Can You Influence Hoof Growth?

We ask an awful lot of an animal who walks on his middle toenails. Humans have recognized for centuries that the foundation of a horse's soundness lies in his hooves—"No foot, no horse" is about as basic a principle as there is. It all comes down to the forces exerted by a 1,000- to 2,000-pound animal on four rather small and specialized bits of keratin.

And yet, there's much we don't understand about why some horses grow dense, tough, virtually indestructible hooves, while others produce feet with the consistency of dead cork. What do we know about the process of hoof growth, and how might we be able to influence its rate and quality?

Hoof growth is influenced by many conditions, but can you "tweak" your horse's system to help him produce better-quality feet?

What Makes a Hoof?

Hoof horn is a highly modified, specialized skin derivative. It has two main layers, the outer epidermis and the underlying dermis (which, when you're talking hooves, is called the corium). The epidermis contains no blood vessels of its own; it obtains its oxygen and nutrients from the blood supply to the underlying corium of the foot.

The hoof's hardness is derived from a fibrous protein called keratin, the same substance that makes up human fingernails. Keratin is manufactured and retained in the basal cells of the epidermis. As
Anatomy of the Growing Hoof Wall

An artificial separation has been made through the dermal/epidermal junction of the hoof.

Common digital extensor tendon
Skin
Coronary cushion
Perioplar corium
Perioplar papillae
Coronary corium
Coronary papillae

DERMIS

Middle phalanx (P3)
Joint capsule of distal interphalangeal (coffin) joint
Distal interphalangeal joint (coffin joint)
Extensor process
Distal phalanx (P3)
Primary dermal lamina
Secondary dermal laminae
Laminar corium
Periosteum
Laminar subcutis

SITE OF STUDY

Primary epidermal lamina
Secondary epidermal lamina

EPIDERMIS

Stratum medium
Stratum internum

STEP BY STEP

new keratin-containing cells are formed, they flatten, something like roof shingles. Eventually, they lose their nuclei and most of their other cell organelles and become flat, plate-like horn cells, which contain the filamentous keratin embedded in a matrix of sulfur and tyrosine proteins. The proportion of keratin to non-filamentous matrix, which can vary, is one of the factors that determines the mechanical properties of the horse's hoof horn (in other words, how tough it is).

Keratin-containing epidermal cells arrange themselves in long tubules, with each one overlying a finger-like connective tissue papilla underneath. Between the tubules is more keratin-containing intertubular horn. If we were to look at a cross-section of a horn tubule, we'd see a central core around which the keratin cells are arranged in a tight concentric spiral. This design allows for the tubules to deform and bounce back into shape when the horse bears weight on each foot, then lifts the foot. The tube shape also helps the hoof repel moisture from the environment.

The laminae—frond-like, blood-rich connective tissues that bond the hoof's internal structures to its hard outer layer—and the coronet (coronary band), together generate the outer wall of the hoof capsule. The bond with each is constantly changing as the live tissues grow.

Experiments using radioactive tracers have shown that keratin cells generated from the laminae grow in a peripheral (outward) direction and eventually merge with the intertubular horn produced by the coronary region. In this way, a strong bond develops between the coronary horn growing...
toward the ground and the underlying coffin and navicular bones. (Most horse people are familiar with what happens when this normally strong bond weakens or fails—a traumatic syndrome called laminitis results.)

The hoof wall plays a pivotal role in weight bearing. The weight of the horse is transmitted down through the column of leg bones of each limb, ultimately coming to settle on the coffin bone (third phalanx or P3). But the tight interlocking of the laminae between the coffin bone and the hoof capsule transfers the weight of the body to the hoof wall. In essence, the horse’s body weight ends up suspended from the inside of the hoof, with the ground reaction force borne by the hoof wall.

The outermost external layer of the hoof, called the periole, is an extremely thin layer of tubular horn. Ordinarily, it covers the bulbs of the heels and a variable part of the upper hoof wall. You can spot it on a wet hoof because it turns white in the presence of moisture. The periole acts as a barrier, helping the hoof retain its interior moisture balance and resiliency. In most horses, the periole doesn’t extend all the way to the ground because it gets worn away through abrasion with soil or sand as the horse moves.

The hoof wall isn’t the only part that grows, of course. The sole of the foot is also composed of tubular and intertubular horn that is completely replaced by new growth about every two months. As each tubule extends outward from the inner tissues of the foot and approaches the solar surface, it curls from the ground pressure, which causes a natural shedding process and limits how thick the sole can become. In most feet, it also results in a concave bearing surface.

The familiar triangle-shaped frog, based at the heels and projecting out into the middle of the sole, is another structure that is designed to help the hoof absorb the shock of landing. It’s less keratinized than the wall and the sole, and has a higher water content that gives it a softer, more pliable consistency than the rest of the hoof.

How Does the Hoof Grow?

Understanding the structures of the hoof gives us a basis for understanding how it grows. The rate and quality of growth varies, just as it does in human fingernails. But while we humans no longer depend on our “claws” for survival, horses do depend on their hooves, so there’s considerable evolutionary advantage in having good feet.

The hoof wall of a normal adult horse grows at a rate of approximately 0.24-0.4 inches (six to 10 millimeters) per month. At the toe, it takes between nine and 12 months for hoof horn to grow down from the coronet to the ground surface; at the quarters, six to eight months; and at the shorter heels, four to five months. Naturally, this time is longer for horses kept with longer feet, such as saddleseat-shown American Saddlebreds and Tennessee Walking Horses.

Because the distance from the coronet to the ground is shorter at the heels than at the toe, heel horn at the ground surface is always younger than the toe horn, so it has more elasticity and contains more moisture.

A newborn foal is born with soft extensions on his hooves to keep from injuring the mare. These wear off quickly when he gets on his feet. The entire foot is softer because of the uterine fluid—it will harden in response to the outside environment.

The rate of hoof growth is considerably faster in young horses than in adults. The foot of a nursing foal, for example, grows at a rate of about 0.6 inches (15 mm) per month. As the horse matures, the rate slows; yearling feet grow about 0.48 inches (12 mm) per month.
The tubules at the heel are turned underneath this hoof instead of growing parallel to the tubules at the toe. This is a common result of a long-toe, low-heel situation.

A shelly foot is seen more often in some breeds, and can be aggravated by frequent shoeing. Constantly making new nail holes in weak wall to hold on shoes contributes to a vicious cycle.

Hoof cracks can be caused by nutritional problems, genetics, and changes in environmental conditions. They can also be caused by any combination of these factors.

**STEP BY STEP**

Other than youth, what might affect the rate at which a horse’s hooves grow? There are a number of considerations, including:

- **External temperature**—Mid-winter cold tends to slow hoof growth; the rate accelerates in the spring.
- **Environmental moisture**—Extremely dry conditions retard hoof growth. Generally speaking, hooves grow faster in soggy Seattle than they do in the Arizona desert.
- **Genetics**—Some breeds are well-known for the quality and denseness of their hoof horn (Arabians and many pony breeds, for example), while others are recognized for often having poor-quality feet (Thoroughbreds in particular). There is a great deal of variation within each breed, however, and environment can play a large role.
- **Illness and fever**—High body temperatures might retard or deform hoof growth so that several months later, the horse exhibits “fever rings” on his hooves.
- **Injury to the coronary band**—When these generative tissues are damaged, the resulting hoof wall from that area might also be damaged or grow more slowly.
- **Weight-bearing on other feet**—If a horse suffers a severe lameness in one leg such that he puts no weight on it, the hoof
growth of the opposite leg, which bears all the weight, will be slower than normal. This might also produce distortions in the hoof capsule.

**Exercise**—When a horse begins training for an athletic task, its metabolic rate will increase, and hoof growth will accelerate along with it.

**Nutrition**—This is a crucial consideration, because several dietary elements need to be in place in order for the horse to grow good-quality hoof horn. If the horse is deprived of any of these nutrients (more on these in the next section), the hoof will grow more slowly and the horn produced will be ill-equipped to support the horse's weight and retain its integrity.

### Feeding the Feet

The influence of diet on hoof growth is a subject currently generating a fair bit of research interest, and lots more interest from supplement manufacturers hoping to cash in on the latest developments! We know that basic malnutrition (a shortage of all nutrients) can have an adverse effect on hoof growth. In one study cited in *Feeding and Care of the Horse*, weanling ponies fed a restricted diet (one-third of their daily nutritional calorie requirement) had a hoof growth rate one-third slower than a control group of weanling ponies fed an adequate diet. Interestingly, though, the diet restriction had no effect on hoof strength or elasticity.

Certain specific nutrients can also have an impact on hoof growth. Horses which take in too little protein, for example, have slowed hoof growth and tend to produce inferior quality horn that is prone to cracking and splitting. In reality, of course, the only horses which are likely to suffer protein deficiencies are young, growing horses and lactating broodmares (both of which have high protein requirements) being fed exclusively over-mature grass pasture or hay with no other supplements. The diet of most mature horses contains ample quantities of protein for good hoof growth.

It's no surprise that calcium—a macromineral that plays an important role in the formation of bones, muscles, teeth, and virtually every other structure in the horse's body—is also crucial to good hoof growth. Calcium is essential for the cohesion of one cell to another, and it is thought to play a role in the tightly wound arrangement of keratinized cells in the hoof tubules.

Horses fed a high-phosphorus, low-calcium diet based on lots of grain and bran with relatively little hay can suffer a calcium deficiency, which causes all sorts of problems (poor hoof quality included). In one British study, a number of horses initially fed oats, bran, and grass hay showed a 22-25% improvement in the amount of hoof horn they produced over a period of nine months after half of their grass hay was replaced with high-calcium and high-protein alfalfa hay.

No other nutrient has received more attention in terms of hoof growth than biotin. A B vitamin, biotin is produced in the horse's gut in sufficient quantity to satisfy his basic nutritional needs, but some horses with poor-quality hooves appear to benefit from supplemental quantities of this vitamin (above what's needed for everyday metabolism). Readily available and with no known side effects, biotin is a popular supplement that's fed to enhance the repair of hoof defects and as a preventive against slow or poor-quality hoof growth.

Researchers still don't understand exactly why some horses respond to biotin...
supplementation and others do not, but the vitamin seems to be most beneficial to horses with thin, brittle hoof walls and tender, thin soles—that familiar horse that loses shoes easily and loses chunks of the hoof wall when he does so.

Some studies have shown improvement in the hoof quality of biotin-supplemented horses, although some have not. If it is beneficial, there’s still considerable debate as to what the optimum dosage might be. One thing is clear, however: Biotin supplementation, if it is to be effective, takes several months to produce results. The reason for this is that the effects of any supplement that affects hoof growth will not be seen until that new and improved growth comprises most of the hoof, and it takes at least six to nine months, in an average horse, for that growth to reach the point where a farrier will be trimming it.

In one study of 42 Lipizzaner stallions, 26 of which were fed biotin at 20 mg/day, improvement in hoof quality was first noted six months after the study began, with the best results after 14 months, with improvement being measured as a decreased incidence of cracks, less crumbling of the horn, and greater measurable tensile strength.

Various amino acids also have been considered nutritionally important for hoof growth. Methionine and cystine, in particular, have received considerable attention because they both contain sulfur, an essential element in the formation of keratin. Methionine, an essential amino acid (meaning the horse cannot manufacture it for himself; he must take it in through his diet) is present in only very small amounts in keratin, but it can be converted to cystine once in the system. It probably will not improve hoof growth or quality on its own, but it’s often included in biotin supplements and could play a helpful role there. They are believed to work synergistically (acting together such that their effect together is greater than the sum of their separate effects), but more research is needed.

Finally, zinc is a trace mineral that is involved with growth rates and healing throughout the equine body. Horses deficient in zinc have impaired cellular division and growth, which might be related to a depressed ability to utilize amino acids and sulfur. Since zinc absorption is closely tied to copper levels in the body, both minerals must be supplemented in a correct ratio (from 3:1 to 5:1, zinc to copper) in order to rectify a deficiency. As with methionine, zinc supplementation on its own probably does little to influence hoof growth, but in combination with copper, biotin, and amino acids, it might have a positive effect.

**Stress and Hoof Growth**

How do the everyday stresses of the hoof wall endure affect the growth rate of the foot? That’s the question posed by Jeff Thomason, PhD, of the Department of Biomedical Sciences at the University of Guelph. For several years, Thomason has been examining the way hooves deform and bounce back under pressure. Now, with the help of a responsive computer model of the equine foot he and resident technician Heather McClinchey have designed, Thomason hopes to move into the next phase of his research—measuring hoof growth relative to where the load is centered on the foot.

“We’ve established the basic pattern of strains and stresses the equine hoof horn experiences under various conditions,” Thomason explains. “Now we need to measure the rate of hoof growth in horses for which we already have measurements of those stresses on various parts of the hoof wall. We will need to record the strains on them over a long period of time—about every second shoeing for a period of a year. This will help us quantify the amount of force involved and determine how those forces might have changed the growth rate.

“The basic question is this: Do horses with increased strain on their feet—from pounding on hard ground, from shoeing, or whatever—have increased hoof growth, or decreased? And how does the location where the load is concentrated on the wall change the relative growth around the wall? We’re just about ready now to begin exploring that.”

Research like this eventually could affect popular methods of shoeing. For example, Thomason’s work might demonstrate whether there are extraordinary stresses placed on Thoroughbred feet trimmed in the “long toe, low heel” configuration still popular at many racetracks. When he has a better understanding of all the mechanical factors affecting hoof growth, horse owners will have more knowledge of how to improve the quality of the hooves on which their horses stand. And that’s the least we can do for the horses which bear not only their weight, but ours as well, on their middle toenails. 🌺