

# The Horse

## Introduction

The HORSE is a large land mammal notable for its speed, strength, and endurance. Horses are members of the Equidae family, which also includes zebras and asses. Like all equids, the horse is extremely well adapted to traveling long distances with great efficiency and to surviving on a diet of nutrient-poor, high-fiber grasses. The horse is an intensely social animal, forming strong associations with members of its herd and possessing a keen ability to recognize subtle social cues. These instinctive behaviors form the basis of the horse's ability to bond with and obey a human trainer.

The horse's influence on human history and civilization make it one of the most important domestic animals. Horses were domesticated in Eurasia around 6,000 years ago. Throughout much of human history, they have provided humans with mobility and have served in agriculture, warfare, and sport. Today domestic horses are found throughout the world, with a total population estimated at 60 million. So-called wild horses, such as those found in the American West, are actually feral animals, free-living descendants of domestic horses that escaped or were turned loose.

The wild ancestors of the modern horse evolved for millions of years in North America. They spread to other parts of the world by traveling southward to South America and by crossing land bridges that connected North America to Europe and Asia during the ice age. Horses vanished from both North and South America in a wave of extinctions that occurred near the end of the Pleistocene Epoch, about 15,000 years ago. They were not seen in the Americas again until 1494, when Italian explorer Christopher Columbus transported them on ships from Spain on his second voyage to the New World.

Przewalski's horse, which is believed to be the only truly wild horse to survive to modern times, probably became extinct in the wild in Mongolia in the 1960s. About 1,100 Przewalski's horses survive today in captivity in zoos and wildlife parks.

## Physical Characteristics

As a result of deliberate breeding by humans, horses display a remarkable variation in size, body shape, and coat color. Traditionally, a horse's size is measured at the withers—an elevated part of the spine between the neck and the back. The measurement is made in hands; one hand equals about 10 cm (4 in). Typical riding horses stand 14 to 16 hands high and weigh 400 to 500 kg (900 to 1,100 lb). The smallest horse on record, a Falabella miniature pony, stood 48 cm (19 in), or just under 5 hands, and weighed 14 kg (30 lb). The largest horse on record was a Belgian that stood 1.8 m (6 ft) tall, or 18 hands, and weighed 1,450 kg (3,200 lb).

The horse has a hairy coat and a long mane and tail. A heavy winter coat grows in the fall and sheds in the spring. Typical coat colors include black, brown, gray, cream, gold, and white. The mane and tail can be the same or different from the body color, and many variations in color can result from

inherited traits that cause spotting, dilution of the basic coat colors, or a sprinkling of white hairs in the coat. Many color patterns have specific names, such as bay (brown with black mane and tail), chestnut (reddish brown with mane and tail of the same or lighter color), and palomino (gold with a creamy white mane and tail).

A horse's head is composed of the cranium, which encloses the animal's large, complex brain, and the face, distinguished by a long muzzle consisting of the nose and lips. The muzzle provides enough distance between the horse's mouth and its eyes so that it can graze and watch for danger at the same time.

Horses have the largest eyes of any land mammal. The large eyes protrude from the sides of the head, enabling horses to see almost directly behind themselves, even while facing forward. Their night vision is excellent. Horses have limited color vision, which appears to be similar to one of the less common forms of color blindness in humans—they perceive red and blue, but they cannot distinguish between green and shades of gray.

Horses have powerful teeth and jaws to grind and break down plant fibers. Their teeth grow continuously as their surfaces wear down. Male horses usually have 40 teeth and females have 36. Between the front incisors and the rear molars is a gap called the diastema, where the bit is placed. Horses can close their wide nostrils against dusty winds, and they can move their large ears to detect sounds from various directions.

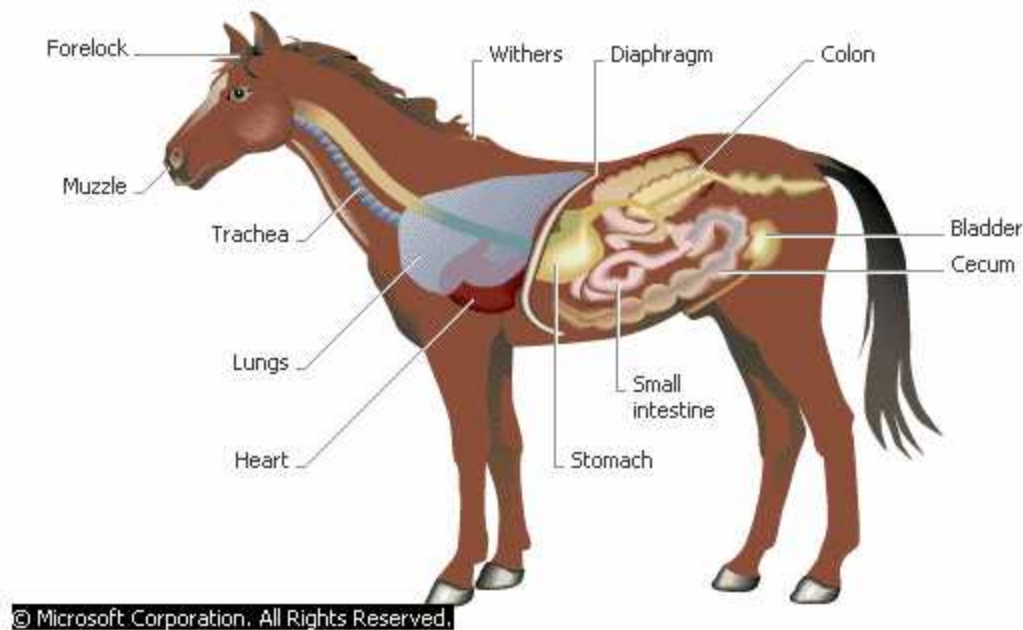
A horse's head is held up by its long, flexible neck, which lets the horse reach down to the ground to feed, rise to a high vantage point to sight danger, and bite itches on the front part of its body. The horse's body has a wide chest, which holds its enormous lungs and heart; and a muscular back, beneath which lie the horse's internal organs for digesting food and reproducing. A horse's long, flowing tail helps keep its hindquarters warm and is used to swish away insects.

The specialized structures of the horse's legs make the animal a very efficient runner. What we think of as the horse's knee is actually the equivalent of a human's ankle, so from the knee down the leg is really a highly elongated foot. The lowest part of the foot is the tip of a single toe, which corresponds to the tip of a person's middle toe. This large, strong toe tip is well protected by a tough, curved hoof. By "standing on its toes," the horse has a very long leg for an animal of its size, but also a very light leg, since toes are lightweight structures, carrying a minimum of bone and tendon and no muscle at all. Like a person's foot, a horse's foot has a sole. In the horse, the sole includes a rubbery, V-shaped structure called the frog, which helps absorb the impact of the foot against the ground.

Many of the joints in horses' legs are comparable to hinges that permit forward and backward motion only. This type of joint requires fewer muscles than are needed for the kind of ball-and-socket joint that occurs in the human hip, which can rotate in any direction. This yields a further savings in weight. Long, light legs allow a horse to move very efficiently. A long leg produces a long stride, and a light leg allows the horse to swing its limbs back and forth quickly with a minimal expenditure of energy. The top speed of the horse is about 70 km/h (45 mph).

## Internal Organs

The horse has very efficient respiratory and circulatory systems that enable it to race at high speeds without running short of air. While walking, a horse consumes only 1 liter (about 0.25 gallon) of oxygen a minute, but at a racing gallop, its oxygen consumption can approach 60 liters (nearly 15 gallons) per minute. At the gallop, the horse's head and neck move up and down in rhythm with each stride. This motion tends to squeeze and expand the lungs, so that a galloping horse automatically takes exactly one breath per stride. This mechanism ensures that the faster the horse gallops, the more air it takes in.



The horse has a single stomach and a large digestive organ called the cecum, which forms a dead-end alley at the junction of the large and small intestines. Microorganisms that live in the cecum break down cellulose, a tough substance within the walls of plant cells, making it possible for the horse to digest grasses. The cecum has a comparable role to the rumen, a specialized stomach chamber present in ruminants, or cud-chewing animals, such as cows and sheep. Horses cannot extract as much energy out of food as ruminants do, but they are able to digest food more quickly. As a result, a horse can eat more food each day than a cow of the same size. Due to this difference, horses can survive on stemmy, high-fiber roughage that would not sustain a cow.

## Reproduction

Horses reach sexual maturity at about one and a half years. The estrous cycle in the mare—a mature female horse—typically lasts 21 days. During the first five days of the cycle, the mare is usually receptive to mating. The estrous cycle stops during winter and resumes in the spring, which is the start of the breeding season. A stallion—a mature male horse—approaching a mare in estrus engages

in various courtship rituals. These include uttering nickering sounds and sniffing and licking the mare's genital area.

The gestational period in the horse averages 11 months. Mares generally give birth to a single offspring, or on rare occasions, twins. Young horses that have not yet been weaned are called foals. Young female horses are called fillies, and young males are called colts.

Among feral horses, stallions guard a harem of mares and compete with other stallions for "ownership" of mares. A harem commonly consists of a single stallion, one to three mares, and their immature offspring. Stallions challenge one another by competing in lengthy squealing contests; often a horse that squeals the longest is able to claim the superior position without physical combat. Stallions that take over a harem from another male will often cause abortions in pregnant mares by chasing and aggressively attacking them. This allows the new stallion to immediately rebreed the mares and produce his own offspring.

To control aggressive behavior in stallions, which is closely linked to the hormone testosterone produced in the testes, horse owners usually castrate males that will not be used for breeding. A castrated male horse is called a gelding.

## Behavior

As herd animals, horses have highly developed social behaviors that help hold the group together and maintain the ranking of each individual within the group. Horses have a basic instinct to form fixed friendship bonds with other members of their group. Mares in feral herds or farm groups invariably pair off with particular other mares. These pairs often engage in mutual grooming, which involves standing side by side and head to tail while each one scratches the other's neck and back with her teeth.

As with all group animals, horses establish and defend a strict pecking order, which helps them avoid constant fighting over access to food, water, and mates. They respond to subtle social signals, such as pinned-back ears, which signal aggressiveness. Once its place in the social hierarchy is established, a lower-ranking horse almost always gives way to a higher-ranking horse without a fight. Most communication between horses takes the form of physical gestures rather than sounds. This behavior reflects horses' evolution in open, unforested habitats where they relied heavily on vision for survival. The horse's repertoire of vocal signals is quite limited compared to many other mammals.

Humans, in establishing their relationship with domestic horses, exploit both the horse's bonding instinct and its instinctive recognition of the pecking order. Trainers often initiate a horse's training in the spring, when horses are shedding heavily and appreciate being groomed. Grooming helps cement the friendship bond and makes the horse willing to allow the human to invade its personal space. By establishing a position as a higher-ranking member in the group hierarchy, the human trainer can generally get a horse to cooperate with a minimal use of physical force or punishment.

# Breeds of Horses

Selective breeding by humans has produced more than 100 breeds of horses, many of which are characterized by distinctive traits such as size, appearance, or temperament. Some breeds are the product of deliberate efforts over many centuries to develop horses suited for specialized tasks, such as racing, herding livestock, or pulling plows, wagons, or carriages. Other breeds simply reflect regional differences that have accumulated over years as relatively isolated populations of animals were bred together.

Horse breeds are often divided into three broad classes: light horses, heavy horses, and ponies. These are not strict categories, however, and do not, as is sometimes claimed, mean that these types of horses descended from different populations of wild horses.

Light horses include saddle horses, such as thoroughbreds, quarter horses, and Arabians; and light harness horses, such as standardbreds and Morgans. The thoroughbred is the preeminent racehorse breed; thoroughbreds are also used as hunters and jumpers. All thoroughbreds are descendants of three Arabian stallions that were brought to England in the late 1600s and early 1700s and bred with native European mares. Quarter horses were developed in America from crosses between thoroughbreds and descendants of Spanish horses. Their name reflects their use in quarter-mile races. Quarter horses are widely used for work on cattle ranches, most notably as cutting horses, which are trained to separate out a single head of stock by moving deftly to cut it off as it tries to return to the herd. Another distinctive American breed is the Morgan, developed in Vermont from matings between various female horses and a single, famous male—a dark bay called Justin Morgan who was born in the late 18th century. Used originally to pull light carriages, the Morgan is now considered a multipurpose breed and is popular as a saddle horse. The standardbred, developed from crossing thoroughbreds with Morgans and other light horses, is used in harness racing.

Heavy horses include draft horses and coach horses. Draft horses were developed in the Middle Ages as the heavy chargers ridden into battle by armor-clad knights. They were later used to pull plows and heavy wagons and perform other farm work; they have largely been displaced in the 20th century by tractors. Draft horse breeds include the Clydesdale, Belgian, Percheron, and Shire. Coach horses were bred for pulling large carriages and for light farm work. The Cleveland Bay is an example of a typical coach horse breed.

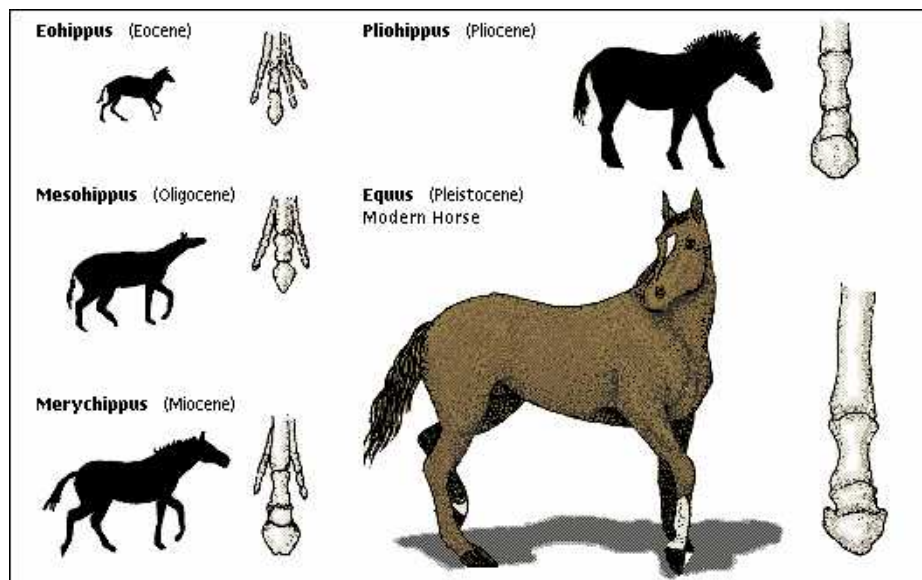
Ponies are usually defined as any horse that stands less than 14.5 hands high. The most familiar pony breeds are the Welsh mountain pony and the smaller Shetland pony, which is usually less than 11 hands high. Ponies have a reputation for being smart and wily.

The modern equid family consists of horses, zebras, and asses. All of these animals diverged from a common ancestor about 4 million years ago. Relatives in the equid family, such as an ass and a horse, can interbreed, but the resulting offspring are nearly always infertile.

# Evolution

The evolution of equids did not proceed in a straight line to culminate in today's horses and their relatives. Instead, the modern equids are a small remnant of a once vast and diverse family. This family came into being about 55 million years ago with the emergence of *Hyracotherium*, which is commonly known as the dawn horse, or eohippus. *Hyracotherium* weighed about 35 kg (80 lb) and lived in forests in North America. It had four toes on its front feet, three toes on its rear feet, and small teeth suitable for a diet of fruit and leaves.

A turning point in the evolution of equids occurred about 20 million years ago, when the dense forests of North America gave way to more open grasslands. At this time, the equids underwent an evolutionary explosion that produced a wealth of species displaying a wide variety of physical types, all of which were well adapted to their particular environments. Some of these horses, such as *Merychippus*, which weighed some 200 kg (450 lb), showed a trend toward the large, modern one-toed horse with broad-surfaced teeth well adapted to chewing grass. Others, such as *Nannippus*, a tiny browser that ate leaves and fruits, filled a very different ecological niche. Most horses from this period had three toes on each foot, but in one branch, the *Hipparion* species, the two side toes did not touch the ground. In the line that would lead to the modern horse, the side toes became increasingly reduced until they finally disappeared. As equids increased in diversity, they also increased their range by spreading across North America and, via land bridges, to Europe and Asia.



## Evolutionary History of the Modern Horse

The horse is a well-documented case study in evolution. The fossil record shows clear steps in the progression from a four-toed, small browsing animal—one of a line that gave rise to tapirs, rhinoceroses, and other mammals in addition to horses—to the modern horse, a large grazing animal with a single leg bone and enlarged middle toe. The doglike eohippus of 60 million years ago had molars with small grinding surfaces to chew the succulent leaves of its forest habitat. With the spread of Miocene grasslands 25 million years ago, only the descendants whose teeth had adapted to grinding survived. A drying climate produced harder ground, and the middle digit of *Merychippus*, expanded to bear the strain of its increased weight, became a single digit in *Pliohippus*. The horse's sturdy legs evolved to pound the ground at speeds fast enough to outrun predators.

Horses were widespread across North America, Europe, Asia, and Africa during the ice ages. But as the climate warmed and open tundra gave way to forest around 15,000 years ago, the habitat for the horse began to vanish. In North America, where horses also suffered from being hunted by Paleo-Indians, they became extinct. Horses nearly became extinct in the rest of the world as well; by about 7,000 years ago the world's only horses were confined to a small area in the still-open grassland steppes of Ukraine and Central Asia.

## Horses and Humans

Horses were widely hunted as a source of food by early humans in North America and Europe. About 6,000 years ago, the peoples living north of the Black Sea in a region between the forest and the steppe began to face dwindling supplies of forest game, such as boar and deer. They began to exploit the steppe-dwelling horses for meat. Archaeological evidence cannot clearly establish whether the horse was domesticated at this time as a source of food, or whether the horses remained wild and were hunted. But not long after the peoples of this region began consuming large amounts of horse meat, they also began riding horses. Horses from this period were buried in ritual graves along with perforated antler tines that appear to be the cheek pieces for a rope bridle. Microscopic analysis of the teeth of these ritually buried horses show wear patterns that are unique to horses that have carried a bit in their mouths.

Over the next thousand years, the horse staged a dramatic comeback, repopulating Europe and Asia, but now as a domestic animal under the control of humans. Archaeological remains show that tribes that possessed horses suddenly became larger, possessing greater material wealth and prospering with larger households. Horses enabled them to exploit the resources of the steppes, trade with distant lands, and bring sudden, ferocious warfare upon their less mobile neighbors.

The association of the horse with warfare dates from earliest times and persisted into the 20th century. By 2000 BC, the chariot, pulled by a pair of matched and well-trained horses, was well established as the supreme weapon of war in Egypt and western Asia. Charioteers in ancient Egypt were exclusively noblemen of high status. This reflected the huge cost of maintaining horses in the ancient world; the feed for a pair of chariot horses is estimated to have taken the entire crop from 4 hectares (10 acres) of barley each year.

Modern equestrian recreations such as horse racing, hunting, and polo also date back to ancient times. The *Iliad* contains an account of chariot racing at the time of the Trojan War, which was fought in the late 13th or early 12th century BC. Throughout the Middle Ages (around the 5th century to the 15th century AD) and even until modern times, the horse played a pivotal role in expanding trade, in exploring new lands, and in providing the motive power for farmwork.

Today most horses are pleasure and sport animals. There are more than 7 million horses in the United States today, more than there were in the 1940s when the U.S. Cavalry was disbanded. Popular activities on horseback include trail riding and competition in horse shows and rodeo events.

## Training

Training a horse is a complex art. Trainers typically begin a young horse's training by introducing the horse to human contact and teaching it to follow on a lead rope. One method of training involves working the horse on a lunge line, a long rope attached to a halter placed over the horse's head. In this method, the trainer keeps the horse moving in a large circle. Horses can be taught to respond to voice commands, such as "walk," "trot," and "whoa," while being worked on a lunge line. Horses need to be gradually accustomed to a saddle and bridle and to bearing weight on their back.

More advanced training involves teaching the horse to respond to signals from a rider's legs and hands. A well-trained horse will learn to change gaits or move from side to side with a very subtle pressure from the rider's legs or a small pull on the reins. The reins are used in several ways to communicate with the horse. In neck reining, a rein is laid against one side of the neck; this signals the horse to turn in the opposite direction. Neck reining is used mostly in Western riding and by polo players who keep only one hand on the reins. Horses are similarly taught to move in a direction away from the pressure of the rider's leg. Reins can also be used to apply direct pressure via the bit to one side of the mouth or both to signal the horse to turn or slow down. Training for harness horses begins with a person holding long reins and walking behind the horse. Once the horse learns to respond to basic commands, it can graduate to pulling a cart or carriage.

The basic method used in all training is to reward a correct response, thus helping the horse to make an association between the trainer's signal and its own response. Horses have excellent memories. Their ability to form associations is often strongly influenced by individual temperament; nervous or high-strung horses and excessively shy horses are poor learners. Most training of horses uses what animal behaviorists call negative reinforcement, which means that the reward is the removal of an unpleasant stimulus. For example, to get the horse to move forward, the rider squeezes with his or her legs; once the horse moves forward the rider stops squeezing, thereby rewarding the horse by removing the stimulus. This is different from punishment, which is applied after an incorrect response. Punishment is generally much less effective than negative reinforcement, although it is occasionally necessary to maintain the trainer's position as the dominant member of the social hierarchy.

## Caring for a Horse

The amount of food and care a horse needs varies according to how much the animal is worked. Many horses that are lightly worked or not worked at all thrive without any difficulty on grasses found in pastures, and without any special food. All horses, however, need continual access to fresh water and mineral salt blocks that provide needed trace minerals in their diet. In areas with mild winters it is often possible to stockpile grass in one portion of a pasture by leaving it to grow in late summer and fall and then allowing horses to graze during the winter. In such cases, horses do not even need to be

fed hay. When winter pasture is not available, a 500 kg (1,100 lb) horse typically requires about 7 kg (15 lb) of average quality hay a day to maintain its weight and health.

Horses that are worked several hours a day or more generally need some supplementary grain in their diet. Individual horses vary considerably in their needs, which are also affected by weather. A horse kept in a warm stall or turned outside with a blanket on will need less feed, and a horse that is let outside in cold weather or that has had its coat clipped will need more feed. Working horses typically need several quarts of grain a day in addition to hay.

Horses' needs for shelter also vary widely. Except in severe climates, horses can generally be left outside without harm. Show horses and racehorses are usually kept in stalls almost all the time they are not working. Keeping them in stalls protects them from injury, keeps them clean, and ensures that they receive constant care and attention. Stalls need to be supplied with a heavy layer of bedding, such as sawdust or straw, and must be cleaned daily. Horses that are stabled need regular exercise. Most pleasure horses need only be brought into a stall on cold winter nights. Open shelters that horses can enter and leave as they please are a good means of protecting horses from wind and rain, and from strong sun and flies in the summer.

In addition to food and shelter, horses need other care to keep them healthy. All horses need annual vaccinations to protect against a number of highly contagious, and often fatal, diseases. These diseases include tetanus, rabies, influenza, and Potomac fever. Horses also need oral medication at least every two months to kill intestinal parasites (*see* Diseases of Animals). Horses that are ridden regularly on surfaces other than grass or soft ground need to be fitted with shoes, and this can represent a considerable part of the expense of keeping a horse. Working horses generally need new shoes every six to eight weeks, or even more often. A horse's teeth need to be checked periodically, and they may require filing to remove sharp edges and align the biting surfaces.

Daily grooming is important in maintaining the bond between a horse and its owner. It also helps to keep a horse looking neat and provides a regular chance to check for injury or other health problems. Thorough brushing of the region under the saddle and girth—the strap below a horse's belly that holds the saddle in place—is especially important in preventing the skin from becoming irritated by dirt and grime. A horse's feet need to be picked out frequently to remove stones that can cause bruises. Picking out the hooves also helps to prevent an infectious condition known as thrush, which is caused by microorganisms that grow in the absence of air.

## Scientific Classification

Scientific classification: Horses belong to the family Equidae of the order Perissodactyla. The domestic horse is classified as *Equus caballus*, and Przewalski's horse is classified as *Equus caballus przewalskii*.

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