

# AGA 2110

## THE SKELETAL SYSTEM 3

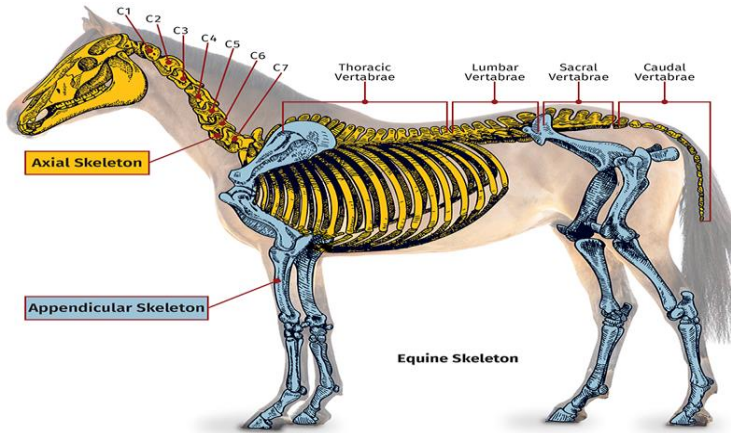
### THE LIMBS AND JOINTS

Dr J Mufungwe

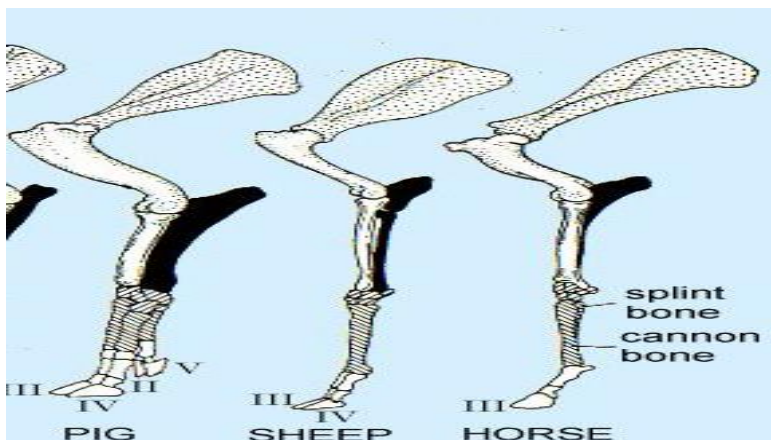
## THE LIMBS

- The **limbs** are part of the appendicular skeleton
- The appendicular skeleton comprise those bones coming off the midline of the body including
  - i. **Forelimbs**
  - ii. **Hindlimbs**
  - iii. **Bones in the pelvic region**

# POSITIONS OF THE AXIAL & APPENDICULAR SKELETON



## APPENDICULAR SKELETON



## VARIOUS VERTEBRATE LIMBS

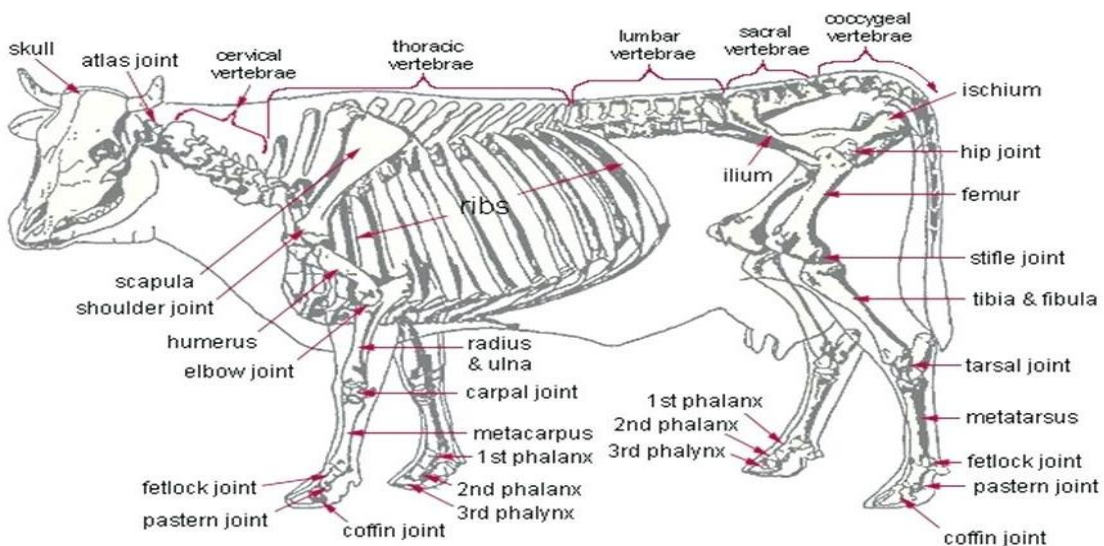
❑ **THE FORELIMB (THORACIC LIMB)** consists of:

- i. Scapula
- ii. Humerus
- iii. radius and ulna
- iv. carpals
- v. Metacarpals
- vi. digits or phalanges

❑ The humerus articulates with the **scapula** at the **shoulder joint**.

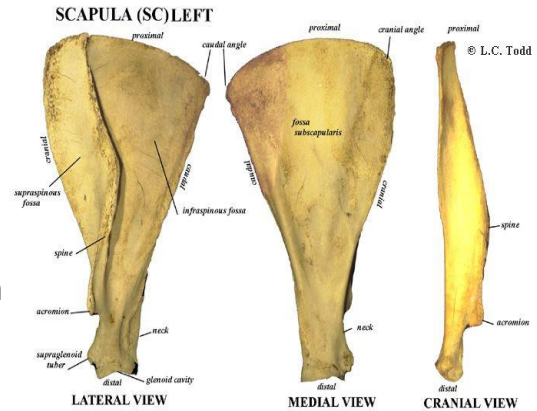
**\*By changing the number, size & shape of the various bones, fore limbs have evolved to fit different types of species\*\***

## APPENDICULAR SKELETON

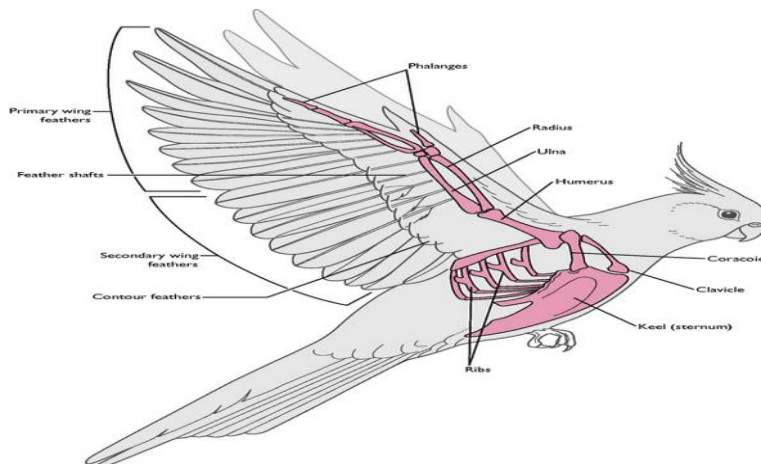


## SCAPULA (SHOULDER BLADE)

- Flat bone
- lateral surface has a ridge called spine
- spine divides scapular into suprascapular (cranial) and infrascapular (caudal) fossa
- Distal part form shoulder joint with humerus

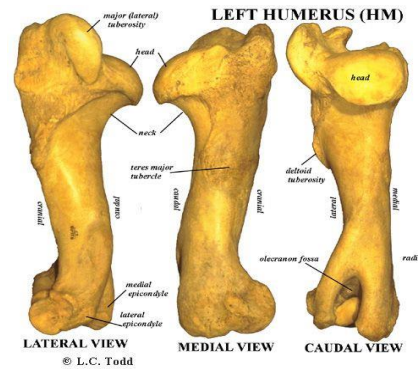


## FORELIMBS OF A BIRD

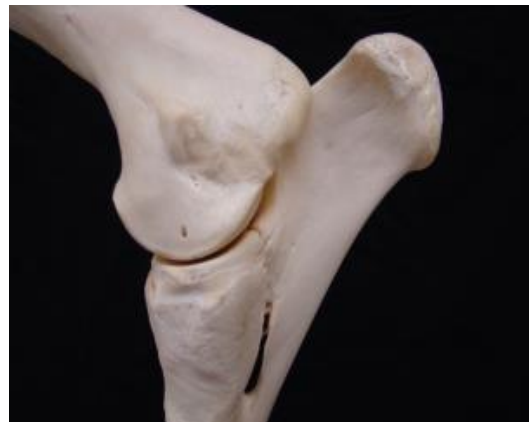
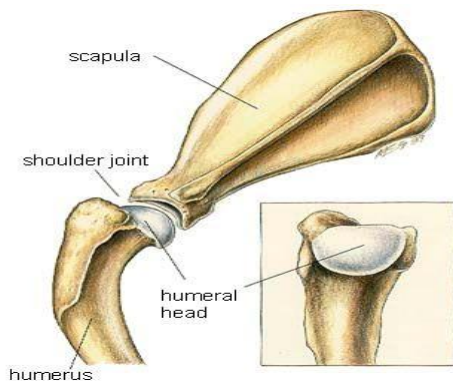


# HUMERUS

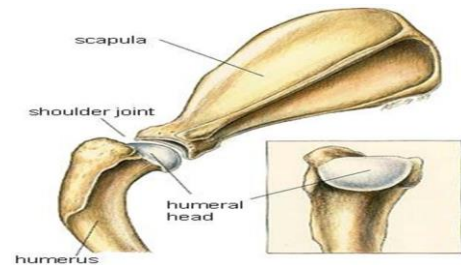
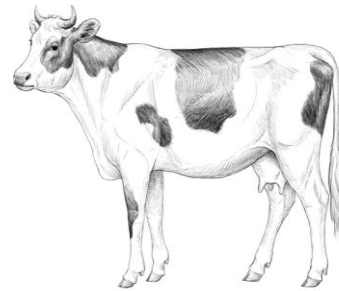
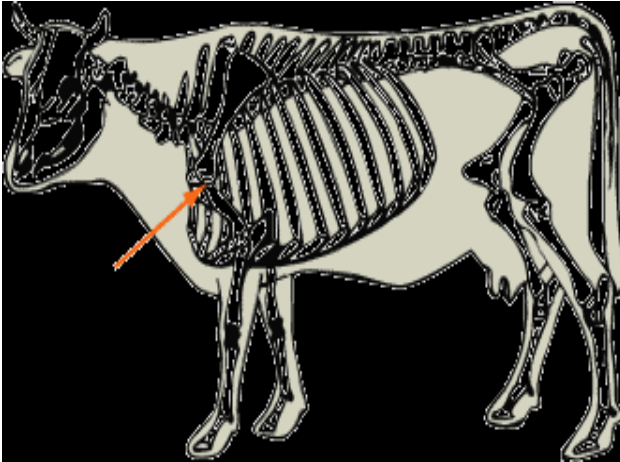
- Long bone
- shaft and 2 extremities
- Proximal end has a round articular head
- Proximal end forms scapulohumeral (shoulder) joint
- Proximal end has a number of tubercles for muscle attachment
- Palpable part on the proximal end is called point of the shoulder



## SHOULDER JOINT & ELBOW JOINT

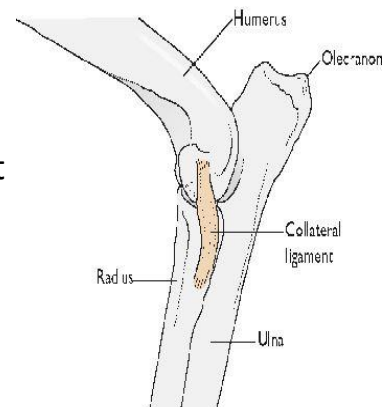


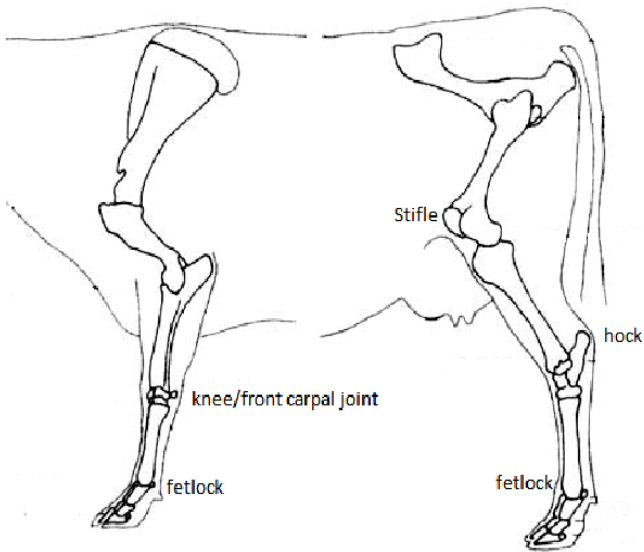
## SHOULDER JOINT



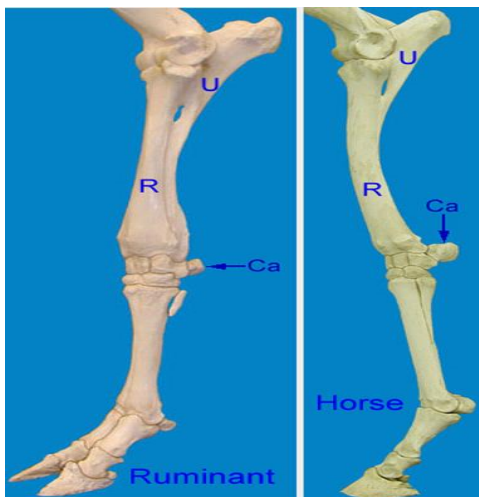
## RADIUS & ULNA

- ❑ Radius & ulna are the bones of the **antebrachium** (Forearm)
- ❑ radius is larger
- ❑ Ulna has a prominent **olecranon process** (point of the elbow)
- ❑ Olecranon is a point of attachment for muscle that **extend the elbow**
- ❑ Articulate with humerus to form elbow joint





## RADIUS & ULNA – SPECIES VARIATION



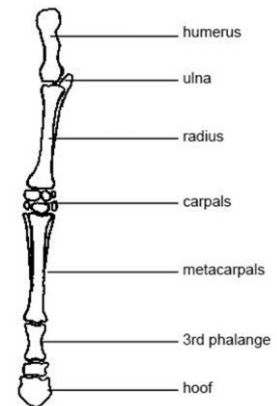
Species variations:

**Cattle:** fused but both visibly clear

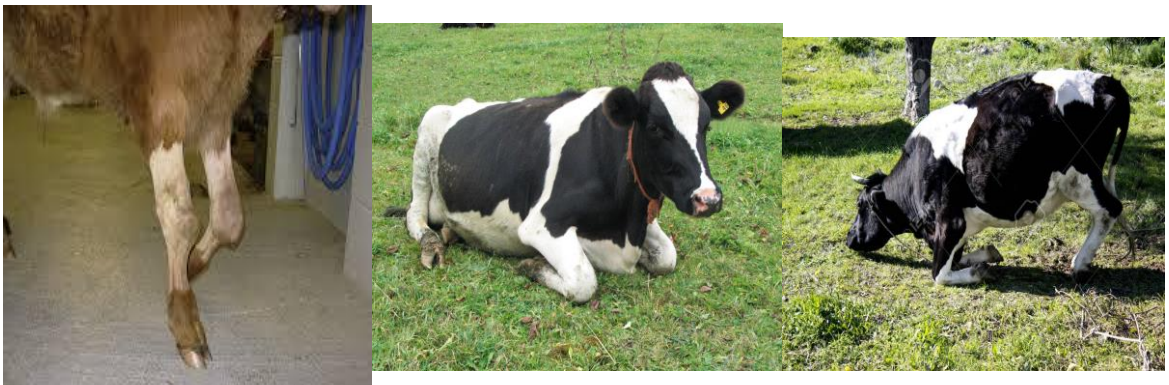
**Horse:** Distal end of ulna is 'absorbed' into radius & is not distinct

## THE CARPUS

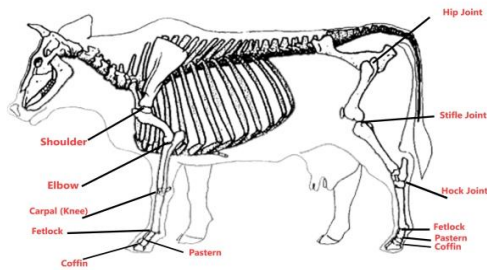
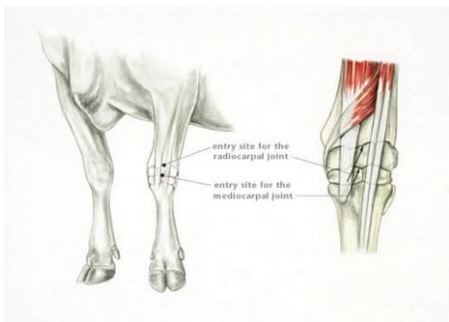
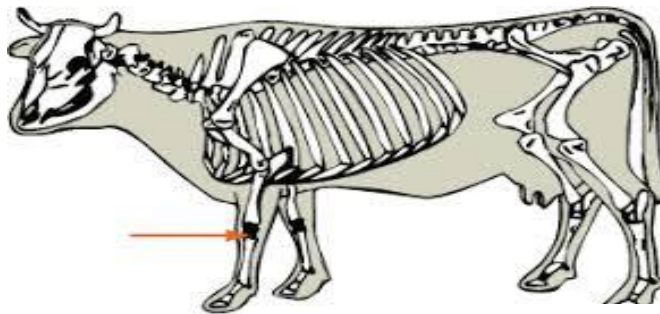
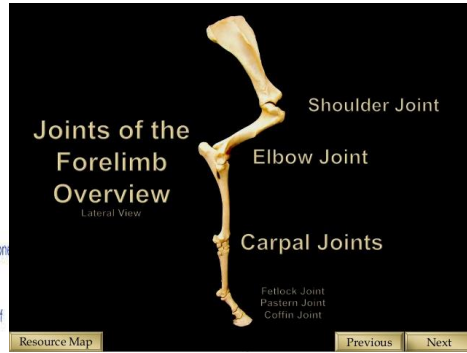
- Complex region
- Has 2 rows of small bones
- Carpal bones in proximal row (from medial to lateral) are **radial, intermediate & ulna**
- In the distal row are numbered 1-4 (from medial to lateral)
- Accessory carpal bone



## CARPAL JOINT (KNEE JOINT)- WRIST IN HUMANS



# CARPAL JOINT (KNEE JOINT)- WRIST IN HUMANS

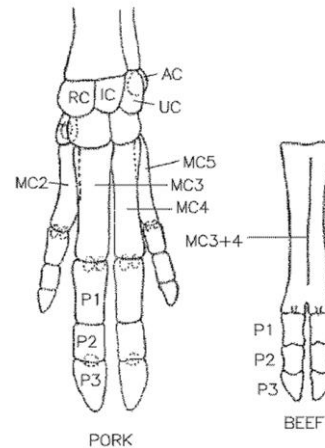


Limb Joints of Cattle

-sulovekoirala

# THE CARPUS

## ☐ Accessory carpal bone



## CARPUS – DISTAL ROW

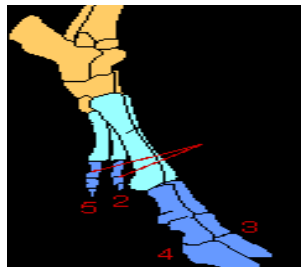
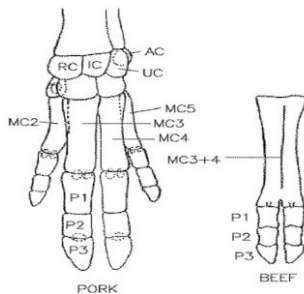
- ☐ Numbered 1 -4
- ☐ species variations occur
- ✓ **Pig** – has 4 carpal bones
- ✓ **Horse** – 1<sup>st</sup> carpal bone is small and non weight bearing
- ✓ **Ruminants** – 1<sup>st</sup> carpal bone is missing, 2<sup>nd</sup> & 3<sup>rd</sup> bones are fused

## METACARPUS

- ❑ Distal to the carpus
- ❑ **Species variations occur**
- ✓ Horse - 1 metacarpal bone (**cannon bone**)
- ✓ Pig - Pig has 4 metacarpal bones (1<sup>st</sup> is absent, 2<sup>nd</sup> & 5<sup>th</sup> are reduced, 3<sup>rd</sup> & 4<sup>th</sup> bear the weight)
- ✓ Cattle – has 2 metacarpal bones (3<sup>rd</sup> & 4<sup>th</sup> metacarpal bones are fused)

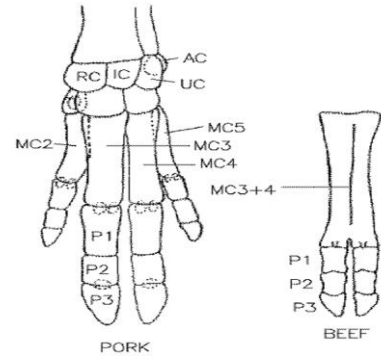
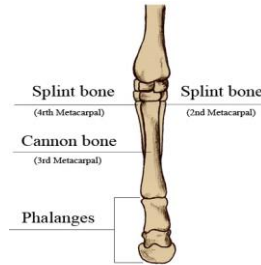
## METACARPAL BONES - PIGS

- Pig - Pig has 4 metacarpal bones (1<sup>st</sup> is absent, 2<sup>nd</sup> & 5<sup>th</sup> are reduced, **3<sup>rd</sup> & 4<sup>th</sup>** bear the weight)

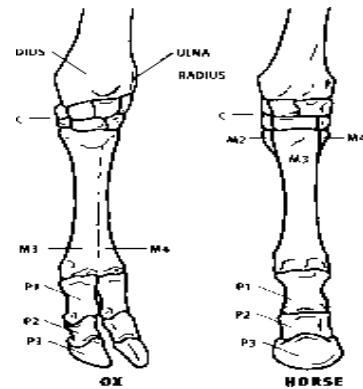
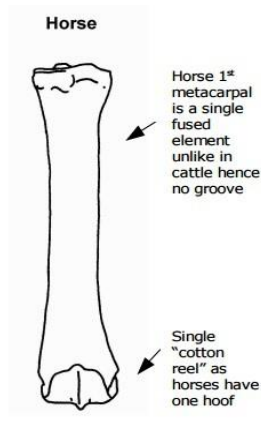
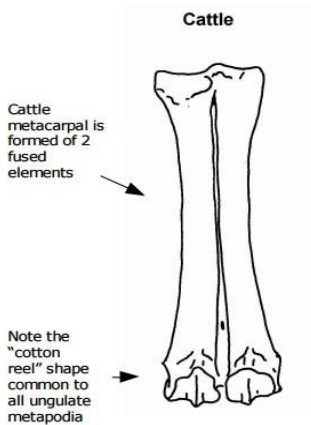


# METACARPAL BONES – SPECIES VARIATIONS

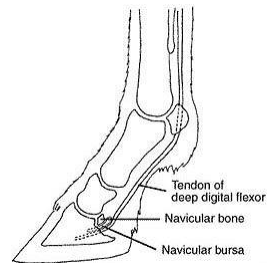
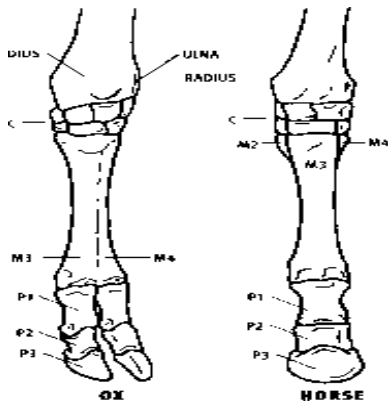
- ❑ Pig has 4 metacarpal bones,
- ❑ 2<sup>nd</sup> & 5<sup>th</sup> are reduced, 3<sup>rd</sup> & 4<sup>th</sup> bear the weight.
- ❑ Cattle – fused 3<sup>rd</sup> & 4<sup>th</sup> MC bones



# METACARPAL BONES IN CATTLE & HORSE



# METACARPAL BONES IN CATTLE & HORSE



## PHALANGES

- ❑ The phalanges are the bones that make up the ‘fingers of the hand’ and the ‘toes of the foot’.
- ❑ Phalanx (plural: phalanges) refers to the bones found in fingers, toes, paws, wings, hooves of animals.
- ❑ These are long bones whose length exceeds their breadth
- ❑ Digitigrade. A digitigrade is an animal that stands or walks on its digits, or toes
- ❑ plantigrade - (of a mammal) walking on the soles of the feet, like a human or a bear.
- ❑ Ungulate - Cows, sheep, goats, buffalos, deer, giraffes, pigs and camels are just a few of the many even-toed ungulates

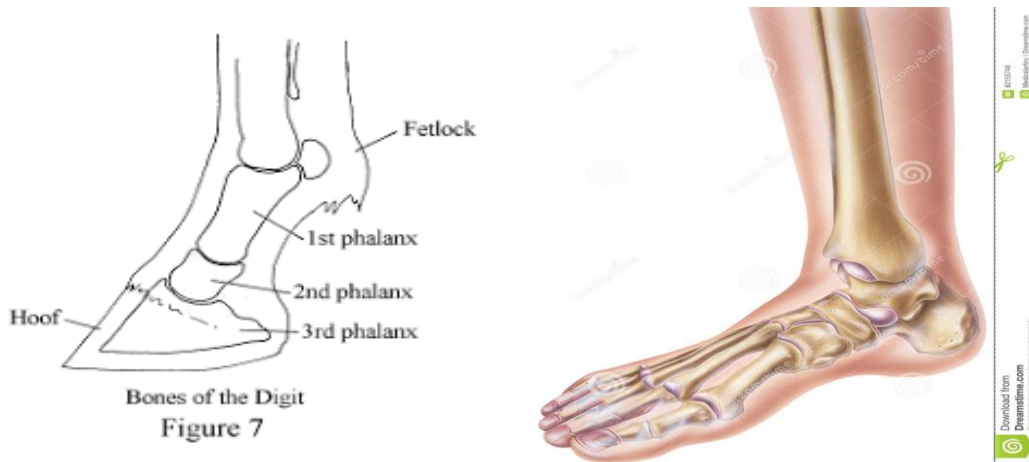


### BONES OF FOOT

- Distal phalanges
- Middle phalanges
- Proximal phalanges
- Metatarsal bones
- Tarsus:
  1. Cuneiform bones
  2. Cuboid
  3. Navicular
  4. Talus
  5. Calcaneus

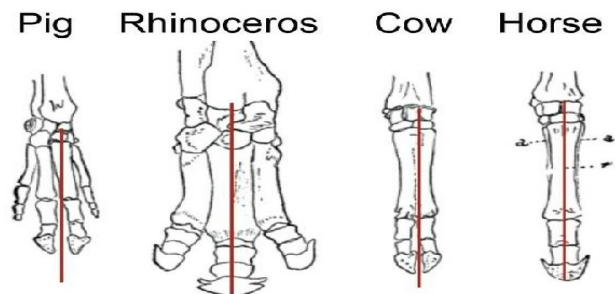


## DIGITIGRADE VS PLANTIGRADE



## DIGITS – SPECIES VARIATIONS

- ❑ Numbered 1-5 depending on species



Source: [http://en.wikibooks.org/wiki/Popular\\_Science\\_Monthly/Volume\\_52/January\\_1908/Foot\\_and\\_Hand\\_I](http://en.wikibooks.org/wiki/Popular_Science_Monthly/Volume_52/January_1908/Foot_and_Hand_I)

- ❑ **Cattle**, sheep, goats, and pigs are **cloven-footed** animals, meaning that the hoof consists of two **digits**, instead of one solid entity like that of a **horse**
- ❑ **Cloven hoofed** - Having split hoofs, once assumed to represent the halves of a single undivided hoof, as in cattle

## DIGITS – SPECIES VARIATIONS

- ❑ Numbered 1-5 depending on species
- ❑ Each complete digit is made of 3 phalanges
  - i. Proximal phalanx
  - ii. Middle phalanx
  - iii. Distal phalanx

# DIGITS – SPECIES VARIATIONS

☐ Ox, sheep, goat

✓ 2 principle digits (3<sup>rd</sup> and 4<sup>th</sup>)

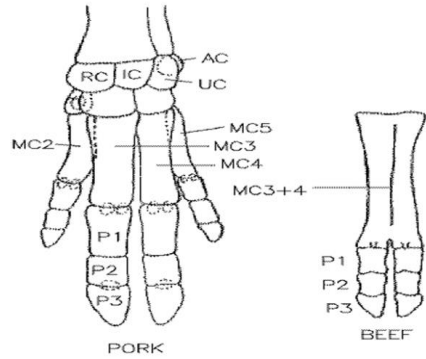
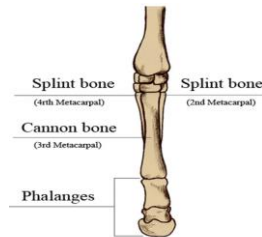
✓ 2<sup>nd</sup> and 5<sup>th</sup> represented by dew claw

☐ PIG

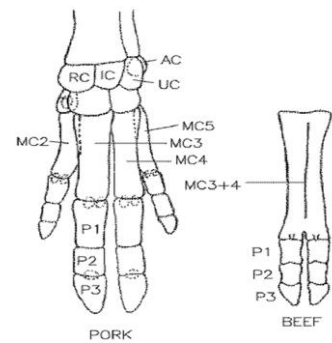
✓ 4 digits

☐ HORSE

✓ 1digit (3<sup>rd</sup>)



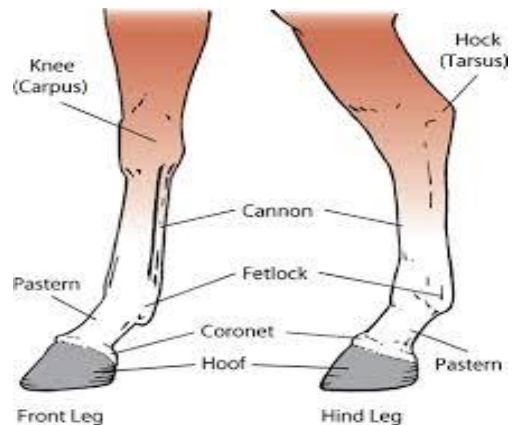
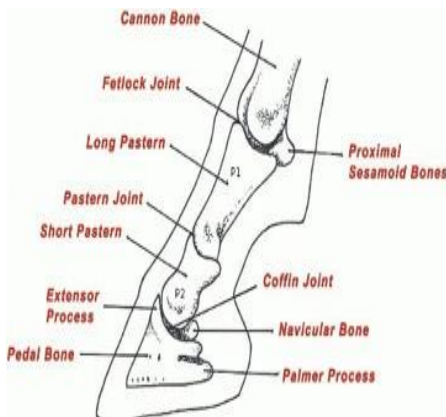
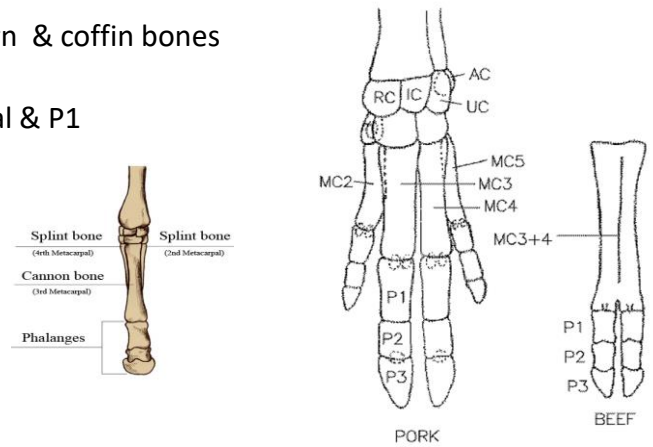
# DIGITS – SPECIES VARIATIONS

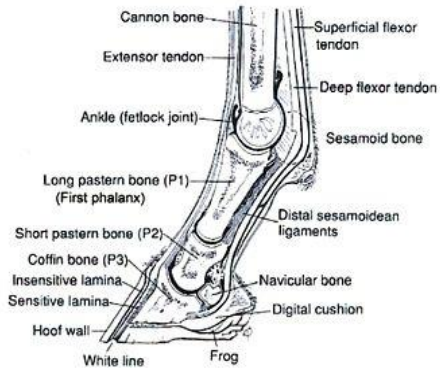


## DIGITS – JOINTS

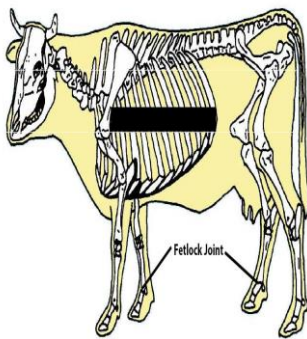
- ❑ Each digit is made up of 3 phalanges – proximal, middle & distal
- ❑ In horse long pastern, short pastern & coffin bones respectively
- ❑ Fetlock joint – between metacarpal & P1
- ❑ pastern joint – between P1 & P2
- ❑ coffin joint – between P2 & P3

\*\*\*P = phalange (should be written in full)

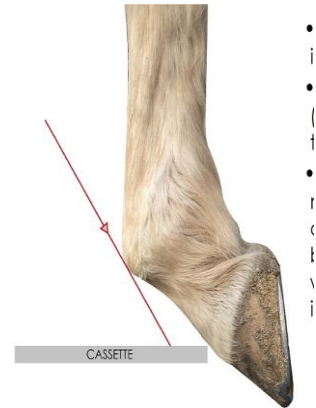




LONGITUDINAL SECTION OF FETLOCK & FOOT



# Fetlock joint



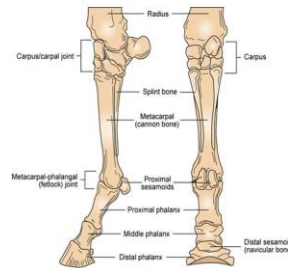
# CATTLE DEWCLAW



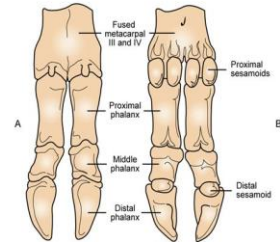
## DIGITS – SESAMOID BONES

- ❑ Digits have 2 proximal sesamoid bones at the palmar aspect of the joint between the 3<sup>rd</sup> metacarpal bone & proximal phalanx

### EQUINE

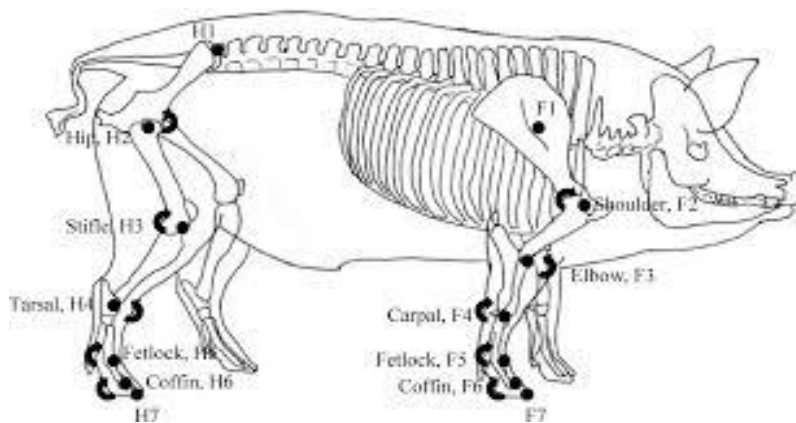


### BOVINE



- ❑ Distal sesamoid bone (navicular) bone at the junction of the middle and distal phalanges

## APPENDICULAR SKELETON OF THE PIG

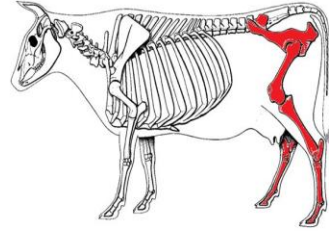


## THE HINDLEG

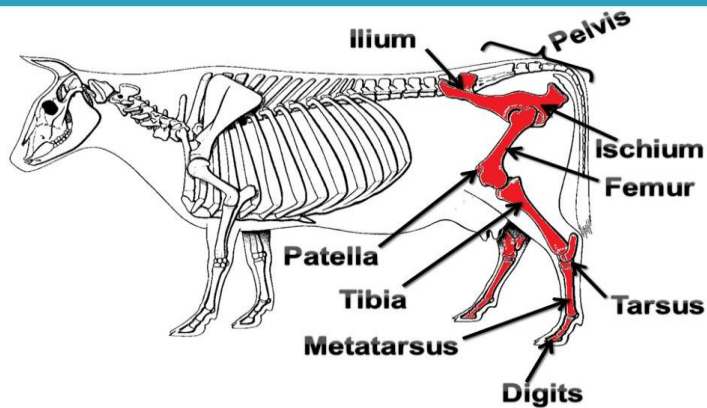
- ❑ The hind limbs have a similar basic pattern to the forelimb.
- ❑ They consist of:
  - -femur
  - tibia and fibula
  - tarsals, metatarsals, digits or phalanges
- ❑ The top of the femur moves against (articulates with) the pelvis at the hip joint.

### Bones of the Pelvic Skeleton

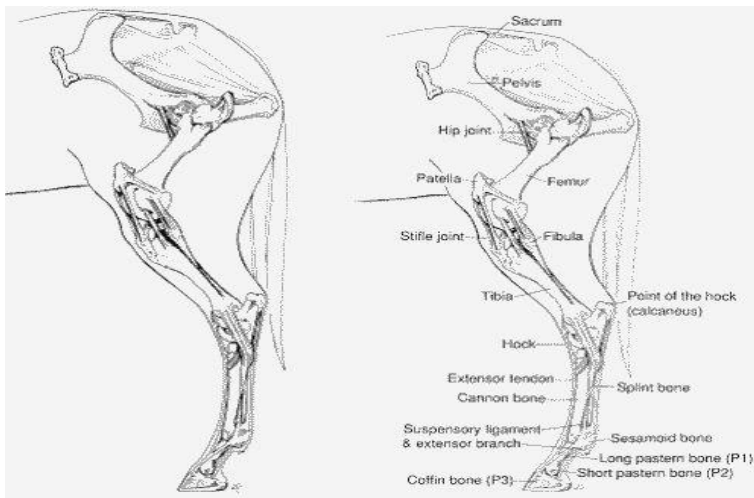
- Pelvis
  - Ilium
  - Ischium
- Femur
- Patella
- Tibia
- Tarsus
- Metatarsus
- Digits



## THE HINDLEG



## THE HINDLEG

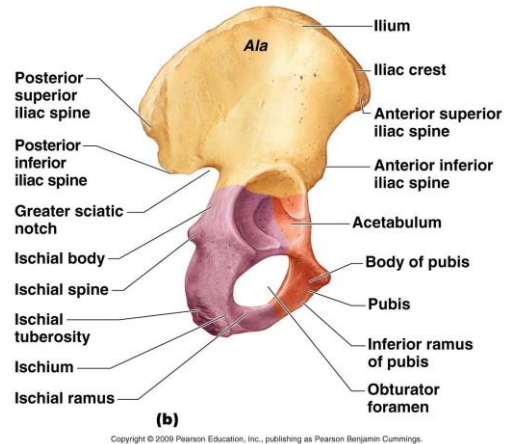
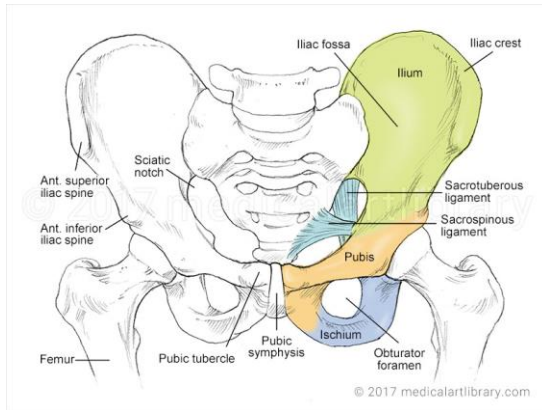


## BONES OF THE PELVIS

- ❑ The *os coxae* (pelvic bone) consists of 3 bones
  - i. Ilium
  - ii. Ischium
  - iii. Pubis
- ❑ The 3 bones are fused to form the *os coxae* or pelvic bone
- ❑ These 2 *ossa coxarum* are firmly attached to one another at the pelvic symphysis ventrally & are joined to the sacrum of the axial skeleton by two strong sacroiliac joints.
- ❑ All 3 bones participate in formation of the acetabulum of the hip joint



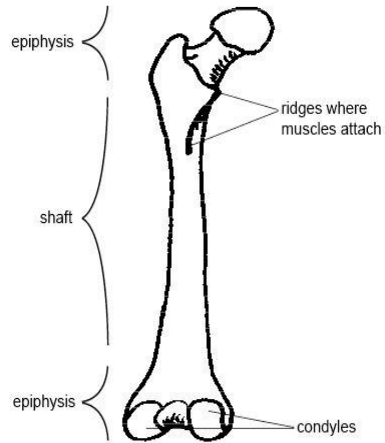
## BONES OF THE PELVIS



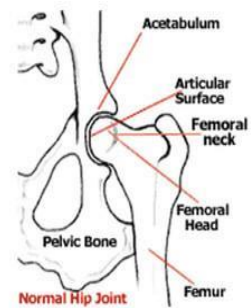
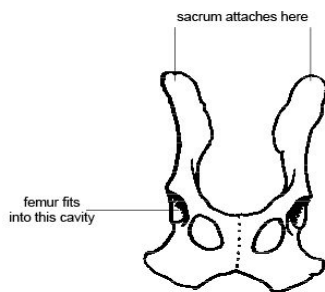
## THE FEMUR (THE THIGH BONE)

- ❑ The thigh bone extends from the coxofemoral (hip) joint to the stifle (the joint corresponding to the human knee).
- ❑ The proximal end of the femur has a nearly spherical head that articulates with the acetabulum of the *os coxae* to form the hip joint
- ❑ The proximal end also has several roughened prominences called trochanters which are for attachment of heavy thigh & hip muscles
- ❑ The distal end has two condyles for articulation with the tibia & a trochlea for articulation with the patella, a sesamoid bone embedded in the tendon of insertion of the large quadriceps muscle

# THE FEMUR



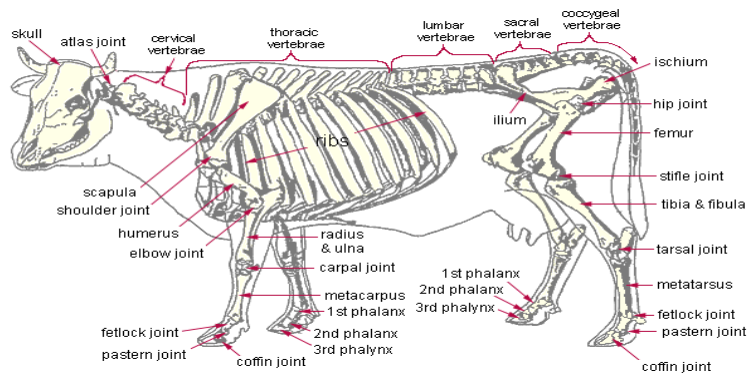
# HIP JOINT



## TIBIA & FIBULA

- ❑ Are bones of the true leg (part between the stifle & hock)
- ❑ The tibia is the largest of the 2 bones
- ❑ The tibia has an expanded proximal end that participates in the stifle joint
- ❑ The distal end of the tibia has two concave depressions that form the hinge joint of the hock with the talus (tibiotarsal bone).

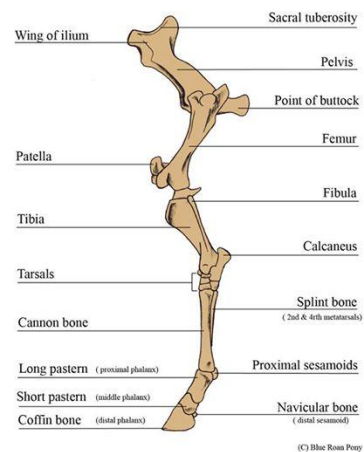
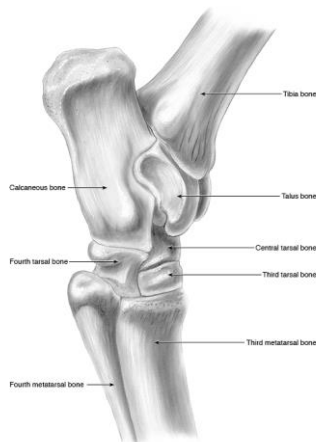
## STIFLE JOINT



## THE TARSUS (THE HOCK)

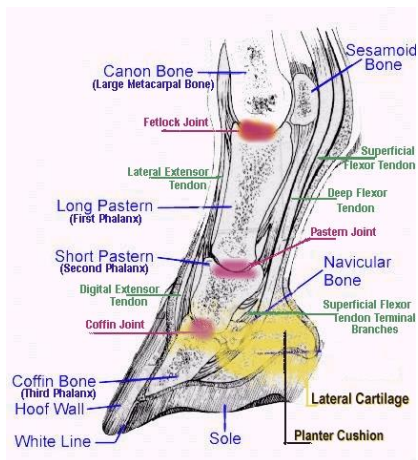
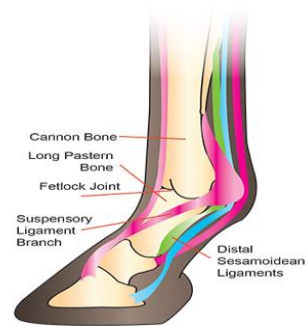
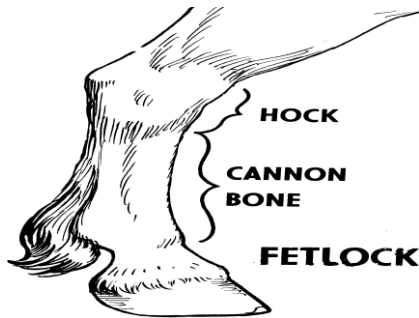
- ❑ It is like the carpus in the thoracic limb
- ❑ It is composed of 2 rows of small bones
- ❑ It corresponds to the human ankle.
- ❑ The proximal row of tarsal bones consists of two large bones, **talus** and **calcaneus**
- ❑ The calcaneus projects proximally and caudally to form the point of the hock.
- ❑ The calcaneus corresponds to the human heel, acts as a lever for the muscles extending the hock.
- ❑ The bones of the distal row are numbered 1 to 4 from medial to lateral.

## THE TARSUS

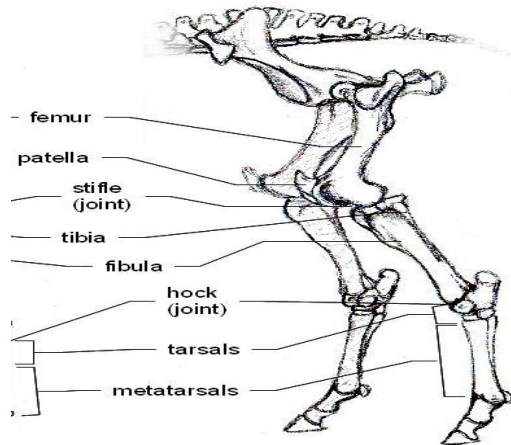


## THE METATARSUS & DIGITS OF THE HINDLIMB

- The metatarsus and digits of the pelvic limb are similar to the metacarpus and digits of the thoracic limb



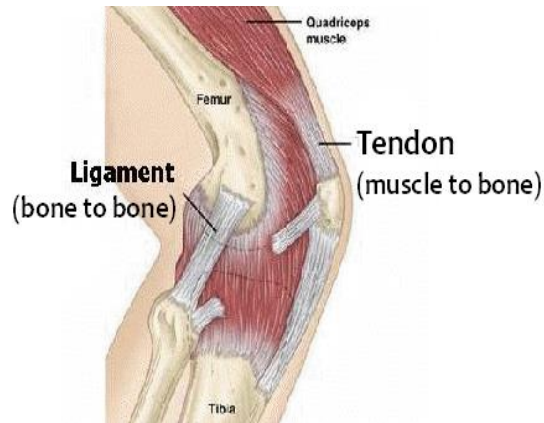
## BONES OF THE HINDLEG



## CONNECTIVE TISSUE

- Connective tissue binds tissues together to give form & strength to organs and provide protection & leverage
- 4 types of connective tissues exist within the skeletal system
  - i. Ligaments
  - ii. Tendons
  - iii. Cartilage
  - iv. Fascia
- Ligaments connect bone to bone
- Tendons attach muscle to bone

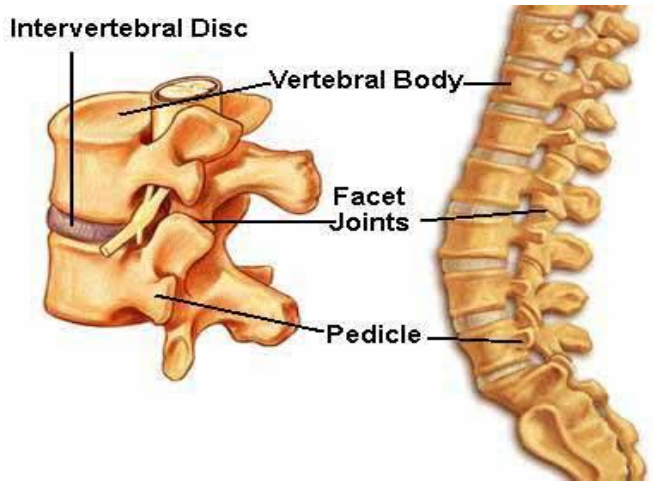
## TENDONS AND LIGAMENTS



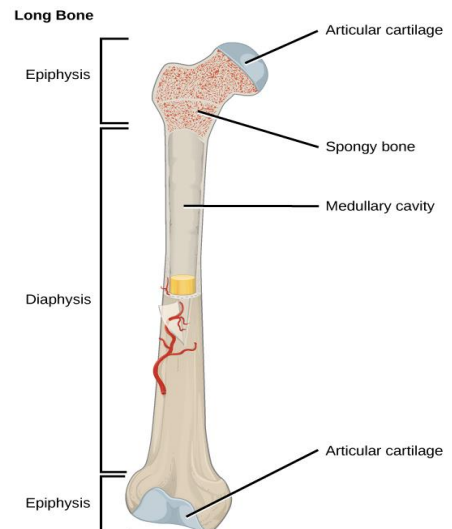
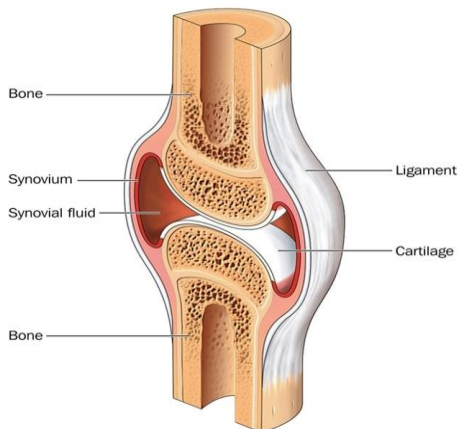
## TYPES OF CARTILAGE

- Hyaline cartilage is found on the ends of bones and acts as cushioning in joints.
- Elastic cartilage makes up body parts such as the ears.
- Fibrocartilage found in the intervertebral discs

# FIBROCARTILAGE

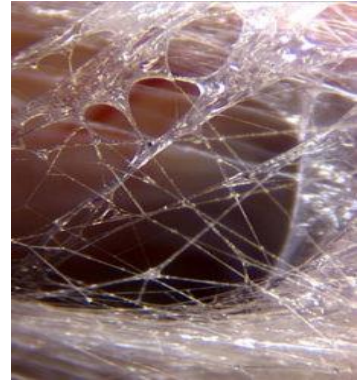


# HYALINE CARTILAGE



## FASCIA

- Fascia is located between the skin and the underlying muscle or bone.
- It is comprised of two layers.
  - i. The top layer, superficial fascia, is attached to the skin
  - ii. The bottom layer, deep fascia, covers the muscle or bone



## JOINTS

- Joints are articulations (unions) between bones.
- Joints can be
  - ✓ highly movable – for example, the shoulder joints
  - ✓ Partially movable – for example, the ribs
  - ✓ Immovable – for example, suture joints between the plates of the skull.
-

## TYPES OF JOINTS FOUND IN FARM ANIMALS

☐ Three (03) types of joints are found in the body

1. Fibrous
2. Cartilaginous
3. Synovial

## JOINTS

### 1. FIBROUS JOINTS

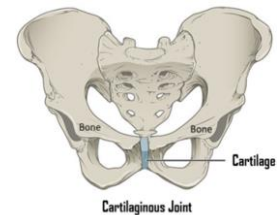
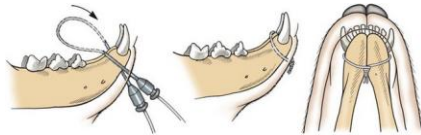
- ☐ Fibrous joints are immovable in that the bones are firmly united by fibrous tissue.
- ☐ Have no joint cavity
- ☐ Examples include the sutures that unite most of the skull bones



# JOINTS

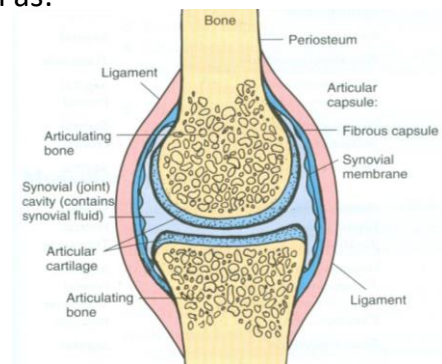
## 2. CARTILAGINOUS JOINTS

- Bone are united by cartilage & joint has no joint cavity
- They are capable of only a slight rocking movement.
- Examples include
  - ✓ the intervertebral joints (containing discs) between the bodies of adjacent vertebrae in the spine
  - ✓ Symphyses between the two halves of the pelvis
  - ✓ Between the two sides of the mandible



## 3. SYNOVIAL JOINTS

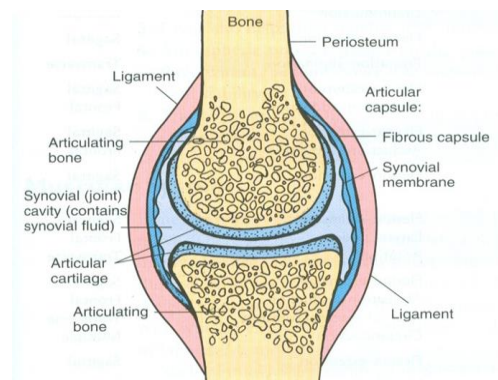
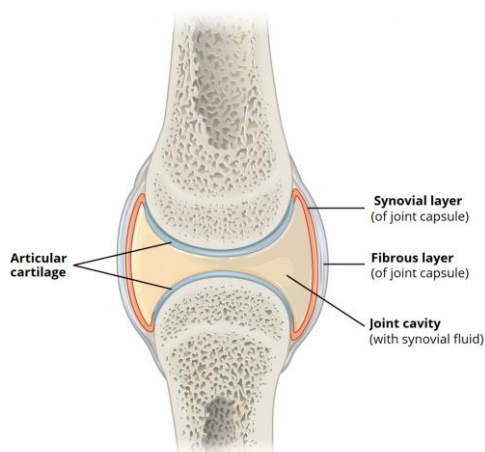
- Allow one surface to glide over another
- Allow the greatest range of movement such as:
  - Gliding
  - Flexion
  - Extension
  - Hyperextension
  - Rotation
  - Adduction
  - Abduction
  - Circumduction



## SYNOVIAL JOINT - CHARACTERISTICS

- ❑ The joints have the following;
  - ✓ Articular surfaces on the bones,
  - ✓ Articular cartilage (hyaline) covering the articular surfaces
  - ✓ Articular **cavity** enclosed by a **joint capsule**.
- **Articular cavity is the space between adjacent bones of a joint surrounded by a joint capsule**
- ✓ Firm connective tissue bands called **ligaments** may help stabilize the bones and hold the joint together.
- ❑ The outer layer of the joint capsule is fibrous tissue, and the lining layer is called **synovial membrane**.
- ❑ The synovial membrane produces the **synovial fluid** that lubricates the joint surfaces.

## SYNOVIAL JOINT



## SYNOVIAL JOINT

☐ Joint capsule has 2 layers

i. **Synovial membrane**

- inner layer
- extends from the edges of the articular surfaces, but does not cover cartilage
- Secretes synovial fluid

ii. **Fibrous capsule**

- outer layer
- thick fibrous layer

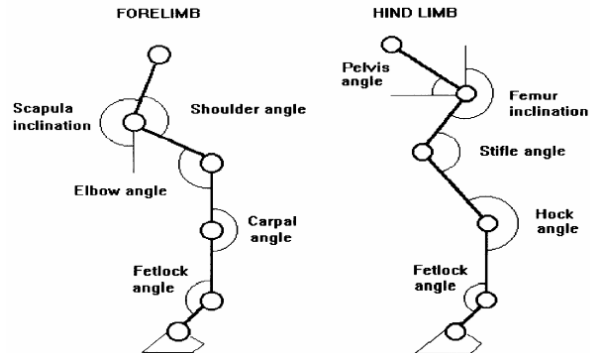
## SYNOVIAL JOINTS

☐ Synovial joints may exhibit one or more of the following movements:

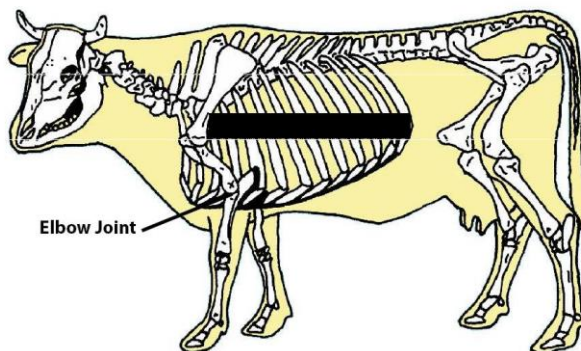
- ✓ gliding or sliding
- ✓ flexion
- ✓ extension
- ✓ Hyperextension
- ✓ rotation
- ✓ adduction
- ✓ abduction
- ✓ circumduction

## TYPES OF SYNOVIAL JOINTS

- Synovial joints can be categorized according to the type of joint surfaces & the movements that are possible.



## JOINTS OF A FARM ANIMAL

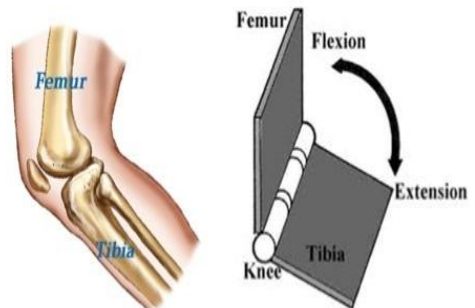


## TYPES OF SYNOVIAL JOINTS IN FARM ANIMALS

- ❑ Synovial joints are classified according to the type of joint surface & movements
  - i. Hinge
  - ii. Gliding
  - iii. Pivot
  - iv. Ball and socket

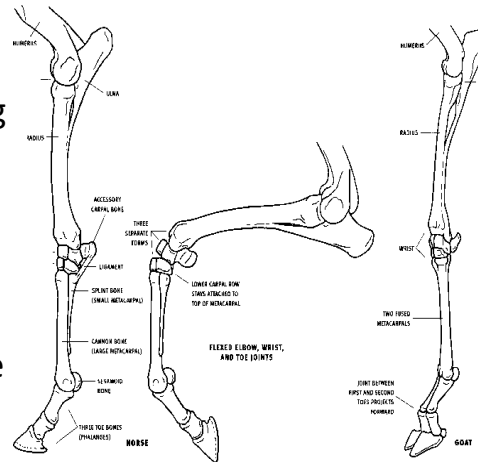
### HINGE JOINT

- ❑ One joint surface swivels around another.
- ❑ The only movements possible are flexion & extension
- ❑ Examples; **elbow joint, fetlock**



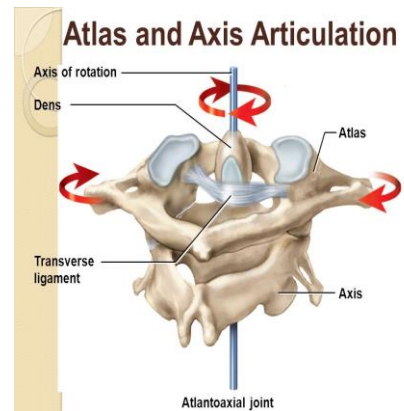
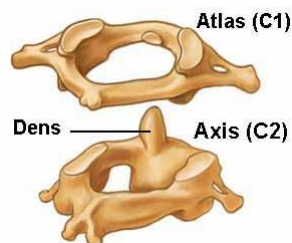
## GLIDING JOINT

- The joint surfaces of a gliding joint are **relatively flat**.
- Movement between bones is a rocking motion of one bone on the other.
- Main movements possible are flexion & extension, but some abduction and adduction may also be possible.
- Exaples :The *carpus*
- Most 4-legged animals can do only the flexion & extension part



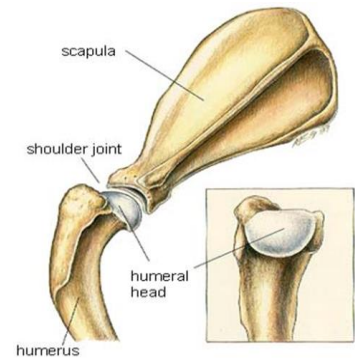
## PIVOT JOINT

- ❑ One bone *pivots* or *rotates* on another.
- ❑ The only movement possible is rotation.

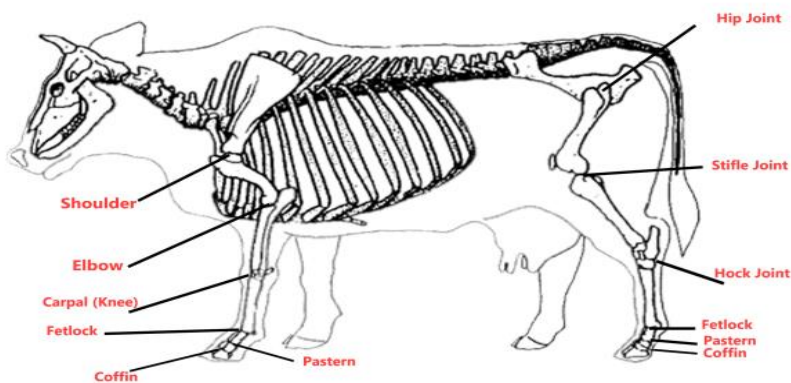


## BALL AND SOCKET JOINTS

- ❑ They allow the most extensive movements of all the joint types & allow all the synovial joint movements.
- ❑ Ball-and socket joints permit flexion, extension, abduction, adduction, rotation, and circumduction.
- ❑ The **shoulder & hip joints** are ball-and-socket joints



## LIMB JOINTS OF CATTLE



Limb Joints of Cattle

-sulovekoirala