The forefoot of the horse is a product of evolution and a miracle in bio-engineering. It is extremely light in weight, flexible, and yet it withstands constant shock and concussion due to the forces of locomotion. The hoof is a highly specialised horny shell composed of three layers, the stratum externum (outer layer of the wall,) stratum medium and stratum internum (middle and inner layers.) The hoof covers the sensitive bones, nerves, connective tissue and vascular tissue of the forefoot. The primary function of the hoof is to protect the underlying structures, and to increase the surface area for the dissipation of locomotor forces.

The hoof wall itself is composed mainly of keratinised tissue representing the modified epidermis of the skin. However the innermost layer of horn adjacent to the corium, is a growing layer consisting of horn cells. Cells from this layer are continually dividing to produce horn cells which are added to the bulk of the horn. Growth occurs in a tubular fashion from the surface of papillae projecting from the coronary corium. The hoof wall is therefore formed of tubules of horn tissue held together by non-tubular horn. Keratin Sulphate (a proteinaceous material with a high sulphur content) forms the structural component in this matrix bonding the cells and tubules. Keratin Sulphate is a mucopolysaccharide and as such, has a great affinity for water molecules. It’s integrity is fundamental, because Keratin’s attraction for water facilitates the high moisture content in the hoof horn.

The maintenance of moisture content in the hoof horn is extremely important. Elasticity and the ability to absorb compression are essential factors in the dissipation of the concussive forces of locomotion. If the hoof horn is deprived of good quality protein, bioavailable sulphur, calcium, zinc, or biotin, irregularities can occur in the hoof wall. This will manifest itself as cracks or brittle crumbling hooves. Manmade environmental factors such as synthetic working and racing surfaces, manmade roadways, certain bedding, and high grain rations all put increased pressure on the self-maintenance of horses’ hooves.
The direction of growth of horn is downward from the coronet so that tubular horn is pushed downward to produce the wall and bearing surface, whereas tissue loss due to friction and abrasive forces occurs on the ground surface of the hoof. Thus the youngest horn is closest to the coronary band, and the oldest is on the bearing surface of the wall. This method of growth explains the presence of ridges in the horn. When the rate of growth is irregular alternating ridges and depressions encircle the wall. The nutritional content of the diet, which is affected by the seasons may be an influential factor in the rate of horn production. Hoof growth is faster and more prominent in the Spring when the horse is out at grass, producing raised "grass rings."

During this time the nutritional content of pasture is significantly better, than in the Autumn and Winter months. On the other hand during Winter, hoof growth tends to be diminished and lessened in extent, thus circular depressions can mark the season. The vast majority of horses in training have limited access to quality fresh forage, therefore nutritional deficiencies are not uncommon. Irregularities in the epidermal layers, such as the hair and hooves are indicative of nutritional deficiencies in the diet of the horse.
Intestinal synthesis of Biotin is inadequate for active horses and its production is severely compromised by reductions in caecal pH. Dietary supplementation with Biotin is essential to maintain hoof strength and integrity. It has been shown that hoof problems may be resolved by using very high levels of Biotin (>20mg./day) over an extended period of time.

However it is important to note that Biotin supplementation is probably most effective for horses with hoof defects involving the stratum externum. In one study (Kempson et al 1987) a team at the University of Edinburgh located the exact origin of the hoof defects in the hoof horn using a scanning electron microscope. They showed that cracks in the stratum externum typically showed a loss of horn material in the outer layer. Other cracks involved the stratum medium and stratum internum due to a breakdown of structural organisation in these layers. On further investigation they realised that horses with defects in the stratum externum responded very well to Biotin supplementation, whereas cracks that involved the deeper layers benefited most from the addition of protein and calcium to the diet. Horses with defects in the stratum medium and stratum internum respond better to supplementation with a combination of Calcium, Protein, bioavailable Sulphur, Zinc and Biotin, rather than just Biotin alone. High levels of protein in the diet favour the uptake of Calcium, which is essential for cohesion of the hoof wall. Amino Acids are the building blocks of protein, which is vital for complete healing, and improved integrity of Keratin Sulphate – the main protein in the hoof horn. Bioavailable Sulphur, whether in the form of MSM, or Methionine, is also an extremely important nutrient in the diet of the horse, especially with regard to hair and hoof growth, and integrity of connective tissue. The importance of Sulphur in relation to improved hoof growth relates to the durability of the Keratin Sulphate molecule, which relies on the integrity of it's numerous disulphide bonds made up of Sulphur-bearing amino acids. The major function of Zinc in the body is to act as a component of many metalloenzymes involved in protein and carbohydrate metabolism. A deficiency of Zinc may impair cellular division, and so it's presence is paramount for the proper healing of all epidermal tissue, especially the hooves.

Hoof Care — A Three Fold Approach

Nutrition

All horses in training should receive a balanced diet, if they are expected to perform at the very highest level. Nourishment of the hoof and the underlying structures should receive primary attention, as they are the foundation of the horse. Lameness is the biggest reason for under performance in the horse, and interestingly foot lameness is the most common type of lameness seen in the equine athlete.

The most critical vitamin in the process of hoof growth and regeneration is Biotin. It is a member of the B vitamin family, but historically was referred to as vitamin H. It is available in plentiful supply in good grass/legume mixtures but is otherwise poorly available from other food sources.
Foot Hygiene

First and foremost, stables should be designed to incorporate a “run-off” for urine and water; ammonia in manure and urine will cause the hoof to soften and create perfect breeding conditions for bacterial infections such as thrush, and other fungal infections. Hooves should be picked out on a regular basis to remove any debris picked up. Fresh air should be a priority in the stable environment. The choice of bedding is subjective, but in any case it is important that bedding, with a tendency to dry out the hoof, should be avoided. Bedding should be kept as fresh as possible.

Farriery

A qualified farrier should always conduct trimming and shoeing work. The farrier has a huge influence on the balance of the foot. Preparation of the hoof, the type of shoe used, and its placement, will all affect the displacement of force on the forefoot and adjoining limb. Many hoof defects are multi-factorial in their origin. Incorrect shoeing and neglect can be one of the pre-disposing factors to disease and the breakdown of hoof horn function, cracks and brittle hooves.