Equine Skeletal System

EQS 110
# Lecture – Equine Skeletal System

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Functions of the Skeletal System

The equine skeletal system is a complex structure consisting of approximately 205 bones. The main functions include:

1. Providing a framework
2. Aiding in locomotion
3. Protecting vital organs
4. Storing minerals (Calcium & Phosphorus)
5. Being a site of red blood cell formation

Skeletal Strength

In order for a horse’s skeleton to withstand the activity we ask of it, such as racing, it must be strong! Bone strength, and therefore skeletal strength, comes from minerals; 70% of the skeleton’s strength is due to mineral content!

Meeting mineral content is the result of appropriate nutrition; poor nutrition, especially in early stages of life, can affect skeletal development, which can then affect the horse’s ability to perform.

Appropriate skeletal strength is vital to a racehorse’s success. A Thoroughbred is not born with a skeleton to withstand racing – it is our training, conditioning, and overall care that will create it. Bone is living tissue that has the ability to adapt to exercise, or lack of it. Mineral content, and thereby skeletal strength, play an important role when adapting to exercise.

When exercising a horse, whether it is a Thoroughbred racehorse or a Warmblood show jumper, the bone is responding to the force put upon it through two methods – modeling and remodeling. Modeling refers to the growth and shaping of immature bones; it is how bone adds to itself both inside and out. The image on your right is an x-ray of a young horse’s tibia, also called the shin bone. The bone you see to the right of the red line is new bone that has formed due to modeling as a result of appropriate training. Remodeling is how existing bone alters itself; it involves the removal of old bone followed by the formation of new bone. Remodeling is a repair process that occurs on a continuous basis. In order for these two processes to occur, appropriate mineral content is needed!
Bone Classification

The bones of the horse can be classified five ways based on their shape and function.

Long Bones

Greater in length than in width to aid in locomotion and storage of minerals, these bones are found mainly in the limbs. Long bones are often the focus during skeletal development because they have the greatest impact on soundness, which means the horse is not lame. Lameness, which is a deviation from the horse’s normal movement (think of it as limping), is a common cause of athletic failure or inability to perform. Due to this importance, we will look at the long bone with greater detail than our other classifications.

Parts of the Long Bone

A long bone has three components that are essential to its development and growth:

1. **Diaphysis** – Shaft of the long bone, where modeling and remodeling occurs
2. **Epiphysis** – Ends of the long bone, forms the joint surface
3. **Physis** – The growth plate, allows the bone to lengthen during growth

Damage to the diaphysis, epiphysis, or physis can be detrimental to bone growth and result in stunted or incorrect growth!

Surrounding the diaphysis is a tissue known as the **periosteum**. Periosteum is a thin, tough, nerve-rich membrane that covers the entire diaphysis to allow for tendon and ligament attachment. This membrane is a concern for the young athletic horse because it can become stressed and inflamed.
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Short Bones

Cuboid or approximately equal in all dimensions to help absorb concussion. These bones are found mainly in the joints.

Flat Bones

Thin and expanded in two dimensions to protect vital organs. They also provide attachment sites for muscles.

Sesamoid Bones

Found near joints and embedded within a tendon to help reduce friction.

Irregular Bones

Come in a variety of shapes and structures, many of these bones protect the horse’s nervous system.
Skeletal Classification

In addition to classifying individual bones, we can also classify the skeleton of the horse two ways:

- Axial Skeleton
- Appendicular Skeleton

Axial Skeleton

The axial skeleton consists of the skull, sternum, vertebrae, and ribs.

The Skull

The skull alone consists of 34 flat and irregular bones connected by fibrous joints that ossify with age! The two main bones of the skull are the mandible (lower jaw) and the maxilla (upper jaw).

The Sternum

The sternum is an often overlooked component of the skeletal system but can have a big impact on the performance of the horse. Sternum restriction can inhibit movement and affect a horse’s attitude, especially while tacking and girding. This restriction can be the result of trauma as well as discomfort while being tacked. Evaluating the reaction of a horse while applying pressure to the chest and sternum area can indicate if there is a restriction.
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**Ribs & Vertebrae**

The vertebral column is what makes up the spine - depending on the breed, a horse may have 54 – 58 individual vertebra.

**Cervical Vertebrae**

A horse has 7 cervical vertebrae, which form the neck. The 1st two vertebrae, C1 (Atlas) and C2 (Axis), help support and move the skull.

**Thoracic Vertebrae**

A horse has 18 thoracic vertebrae which form the withers as well as part of the back. There is a set of ribs attached to each thoracic vertebra. The ribs protect the heart and lungs.

**Lumbar Vertebrae**

A horse has 6 lumbar vertebrae which are often prone to muscle soreness and strain due to this region not being supported by the pelvis or ribs. The lumbar form the horse’s loin.

**Sacral Vertebrae**

There are 5 fused sacral vertebrae that form the horse’s croup. The junction between the lumbar and sacral vertebrae is called the lumbosacral junction – its function is to enable the hind legs to reach under the body. Any restriction in this joint can hinder a horse’s performance and ability to engage the hind end.

**Caudal/Coccygeal Vertebrae**

The caudal/coccygeal vertebrae make up the tail bone. A horse may have 18 – 22 individual caudal/coccygeal vertebra.
Appendicular Skeleton

The appendicular skeleton consists of the bones in the limbs. A horse’s appendicular skeleton can be broken down into:

- Thoracic Limb = Forelimb
- Pelvic Limb = Hindlimb

Thoracic Limb (Forelimb)

The horse’s forelimb supports 60 – 65% of the horse’s weight and that percentage increases with speed! The forelimb attaches to the spine by the thoracic sling, which is made up of muscles. This structure significantly disperses and reduces the amount of concussion reaching the spine.

We are first going to review the bones that make up the proximal or upper forelimb. The following bones make up the proximal forelimb – scapula, humerus, radius, ulna, and carpus.
Bones of the Proximal (Upper) Forelimb

Name: Scapula
Common Term: Shoulder Blade
Type of Bone: Flat
Bones of the Proximal (Upper) Forelimb

**Name:** Humerus

**Common Term:** Arm Bone

**Type of Bone:** Long
The radius and ulna are *fused* (joined together). The ulna is responsible for creating the horse’s elbow.

**Name:** Radius & Ulna  
**Common Term:** Forearm  
**Type of Bone:** Long
A horse’s carpus contains two rows of carpal bones.

**Name:** Carpus / Carpal Bones

**Common Term:** Knee

**Type of Bone:** Short
Pelvic Limb (Hindlimb)

The horse’s pelvic limb is attached to the spine by the pelvis at the sacroiliac joint (SI joint) and is responsible for the propulsive force. The complexity of the SI joint can be a source of back pain but the inaccessibility and depth of muscle mass make problems difficult to diagnose.

Similar to the forelimb, we are first going to review the bones that make up the proximal or upper hindlimb. The following bones make up the proximal hindlimb – pelvis, femur, patella, tibia, tibula, and tarsus.
A horse’s pelvis is a union of three flat bones.
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Bones of the Proximal (Upper) Hindlimb

Name: Femur
Common Term: Thigh Bone
Type of Bone: Long
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Bones of the Proximal (Upper) Hindlimb

The patella sits at the distal end of the femur. It is responsible for allowing the horse to lock its leg so it can sleep standing up.

**Name:** Patella

**Common Term:** None

**Type of Bone:** Sesamoid
Bones of the Proximal (Upper) Hindlimb

Name: Tibia & Fibula
Common Term: Shin Bone
Type of Bone: Long

The fibula sits laterally on the tibia
Bones of the Proximal (Upper) Hindlimb

A horse’s tarsus contains three rows of tarsal bones

Name: Tarsus / Tarsal Bones
Common Term: Hock
Type of Bone: Short
Distal (Lower) Limb

The bones of a horse’s distal (lower) front limb consist of everything below the carpus in the forelimb and the hock in the hindlimb. The bones of the distal limb have the same name in the front and hind limbs.

The distal limb is extensively evaluated during training because a horse at race speed will place 3x its body weight as force on the lower limb!

We will now review the bones that make up the distal limb – splint bones, cannon bone, proximal phalanx, middle phalanx, distal phalanx, and distal sesamoid bone.
Bones of the Distal Limb

- **Name:** Cannon Bone  
  **Type of Bone:** Long

- **Name:** Splint Bone  
  **Type of Bone:** Long

- **Name:** Proximal Phalanx / P1 / Long Pastern Bone  
  **Type of Bone:** Long

- **Name:** Proximal Sesamoids  
  **Type of Bone:** Sesamoid

- **Name:** Middle Phalanx / P2 / Short Pastern Bone  
  **Type of Bone:** Short

- **Name:** Distal Sesamoid Bone / Navicular Bone  
  **Type of Bone:** Sesamoid

- **Name:** Distal Phalanx / P3 / Coffin Bone / Pedal Bone  
  **Type of Bone:** Short

The splint bones are found on the medial and lateral side of the cannon bone, on the palmar (or plantar) aspect.

The distal sesamoid bone sits underneath the distal phalanx.
Putting It All Together

Knowing the basic bones of the equine skeleton is a **must** for all individuals who wish to work in the equine industry, whether you are hands on or hands off. Understanding appropriate terminology will make it not only easier for you to communicate with your fellow coworkers and employers, but also demonstrate your knowledge base and capability as an equine professional. You must not only know the individual bones, their various names (if applicable), and classification, but also how they fit in with the overall skeleton of the horse. The best advice I can give for learning the equine skeletal system is to **study, study, study**! Make flashcards of the individual bones and/or equine skeleton to test yourself on, trace an equine skeleton and label it or even color it multiple times, there are many ways one can practice but it will be up to you!

Application of the bones and this information is another means of learning and studying, which is why I have developed a “Day on the Job” assignment to be an interactive simulation in which you will put this information to use. While you need to complete it only once for a grade, please feel free to repeat this assignment multiple times as a means of studying.

I cannot emphasize enough the importance of knowing the equine skeletal system. Please be aware that your **Skeletal ID Assessment** is a quiz worth 50 points (20% of your overall assignments, quizzes, and assessment grade). You must successfully complete this assessment with a score of 100% in order to progress forward in this course; you will not see any further quizzes or assignments until this occurs. Multiple retakes of this assessment are allowed to improve your grade and reach this marker – your final assessment grade will the highest grade received. **Failure to comply will result in an assessment grade of 0.**
Labeled Equine Skeleton

Maxilla

Mandible

A: Cervical Vertebrae
B: Thoracic Vertebrae
C: Lumbar Vertebrae
D: Sacral Vertebrae
E: Caudal Vertebrae
F: Scapula
G: Humerus
H: Ulna
I: Radius
J: Carpal Bones
K: Splint Bone
L: Cannon Bone / 3rd Metacarpal
M: Proximal Sesamoids
N: P1 / Long Pastern / Proximal Phalanx
O: P2 Short Pastern / Middle Phalanx
P: P3 / Pedal Bone / Distal Phalanx
Q: Pelvis / Pelvic Girdle
R: Femur
S: Patella
T: Tibia
U: Tibia
V: Tarsal Bones
W: Navicular Bone / Distal Sesamoid Bone
Non-Labeled Equine Skeleton
Self-Knowledge Checks

1. 70% of the skeleton’s strength is due to _______ content.
   a. Fat  
   b. Mineral  
   c. Vitamin  
   d. Cartilage

2. Appropriate training can increase the density of immature bone – would this be considered modeling or remodeling?
   a. Modeling  
   b. Remodeling

3. This category of bone is greater in length than in width, aids in locomotion, and assists in the storage of minerals.
   a. Short  
   b. Sesamoid  
   c. Long  
   d. Flat

4. Using the image below, identify where modeling and remodeling occur.

5. Which of the following bones are not part of the axial skeleton?
   a. Thoracic vertebrae  
   b. Sternum  
   c. Mandible  
   d. Humerus

6. Which vertebrae form the horse’s loin?
   a. Cervical  
   b. Lumbar  
   c. Thoracic  
   d. Caudal

7. The appendicular skeleton consists of:
   a. All the bones in the limbs  
   b. All the bones in the skull  
   c. All the vertebrae  
   d. All the ribs

8. Which bone is displayed below?

   a. Scapula  
   b. Tibia & Fibula  
   c. Radius & Ulna  
   d. Tarsus

9. Which of the following statement correctly describes the distal limb?
   a. It consists of all the bones above the knee  
   b. It consists of all the bones above the hock  
   c. It consists of all the bones below the knee/hock

10. Which pelvic limb bone allows the horse to lock its leg so it can sleep standing up?
    a. Distal Sesamoid Bone  
    b. Patella  
    c. Tarsus  
    d. Splint Bone
Answers

1. 70% of the skeleton’s strength is due to _______ content.
   b. Mineral

   Bone strength, and therefore skeletal strength, come from minerals; 70% of the skeleton’s strength is due to mineral content.

2. Appropriate training can increase the density of immature bone – would this be considered modeling or remodeling?
   a. Modeling

   Remember that the bone is living tissue that has the ability to adapt to exercise, or lack of it. When exercising a horse, the bone responds to the force put upon it through two methods – modeling and remodeling. The method that is employed by the body depends on the current state of the bone – if it is immature bone (such as in a young and growing horse) the bone will undergo modeling while mature bone (as in an older horse) will remodel.

3. This category of bone is greater in length than in width, aids in locomotion, and assists in the storage of minerals.
   c. Long

   Long bones are greater in length than in width, aid in locomotion and the storage of minerals.

4. Using the image below, identify where modeling and remodeling occur
   A

   On the presented image, “A” signifies the diaphysis, which is the shaft of the long bone. The diaphysis is where modeling and remodeling occur.

5. Which of the following bones are not part of the axial skeleton?
   d. Humerus

   The axial skeleton consists of the bones of the skull, sternum, vertebrae, and ribs. The humerus is a long bone found in the proximal forelimb – bones in the limbs are part of the appendicular skeleton.

6. Which vertebrae form the horse’s loin?
   b. Lumbar

   If you recall your parts of the horse, the loin is the short region joining the back to the croup. Skeletally, the lumbar vertebrae make up the horse’s loin. This region is often prone to muscle soreness and strain due to a lack of support from the pelvis or ribs.

7. The appendicular skeleton consists of:
   a. All the bones in the limbs

   The appendicular skeleton consists of all the bones in the limbs. We can further break down the appendicular skeleton into thoracic limb (forelimb) or pelvic limb (hindlimb).

8. Which bone is displayed below?
   c. Radius & Ulna

   The bone displayed is the radius and ulna, two bones that are fused, forming the horse’s forearm in the thoracic limb (forelimb).

9. Which of the following statement correctly describes the distal limb?
   c. It consists of all the bones below the knee/hock

   Think back to your directional terminology – the term distal means further from the body. We also can think of distal as “below”. The distal limb of a horse consists of all the bones below the knee or hock.

10. Which pelvic limb bone allows the horse to lock its leg so it can sleep standing up?
    b. Patella

    The patella is a sesamoid bone that sits at the distal end of the femur. This bone slides up and down, locking to allow the horse to sleep standing up.
Glossary

**Appendicular Skeleton** – Classification of the skeleton that consists of the bones in the limbs

**Axial Skeleton** – Classification of the skeleton that consists of the skull, sternum, vertebrae, and ribs

**Cannon Bone** – Also referred to as 3rd Metacarpal in the front limb or 3rd Metatarsal in the hindlimb; categorized as a long bone

**Carpus** – The knee of the horse; consists of two rows of carpal bones

**Caudal Vertebrae** – Also referred to as coccygeal; vertebrae that make up the tail bone. A horse may have 18 – 22 caudal/coccygeal vertebrae

**Cervical Vertebrae** – Vertebrae that form the neck; a horse has 7 cervical vertebrae

**Diaphysis** – Shaft of the long bone; where modeling and remodeling occurs

**Distal Limb** – Also referred to as the lower limb; consists of everything below the carpus in the forelimb and the hock in the hindlimb

**Distal Phalanx** – Also referred to as P3, Coffin Bone, or Pedal Bone; categorized as a short bone

**Distal Sesamoid Bone** – Also referred to as the Navicular Bone; sits underneath the distal phalanx; categorized as a sesamoid bone

**Epiphysis** – Ends of the long bone that form joint surfaces

**Femur** – Thigh bone of the horse; categorized as a long bone

**Fibula** – Part of the horse’s shin bone; found on the lateral side of the tibia; categorized as a long bone

**Flat Bones** – Thin and expanded in two dimensions to protect vital organs and provide attachment sites for muscles; Examples = Scapula, Pelvis

**Humerus** – Arm bone of the horse; categorized as a long bone

**Irregular Bones** – No set shape and/or structure; many serve to protect the horse’s nervous system; Examples = Thoracic vertebrae, Cervical vertebrae, etc.

**Long Bones** – Greater in length than in width to aid in locomotion and storage of minerals; found mainly in the limbs; Examples = Humerus, Cannon, Femur, Radius & Ulna

**Lumbar Vertebrae** – Vertebrae that form the horse’s loin area; prone to muscle soreness and strain due to not being supported by the pelvis or ribs; a horse has 6 lumbar vertebrae

**Lumbosacral Junction** – The joint between the lumbar and sacral vertebrae; allows the hind legs to reach under the body

**Mandible** – One of the two main bones of the skull; the lower jaw
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**Maxilla** – One of the two main bones of the skull; the upper jaw

**Middle Phalanx** – Also referred to as P2 or Short Pastern Bone; categorized as a short bone

**Modeling** – The growth and shaping of immature bones; how bone adds to itself both inside and out

**Patella** – Sometimes referred to as the kneecap of the horse; sits at the distal end of the femur; allows the horse to lock its leg so it can remain standing while sleeping; categorized as a sesamoid bone

**Pelvis** – A union of three flat bones

**Pelvic Limb** – Also referred to as the hindlimb; the back limb of the horse

**Periosteum** – A thin, tough, nerve-rich membrane that covers the diaphysis to allow for tendon and ligament attachment

**Physis** – Also known as the growth plate; allows the bone to lengthen during growth

**Proximal Phalanx** – Also referred to as P1 or Long Pastern Bone; categorized as a long bone

**Proximal Sesamoids** – Located at the distal end of the cannon bone; categorized as sesamoid bones

**Radius** – Longer forearm bone of the horse; categorized as a long bone

**Remodeling** – Involves the removal of old bone followed by the formation of new bone; how existing bone alters itself

**Sacral Vertebrae** – Vertebrae that form the horse’s croup area; a horse has 5 fused sacral vertebrae

**Sacroiliac Joint (SI)** – Responsible for attaching the pelvic limb to the spine and providing propulsive force; a complex joint that can be a source of back pain due to deep muscle masses

**Scapula** – Shoulder blade of the horse; categorized as a flat bone

**Sesamoid Bones** – “Sesame seed” shaped-like bones found near joints and embedded within a tendon to help reduce friction; Examples = Proximal Sesamoids, Navicular Bone, Patella

**Short Bones** – Cuboid or approximately equal in all dimension; help absorb concussion; found mainly in joints; Examples = Carpal bones, Tarsal bones

**Soundness** – Refers to the health of the horse in regards to its movement; an unsound horse is lame

**Splint Bones** – Found on the palmar or plantar aspect of the cannon bone along the medial and lateral side, assist in support and stability of the carpus or hock

**Sternum** – Breastbone of the horse; found in the chest cavity

**Tarsus** – The hock of the horse; consists of three rows of tarsal bones

**Thoracic Limb** – Also referred to as the forelimb; front limb of the horse
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**Thoracic Sling** – A group of muscles that attach the forelimb to the spine; helps disperse and reduce the amount of concussion reaching the spine

**Thoracic Vertebrae** – Vertebrae that form the withers and part of the back; a horse has 18 thoracic vertebrae

**Tibia** – Part of the horse’s shin bone; categorized as a long bone

**Ulna** – Smaller forearm bone of the horse; creates the horse’s point of elbow; categorized as a long bone