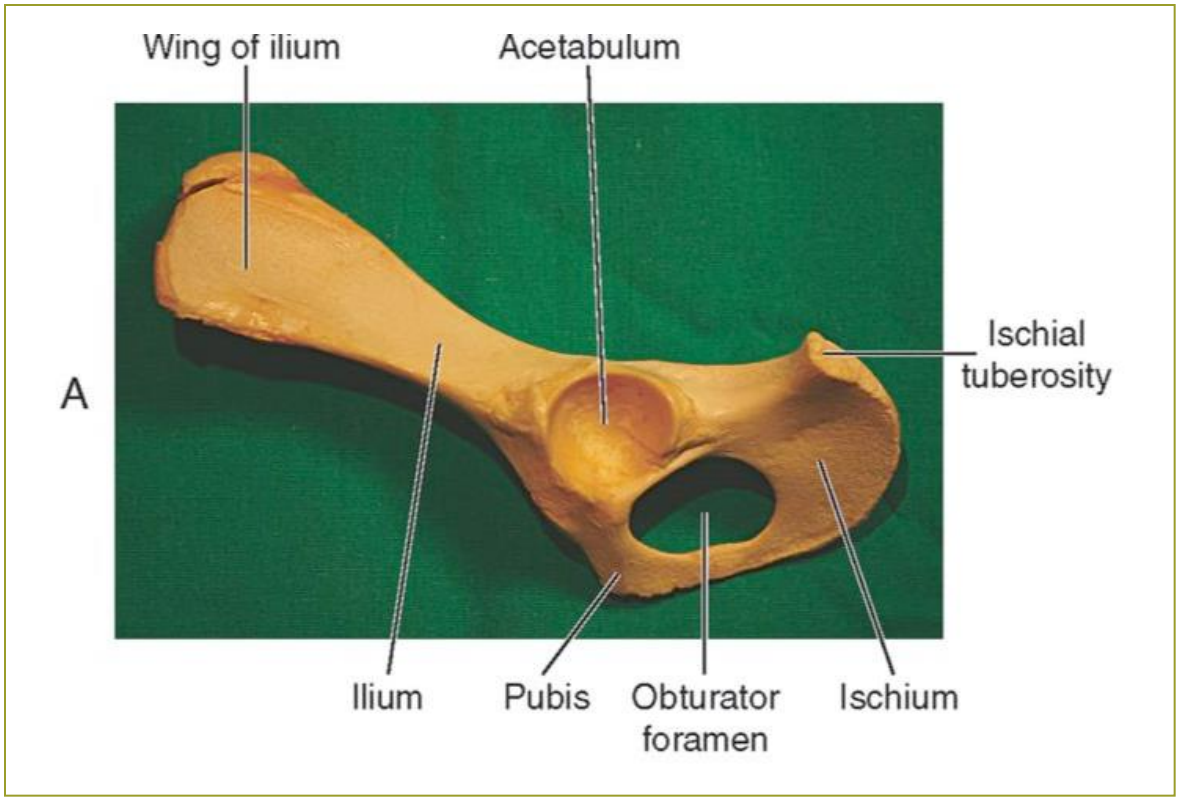
- Pelvis
  - Ilium
  - Ischium
  - Pubis
  - Acetabulum
  - Obturator foramen
- Femur
- Patella
- Fabellae



Pelvis

Figure 6-33A, Page 182

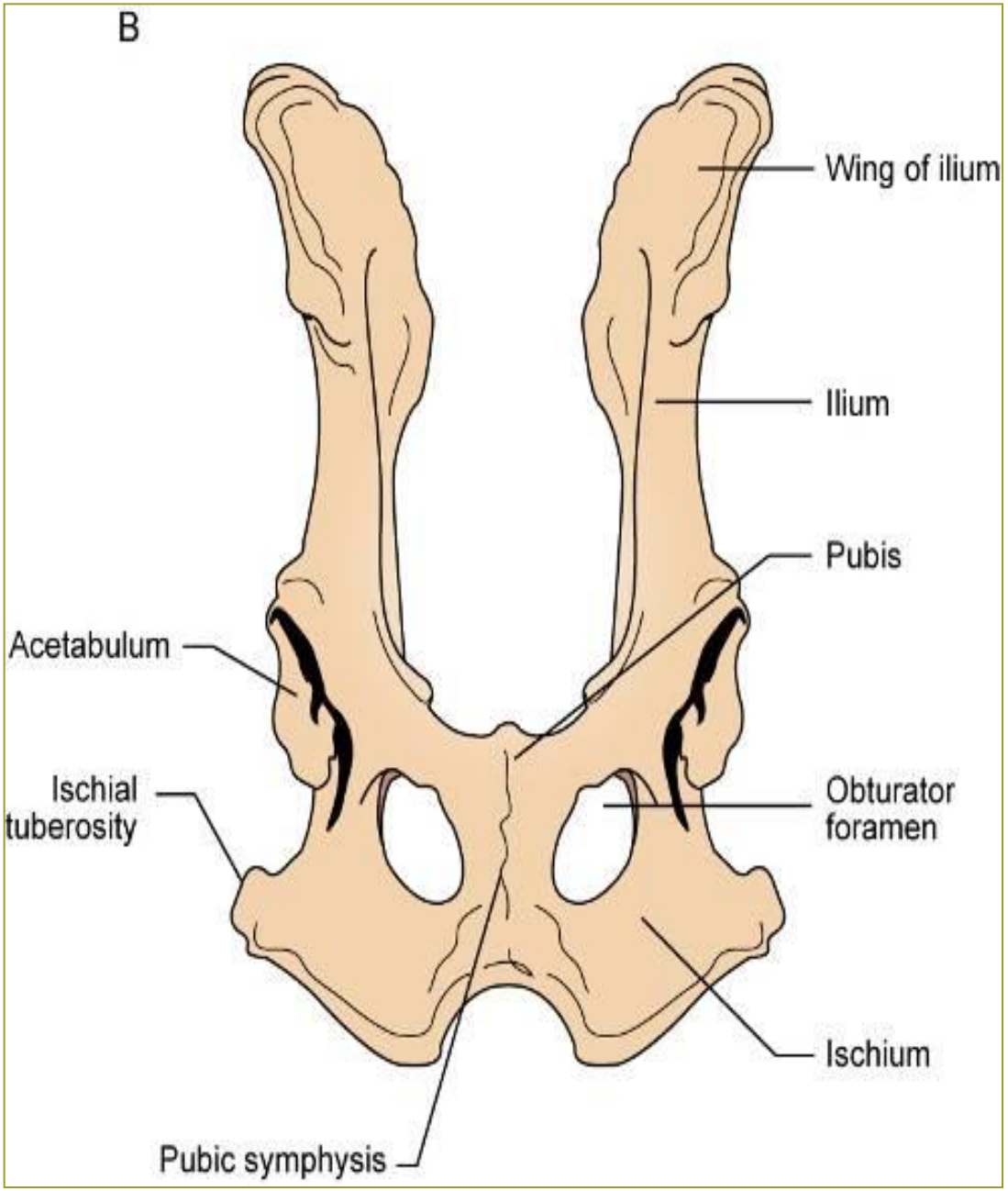
- Ilium
- Ischium
- Pubis
- Acetabulum
- Obturator foramen
  - What structure comes through here?
- Ischial tuberosity



Pelvis

Figure 6-33B, Page 182

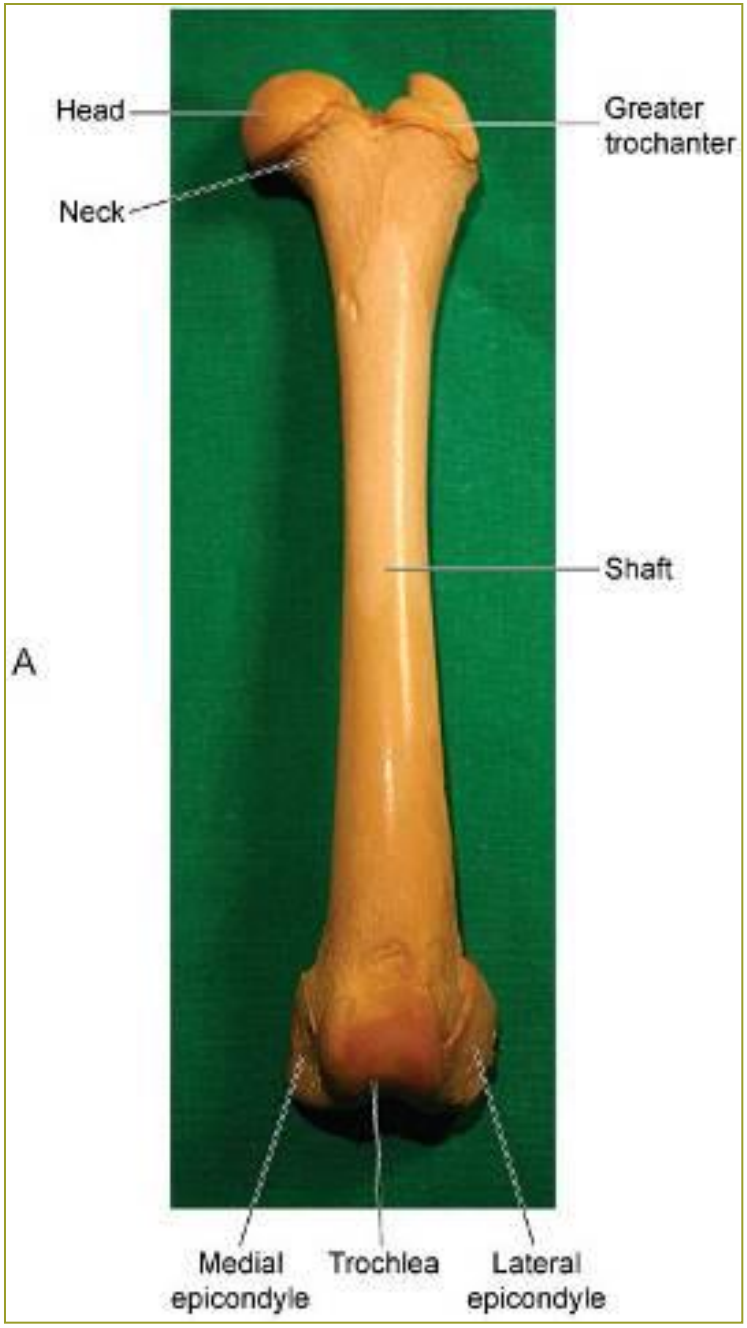
- 3 **fused** bones
  - Ilium
  - Ischium
  - pubis
- **Pelvic (pubic) symphysis**
  - Cartilaginous joint between two halves of pelvis



Femur

Figure 6-34A, Page 183

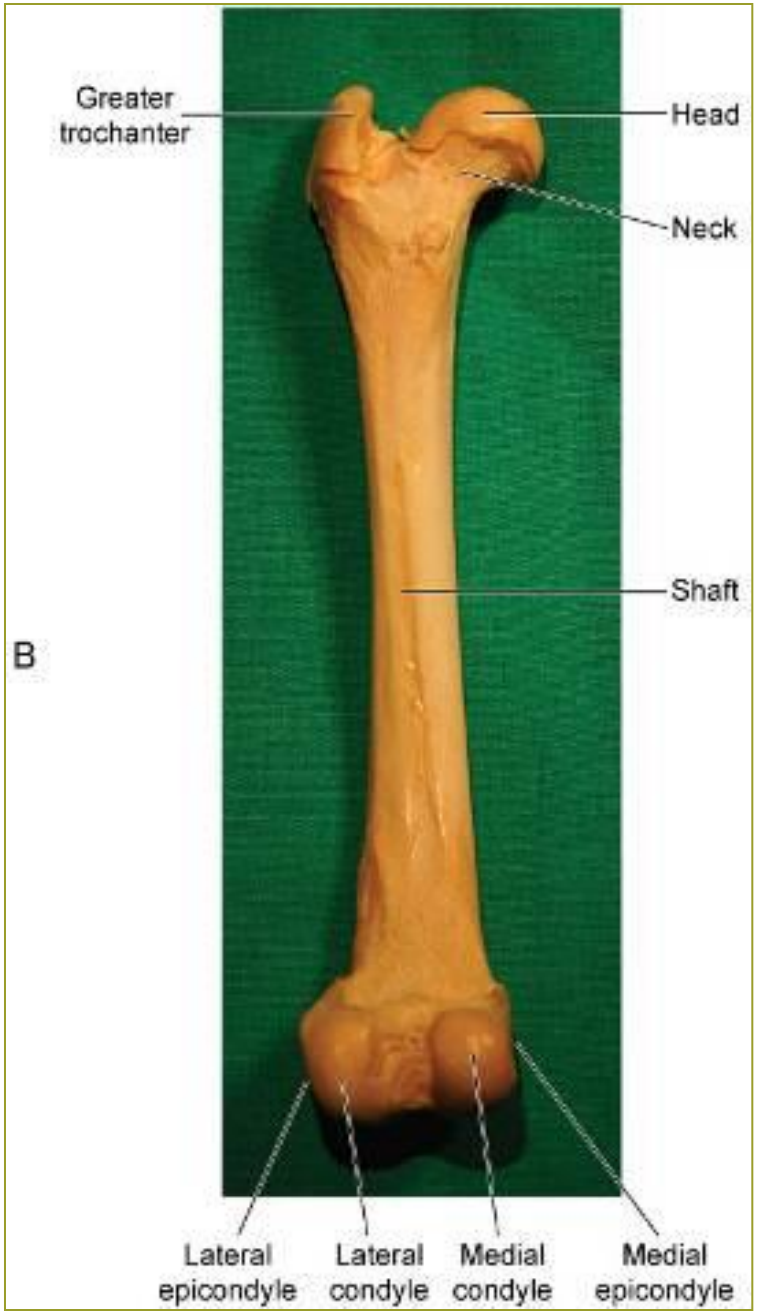
- Proximal end forms part of **hip joint**
- **Femoral head** fits deeply into **acetabulum** of pelvis
- **Trochanters**: processes where hip and thigh muscles attach



Femur

Figure 6-34B, Page 183

- Shaft extends distally to form **stifle (knee) joint** with patella & tibia
- Articular surfaces:
  - 2 Condyles
  - Trochlea
- Trochlea: articular groove containing patella



Patella and Fabellae

Patella

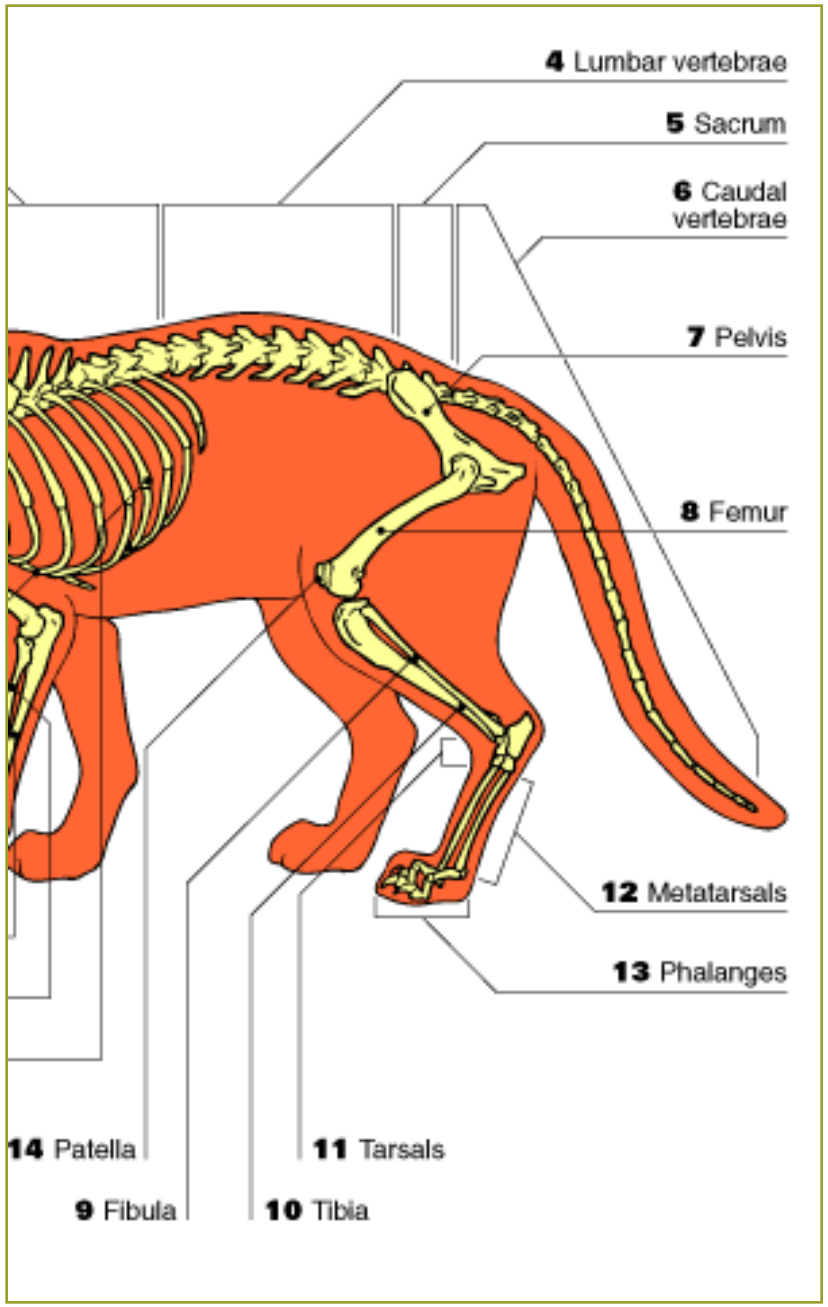
- Large **sesamoid** bone
- Formed in distal **tendon** of quadriceps femoris muscle
- Protects tendon

Fabellae

- Two small **sesamoid** bones in proximal gastrocnemius muscle tendons of dogs and cats
- Not present in cattle or horses

Pelvic Limb Distal to Knee

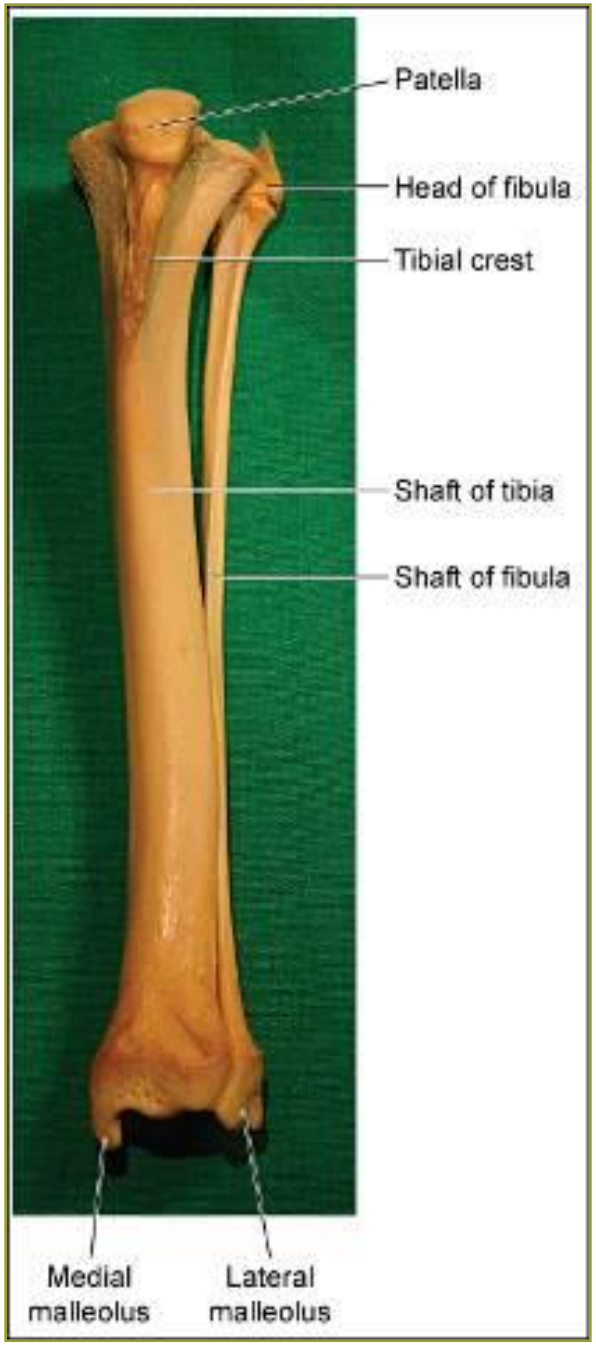
- Tibia
  - Tibial crest
- Fibula
- Tarsal bones (tarsus)
- Metatarsal bones
- Phalanges



Tibia

Figure 6-35, Page 184

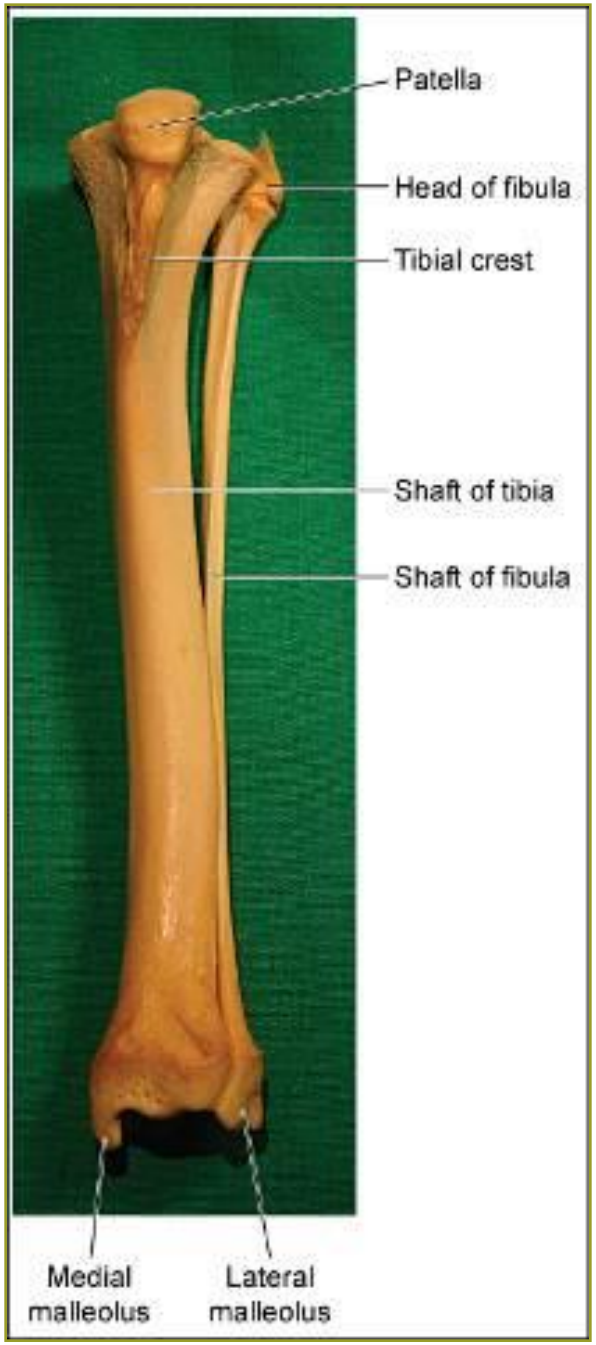
- **Main weight-bearing bone of lower limb**
- Forms **stifle joint** with femur, **hock (ankle) joint** with **tarsus** (tarsal bones)
- **Tibial tuberosity** (tibial crest)



Fibula

Figure 6-35, Page 184

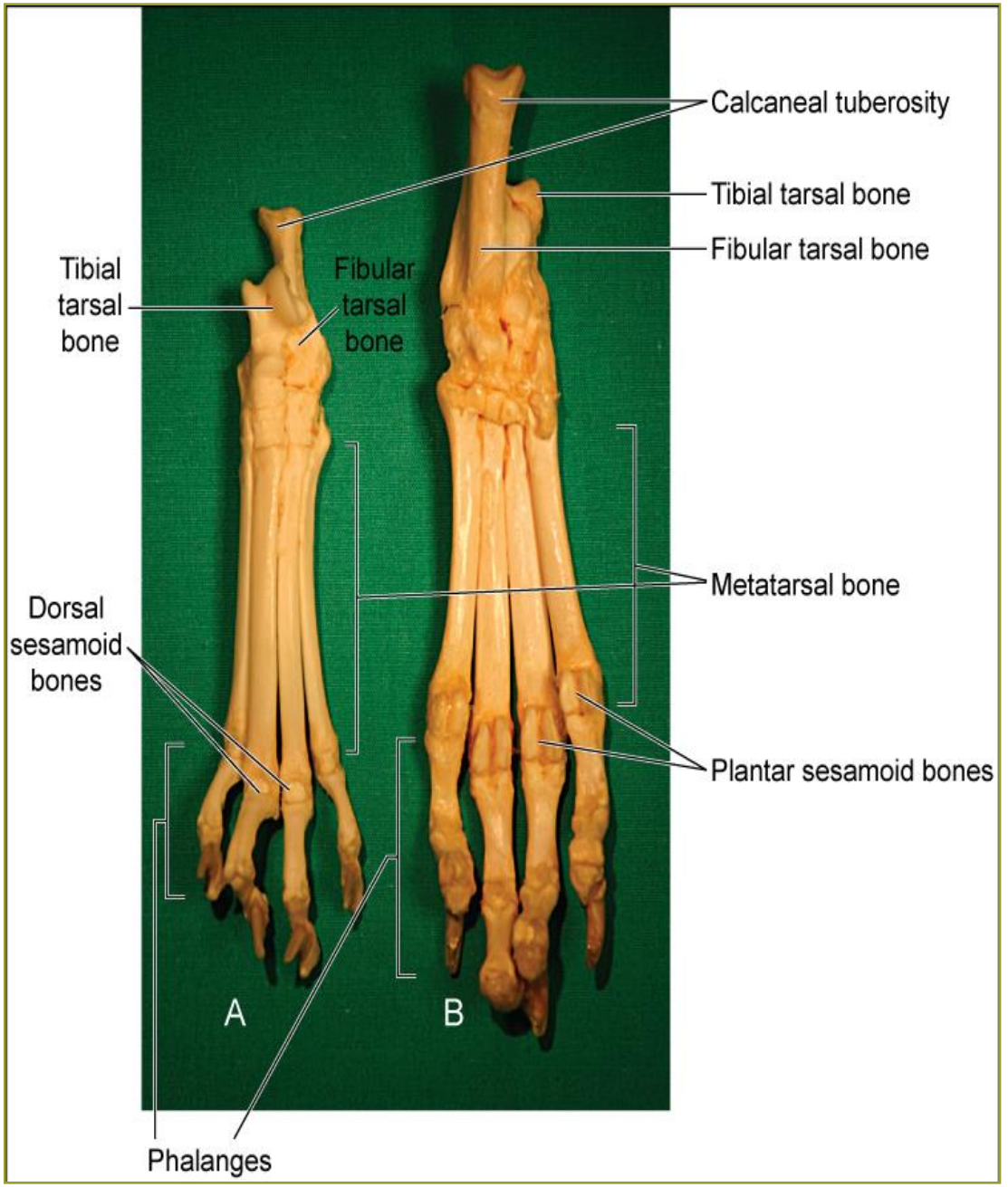
- Parallel to tibia
- Not weight-bearing
- Serves as muscle attachment site
- Lateral malleolus: knob-like process



Tarsus (Hock, Ankle Joint)

Figure 6-36, Page 185

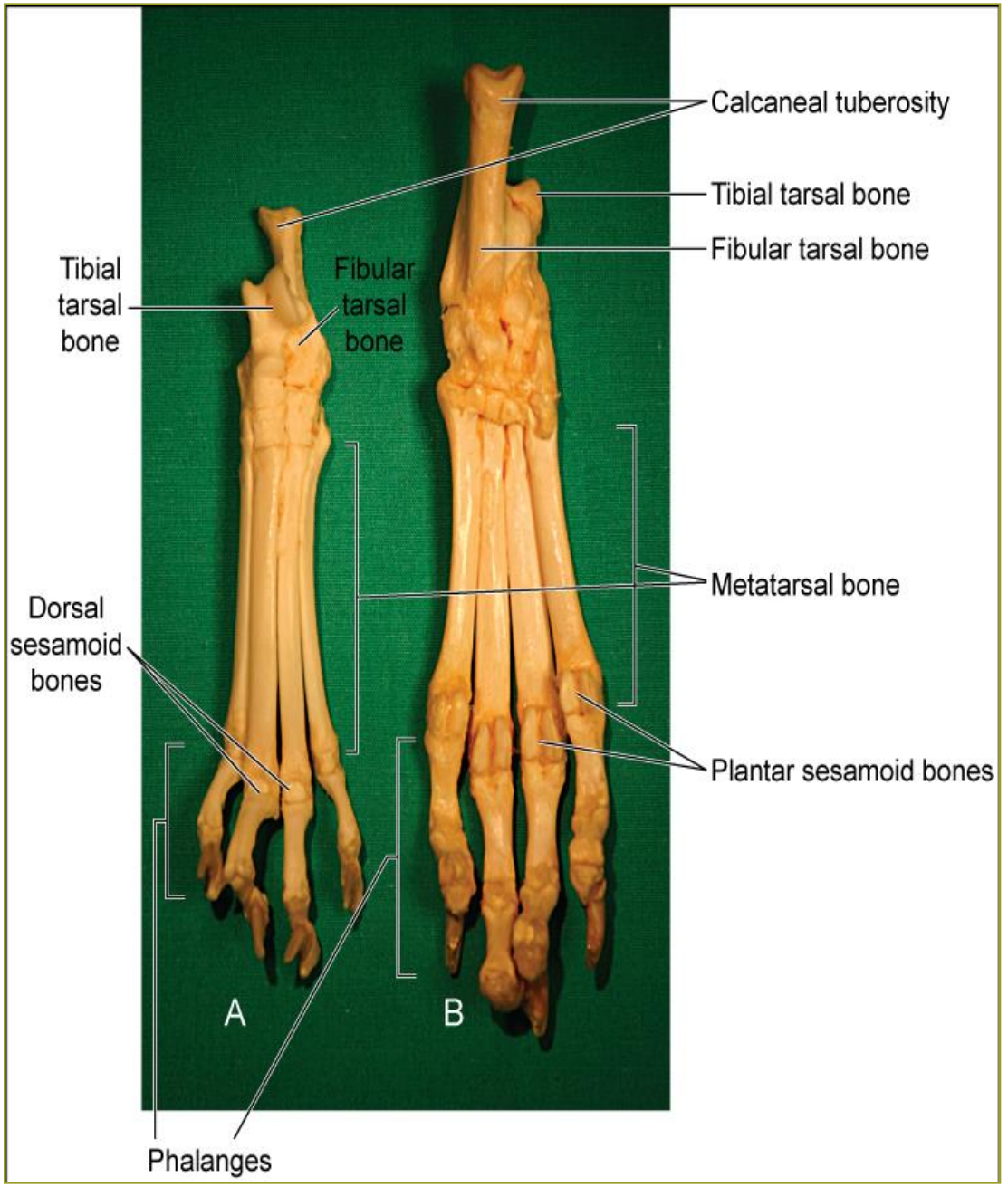
- AKA "tarsal joint"
- 2 rows of tarsal bones
  - Proximal row named; distal row numbered medial to lateral



Tarsus (Hock, Ankle Joint)

Figure 6-36, Page 185

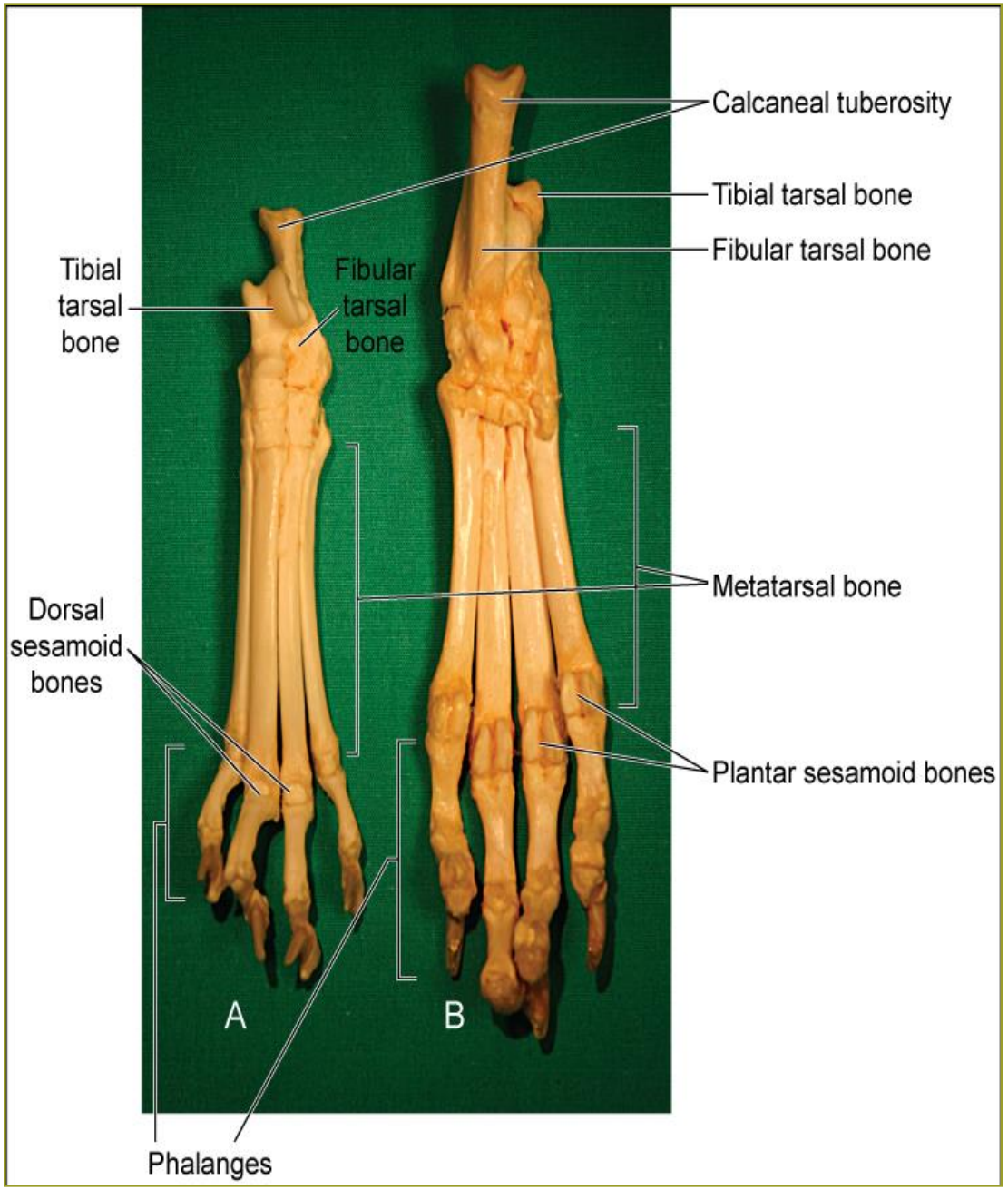
- Calcaneal tuberosity
  - Aka "tuber calcis"
  - Point of attachment on calcaneus for tendon of gastrocnemius muscle



Metatarsal Bones

Figure 6-36, Page 185

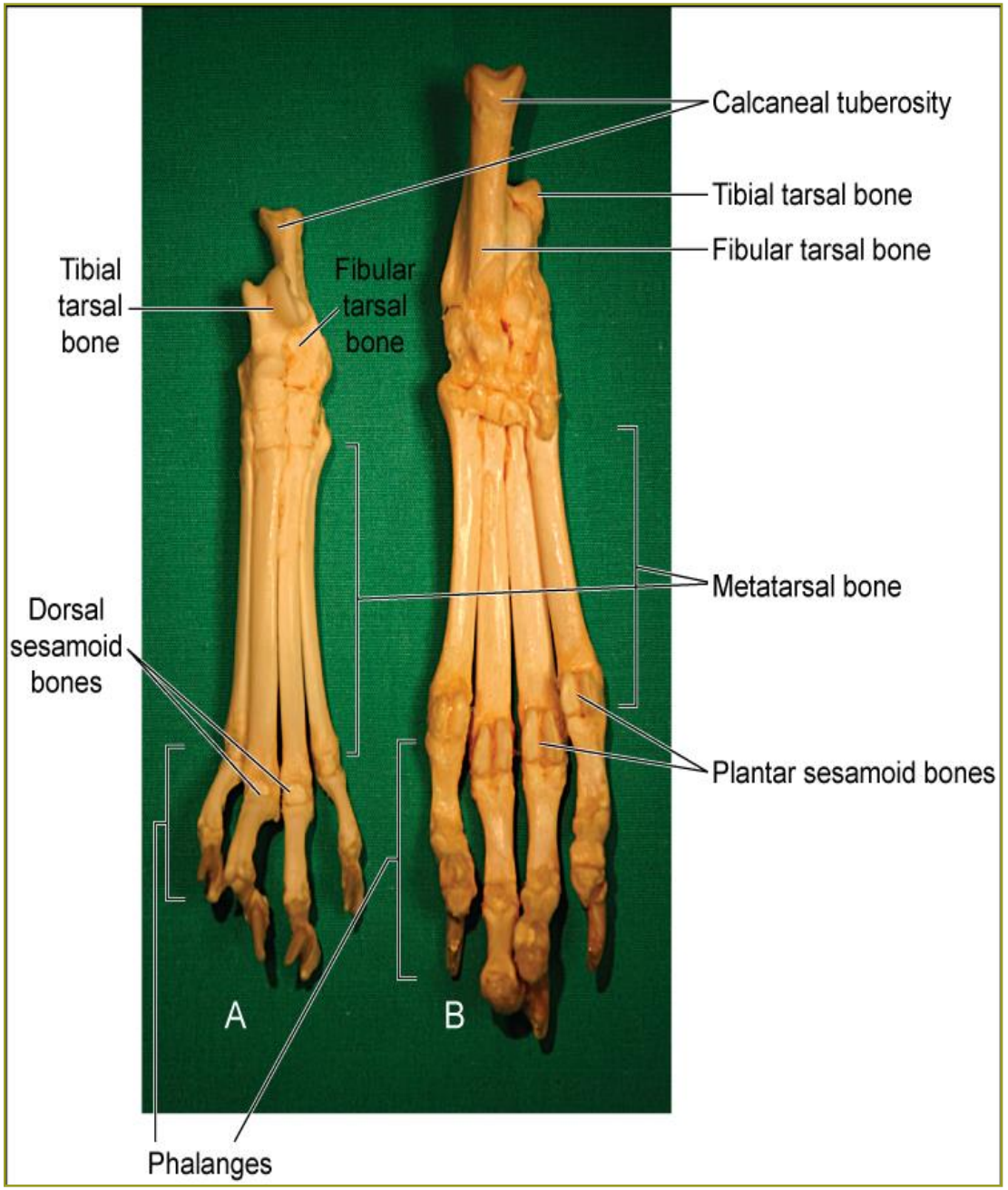
- Dogs & cats: four metatarsal bones (II to V)
- Horses: one large metatarsal bone (III) (cannon bone) and two small metatarsal bones (splint bones)



Pelvic Limb Phalanges

Figure 6-36, Page 185

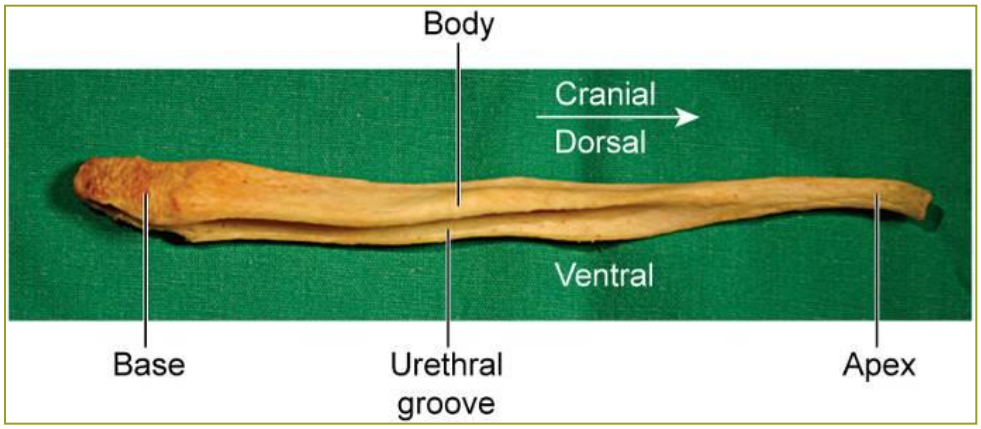
- Similar to thoracic limb phalanges
- Exceptions: dogs and cats
  - Usually only **4 digits** (II to V)



Visceral Skeleton

Figure 6-37, Page 185

- Bones that form in organs
- Examples
  - os cordis: in heart of cattle and sheep
  - os penis: in penis of dogs, beaver, raccoons, and walruses
  - os rostri: in nose of swine



Joints

Arthrology

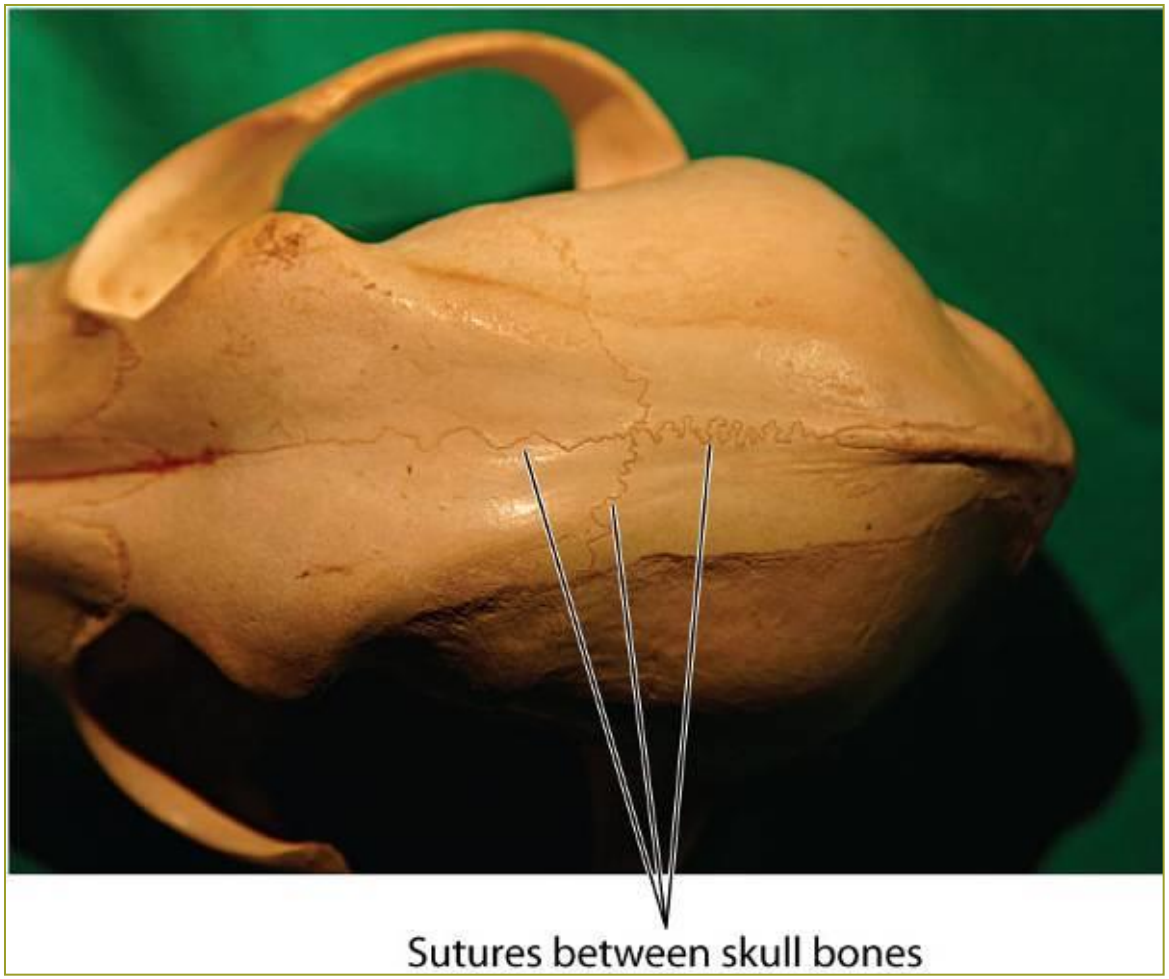
Joints

- Arthrology
- Types of joints
  - Fibrous joints (synarthroses)
    - Sutures, periodontal membrane
  - Cartilaginous joints (amphiarthroses)
    - Epiphyseal plate, costo-chondral junction, pelvic symphysis, intervertebral disc
  - Synovial joints (diarthroses)
    - All movable joints in the animal's body

Fibrous Joints (Synarthroses)

Figure 6-38, Page 186

- United by fibrous tissue
- Examples: sutures of skull, splint bones of horses



Cartilaginous Joints (Amphiarthroses)

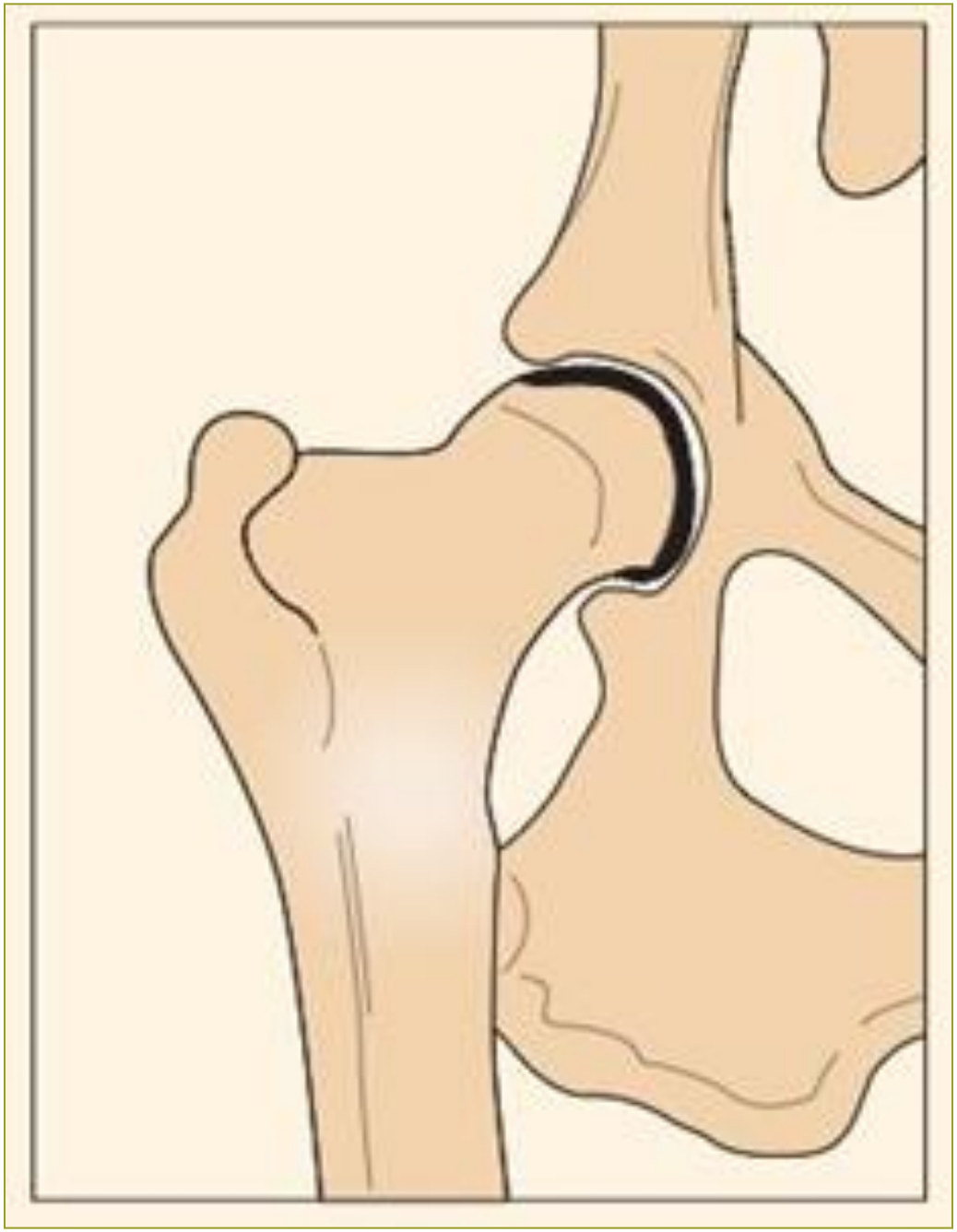
Figure 6-39, Page 186

- Capable of slight rocking movement
- Examples: mandibular symphysis, pubic symphysis, **intervertebral disks**

Synovial Joints (Diarthroses)

- Components
  - Articular surfaces on bones
  - Articular cartilage (hyaline) covering articular surfaces
  - Fluid-filled joint cavity enclosed by a joint capsule
    - Synovial membrane
    - Synovial fluid
  - Ligaments – fibrous connective tissue

Which Synovial Joint?



Answer – Hip Joint

Bassert Lab Manual – Page 131

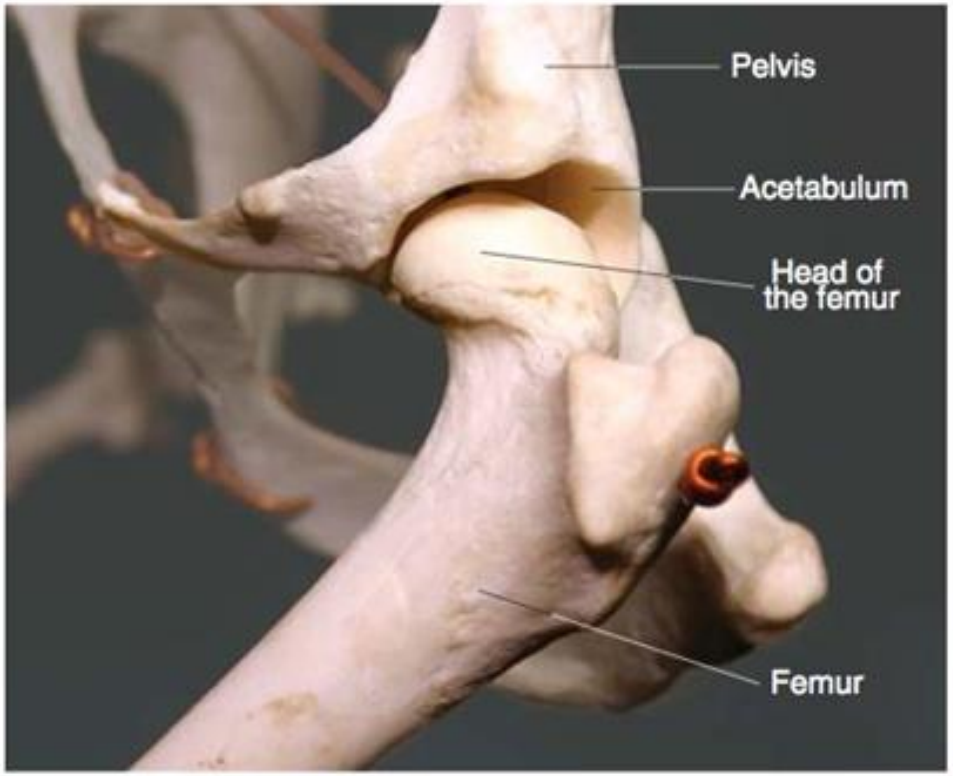
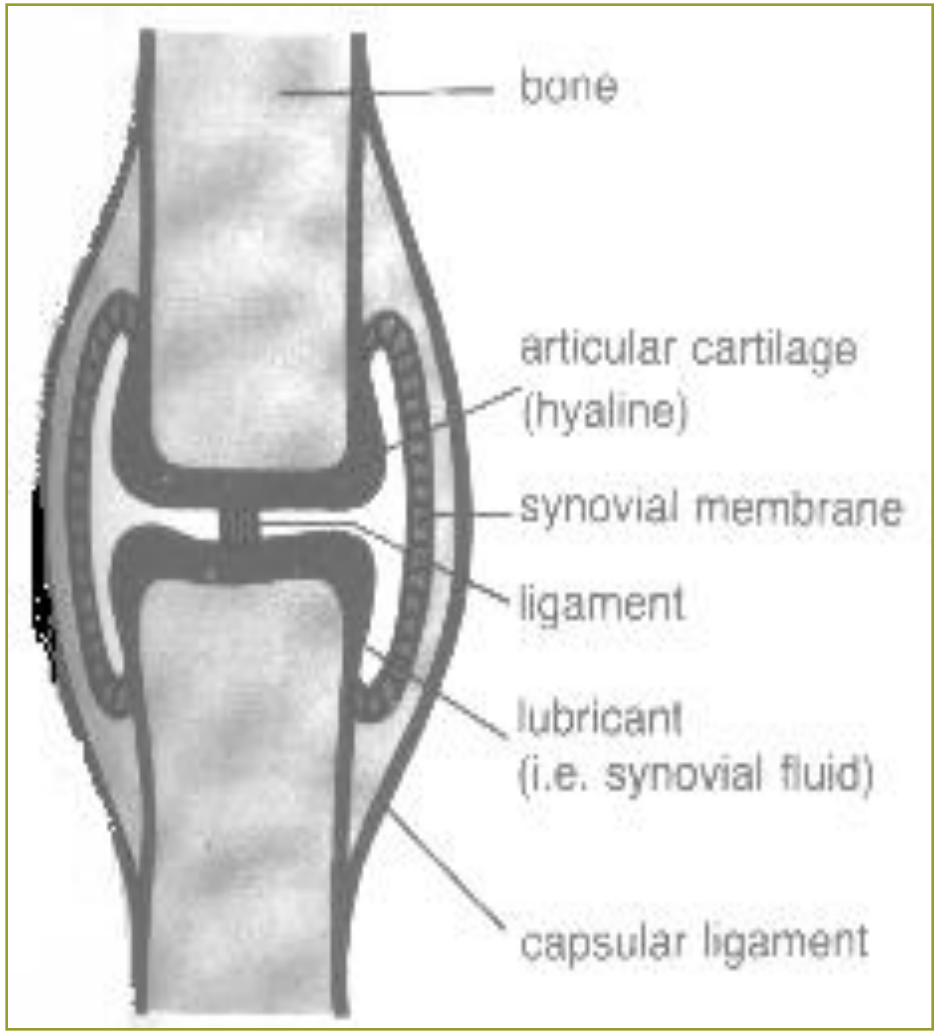
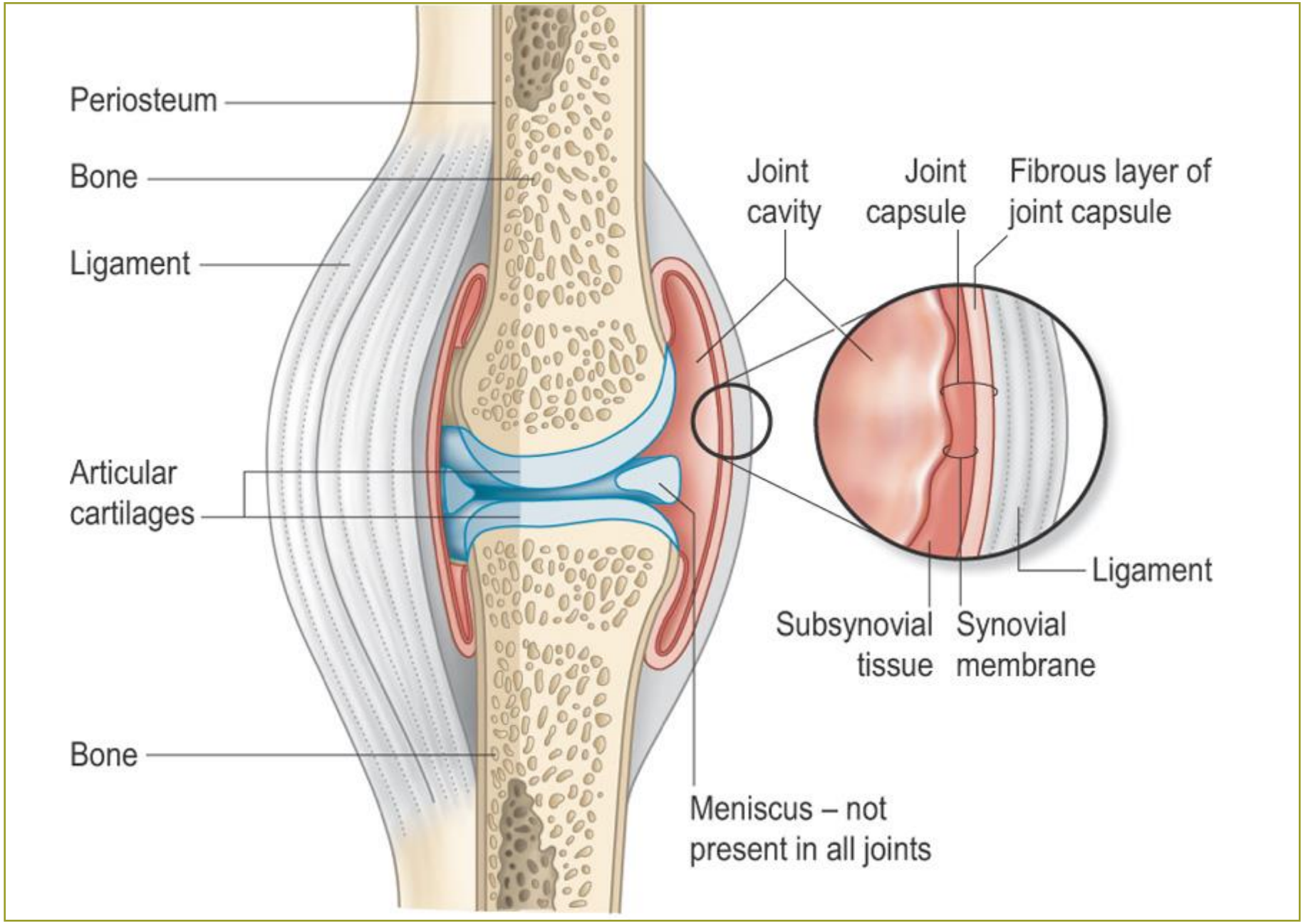


Figure 6-67 **Canine Hip Joint.** This is an example of a ball and socket joint. The ball is the head of the femur and the socket is the acetabulum in the pelvic bone.

Anatomy of a Synovial Joint

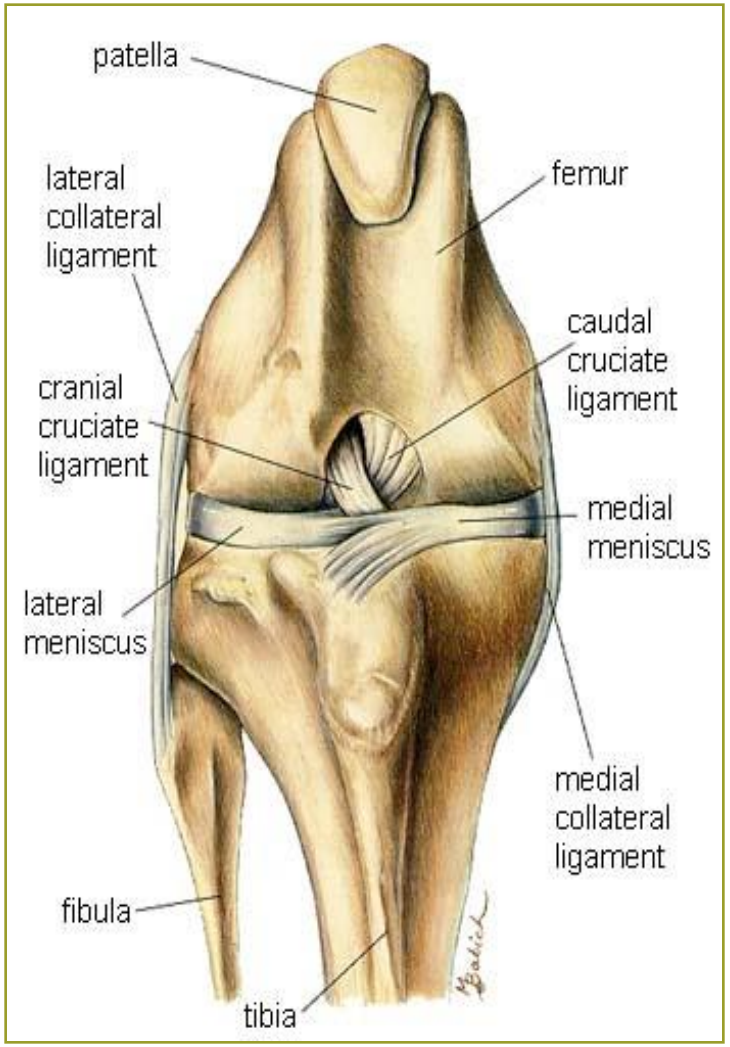
- Joint capsule
  - Ligaments
- Joint cavity space)
- Synovial membrane
- Synovial fluid
- Articular cartilage
  - (Hyaline cartilage)




Periosteum
Bone
Ligament
Articular cartilages
Bone
Meniscus – not present in all joints
Joint cavity
Joint capsule
Fibrous layer of joint capsule
Ligament
Subsynovial tissue
Synovial membrane

Anatomy of the Stifle (Knee) Joint

- Same structures as other synovial joints
- Meniscus
  - (medial & lateral)
- Extracapsular ligaments
  - (collateral)
- Intracapsular ligaments
  - (cruciate)



Types of Synovial Joints

Hinge joints

Gliding joints

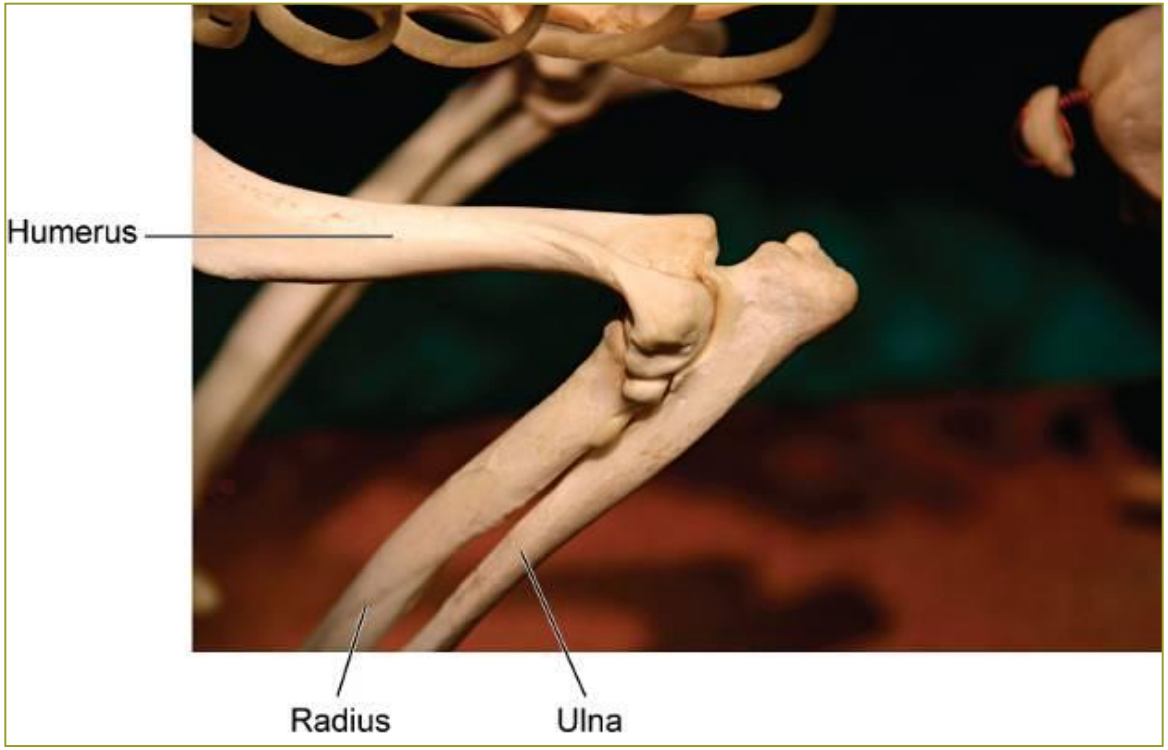
Pivot joints

Ball-and-socket joints

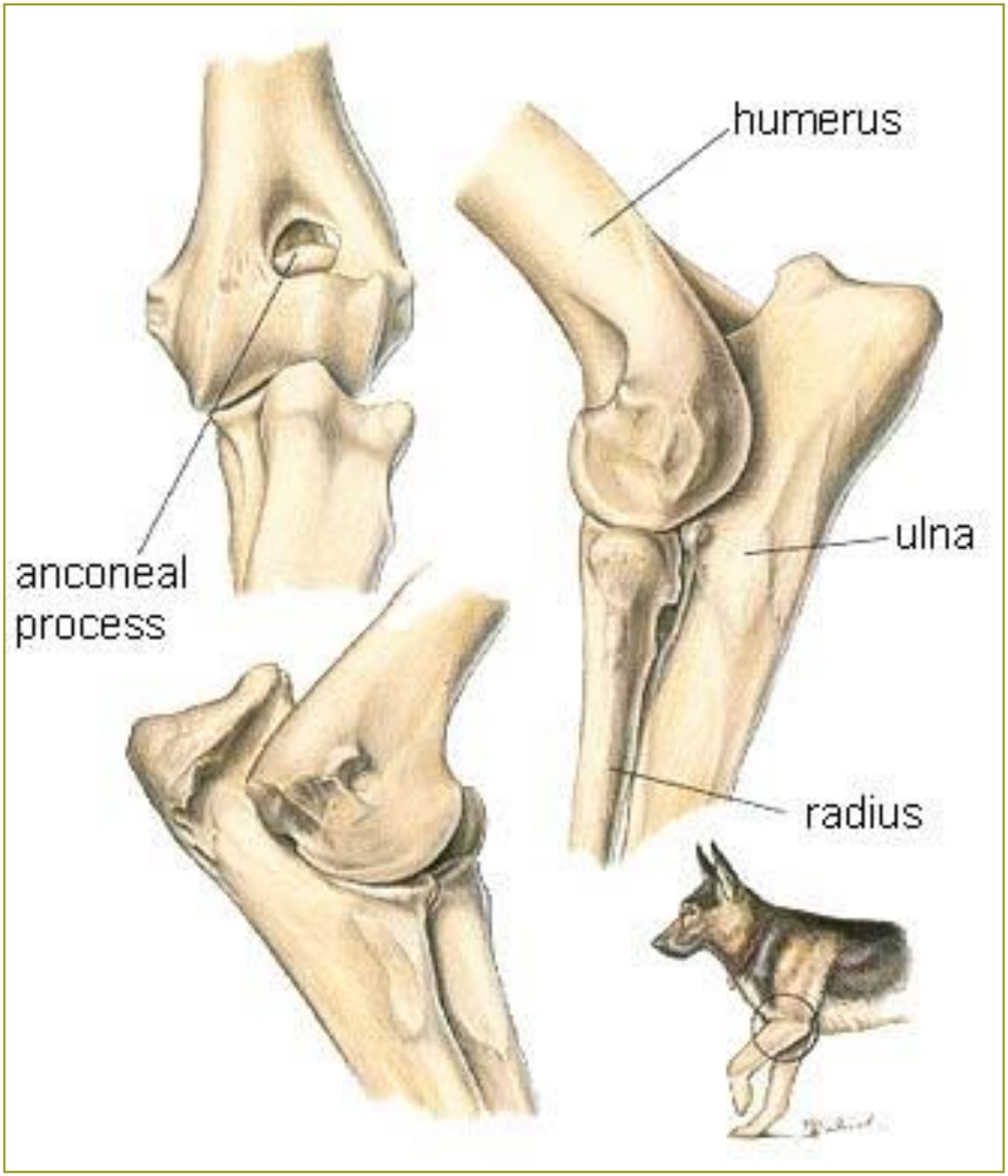
Hinge Joints

Figure 6-42, Page 188

- Ginglymus joints
- One joint surface swivels around another
- Only capable of flexion and extension
- Example: elbow joint



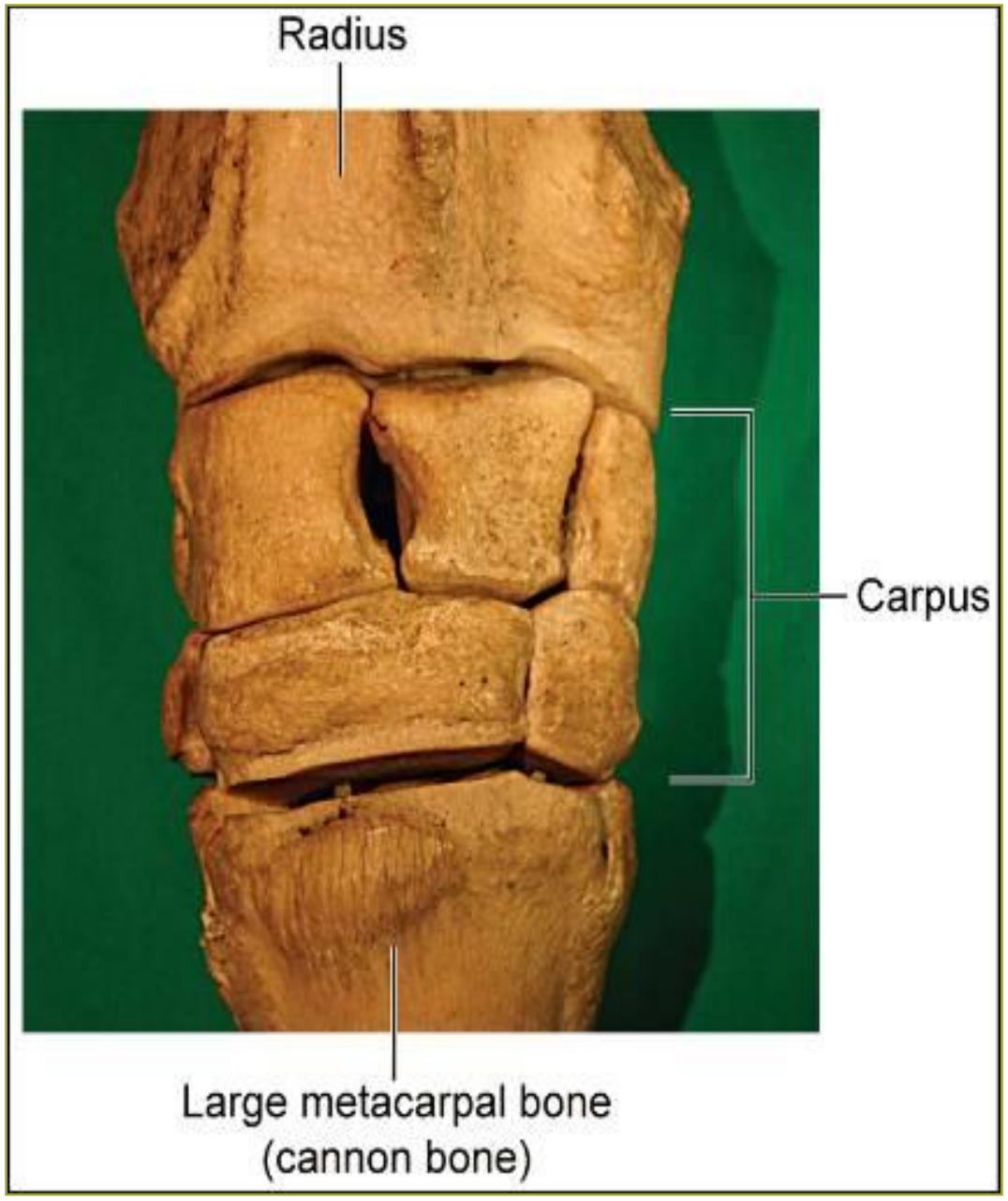
Ununited Anconeal Process (Elbow Dysplasia)



Gliding Joints

Figure 6-44, Page 189

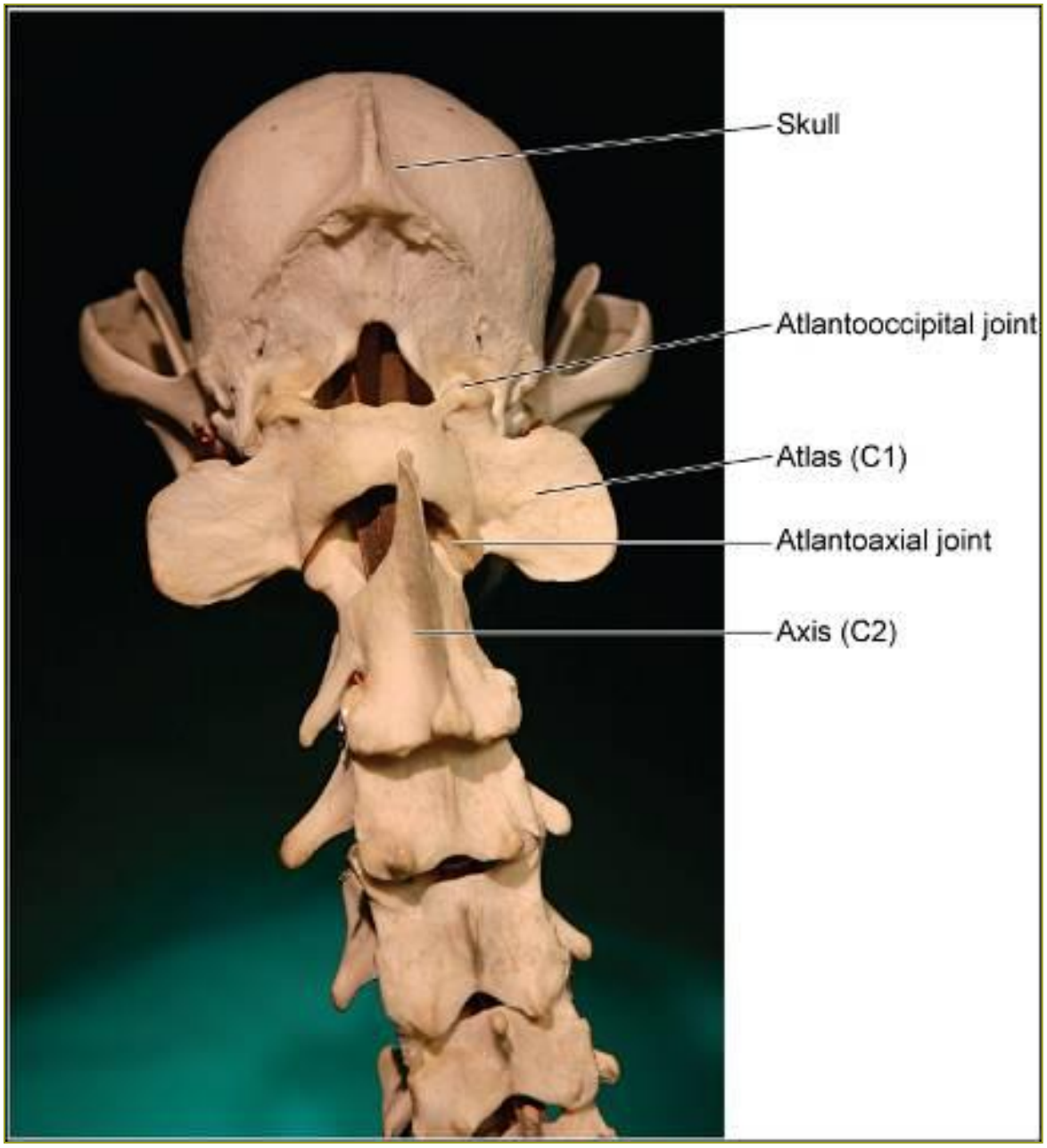
- Arthrodial joints
- Rocking motion of one joint surface on the other
- Primarily capable of flexion, extension
- Abduction, adduction possible
- Example: carpus



Pivot Joints

Figure 6-43, Page 189

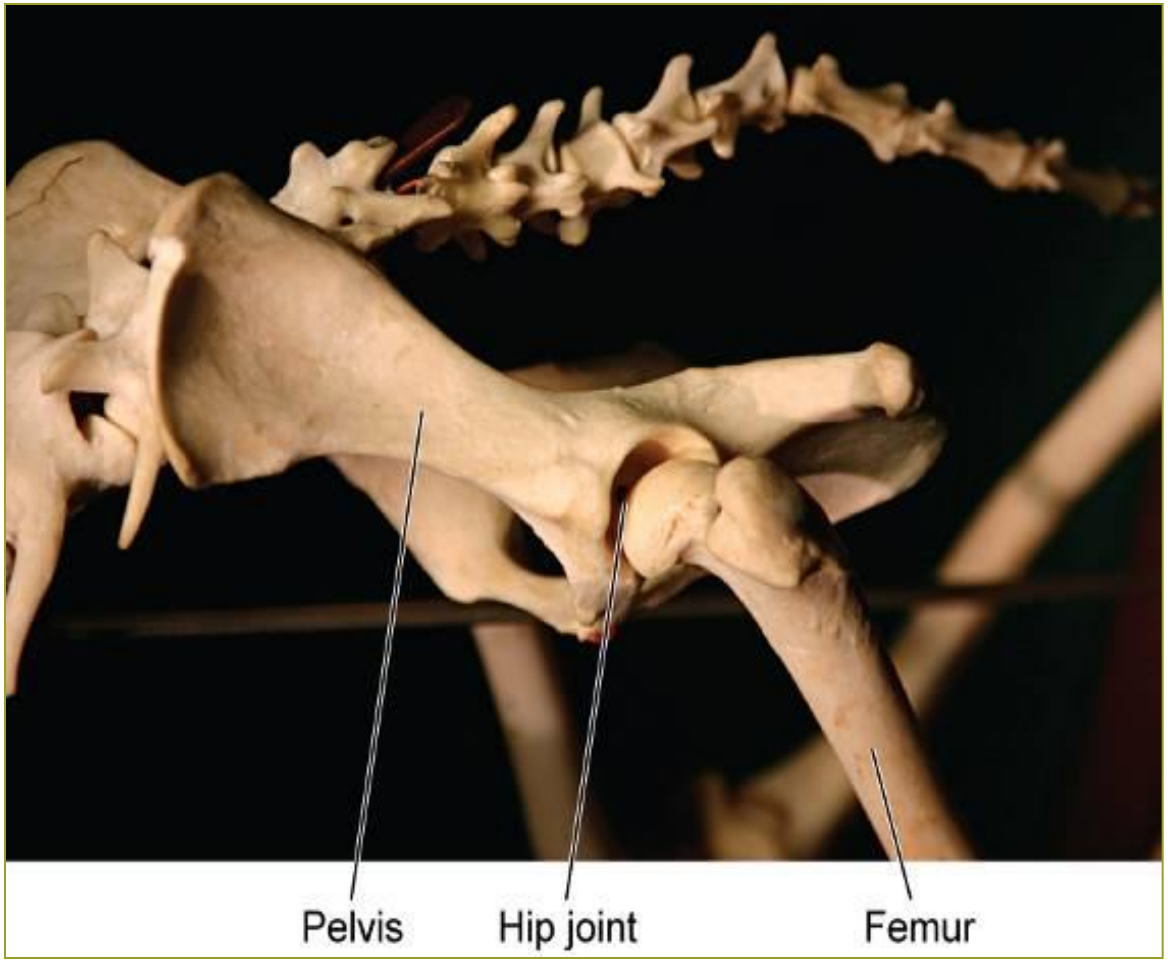
- Trochoid joints
- One bone pivots (rotates) on another
- Only capable of rotation
- Example: atlantoaxial joint



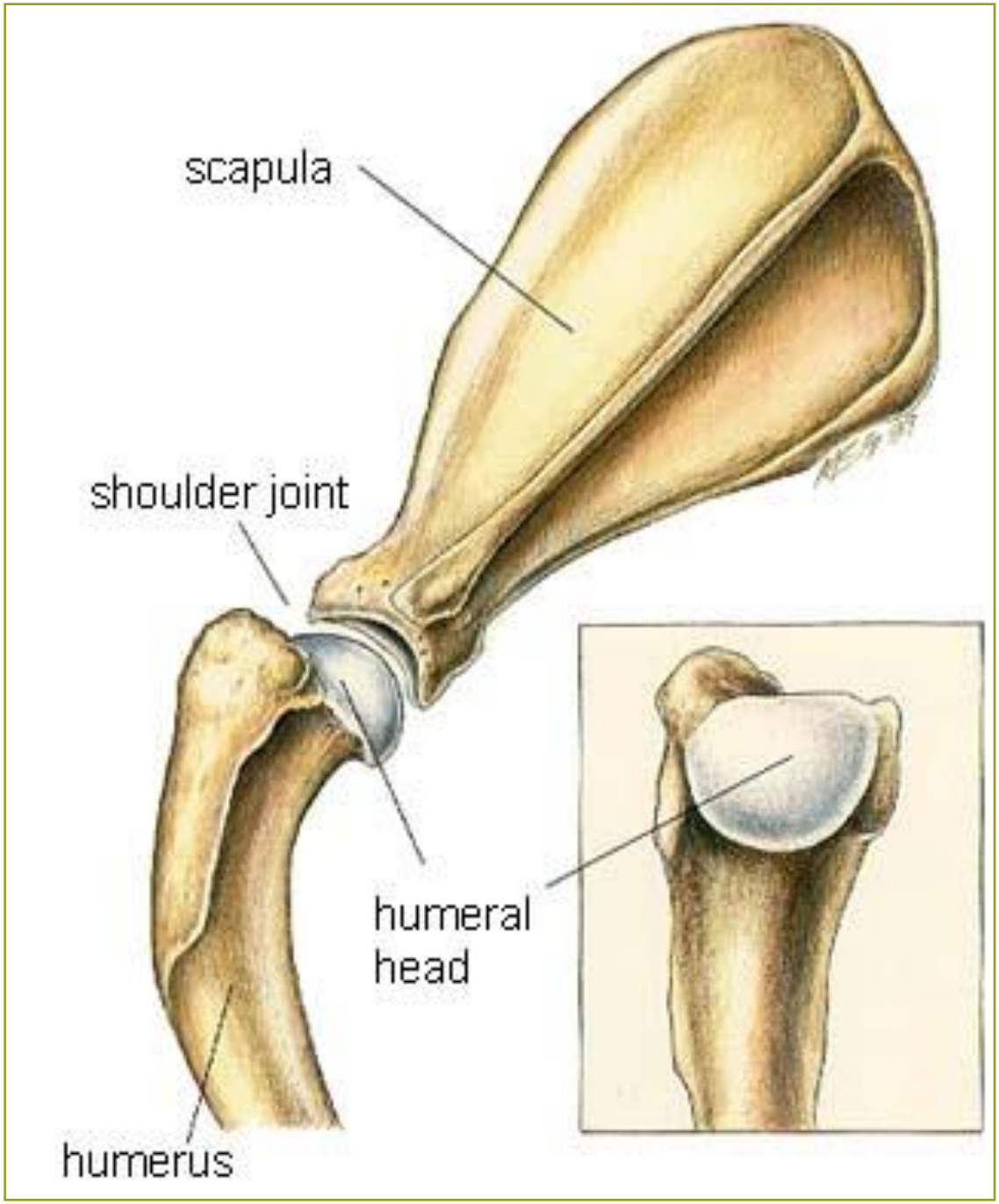
Ball-and-Socket Joints

Figure 6-43, Page 190

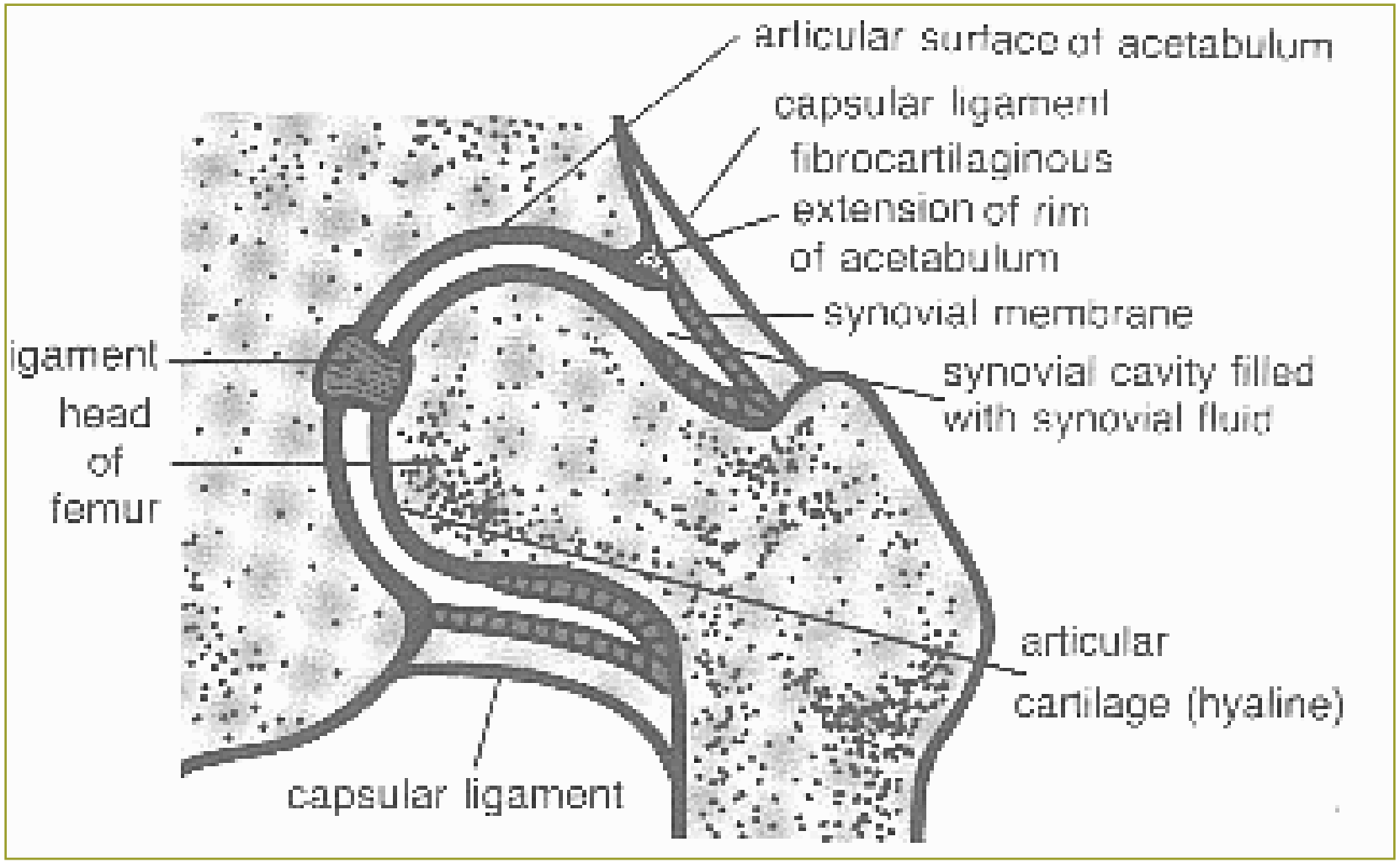
- Spheroidal joints
- Allow for **all** joint movements
- Examples: **shoulder** and **hip joints**



Ball & Socket Joint – Shoulder



Ball & Socket Joint – Hip



Synovial Joint Movements

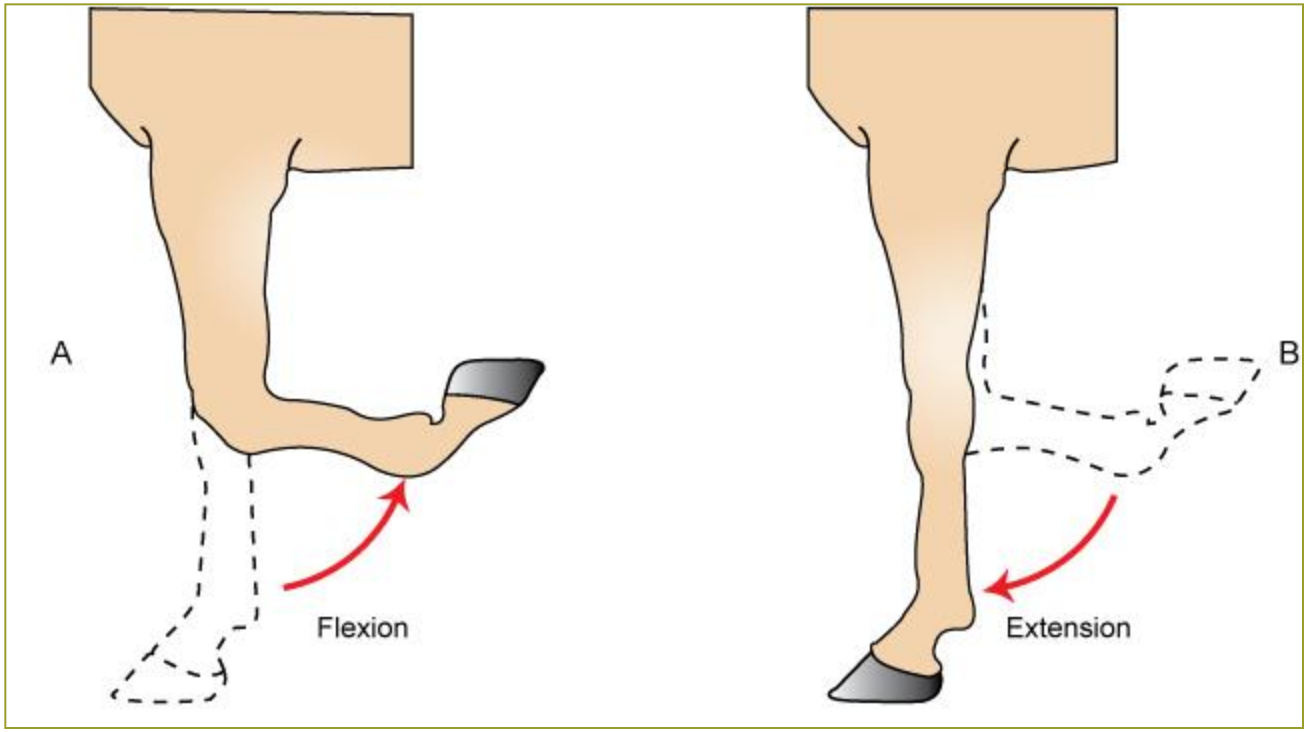
http://www.youtube.com/watch?v=dMH0bHeiRNg&eurl

- Flexion
- Extension
- Adduction
- Abduction
- Rotation
- Circumduction

Flexion and Extension

Figure 6-40-A & B, Page 187

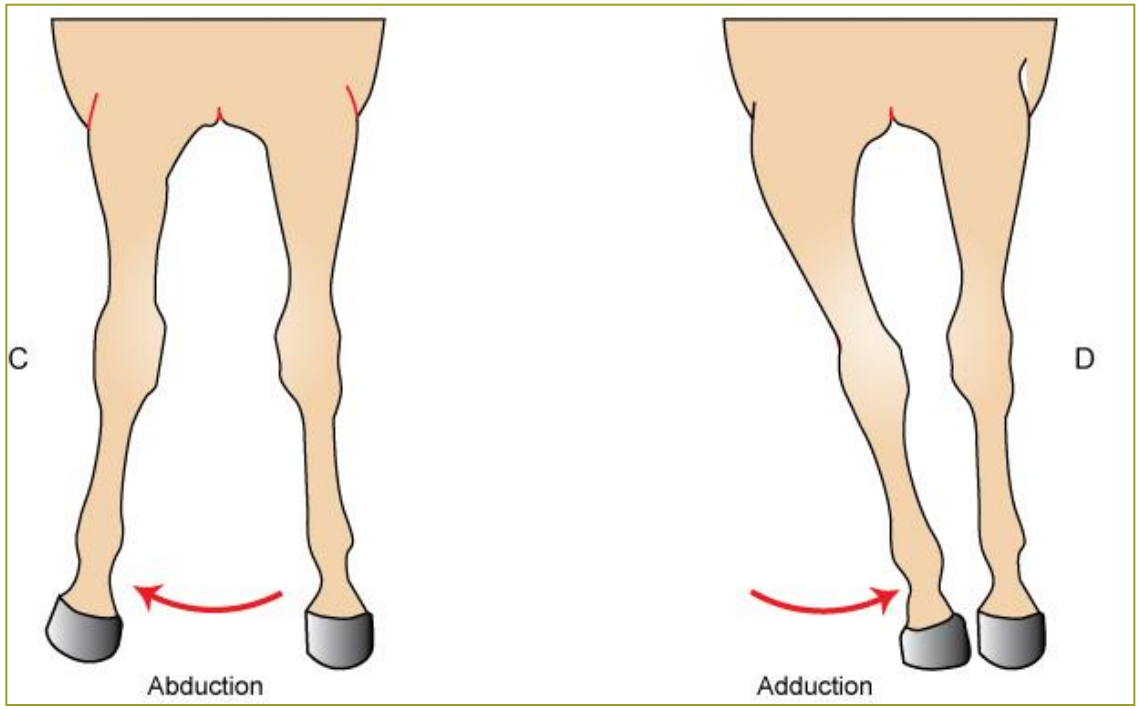
- Opposite movements
- Increase or decrease angle between two bones



Adduction and Abduction

Figure 6-40-C & D, Page 187

- Opposite movements
- Move an extremity toward or away from medial plane



Rotation & Circumduction

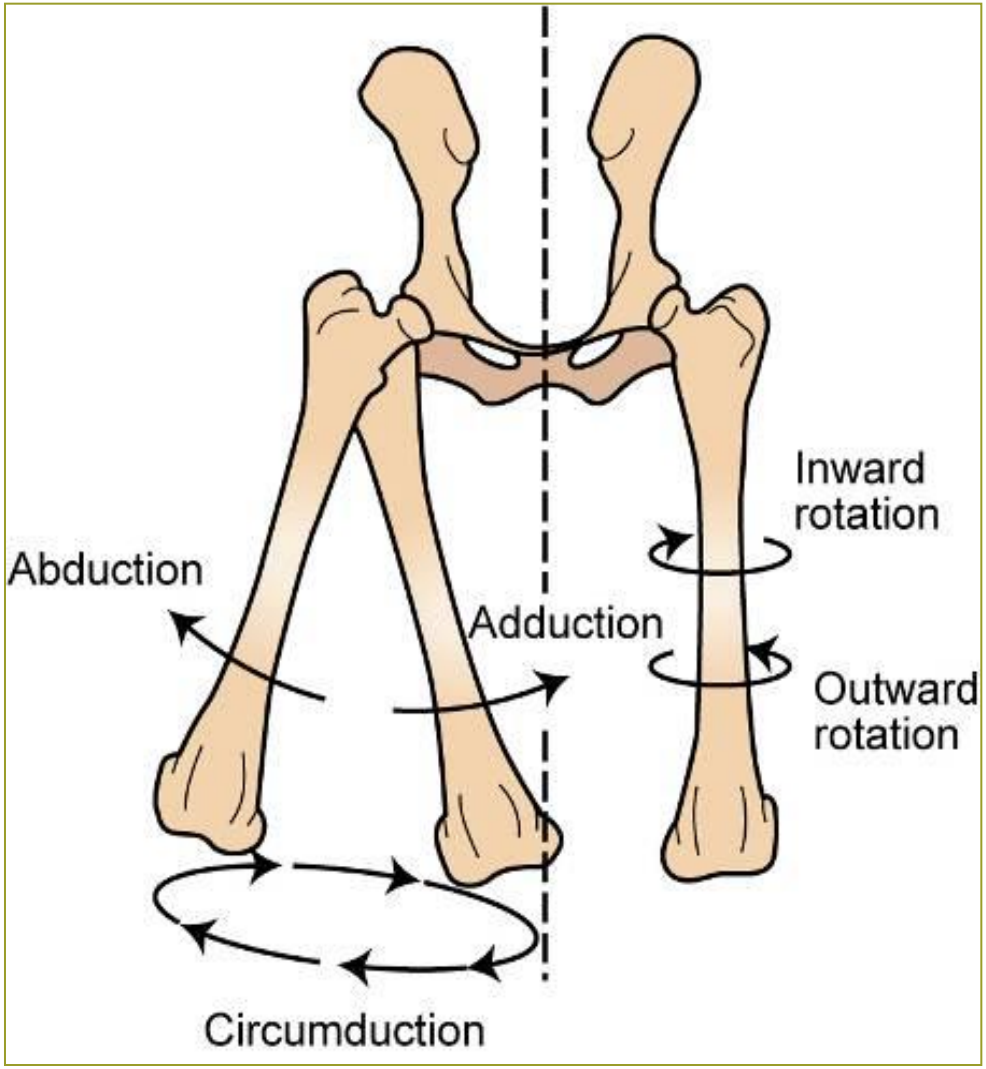
Figure 6-41, Page 188

Rotation

- Twisting movement of a part on its own axis

Circumduction

- Movement of an extremity so that the distal end moves in a circle



Skeletal System Pathology

Genetic

Nutritional

Traumatic

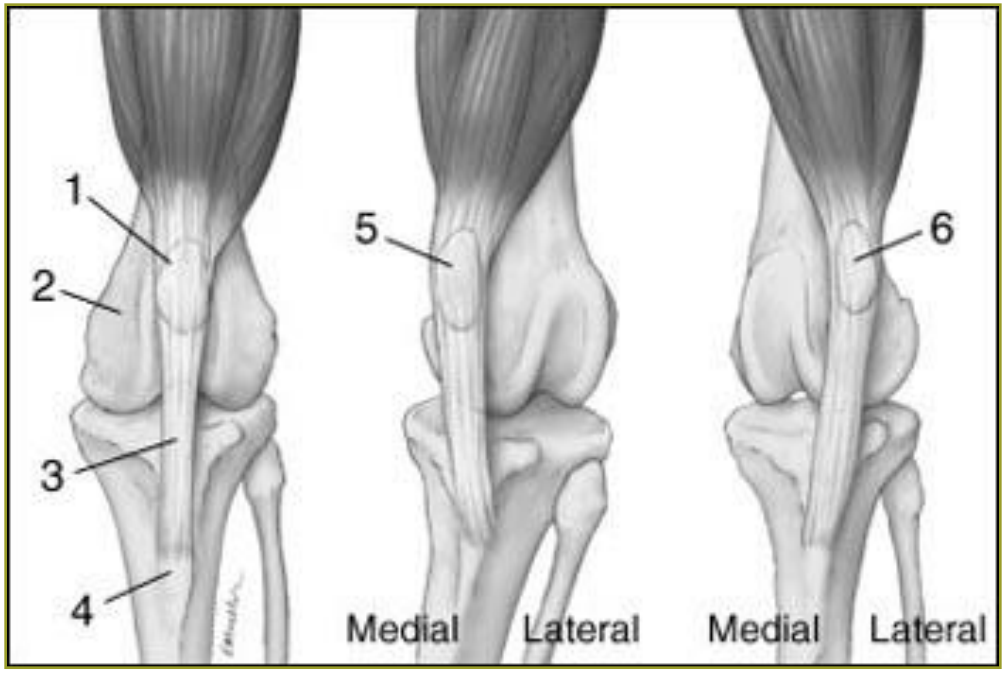
Genetic Pathology
Clinical Applications

- Ununited Anconeal Process (Elbow Dysplasia) (page 176)
- Hip Dysplasia (Page 182)
- Luxating Patellas (Page 184)
- Osteochondritis Dessicans (OCD)

Patellar Luxation

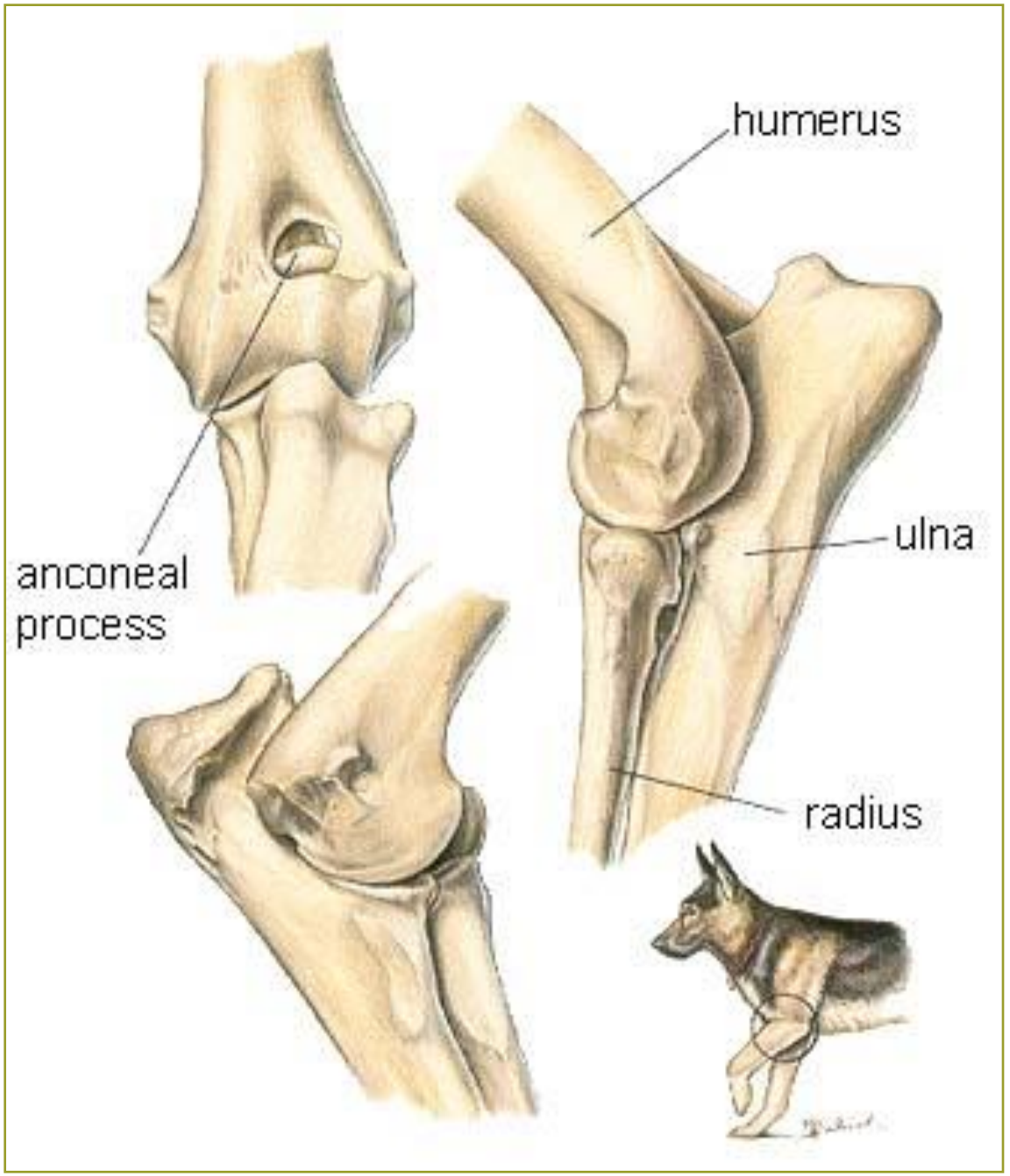
Clinical Application, Page 184

1. Patella
2. Femur
3. Patellar ligament
4. Tibial Tuberosity
5. Medial Luxation of Patella
6. Lateral Luxation of Patella



Ununited Anconeal Process

Clinical Application
Page 176



Hip Dysplasia

Clinical Application, Page 182

Anatomy & Pathology

Hip Dysplasia

http://www.merckmanuals.com/vet/musculoskeletal_system/arthropathies_and_related_disorders_in_small_animals/hip_dysplasia_in_small_animals.html?qt=&sc=&alt=

Hip Dysplasia in Small Animals

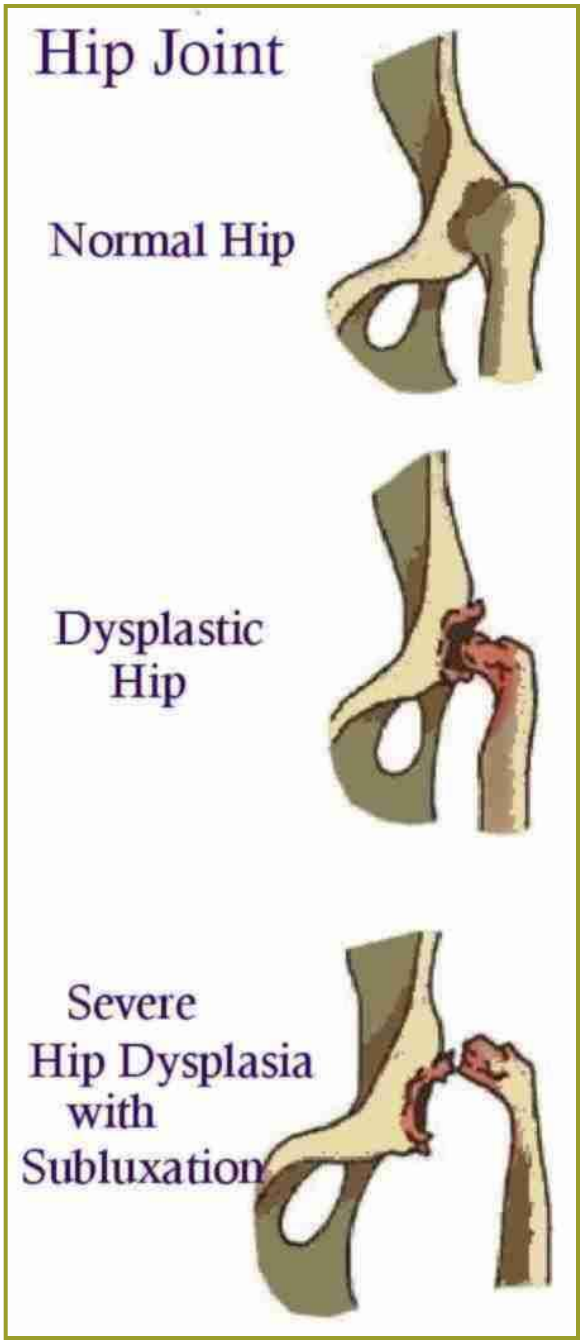
Hip dysplasia is a multifactorial abnormal development of the coxofemoral joint in large dogs that is characterized by joint laxity and subsequent degenerative joint disease. Excessive growth, exercise, nutrition, and hereditary factors affect the occurrence of hip dysplasia. The pathophysiologic basis for hip dysplasia is a disparity between hip joint muscle mass and rapid bone development. As a result, coxofemoral joint laxity or instability develops and subsequently leads to degenerative joint changes, eg, acetabular bone sclerosis, osteophytosis, thickened femoral neck, joint capsule fibrosis, and subluxation or luxation of the femoral head.

Clinical signs are variable and do not always correlate with radiographic abnormalities. Lameness may be mild, moderate, or severe, and is pronounced after exercise. A "bunny-hopping" gait is sometimes evident. Joint laxity (Ortolani sign), reduced range of motion, and crepitation and pain during full extension and flexion may be present. Radiography is useful in delineating the degree of arthritis and planning of medical and surgical treatments. Standard ventrodorsal views of sedated or anesthetized animals can be graded by the Orthopedic Foundation for Animals, or stress radiographs performed and joint laxity measured (Penn Hip). A dorsal acetabular rim view is used by some surgeons to evaluate the acetabulum before reconstructive surgery. Modified ventrodorsal and dorso-ventral projections have also been proposed in an effort to mimic the normal standing posture of dogs.

Treatments are both medical and surgical. Mild cases or nonsurgical candidates (due to health or owner constraints) may benefit from weight reduction, restriction of exercise on hard surfaces, controlled physical therapy to strengthen and maintain muscle tone, anti-inflammatory drugs (eg, aspirin, corticosteroids, NSAID), and possibly joint fluid modifiers. Surgical treatments include pectineal myotenectomy to reduce pain, triple pelvic osteotomy to prevent subluxation, pubic fusion to prevent subluxation, joint capsule denervation

Hip dysplasia, German Shepherd

Surgery to Repair?



Nutritional Pathology

- Rickets
- Hypocalcemia
  - Eclampsia
  - “Milk fever”

Traumatic Pathology

- Cruciate Ligaments (Page 187)
- Navicular Disease (Equine) (Page 181)
- Fractures
- Arthritis
  - Acute
  - Chronic, degenerative
- Laminitis (Page 152)
- Ankylosis

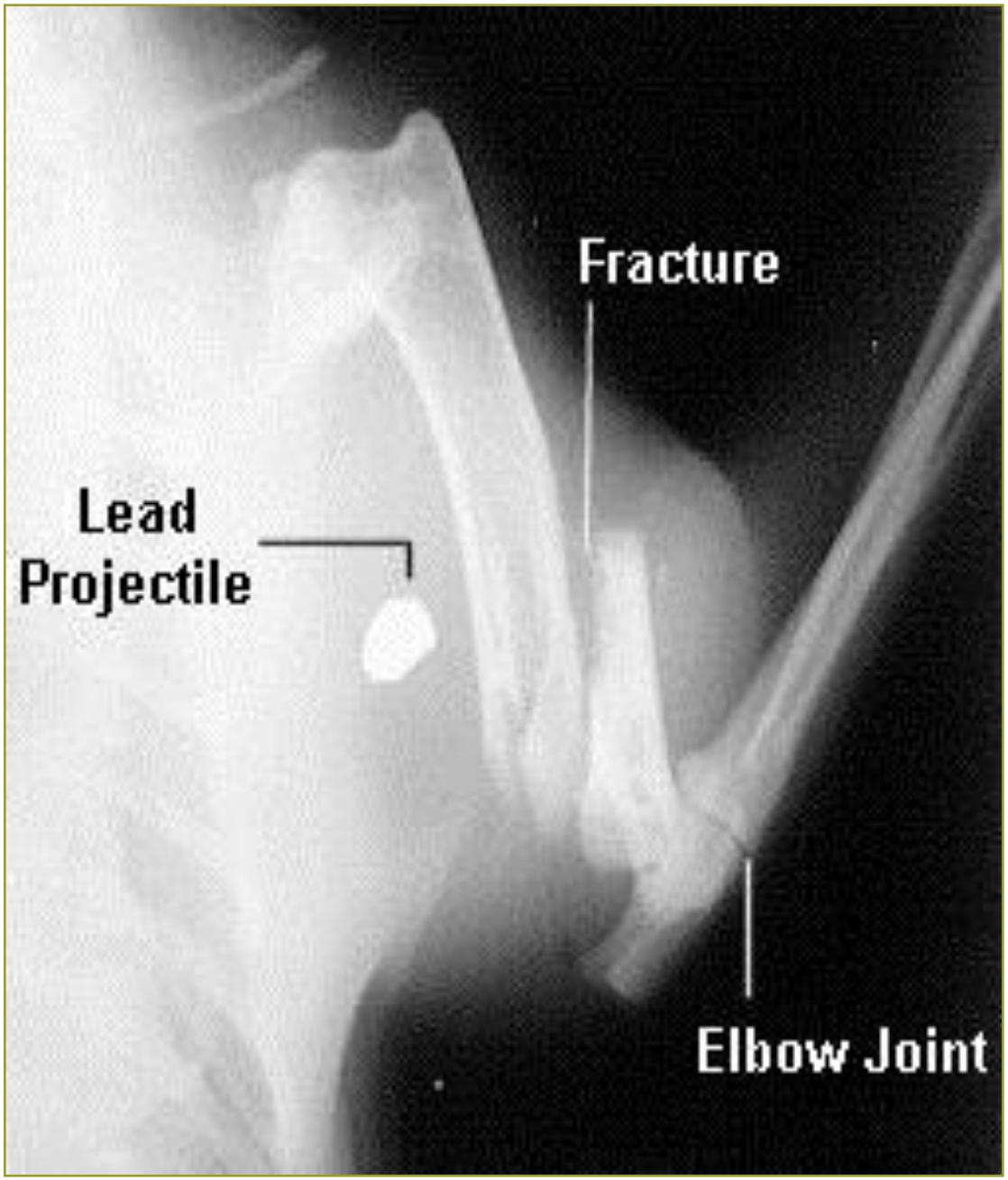
Fractures

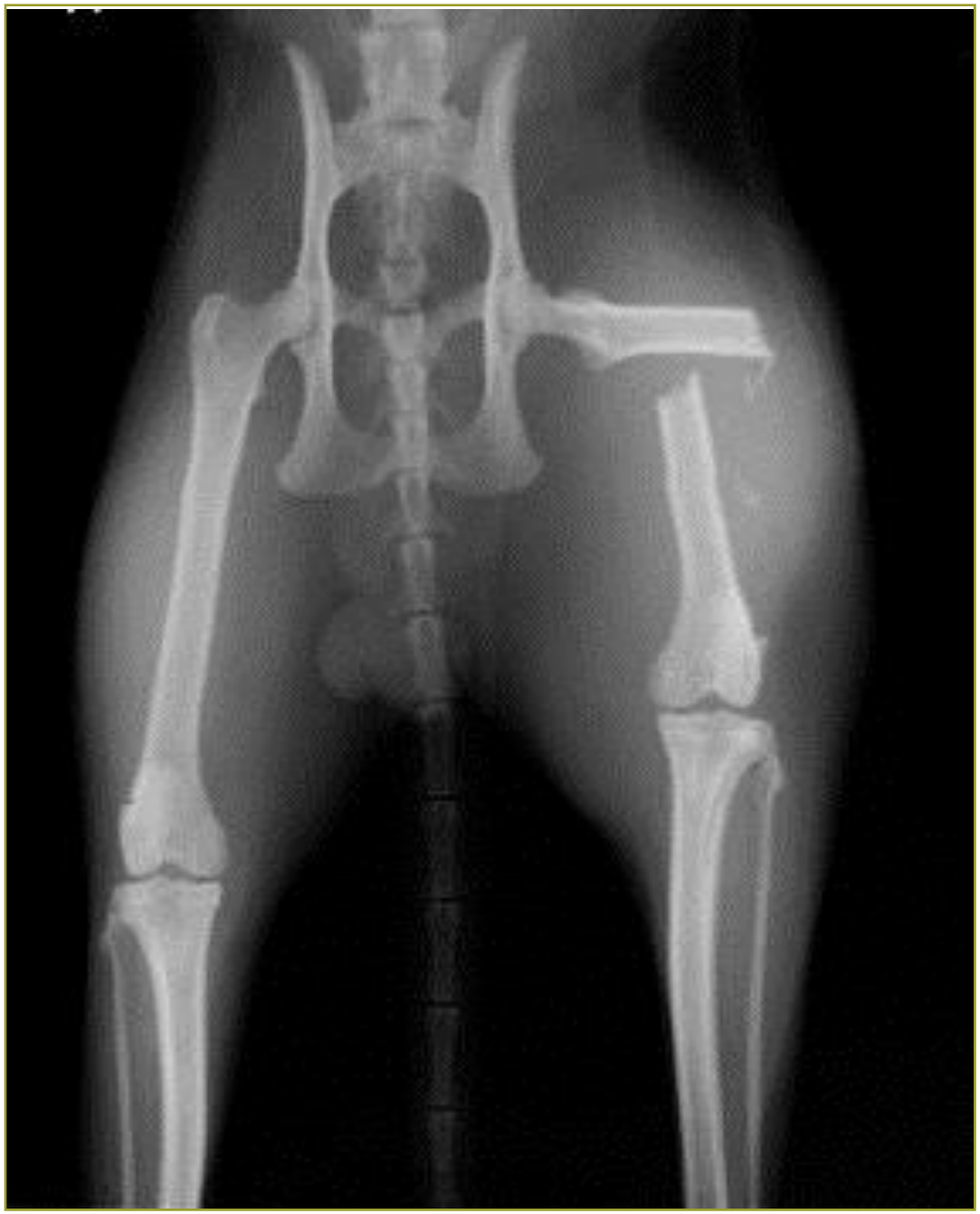
Clinical Application, Page 158

- Automobile accidents most common cause
- #1 bone fractured – Femur
- #2 bone fractured – Pelvis……. Why?

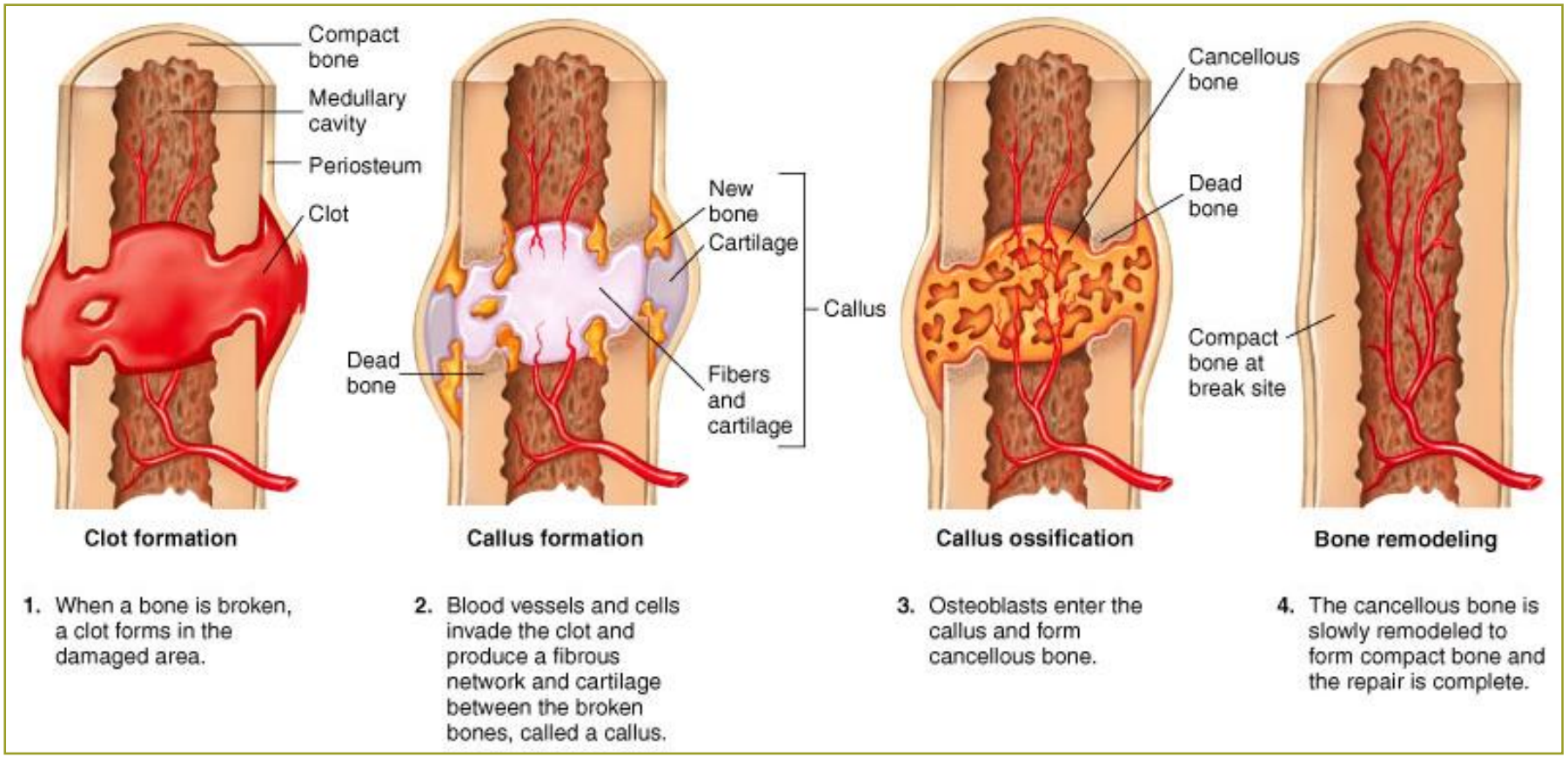
Common Types of Fractures

- Closed (simple) -- no break in skin
- Open (compound) -- skin broken
- Comminuted -- broken ends of bones are fragmented
- Greenstick -- partial fracture
  - Young animals with bones not yet calcified


Fracture
Lead
Projectile
Elbow Joint



Steps in Healing of Fractures



Clinical Application!

Fracture Repair, Page 158

CLINICAL APPLICATION

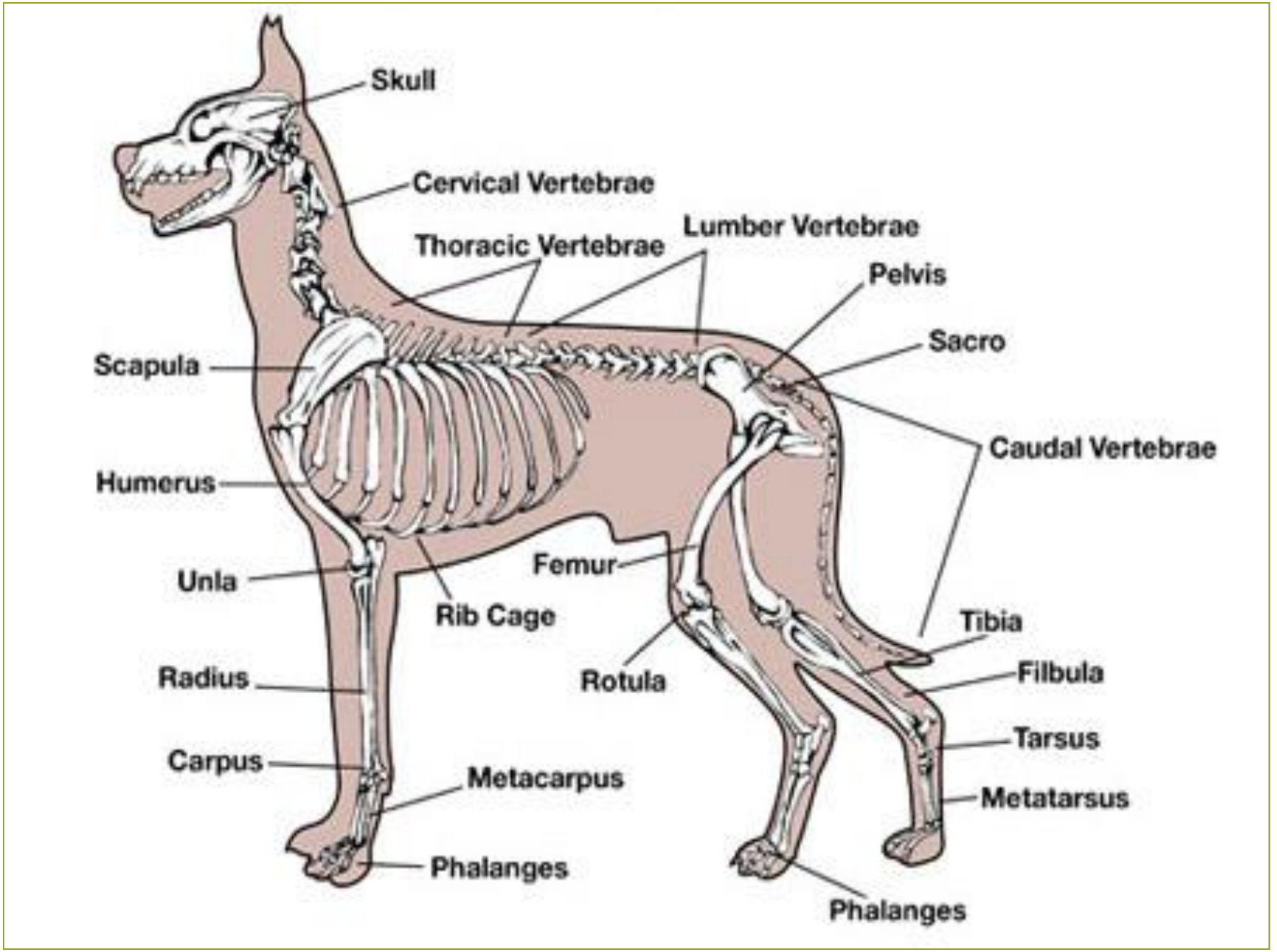
Fracture Repair

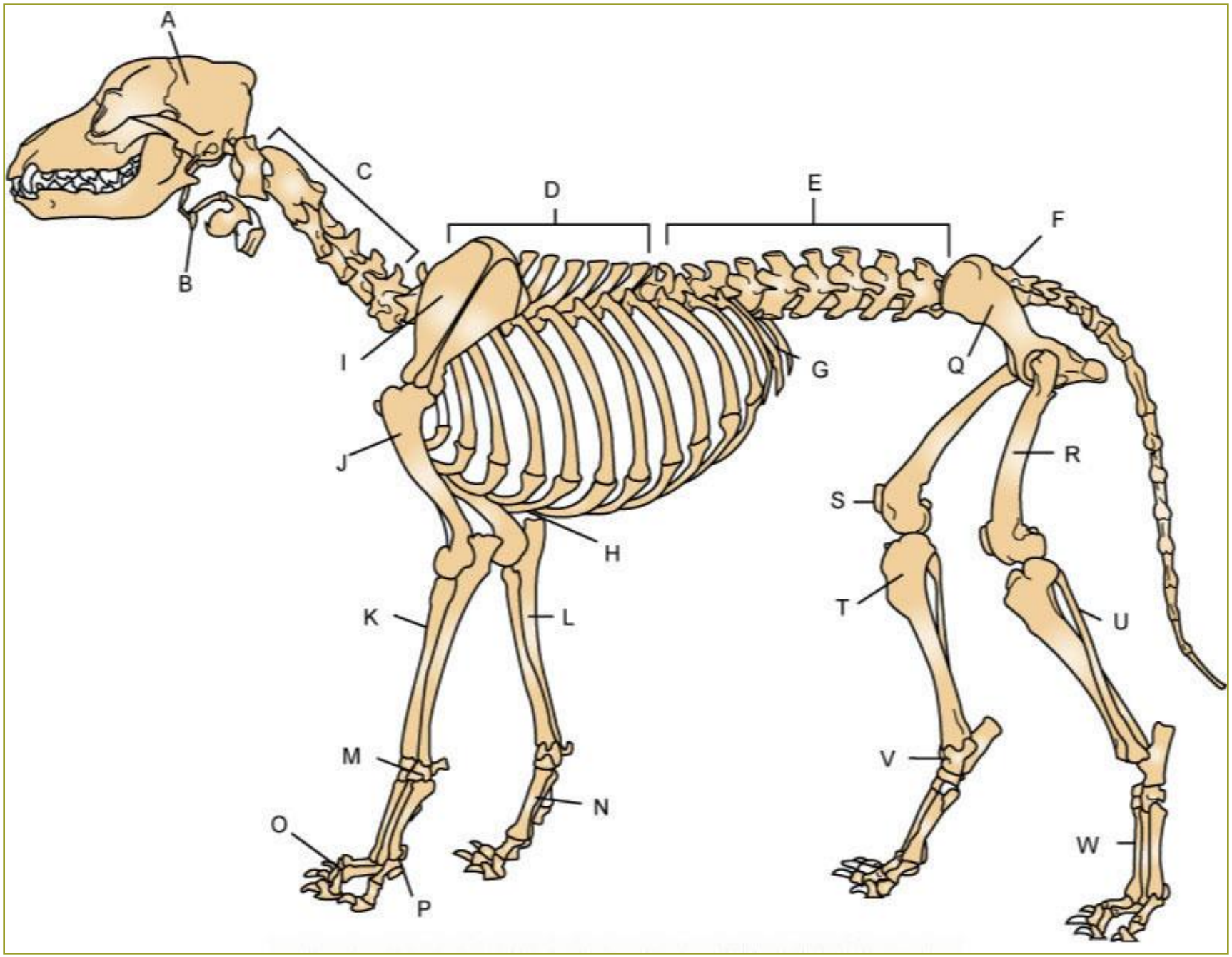
Bones are among the best healing tissues in the body. When bones are broken, three things are necessary for optimal healing to occur: *alignment, immobilization*, and *time*. The fractured ends must be brought close together in reasonable alignment and must be kept from moving apart until healing processes have had adequate time to effect new bone growth. Alignment of the fractured fragments is called *setting* or *reducing* the fracture; immobilization is called *fixation* of the fracture.

External fixation devices such as splints and casts may be used, as can internal devices such as pins, wires, screws, or plates, which must be surgically implanted. The length of time that the fixation device must be kept in place varies with the type and location of the fracture and must take into consideration the physical characteristics of the animal. Factors such as species, age, physical condition, and size of the animal affect the speed of healing. In a small, young animal, the whole process might only take a couple of weeks; in an older or larger animal, it might take several months or more.

Regardless of the type and location of the fracture, the basic healing processes are the same. The large blood supply of bones results in considerable bleeding (hemorrhage) at the fracture site. After the blood begins to clot, forming what is called the *fracture hematoma*, the bone is gradually infiltrated by healing cells and tissues over the next few weeks and months. Osteoblasts from the area form the healing tissue, called the **callus,** that gradually bridges the fracture gap. The callus can be felt as a lump at the fracture site, and the size of the callus is an indicator of how much movement has been occurring between the fracture fragments. The less movement, the smaller the callus. Fractures with small calluses generally heal faster, which is usually our treatment goal. Once the callus is fully formed and mineralized, the basic healing of the fracture is complete; however, what occurs after that is very important. Over the next few months, the body slowly remodels the bone at the fracture site according to the mechanical stresses that are placed on it. Ideally, this gradual remodeling will return the bone to its original size, shape, and strength.

Canine Skeleton Review


Skull
Cervical Vertebrae
Thoracic Vertebrae
Lumber Vertebrae
Pelvis
Sacro
Scapula
Caudal Vertebrae
Humerus
Femur
Unla
Rib Cage
Tibia
Rotula
Filbula
Radius
Tarsus
Carpus
Metacarpus
Metatarsus
Phalanges
Phalanges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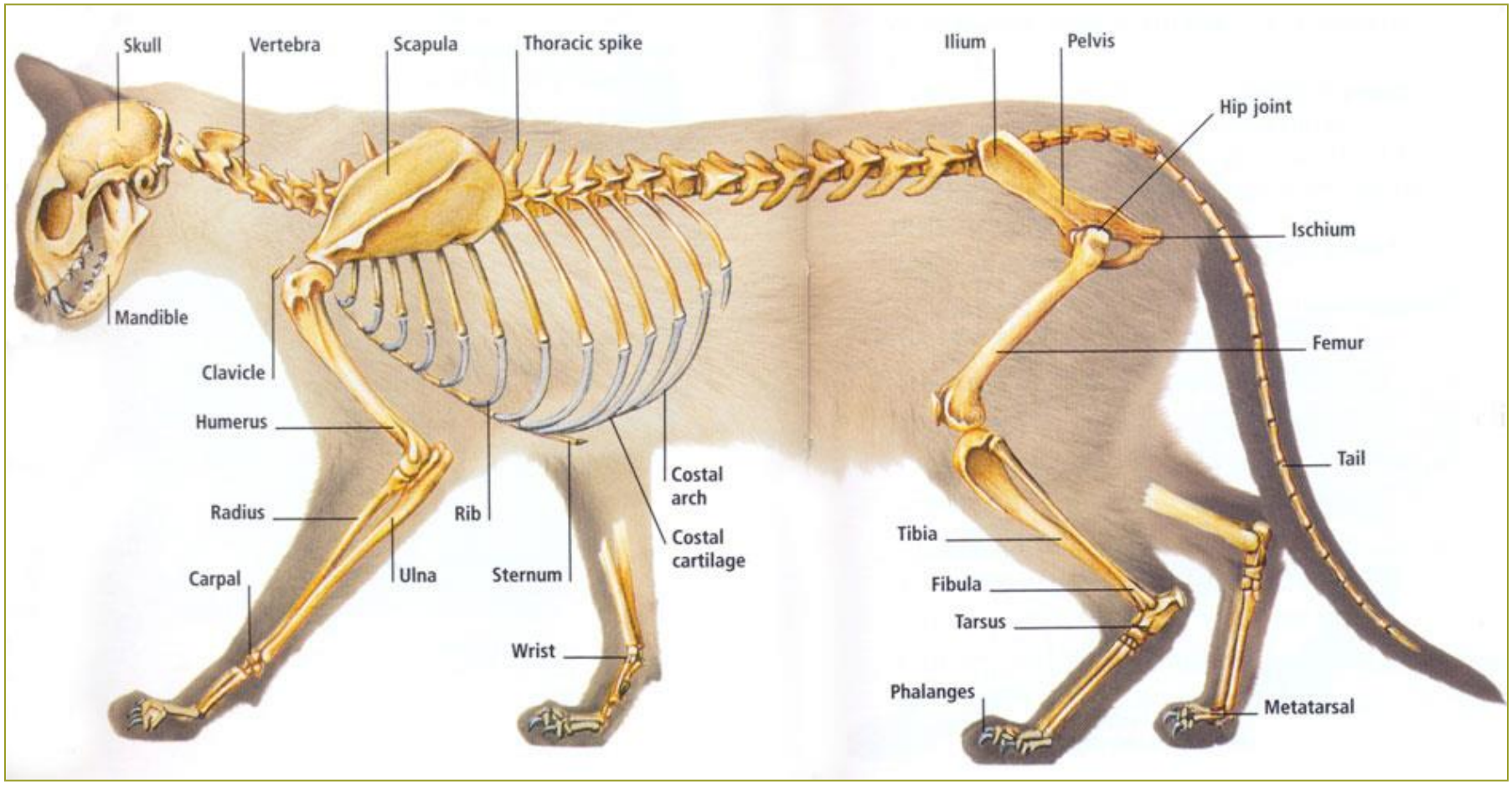
Feline Skeleton Review


Skull
Vertebra
Scapula
Thoracic spike
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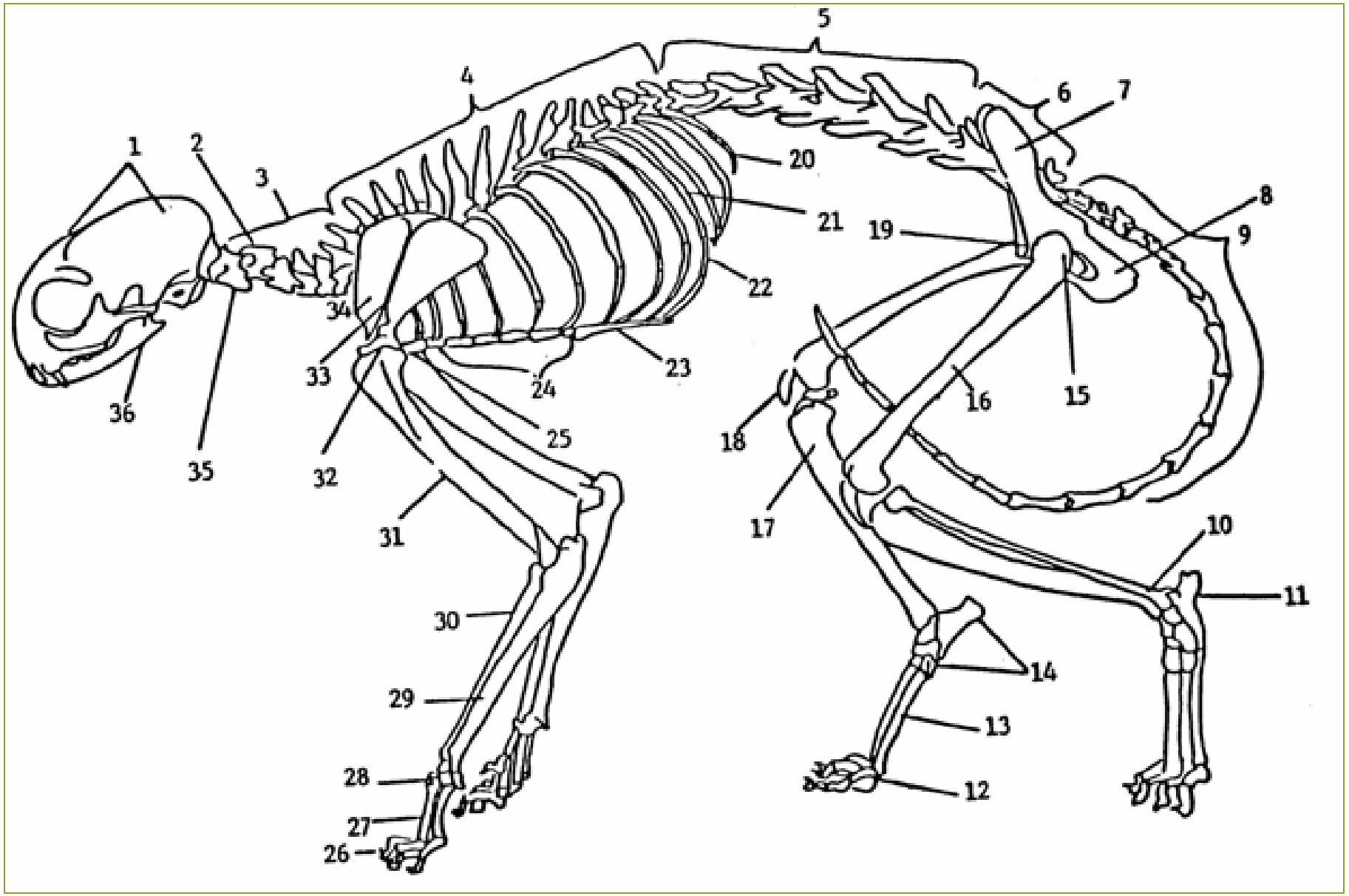
Pelvis
Hip joint
Ischium
Mandible
Clavicle
Femur
Humerus
Tail
Costal arch
Radius
Rib
Costal cartilage
Tibia
Ulna
Sternum
Carpal
Fibula
Tarsus
Wrist
Phalanges
Metatarsal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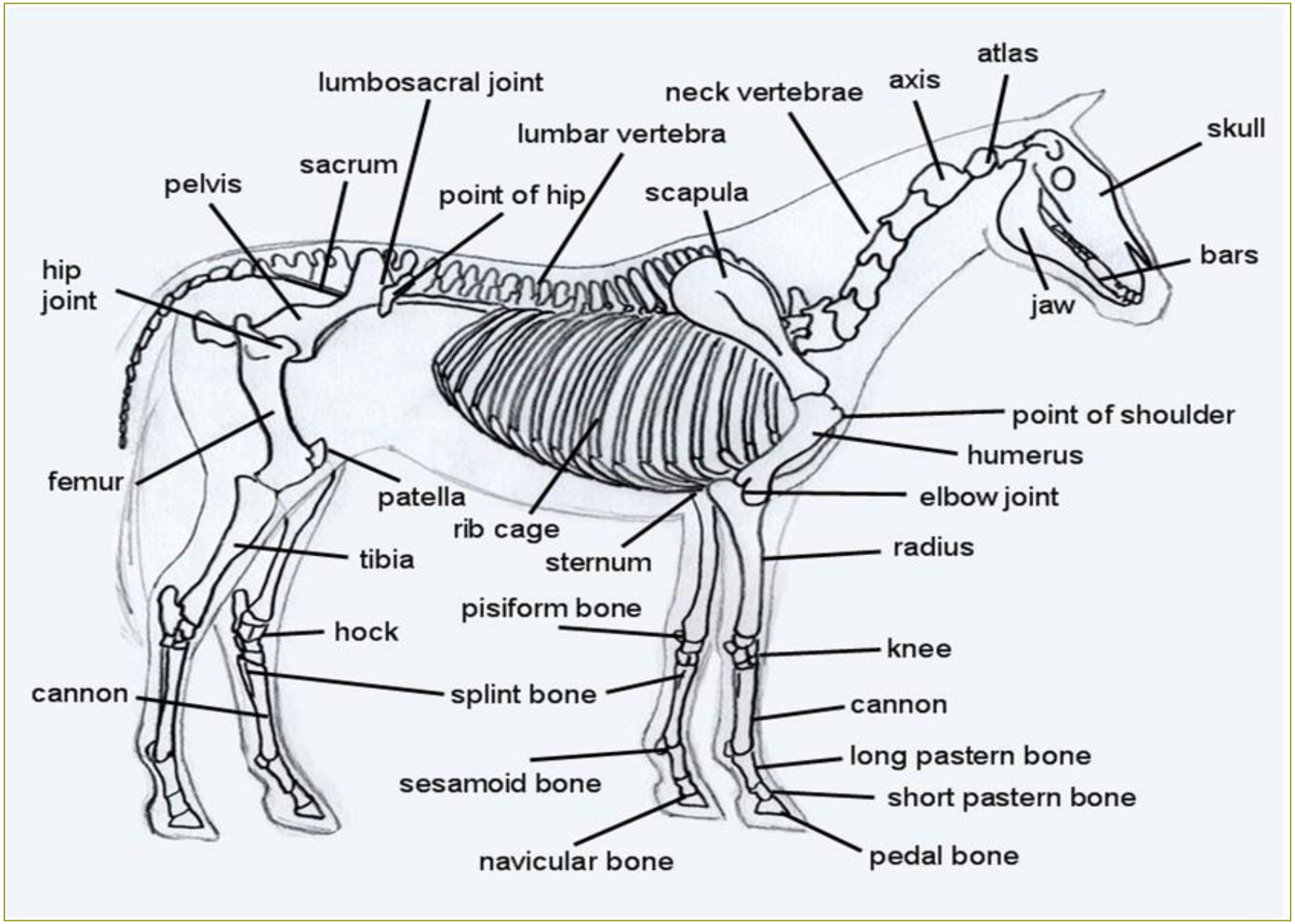
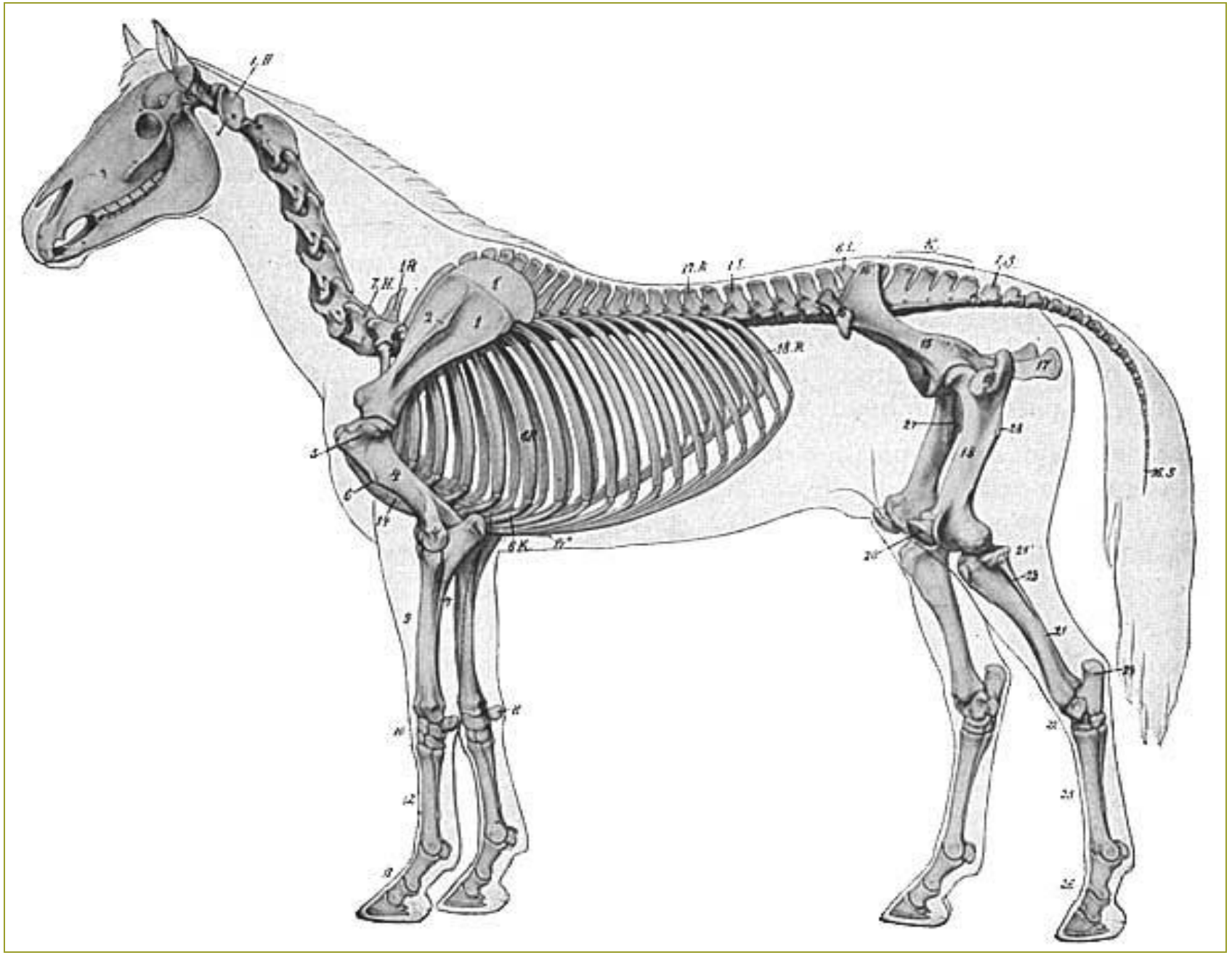
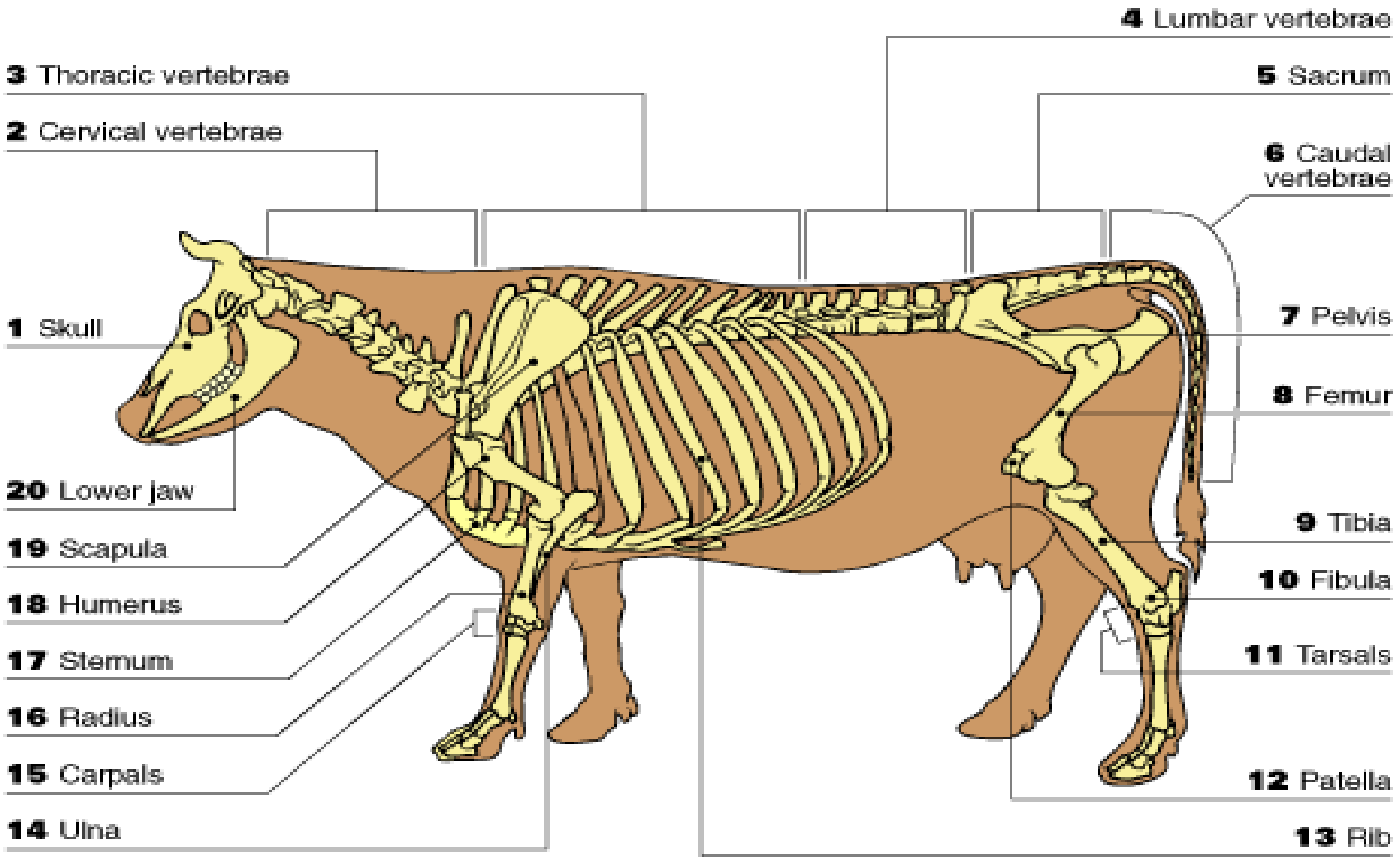
Equine Skeleton Review

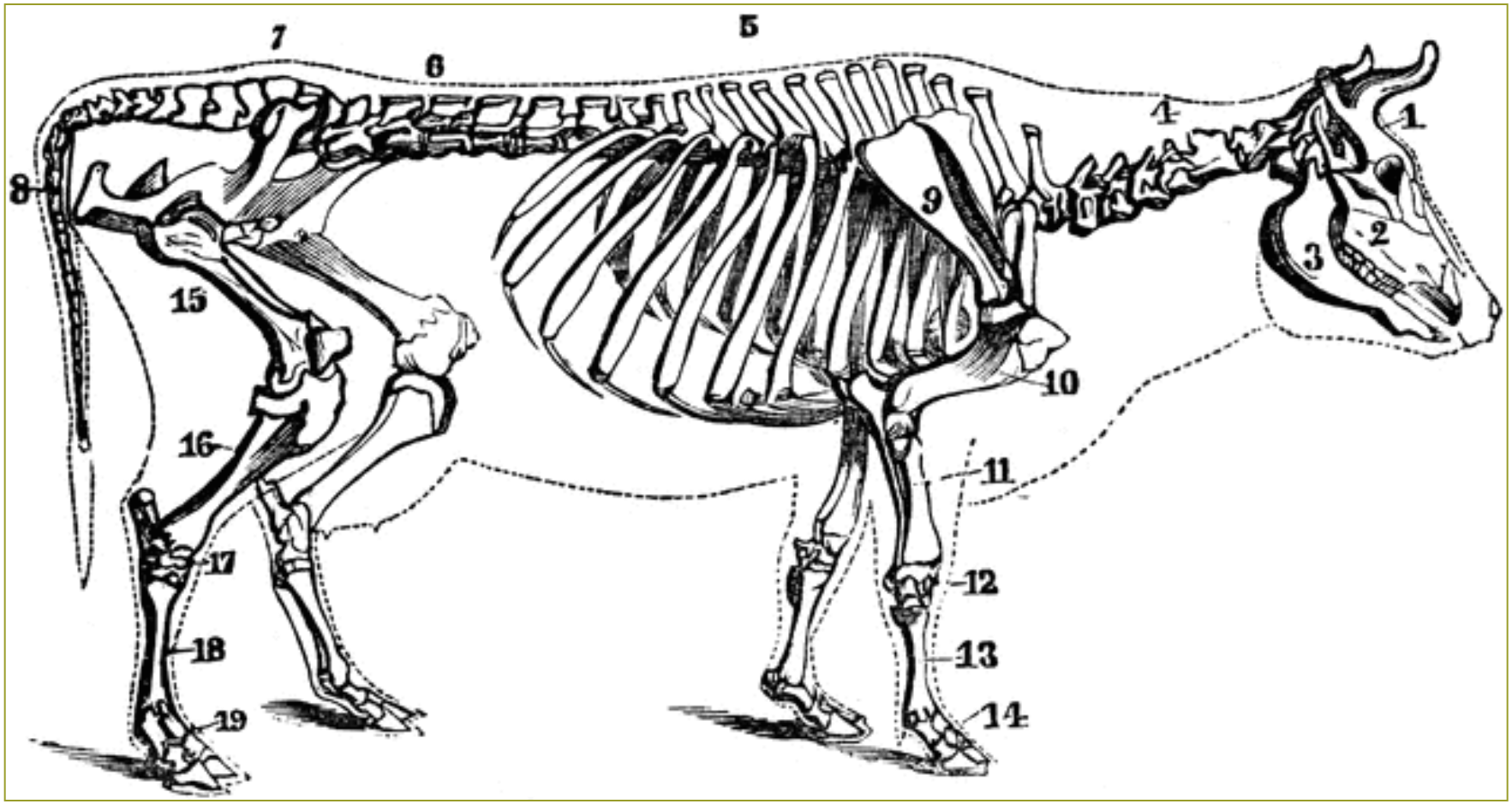

lumbosacral joint
neck vertebrae
axis
atlas
skull
lumbar vertebra
sacrum
pelvis
point of hip
scapula
bars
hip joint
jaw
point of shoulder
humerus
femur
patella
elbow joint
rib cage
radius
tibia
sternum
pisiform bone
hock
knee
cannon
splint bone
cannon
long pastern bone
sesamoid bone
short pastern bone
navicular bone
pedal bone



Bovine Skeleton Review

Whole skeleton

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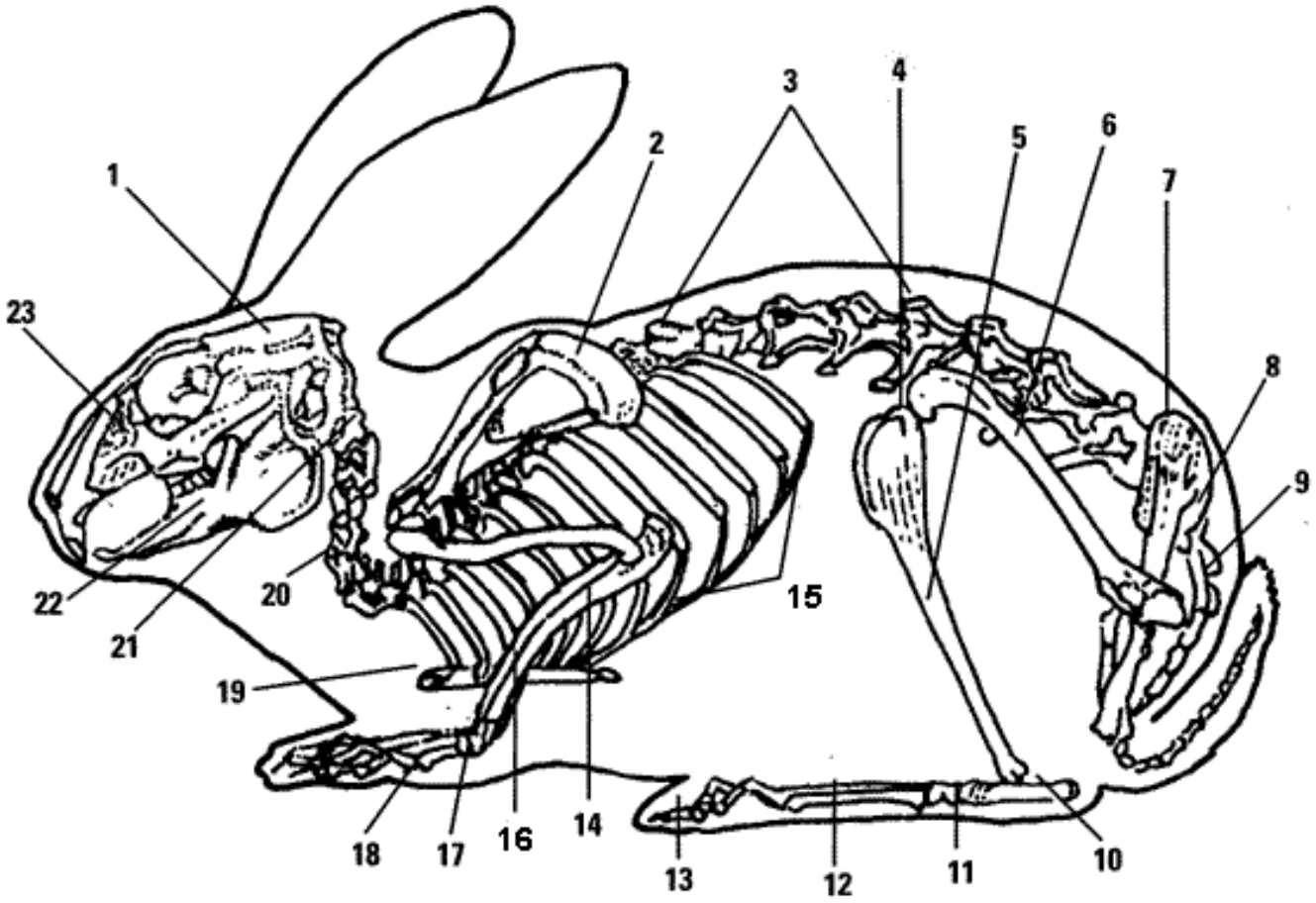
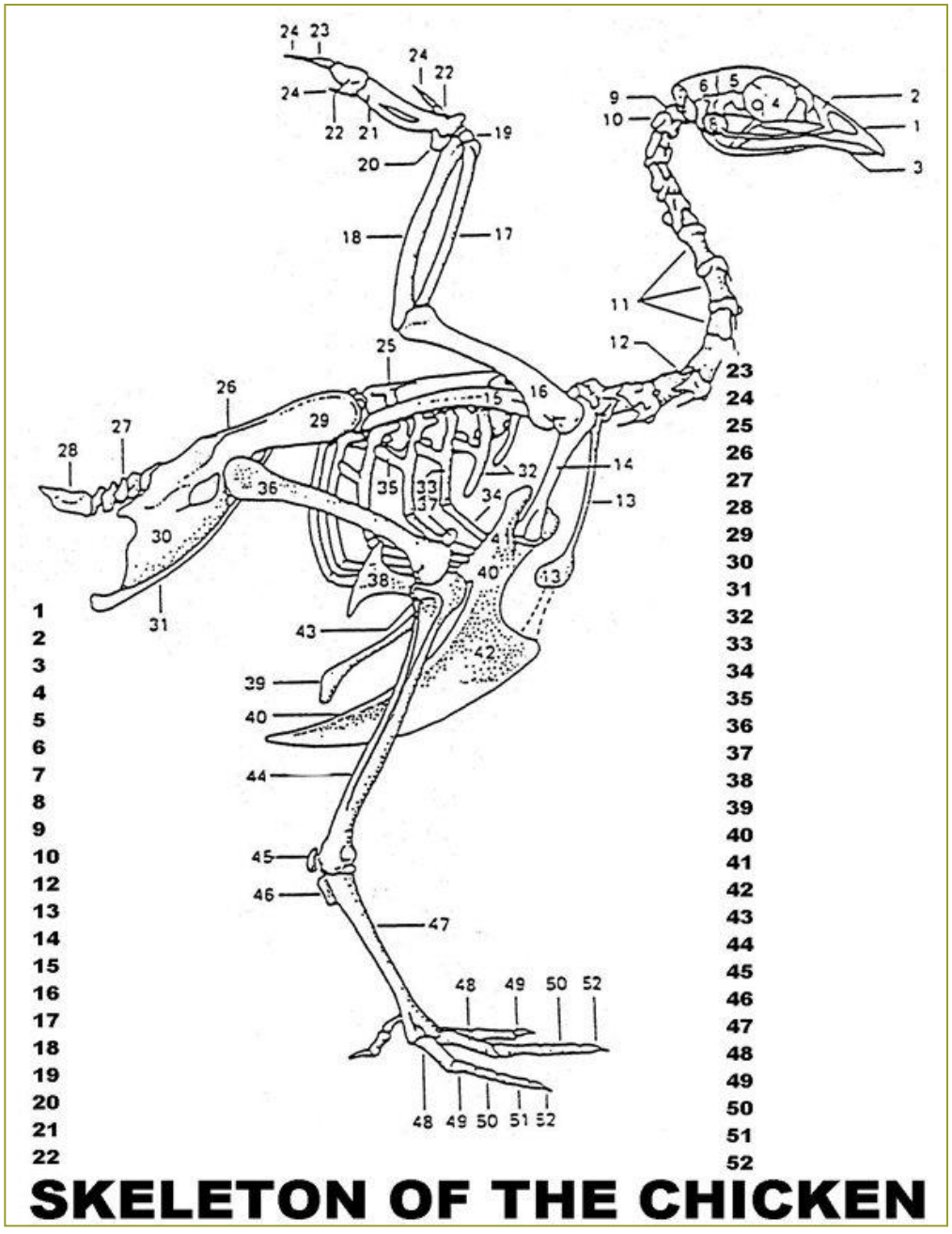
Other Critters? ☺

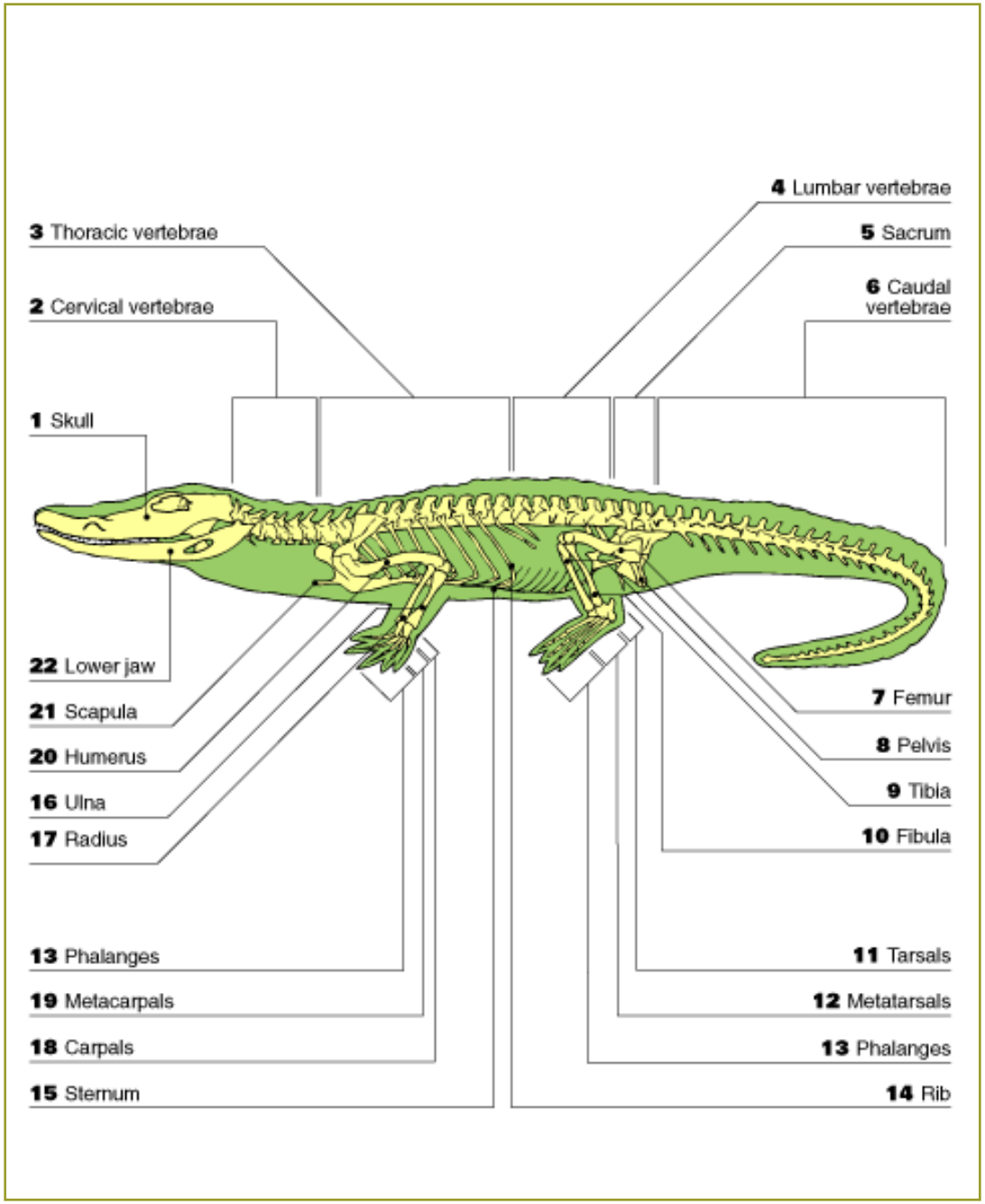


1. Cranium (Skull)
2. Scapula
3. Spine
4. Fibula
5. Tibia
6. Femur
7. Ilium
8. Sacrum
9. Caudal Vertebrae
10. Calcaneus
11. Tarsus
12. Metatarsus
13. Phalanges
14. Ulna
15. Ribs
16. Radius
17. Carpus
18. Metacarpus
19. Sternum
20. Cervical Vertebrae
21. Atlas
22. Mandible
23. Maxilla


SKELETON OF THE CHICKEN

Crocodile Skeleton??

☺



Test Yourself

KNOW THESE IN EVERY CHAPTER!

Pages 157, 160, 169, 174, 179, 184, 190

Clinical Applications

Pages 158, 171, 172, 172, 173, 176, 181, 182, 184, 185, 187