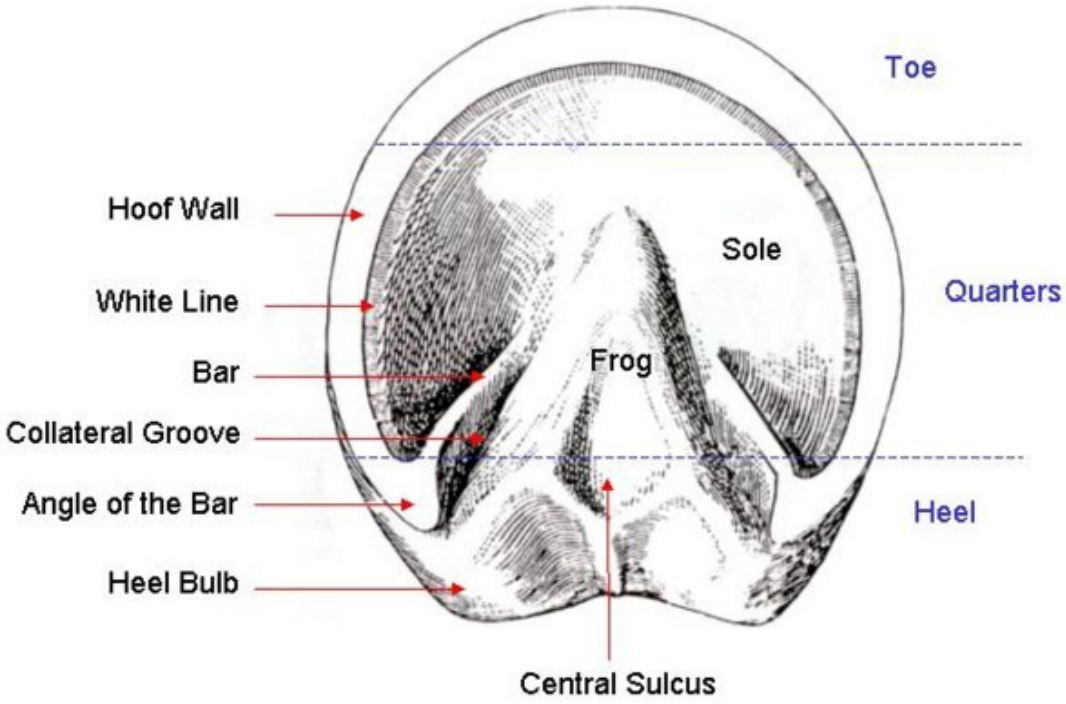
Hoof Anatomy

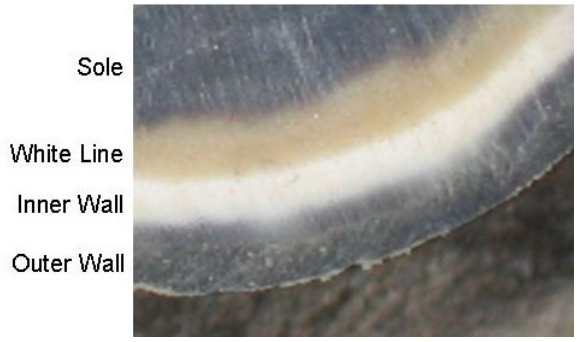
A beginner's Guide

The horse's hoof is a miracle of engineering. It contains a whole host of structures which operate in equilibrium with each other to form a hoof capsule which is able to withstand huge forces, utilising energy to assist with propulsion while providing protection to the sensitive structures beneath.

This is not a definitive guide, but it will allow the horse owner to understand more about this incredible structure.



This newly trimmed section of hoof gives you a good idea of what the different structures of the hoof wall and sole look like. On a white foot, the differences are much less easy to spot.



Sole

The sole is the area inside the white line, but not including the bars and frog. It's primary function is to protect the sensitive structures beneath the sole. However, the outer perimeter of sole also provides support, sharing some of the weight of the horse with the hoof wall.

White Line

Commonly referred to as the white line, although this is very misleading, not only because it is actually yellowish but also because it is next to the white inner wall of the hoof. This often causes people to misinterpret the white line as inner wall, so I often refer to it as the Golden Line A very accurate description that was commonly used in the 1800s. The purpose of the Golden Line is to join the sole to the inner wall of the hoof and to seal off the border of the pedal bone to protect it from bacterial infiltration. It creates a shallow crease at the bottom of the hoof which fills with dirt, aiding with traction.

Inner Wall

The inner hoof wall is usually white (unlike the outer wall, it does not contain pigment). It is more pliable than the outer wall due to the higher ratio of intertubular horn which bind the tubules together. This intertubular horn has a higher moisture content and enables the inner wall to stretch more as the outer wall moves, ensuring the inner workings of the hoof are protected from too much shock.

Outer Wall

The outer hoof wall is pigmented and contains a higher ratio of tubules. These tube-like structures grow down from the coronary band in a spiral configuration. It has been suggested that this makes them act like tiny springs, but this cannot happen as there is no space between the coils. It is more likely that the tubules are grown this way to add strength. The primary purpose of the outer wall is to store and release energy during the different phases of the stride to help propel the horse along. It also provides protection from the structures within, regulating ingress and egress of moisture . A healthy outer wall will be slightly thicker at the toe and have no growth rings or cracks.

Bar

The bar is an extension of the hoof wall which runs along the side of the frog, terminating approximately half way along the frog. Its primary purpose is to control the movement of the back of the hoof, adding strength to the heel area and protecting it from excess distortion. It should have a high ratio of pliable inner wall to ensure it can move correctly as the heel moves.

Angle of the Bar

Commonly known as the heel, although this description can be misleading. This area is designed to receive the initial impact of the horse's stride and a healthy angle of the bar comprises mainly of pliable inner wall, enabling it to dissipate excess shock with ease. This area plays a major role in supporting the weight of the horse and it is important that it remains correctly balanced.

Collateral Groove

This is the groove that runs along either side of the frog. The outer wall of the groove is made up of the wall of the bar and sole and the wall on the other side comprises the wall of the frog.

Frog

One of the most important, but often neglected structures of the horse's hoof. It should be wide and substantial and made up of thick, leathery material. An unhealthy frog is vulnerable to infection which, if left untreated, can lead to significant loss of structure in the back of the hoof causing severe lameness. The frog works in concert with the coronary band, the bars and the sole to provide resistance to distortion of the hoof capsule during the stride. Pressure placed upon the frog directly influences the health of the digital cushion above it. The frog stay (triangular piece cut out of the sole that the frog sits in) allows independent movement at the heels as the horse lands on uneven ground. The frog also plays a part in protecting the sensitive structures beneath, providing traction, assisting circulation and absorbing shock.

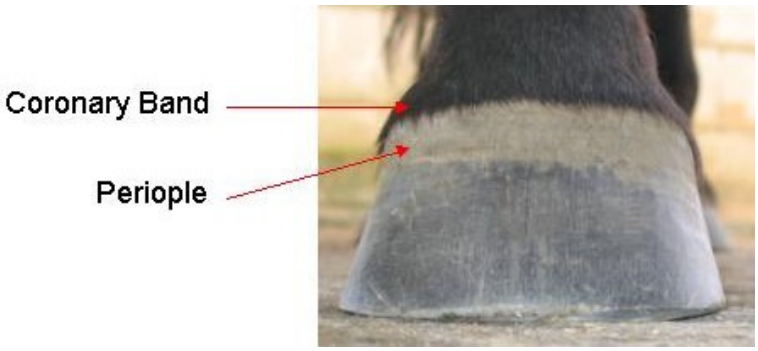
In the centre of the frog, towards the back of the foot is the central sulcus. A healthy sulcus is wide and shallow, but if the frog is weak and narrow it can become a deep crease which is a haven for bacteria and fungus.

Coronary Band

This is a very tough, vascular structure which sits at the top of the hoof wall. It has two very important functions. Firstly it produces the tubules of the outer hoof wall. Secondly, it is incredibly strong and acts as a band of support to add strength to the internal structures as the hoof distorts during the stride.

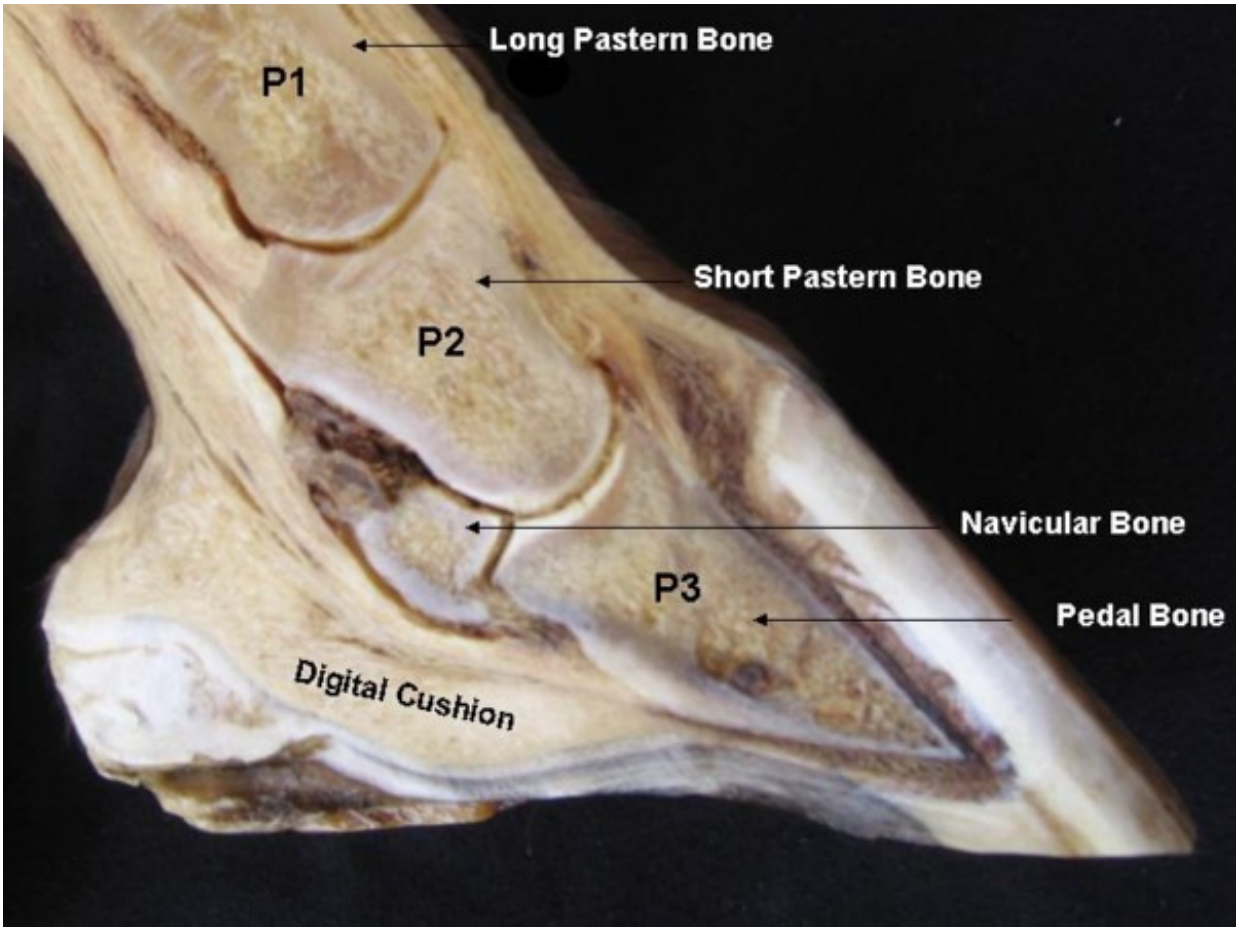
Periople

This is a protective covering for the area newly formed hoof wall just below the coronary band. In the early stages, this horn material is quite soft - deliberately s because it helps to prevent the coronary band being bruised by shock being transferred upwards through the hoof wa during the weight bearing phase of the stride. The periople covers this horn to provide protection.



Internal Structures

There are two and a half bones inside the hoof. The Pedal bone, the Navicular bone and the bottom half of the Short Pastern bone.



Pedal Bone

The large bone inside the hoof capsule is known as the Pedal bone or Coffin bone. Its shape is very misleading when viewed in cross section as it actually looks like this.

The Pedal bone provides strength and stability to the hoof and acts as a framework to hold other structures in place. Surrounding the front wall of the bone is the sensitive laminar corium which produces the intertubular horn of the hoof wall. Underneath, the bone is covered in solar corium which produces the sole. At the back, the bone joins onto cartilage which forms a large portion of the back of the hoof . A multitude of tendons and ligaments attach to this bone and a network of blood vessels run around and through it.

Navicular Bone

This is another bone which is hard to visualise when viewed in cross section. It is thought to have derived its name because it is shaped like a boat. It is also known as the Distal Sesamoid bone (distal meaning furthermost from the body, sesamoid meaning embedded within a tendon). The navicular bone is not actually embedded in a tendon, but it does sit just inside the back of the pedal bone and the deep digital flexor tendon passes over it. It prevents over-articulation of the joint of the pedal bone as well as maintaining a constant angle of insertion of the Deep Flexor Tendon into the back of the Pedal bone.

Short Pastern Bone

Also known as the Middle Phalanx, the short pastern bone sits on top of the articulating joint of the pedal bone and underneath the long pastern bone. Only the bottom portion of this bone extends as far as the hoof capsule.

Digital Cushion

The digital cushion sits just behind the pedal bone and above the sensitive frog. It plays a vital role in the absorption of shock through the transfer of blood through its venous plexuses. In an improperly functioning foot, the digital cushion atrophies and becomes "fatty" as opposed to springy, cartilaginous material and the blood vessels within it will change, inhibiting its ability to absorb shock. The shape and health of the digital cushion will influence the angle of the Pedal Bone. "Flat footed" horses (ie, those whose pedal bones lie flat instead of being tilted slightly on their nose usually have severely atrophied digital cushions.

Coriums

A corium is a vascular structure which manufactures one of the outer elements of the hoof capsule. For instance, the solar corium will produce the sole, the sensitive frog corium produces the sensitive frog - the outer layer of which becomes the insensitive frog we see on the outside. The coronary band contains a corium which produces the tubules and intertubular horn of the hoof wall, whereas more intertubular horn is manufactured in the corium surrounding the pedal bone (also known as the dermal layer). The perioplic corium sits under the coronary band and produces the periople.

Lateral Cartilage

The lateral cartilages are located both above and below the coronary band, extending around the front, the sides and back of the hoof. Below the coronary band they extend out over the digital cushion and attach to the back of the pedal bone. The horn producing corium of the inner hoof wall attaches to the lateral cartilages at the back of the hoof where the pedal bone does not reach.
There is new evidence to suggest that the lateral cartilages form a matrix which extends under the digital cushion forming a sort of hammock. These cartilages provide resistance as the pedal bone descends during weight bearing, regulating the amount of pressure applied to the coriums. They also help to suspend the pedal bone in the correct position as well as acting as a spring, storing and releasing energy during locomotion.

This shows the approximate position of the lateral cartilage beneath the hoof capsule

Venous Plexuses

The hoof is heavily supplied with blood via five venous plexuses. These are:

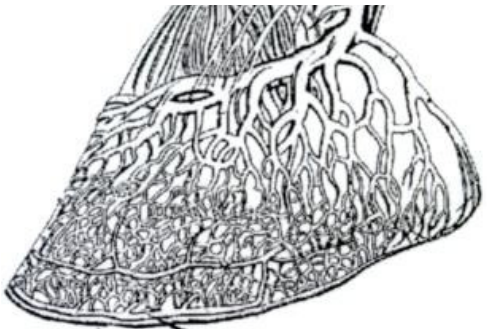
Solar - nourishing the horn producing corium that generates the sole

Digital cushion - a network of blood vessels which run through the digital cushion

Lateral cartilage - supplying the cartilages with blood which helps with energy utilisation

Lamellae - nourishing the corium which produces the intertubular horn of the hoof wall

Coronary - supplying the coronary band with the nutrients it needs to produce the tubules of the hoof wall



This is just a taster of what an amazing and complex structure the equine hoof is. If you would like to learn more about the anatomy of the equine hoof, and the way it functions I suggest you read the following

"The Lame Horse" by James Rooney, ISBN 0-929346-55-6

"Horse Anatomy. A Colouring Atlas", Robert A Kainer and Thomas O McCracken, ISBN 1-57779-017-0

"Practical Guide to Lameness in Horses", Ted S Stashak, ISBN 0-683-07985-9

"The Equine Distal Limb", Jean-Marie Danoix, ISBN 978-1840760019