4-H HORSE PROGRAM
HORSE SCIENCE

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Families (parents or guardians) assume all risk and responsibility of young children if assisting 4-H siblings with large animals.

(Approved by Extension Administration, January 1995)
# 4-H Horsemanship Program

## Unit 2: Horse Science

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Since the time of ancient civilizations, the horse has served man well. He was first a war machine and that was his principal role until World War II. Likewise, the modern age has also relieved him of heavy duty as a beast of burden. But, the horse is not yet about to be turned out to pasture. He is now serving man in a greater way than ever before as a means of recreation and escape from pressure and tension of present-day living. This great versatility is possessed only by the horse because of his (1) anatomical structure and function, (2) speed and endurance, and (3) fear of being hurt. The combination of these characteristics has made it possible for man to obtain performance from the horse far beyond what is possible with any other animal.

ORIGIN OF THE HORSE

The horse had his beginning about 58 million years ago. His original home was in what is now the Great Plains area of North America. He evolved in three stages into his present form. The original ancestor ( eohippus) was only about 12 inches high with four toes on each front foot and three toes each on each hind foot. He had a short neck, even teeth and was well-adapted to living in a forested and swampy environment. As the earth underwent geologic changes, the horse evolved into his second stage (mesohippus). Here he became larger (about 24" high), developed longer legs with only three toes on each foot. The middle toe was the largest. He also developed teeth suitable for grazing on the prairie and greater speed and endurance for finding forage and water and for protection and survival. These changes resulted from gradual adjustment to changing surroundings over millions of years.

Fossil remains have definitely established that the horse originated in North America beginning with eohippus. There may have been an earlier five-toed ancestor but no fossil remains have so far been found.

The third and final stage in the evolution of the horse into his present form (equus) also took place in North America but this species completely died out for reasons yet unknown. Fortunately, some of the population escaped to Asia during the Ice Age (about one million years after eohippus) by way of what may have been a land bridge in the Bering Strait area between Alaska and Siberia. It was, therefore, in Asia and Europe that the horse completed his development and was domesticated. He did not return to North America until brought here by the Spaniards in the Sixteenth Century.

An important point is not how the horse developed into his present form but why. Besides having to go further in search of food and water the horse also had to be able to run further and faster to escape his enemies. The horse is, therefore, a creature of the open country and, to this day, his first reaction to any strange or frightening object or situation is to panic and run away. This great fear of the unusual, plus the speed and endurance he has developed at the gallop, has made the horse a most valuable animal to man. But, it has also made him one of the most dangerous. Unlike a bull or lion, the horse seldom attacks directly. In an instant of fright, he can become completely unreliable and even pay no attention to his own safety. It might, therefore, be said that the modern horse must depend on man for his safety.

The name eohippus or "dawn horse" is derived from the Greek word "eo" meaning dawn. The word horse comes from the Anglo-Saxon word "hors" meaning swiftness.
FUNCTIONAL DIVISIONS OF THE HORSE

The Head and Neck

The head and neck serve the same purpose on the horse as on other animal species. So far as behavior is concerned, the most important feature of this portion of the horse's physical make-up is the eye.

The eyes of the horse are rather large and are set wide apart on the sides of the head. This gives the horse monocular vision or the ability to see separate objects with each eye at the same time. The horse can also see anything behind him that is not narrower than his body. The horse does not have binocular vision except when interested or excited enough to lift his head and point his ears forward. In such case, the object must be some distance away and not closer than four feet. Likewise, the horse cannot see directly downward and, therefore, can't see what he is eating. Neither can a high-headed horse see the ground directly in front of him.

The horse, because of his ability to make a quick getaway, has no need for acute vision as does man. However, his ability to see objects on either side at once, and to the rear, has been a prime feature of his ability to survive.

It is believed that horses do not all have perfect eyesight. No doubt, poor eyesight may have an effect on the behavior of certain horses. Shying at unfamiliar objects may be the result of faulty vision.

By reason of being ever alert to danger the horse, through his eyesight, is very sensitive to quick movements. Any training procedure involving quick motions, such as roping or polo must, therefore, be started slowly and speeded up only after the horse has become familiar with the motion.
The Forehand Assembly

Although no one foot or leg has a single function, the front feet and legs serve primarily to support the horse at rest. In motion the front feet and legs also pull the horse forward. The horse’s center of gravity is located at a point about six inches behind the elbow. At rest the front feet and legs, therefore, support 9 to 10 per cent more weight than the hind legs. The healthy horse at rest cannot shift his weight from one front foot to the other but is continually shifting weight between his hind feet. Only when one front foot is injured does the horse shift weight to the other foot. As a result, the healthy foot may go bad from lack of exercise necessary to promote circulation. To keep his feet healthy the horse must, therefore, have plenty of exercise. Stabled, or closely confined, horses often become nervous and this may well be due to their feet hurting from lack of exercise.

The horse is suspended between his front legs. The front legs are not attached to the main skeleton by any joints, but only held in position by muscular structures. This provides the horse with an almost perfect suspension system for his body. This, along with the elastic and expansive properties of the foot and the angle of the pastern joint, enables the horse to absorb and dissipate a tremendous amount of shock when in motion. For example, an 1100-pound horse carrying 200 pounds weight and running a quarter-mile in 45 seconds with a stride of 20 feet, will absorb and dissipate nearly a ton a second on his lead foot. In so doing, he leaves only a shallow footprint in the dust.

The Rearhand Assembly

This is the horse’s powerhouse or propeller and serves to push the horse along in motion. The hind feet and legs also offer support at rest and catch weight at the end of flight in motion. Although the structure of the hind feet and legs is similar to that of the forelegs, less lameness and unsoundness occurs in the hind feet and legs because of their supporting less weight and doing less work. Proof of this is that the hind feet grow faster than the front feet.
While the horse's center of gravity is located about six inches behind the elbow, the center of motion, however, is located approximately over the 15th vertebra. This bony structure is the most upright member of the spinal column and on a mature horse is about 10 inches back of the center of gravity. The horse in motion goes with these two centers in their relative positions. The position of the center of gravity, however, can be altered by the rider shifting his weight from side to side or front to rear. The horse himself can even shift the center of gravity by raising, lowering or extending his head. In contrast, the center of motion appears to be rather fixed. A rider's weight, positioned as nearly as possible over the center of motion, offers the greatest stability and interferes with motion the least. Weight too far back lessens the horse's propelling power.

The Power of Association

In the struggle to survive through the ages, the horse has learned to avoid or escape situations in which he might get hurt. He has, therefore, developed a great power of association. This is the basis of horse training.

To capitalize on the horse's power of association, signals or cues and punishment in training must be in proper sequence. For example, to teach a horse a particular movement or response, the appropriate signal must first be given and then followed immediately with some stronger force or punishment which will result in the horse responding in the desired manner. Once the horse has learned the lesson, the punishment must be stopped and not used again except as a necessary reminder. Reversing the sequence of signal and punishment will only confuse the horse.

Horses are born with a certain amount of intelligence which must be developed by training and good habits. What a horse knows he must be taught by man and, depending on training, this can either be good or bad.

The horse may shy at unfamiliar objects. He may also shy at familiar objects not in their usual place. Regardless, the horse must never be punished in such situations or due to his power of association he may develop the bad habit of shying at every strange object he sees. With his attention focused on the unfamiliar object the horse, if he can think at all, blames the object for the punishment. It is, therefore, better to let the horse study the object until he learns he will not get hurt and thereby gain confidence in the rider. This may be a rather new idea to many present-day horsemen but the fact was observed by Xenophon, the Grecian soldier and scholar about 350 B.C.
Since both conformation and action need to be included in light horse evaluation, the basic conformation features tending to affect action must be understood. The relationship of body parts to performance (form to function) will be here discussed with the body of the horse divided into four areas: 1. Head and Neck, 2. Fore Quarters, 3. Body or Trunk, 4. Rear Quarters.

**HEAD AND NECK**

The ideal head for each breed is described by the association publications. The descriptions all say the head should be broad in the forehead and between the eyes, short from the eyes to the nostrils and deep in the jaws. These words mean only that the head should be in proportion to the parts of the body of the horse. The proportion of the head tends to be an indication of body proportions. For example, a long narrow head indicates a long, shallow, narrow body. Coarseness about the head indicates a coarse body, lacking quality. The ear should be medium size, attractively set and carried at a 45 degree angle to the axis of the head. Large, full, prominent eyes of a clear deep color are desired. Small blue eyes are considered weak. Small narrow, squinty eyes are often correlated with coarseness in quality and a lazy, sluggish, disposition.

Large nostrils allow for a maximum air intake and are of prime importance because the horse cannot force air into the lungs through the mouth as is possible in other species of animals. All breathing of air by the horse must be done through the nostrils.

All horses, both long and short necked ones, have seven cervical vertebrae. The shape of the neck is due largely to the amount and shape of the muscular tissues. The neck should be long, lean, and attached high up on shoulders with prominent withers. The lower part of the neck should be attached above the point of the shoulders. The throat latch should be cleancut and free from thick, meaty or fatty tissue to facilitate movement of the head at the poll and allow easy breathing.

**SKELETON OF HORSE SHOWING RELATIVE POSITION & SIZE OF BONY PARTS**

1. SHOULDER—LONG
2. ARM—SHORT
3. FOREARM—LONG
4. CANNON—SHORT
5. CROUP—LONG
6. THIGH—SHORT
7. GASKIN—LONG
8. CANNON—SHORT
Length of neck plays an important part in length of stride. Over the neck lie several layers of muscles, some of which control the movement of the scapula or shoulder blade, the arm, and indirectly the forearm. The muscles that control leg movements terminate at the knee. Cannon, pastern and foot action is controlled by ligaments and tendons. Larger neck muscles allow more muscle contraction extending the arm further and raising the forearm higher. This results in a longer stride. Another set of muscles extend from the front of the neck to the shoulder blade. Longer muscles here allow more shoulder blade movement and thus a longer stride.

A thick neck adds excess weight to the front end. This causes increased shock to the front legs because they ordinarily carry two-thirds of the body weight of the horse. A thick neck also decreases head movement giving slow, awkward turns.

FORE QUARTERS

The withers should be prominent, or high and well defined. They should extend rearward about one-quarter of the distance from the fore to the rear flanks. This is not possible unless the shoulder is long and has about a 45 degree slope. Such withers give the horse opportunity to have a long stride besides providing a good seat for the saddle.

The shoulder should be long, flat and smooth, with a 45 degree slope. This allows for increased shoulder movement which determines the arm movement and affects the stride. In a steep-shouldered horse the arm does not extend very far forward during movement. This decreases extension of the forearm and gives a short stride. Accordingly the slope of the shoulder increases length of the muscles and allows for more contraction and greater range of movement of the front leg.

The legs of the horse should be attached to the trunk to give the appearance of being on the four corners of the body. When viewed from the front, the cannons should descend from the center of the knees. Cannon bones should give the appearance of being flat when viewed from the side. This doesn’t mean that the bones themselves are flat, but that splint bones and tendons and ligaments are set apart, well tied and give support at the posterior of the legs.

The front feet should be large, symmetrical and set at the same angle as the pastern. The foot should be especially wide at the heel and have considerable height at the heel as long as it is in keeping with the desired angle.

When viewed from the side the best combination of length for the various parts of the front quarter calls for a long shoulder, short arm, long forearm and short cannon. This gives a longer, more elastic stride and more speed.

A steep shoulder coupled with a long arm, short forearm and long cannon is the most undesirable shoulder and leg structure. This gives a severely shortened stride. Steep shoulders are usually associated with short, steep pasterns giving a hard, jolting ride because of decreased shock absorption.

A long sloping shoulder also forms a more desirable base for neck attachment giving a better balanced, more attractive horse.

TRUNK OR BODY

The trunk or body of the horse should be deep and broad. The back should be short and the loin wide and smooth. The back and loin together make up the top line which must be strong to protect internal organs, bear the weight of the rider and transmit to the front end the propulsion generated by the hind legs. The loin has no bone structure for support, making it the weakest part of the top line. The loin is a bridge between the rib cage and the hips. In order for the loin to perform its function of transmitting power from the rear to front end, it must be short and heavily muscled.

The back which must also be short and heavily muscled gets additional support from the rib cage. Often weak backs result from weak loins.

A short back and loin coupled with desirable shoulder and withers results in a long underline. However, a long underline does not insure a large body capacity unless it is combined with long, deep, well sprung ribs. This combination of short back and loin, long underline and long, deep, well sprung ribs insures ample capacity for breathing and consuming feed.

Length of underline also affects freedom of leg movement. A short underline can cause a horse to forge. This is striking the undersurface of the front foot with the toe of the rear foot.

REAR QUARTERS
The croup or rump should be long, wide and level. This is the area from the loin to the tail head. Although the slope of the croup differs with light horse breeds, a level croup has longer muscles that enable a horse to take long strides and maintain speed for greater distances. A more sloping croup sets the rear legs further under the horse so he may make a quicker start with the more powerful stride. Regardless of breed or slope to the croup, it should be long so the croup muscles can make maximum contraction. All muscles in the croup and thigh must be strong to supply the power from the rear quarters to propel the horse.

Adequate gaskin muscling is desired. The outer gaskin muscles help to pull the leg forward and enable propulsion, giving the horse a long, powerful stride.

The powerful gaskin muscling also gives strength to the legs in turning and pivoting.

The rear quarter is comparable to the forequarter in that a long croup, short thigh, long gaskin and short cannon gives the best stride.

**Action**

A long, straight, free elastic stride and coordinated, collected action is desirable. Excess lateral movement of the feet and legs reduces efficiency. Action is affected by the set of the feet and legs as well as by the anatomical characteristics already mentioned.

Fairly close hock action with the hind legs working beneath the body is essential.

**EXAMPLES OF ANATOMICAL FEATURES RELATING FORM TO ACTION**

1. A thick neck and filled throat latch gives a lack of flexion of the head and slow, awkward turns.

2. Horses with low, rounding withers or thick withers often hang low-headed in the bridle and handle front legs clumsily. They often forge.

3. Length and slope of shoulders tends to correspond to length and slope of pasterns. Properly sloped shoulders and pasterns (45 degrees) are related to a springy stride. Length of shoulders and pasterns is related to the length of stride.

4. Long forearms and gaskins are related to length of stride.

5. Horses standing straight on front feet are more apt to show straight stride and true action.

6. Short, straight shoulders give a short, straight stride with concussion.

7. If the front legs are set far out on the corners of the body, a rolling, laboring action in front will result. This condition often goes with thick withers and straight shoulders.

8. When points of the hocks turn slightly inward with points of the toes slightly outward and the rear cannons parallel, such a position of the rear legs is related to collected, rather than spraddled, action behind.

9. When points of the hocks turn outward, often a defect in action called limber hocks or rotating hocks occurs.

10. A calf-kneed position of the front legs gives a pounding gait and hard concussion of feet at completion of the stride.

11. A pigeon toed horse will paddle or wing out when he travels.

12. A splay-footed or toe-wide horse will dish or wing in when he moves.

13. A straight stiltly angle of pasterns will give a stiltly action and may give cocked ankles or other unsoundnesses such as sidebones.
Soundness in the horse is of extreme importance, since his efficiency in performance is dependent upon his ability to move.

Any abnormal deviation in the structure or function of a horse constitutes an unsoundness. All unsoundnesses do not have the same degree of severity. Some unsoundnesses can be treated successfully, others can not.

An example of a blemish is an unsightly scar or rope burn. A blemish does not interfere with the service ability of the horse.

Any time a horse is lame, we can suspect an unsoundness. Lameness is any irregularity in gait which results from moving with pain or difficulty. Lameness may be detected while the horse is in a standing position, however, it is most noticeable at the walk or trot. If lameness is severe, the horse will refuse to put weight on the affected limb, even in the standing position. When moving, the lame horse is forced to carry most of his weight on the sound limbs, hence the "nodding" of the head when the sound limb strikes the ground. When the lameness is on the left fore leg, the head will nod as the right foot is planted on the ground but will jerk up as the left or lame leg touches the ground. Lameness in both front legs is indicated by a stiff, stilted action and short stride. The head is carried higher than usual without nodding.

The exact location of lameness is often difficult to determine. Many common unsoundnesses of the legs may be detected by carefully comparing the opposite leg. Swelling and implantation can be observed by handling the leg.

Most unsoundnesses of the legs and feet are caused by injury, or excess stress and strain. Horses with faulty conformation are always subject to unsoundness. Many times it is possible to detect an unsoundness by being familiar with correct conformation. Concussion lameness is associated with straight backs and pasterns, for example.
COMMON UNSOUNDNESSES
AND BLEMISHES

The following unsoundnesses and blemishes are identified: U-unsoundness, B-blemish.

Head
1. cataract (U)—cloudy or opaque appearance of the eye.
2. defective eyes (U)—impairment of vision or blindness.
3. poll evil (U)—inflamed swelling of poll between ears.
4. roman nose—faulty conformation.
5. parrot mouth (U)—lower jaw is shorter than upper jaw.
6. undershot jaw (U)—upper jaw is shorter than lower jaw.

Neck
1. ewe-neck—faulty conformation.

Withers and Shoulders
1. fistula of withers (U or B)—inflamed swelling of withers.
2. sweeney (U)—atrophy or decrease in size of a single muscle or group of muscles, usually found in shoulder or hip.

Front Legs
1. shoe boil or capped elbow (B)—soft, flabby swelling at the point of elbow.
2. knee—sprung or buck knee—over on the knees. Faulty conformation.
3. calf-kneed—back at the knees. Faulty conformation.
4. splint (B)—capsule enlargement usually found inside upper part of front cannon.
5. wind puff (U)—puffy swellings occurring either side of tendons above fetlock or knee.
6. bowed tendons (U)—enlarged, stretched flexor tendons behind the cannon bones.
7. ringbone (U)—bony growth on either or both sides of pastern.
8. sidebone (U)—bony growth above and toward the rear quarter of hoofhead.
9. quittor (U)—fistula of the hoofhead.
10. quarter or sand crack (B)—vertical split in the wall of the hoof.
11. navicular disease (U)—inflammation of small navicular bone usually inside front foot.
12. founder (U)—turning up of hoof and rough, deep rings in hoof wall caused by over feeding, severe concussion or disease and abnormal management.
13. contracted feet (B)—abnormal contraction of heel.
14. thrush (B)—disease of the frog.
Body
1. heaves (U)—difficult breathing, lung damage.
2. roaring (U)—difficult breathing due to obstruction usually in larynx.
3. rupture (U)—protrusion of internal organs through the wall (hernia) of the body. Umbilical or scrotal areas most common.
4. sway back—faulty conformation.
5. hipdown (U)—fracture of prominence of hip and falling away.

Rear Limbs
1. stifled (U)—displaced patella of stifle joint.
2. stringhalt (U)—nervous disorder characterized by excessive jerking of the hind leg.
3. thoroughpin (U)—puffy swelling which appears on upper part of hock and in front of the large tendon.
4. capped hock (B or U)—enlargement on point of hock. Depends on stage of development.
5. bog spavin (U)—meaty, soft swelling occurring on inner front part of hock.
6. bone spavin or jack spavin (U)—bony growth usually found on inside lower point of hock.
7. curb (U)—hard swelling on back surface of rear cannon about four inches below point of hock.
8. cocked ankle (U)—usually in hind feet, horse stands bent forward, due to contracted tendons.
9. blood spavin (B)—swelling of vein usually below seat of bog spavin.

NOTES
"How old is your horse, mister?" To such a 4-H question, the owner might answer full mouthed, smooth mouthed, he still has corner cups or I don't know as he isn't registered. Such answers tend to confuse the youngster of the motor age, nor can he readily find these answers too easily until he questions the grandfather age group.

General features of horses which indicate advanced ages are grey hairs around the eyes and muzzle, deep depressions above the eyes, slender and hardened muzzles and loose heavy lips with a longer "grin" than younger horses. But, these features are not accurate enough to estimate ages on younger horses. Since the horse is most useful to us from 3 to 15 years of age, we need more accurate methods for age determination during this period.

The teeth of horses under 12 years old can be most closely identified with their approximate age. In general, we must examine the incisor teeth for most accurate results. Of course, the registered horse has a recorded birth date, but many horses are not so fortunate. However, this technique is not foolproof as prolonged droughts, short grazing on sandy soils, cribbers, parrot mouths etc. all tend to make the horse appear different than his actual age. For instance, a horse at 7 years of age grazing in sandy country over a prolonged period might appear to be 8 or 9 by his teeth.

The technique of horse age determination is not new nor especially scientific as it has been passed down for many generations. The basics for determining the age of horses by their teeth are rather simple and is not an art only to be guarded by the horse trader or veterinarian. Age can best be estimated by examining the wear and slant of the incisor teeth.

1. Number and anatomy of teeth.
   a. The foal of either sex has 12 molars or grinders and 12 incisors or front teeth for a total of 24 teeth.
   b. The mature male horse has 24 molars or grinders and 12 incisors or biters plus 4 canine teeth or tushes for a total of 40 teeth.
   c. However, the 4 canine teeth located in the interdental space between the incisors and molars erupt only in the gelding or stallion. These canine teeth in the mare are underdeveloped and seldom erupt above the surface of the gums thus giving the mare a tooth count of 36.
   d. There are 6 incisors in each upper and lower jaw. There are 2 central incisors at the midline, 2 lateral incisors and 2 corner incisors in each jaw. The corners being closest to the interdental space.
   e. Anatomy of teeth. By studying the longitudinal section of incisor teeth we can see how the tooth wears as age progresses.

2. Examining teeth.

   Approach the horse gently from the left side and examine the teeth by parting the lips with the thumb and forefinger leaving the jaws closed. In examining groups of horses of mixed ownership ask the holder to part the lips. The angle of bit and size and color of teeth are noted first.

   For the next examination grab the tongue with the right hand and grab the lower lip with the left hand and the mouth will open for clear examination of the cups, wear etc.
3. General tooth eruption and development by ages. The temporary or milk teeth of the young horse are smallish and white with a distinct neck. The permanent teeth are much larger, stronger and have a darker color with distinct cups on the younger horse. *Inserts from “The Sound Horse”, Mich. Ext. Bull 330.*

a. First period (birth to 2½ years).

1. 10 months. All milk teeth have erupted and in wear at 16-18 months.
2. 2-year-old. All milk teeth in wear.

b. Second period (2½ to 5 years).

1. 2½ years. Temporary centrals loosen and permanent centrals erupt. Age determination is most accurate from 2-5 years. Shedding of milk teeth and eruption of permanents may not occur simultaneously and may overlap one another.
2. 3½ to 4 years. Permanent laterals erupt.
3. 4½ to 5 years. Permanent cornets erupt.
c. Third period (6 to 9 years)
   1. 6 years. Age from here on is estimated mainly by the size, shape and disappearance of cups until 10-12 years of age. Cups disappear at rather regular intervals beginning with the lower centrals at 6 years.
   2. 8 years. Cups have disappeared in the lower centrals and laterals.

d. Fourth period (aged)
   1. 10-12 years. After 9 years the accuracy of age determination becomes more difficult. At this age the angle of the bite slants more outward than the perpendicular bite noticed in younger horses. By 12 years, the cups have disappeared in the upper incisors and the horse has a “smooth mouth”.
   2. 15 years. The dental stars are smaller but more distinct and more centrally located.
   3. 20-21 years. At this age teeth may become shorter, more triangular in shape on the wearing surface, have a noticeable spacing between adjacent incisors and the dental stars may become larger and occupy a central position on the wearing surface. Also, at this age, the bite is very slanting. It is well to note that horses in this age group may appear to have much younger mouths if they have had excellent care with regard to lush grazing and grain feeding with accompanying good health throughout their life.
TEETH OF THE TWENTY-ONE-YEAR-OLD HORSE

GLOSSARY

**Anatomy** - The science of the structure of the animal body and the relation of its parts.

**Angle of bite** - The outer angle at which the upper and lower incisors meet.

**Canine teeth** - Teeth that appear in the interdental space on the male horse at 5 years of age. Sometimes referred to as tusks.

**Centrals** - The first centrally located upper and lower incisors.

**Corners** - The corner incisors or those located back and adjacent to the forward edge of the interdental space (third set of incisors).

**Cribbers** - A bad habit of some horses in which the animal grasps the manger or other object with the incisor teeth, arches the neck, makes peculiar movements with the head, and swallows quantities of air. Called also cribbiting and wind-sucking.

**Crown of tooth** - The top of a tooth protruding above the gum.

**Cups** - The hollow space on the wearing surface of the incisor.

**Dental star** - A star shaped or circle like structure near the center of the wearing surface of the permanent incisors.

**Full mouth** - When the horse has a complete set of permanent incisors.

**Incisor** - Slender teeth in front used for biting grass, feed, etc.

**Interdental space** - The gum space between the incisor teeth and molar teeth.

**Laterals** - The second set of incisors located between the central and corner incisors.

**Longitudinal** - Lengthwise. Parallel to the long part of the tooth.

**Molars** - Rear teeth or grinding teeth of the horse generally not used to determine age.

**Neck of tooth** - The part of the tooth between the crown and root located at the surface of the gums.

**Parrot mouth** - The upper incisors overhang the lower incisors and do not properly meet and therefore cause uneven wear.

**Smooth mouth** - Refers to the smooth biting surface of the upper and lower incisors after the cups have disappeared at 12 years of age or older.

**Wear** - Refers to the amount of use or wear observed on the biting surface of the incisors.

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**NOTES**
The birth of a foal is the end of a wondrous process. It starts with the merging of two tiny cells—one from the female animal (mare), one from the male (stallion). With the joining of these cells, a new animal is conceived.

The cell from the female is called an egg, or ovum. The cell from the male is a sperm. The egg and sperm are both sex cells, the very special cells that contain the genetic material an animal inherits from its parents. Two microscopic cells will completely determine the genetic makeup of the offspring. See the discussion of genes and chromosomes in the guide sheet entitled "How Inheritance Works in Horses".

The production of sex cells is a unique and interesting process. Each of the two sexes has special organs to produce sex cells and carry out the process of reproduction. These are called the reproductive organs. Much of the reproductive process is regulated by secretions from the body's mature gland, the pituitary. A knowledge of many specialized terms is essential for you to properly understand and discuss this reproductive process.

Study This Specialized Glossary Before Proceeding

**SPECIALIZED GLOSSARY**

**Accessory glands** (ak-sees-o-ri). These glands are located along the urethra of the male. They produce fluids that nourish and preserve sperm.

**Birth canal**. The birth canal includes the cervix and the vagina of the female. They are the organs through which the unborn animal passes at birth.

**Cervix** (sur viks). This is the narrow passage or doorway between the female's vagina and uterus.

**Corpus luteum** (kor pus lu-te-um). A solid mass that forms in the follicle after the egg has left. It produces a hormone which helps maintain pregnancy. It prevents other follicles from developing while the unborn animal is growing in the uterus.

**Epididymis** (ep i-did i-mis). A mass of tubes connected to the testicle. Its main function is to store sperm.

**Estrogenic Hormones**. Hormones that stimulate the development and maintenance of feminine sexual characters. The principal estrogenic hormones are: (a) estradiol; (b) estrone; (c) estriol.

**Estrus** (es trus). The estrus period is commonly called "heat."

**Fetus** (fe tus). The unborn animal as it develops in the uterus.

**Follicle** (fol i-k l). A bubble-like structure on the ovary which contains an egg.

**Follicle stimulating hormone** (FSH). Comes from the pituitary and causes follicle growth.

**Hormone** (hor mon). A body-regulating chemical secreted by a gland into the blood stream.

**Infundibulum** (in fun-dib u-lum). The funnel-like membrane that surrounds the ovary. It catches the egg when it is released by the ovary.

**Luteinizing hormone** (LH). Comes from the pituitary and regulates corpus luteum in female and testosterone secretion in male.

**Nucleus** (nu kle-us). The dense center of a cell. It contains the genetic material.

**Ovary** (o va-ri). A female organ that produces eggs. There are two ovaries.

**Oviduct** (o vi-dukt). The tube which carries the egg from the ovary to the uterus.

**Ovulation** (o vu-la shun). The time when the follicle bursts and the egg is released.

**Ovum** (o vum). Scientific name for egg.

**Placenta** (pla-sen ta). The membrane by which the fetus is attached to the uterus. Nutrients from the mother pass into the placenta and then through the navel cord to the fetus. When the animal is born, the placenta is expelled. It is commonly called the "afterbirth."

**Pituitary**. This gland located at the base of the brain secretes hormones which regulate the body.

**Progestosterone**. A steroid hormone secreted by the hypertrophied cells of the corpus luteum. It inhibits the action of estrogens. It aids in the development of the uterus for implantation and effective nutrition of the embryo.

**Prolactin** A hormone produced in the anterior pituitary gland. It initiates lactation or in the case of nursing mothers milk secretion is stimulated.

**Sex cells**. The egg and the sperm. They transmit genetic material from the parents to the offspring.

**Serotum** (skro tum). The sac-like pouch that suspends the testicles outside the male animal.

**Sperm**. Male sex cells produced in the testicles.

**Semen** (se men). Sperm mixed with fluids from the accessory glands.

**Testicle** (tes ti-k l). A male gland which produces sperm. There are two testicles.

**Urethra** (u-re thra). The tube through which both semen and urine pass through the penis of the male.

**Uterus** (u ter-us). The muscular, spongy organ of the female where the unborn animal develops. It is commonly called the womb.

**Vagina** (va-ji na). The canal which leads from the uterus to outside the female. Sperm is deposited there by the male, and the fetus passes through the vagina at birth.

**Vas deferens** (vas def e-renz). The tube that carries sperm from the epididymis to the urethra in the male.
MALE REPRODUCTIVE ORGS

The primary sex organ of the stallion is the testicle. (There are 2 testicles.) The testicles produce sperm in the mature individual and also produce a hormone called testosterone. Testosterone regulates and maintains the male reproductive tract in its functional state. Testosterone is also responsible for the masculine appearance and behavior of the stallion.

Each testicle contains a mass of minute, coiled tubules. The inner walls or surface of these produce the sperm. The numerous thousands of minute tubules merge into a series of larger ducts which pass out of the testicle to a larger, coiled tube located adjacent to the testicle. This tube, the epididymis, is the place where sperm are stored while they mature. Sperm formation in the male is a fairly continuous process.

The testicle and epididymides are located in the scrotum which regulates the temperature of these structures. The scrotal temperature is several degrees cooler than that of the body cavity which is necessary for the normal development of sperm.

From the epididymis, the sperm move through a tube, the vas deferens, into the urethra. The urethra is the tube that carries urine from the bladder through the penis. The urethra also carries sperm from the junction with the vas deferens to the end of the penis.

Along the urethra are the accessory glands. Their names are the prostate, the seminal vesicles and cowpers gland. They produce fluids that nourish and preserve the sperm. During mating, the accessory glands discharge their fluids into the urethra. This washes the sperm forward through the penis. The combined fluid and sperm is called semen.

Puberty, or the capacity to produce sex cells, occurs in the stallion at the age of approximately one year. This is not a period of mature breeding capacity. Two-year-old stallions may be used for limited breeding service. Breeding use of the stallion should be deferred until after the age of two. Ask your veterinarian or an experienced horseman to explain care and management of the mature stallion to you.
FEMALE REPRODUCTIVE ORGANS

The mare's reproductive organs are quite different from the stallion's. The female produces the ova or eggs, receives the sperm from the male, and provides a place for the unborn animal to develop.

The primary sex organ of the mare is the ovary. Each of the two ovaries is usually 2 to 3 inches long and somewhat bean-shaped. The other portion of the female reproductive tract is known as the duct system. It consists of the oviducts, the uterus, the cervix, and the vagina. The various parts of the duct system are connected together and attached internally to the upper body wall by a series of ligaments.

The ovaries produce the eggs. Each egg is contained in a bubble on an ovary. This bubble is called a follicle. There are hundreds of follicles on each ovary. At the same time by a process not completely understood, one or more follicles begin to grow while the others remain small. The follicle grows until it is about an inch in diameter. It is filled with a fluid. The egg is suspended in the fluid. Near the time of mating, a hormone causes the follicle to burst.

The fluid gushes out of the follicle, carrying the egg with it. The egg is then trapped in a very thin membrane that surrounds the ovary. Shaped like a funnel, this membrane is called the infundibulum. The infundibulum narrows into a tube called the oviduct. The oviduct carries the egg to the uterus, or womb. The largest of the female reproductive organs, the uterus is where the unborn young (the fetus) will develop.

The uterus has a thick wall with heavy layers of muscles. At birth, these muscles will contract with great pressure to force the new animal through the cervix and vagina (birth canal) and into the world. The lining of the uterus is soft and spongy, containing a vast network of blood vessels. This network of blood vessels provides a "bed" for the fertilized egg to settle into and develop.

THE ESTROUS CYCLE AND FERTILIZATION

The estrous cycle of the mare may be divided into phases, i.e., diestrous (quiet period); proestrus (preparation); estrus (heat period). The average length of the estrous cycle for mares is 22 days but may vary from 17 to 30 days. Individual mares tend to retain their individual cycle characteristics with regard to length of cycle and length of estrous.

The mare is called polyestrous because she cycles continuously throughout the breeding season in the absence of conception. The mare is called seasonally polyestrous because there is seasonal fluctuation of the estrous cycle with regard to length, intensity and regularity. Most mares that exhibit no outward signs of estrus during winter months are said to be anestrous (without estrus) during that time. The estrous cycle may be irregular in the early spring.

The most easily recognized phase of the estrous cycle is estrus (heat period) or the period of male receptivity. It is caused by the relatively large amount of a hormone, estrogen secreted during this state of rapid and maximum follicle growth. The average length of estrus is 6 days but often varies from 2 to 11 days. Periods usually decrease in length as the summer progresses. Ask your veterinarian or an experienced horseman to explain the external signs of estrus and for instructions on management of your mare during the breeding season.
The period when a mare is out of estrus is generally called diestrus. This phase or stage usually varies from 10 to 18 days. The first part of diestrus involves corpus luteum development. In the absence of conception, the corpus luteum regresses within a few days and new follicle development once again takes place under the influence of a hormone (FSH) from the pituitary gland. The period of rapid follicle growth at the termination of diestrus is commonly referred to as proestrus.

Many mares are capable of first reproduction at 4 years of age. Regular annual foaling is conducive to total life-time production. In most cases it is advisable to have mares examined for reproductive status prior to breeding. Policies regard general sanitation, safety, and medical aspects should be observed in all equine breeding programs.

Fertilization is the process of the uniting of the sperm and the ova. The tubular or duct portion of the female reproductive tract undergoes rhythmic contractions during estrus and this activity is stimulated by mating at which time the sperm is deposited in the tract. This pulsating action plus the locomotion of the sperm in a fluid medium transport the sperm through the cervix and uterus into the oviducts. The sperm and the egg unite in the oviduct.

Only one sperm fertilizes a single egg although several million sperm may be present in the reproductive tract of the female. Only one egg is usually present per conception in horses. Sometimes a mare will produce two eggs and if both are fertilized, twin embryos will start to develop. Identical twins result from a different situation. In this case a single egg divides into two independent cells or cell masses at a very early stage of development. Twin embryos are undesirable in horses because they are generally aborted prematurely.

The egg produced by the mare is small in size although it is much larger than a sperm. The egg has a nucleus which contains the genetic material. The sperm has a much different shape than the egg which is basically round. The sperm has a head, a middle section and a tail. The physical movement of the latter structure gives the sperm cell its property of locomotion in a fluid medium. The genetic material of the sperm cell is contained in the head section.

Upon fertilization, a sperm penetrates the outside membrane of the egg and the head section is drawn into contact and union with the nucleus of the egg; thus the genetic composition of the new individual is established. Fertilization is also the stimulus for the egg to divide and grow to form the new individual.

The fertilized egg usually undergoes its initial cleavages or divisions in the oviduct. Meanwhile, it is transported to the uterus where development progresses.

**PREGNANCY AND BIRTH**

Pregnancy is the time during which the fertilized egg develops in the uterus. This process is also known as gestation. For a period of about six weeks, the cell mass resulting from the fertilized egg grows as a "free floating" object in the uterus. During this time, the fetal membranes commence to form. Nourishment of the new individual during this early stage is provided for by uterine secretions. The hormone progesterone secreted by the corpus luteum assist in regulating the reproductive tract during pregnancy.

At approximately 6 weeks of pregnancy, the placenta attaches to the wall of the uterus and then provides for the nourishment of the fetus. Nutrients and oxygen are carried from the mare to the fetus and waste products from the fetus are eliminated through the placenta. The navel cord connects the fetus to the placenta.

The process of gestation in the mare requires about 340 days; however, it may vary from approximately 300 to more than 400 days following breeding. The fetus develops gradually although the most rapid period of growth takes place during the last 3 or 4 months of pregnancy.

Successful pregnancy ends in birth or parturition. At the proper time due to hormone action, the strong muscles of the uterus contract forcing the new animal through the birth canal and into the world. Until, now, the young animal received nutrients and oxygen from its mother's blood stream. But at birth the navel cord is broken. The animal must live on its own. Apparently the breaking of the navel cord stimulates the animal to breathe. This solves the problem of oxygen. As for nutrients, the mother's body has been preparing them for many weeks. The hormones produced during pregnancy have stimulated the milk glands. By the time of birth, they are ready to provide milk. Later, the mare will expel the remainder of the fluids and placenta to the completion of parturition. The entire process may require several hours.

Milk production and "letdown" is initiated by hormones secreted by the pituitary gland. The first milk or colostrum is seen just prior to or after parturition. Colostrum is very high in proteins and other nutrients which provide the foal with resistance to infections. It is very important to the new born foal that it receives the colostrum. The colostrum is exhausted and replaced gradually with normal milk by about two days after the initial nursing.

There will always be reproductive problems among horses but interferences may be minimized by good management practices. An understanding of some of the basic principles of the processes of reproduction can aid horse breeders materially in dealing with difficulties likely to be encountered.
Two tiny cells are the only links of inheritance an animal has with its parents. A sperm cell from the sire and an egg cell from the dam unite and grow into the new animal.

We know, therefore, that any characteristics inherited from the parents must come from these two cells. With good care and good nutrition, the material in the sperm and egg will determine almost everything about the developing animal—its size, its shape, its color, even its intelligence.

The study of how characteristics are passed from parents to offspring is the science of genetics. It’s easy to see why genetics is important to horse breeders. In trying to understand the mysteries of inheritance, geneticists learn things which help to produce better horses.

**GENES AND CHROMOSOMES**

Inside the cells of animals are certain complex chemical compounds. These substances are the carriers of inheritance. They are called genes and chromosomes.

Chromosomes are long, thread-like structures made of complex protein. They can be seen with a microscope. In all body cells except the sperm and the egg, chromosomes exist in pairs.

Each cell contains a certain number of chromosome pairs, depending upon the animal. Man has 23 pairs of chromosomes in each of his cells. Here are the number of chromosome pairs for farm animals.

- Horses 33
- Pigs 19
- Cattle 30
- Sheep 27
- Goats 30
- Chickens 6

Strung along the chromosomes, somewhat like beads on a string are genes. Genes consist of complex molecules. They are chemically linked to the protein of the chromosome. Genes are too small to be seen with a microscope. But other research methods tell us they are there.

**Genes** are the units of inheritance. Characteristics are passed from parents to offspring through genes. Genes are the “brains” of the cell. They determine what the cell will be like. This, in turn, determines what the body will be like.

Since chromosomes come in pairs, so do genes. Two genes exist side by side, each on one of the chromosomes in the pair. The total number of genes on a chromosome is not known, but they are many. And different chromosomes have different numbers of genes.

The unique thing about genes and chromosomes is that they are able to reproduce themselves.

As an animal grows, cells divide and form two. Before the cell divides, each chromosome duplicates itself. When the cell divides one of the duplicates moves into each of the two new cells. So the two new cells have exactly the same kind and number of chromosomes. This type of cell division is called mitosis.

**CHROMOSOMES IN SEX CELLS**

Genes and chromosomes act somewhat differently when sperm cells and egg cells are formed. In the testes of the male and in the ovaries of the female, cell division happens another way.

The chromosome pairs separate, one member of each pair going to one new cell and the other member going to the other new cell. As these cells divide again, the single chromosomes form duplicates which go into each of the new cells. This makes the sperm or the egg contain only a single chromosome of each original pair of chromosomes. This type of division is called meiosis.

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**NORMAL CELL DIVISION (MITOSIS)**

1. CHROMOSOME PAIR
2. DUPLICATE CHROMOSOME PAIRS
3. CELL DIVISION
4. DAUGHTER CELLS

**SEX CELL DIVISION (MEIOSIS)**

1. TESTICLE CELL
2. CHROMOSOME PAIR
3. OVARY CELL
4. Sperm
5. EGG CELL
6. FERTILIZATION
7. FERTILIZED EGG (CHROMOSOMES IN PAIRS AGAIN)
In horses, the sperm from the stallion and the egg from the mare each contain 33 single chromosomes instead of 33 pairs. Because of the way chromosomes separate at meiosis, millions of different kinds of sex cells can be produced by one animal.

When fertilization occurs, the single chromosomes from the sperm join the single chromosomes in the egg. Once again pairs are formed. So the fertilized egg contains the same number of chromosome pairs as the cells of the parents.

This fertilized egg develops into a new individual, resembling each parent in some ways, yet different from them both. And probably different from any other individual in the world, since the slightest difference in gene make-up would make a difference in the animal.

**Dominant and Recessive Genes**

Most characteristics are determined by several pairs of genes. For this reason it is impossible to tell exactly what an unborn animal will look like.

A few characteristics, however, are determined by only one pair of genes. Black and red coat color in horses is one example. By studying characteristics such as this, we can learn something about how inheritance works.

One pair of genes causes the coat to be either black or red, depending on which particular combination of the two genes is present. There is one gene for black and a corresponding gene (allele) for red. The horse will be black if he has two black genes or if he has one black gene and one red gene. This is because the black gene is dominant. The horse will be red only if he has two red genes.

Here’s how the genes combine. Let the capital B represent the black gene. We use the capital because black is dominant. Let the small b represent the red gene. Since genes come in pairs, a horse could have two black genes (BB), one black and one red gene (Bb), or two red genes (bb). A black horse could have either BB or Bb genotype. (Genotype means genetic make-up.) A red horse would have bb genotype. The gene for red (b) is recessive to the dominant gene for black (B).

Consider this problem: A red (chestnut) mare (bb) is bred to a truly black stallion (BB). What color will the foal be?

As the genes and chromosomes divide in the mare’s ovaries, the bb genes separate. Each egg contains one b gene. Likewise, each sperm from the stallion contains one B gene.

When the sperm and egg unite, two genes influencing coat color are again present. The genotype of the foal will be Bb. Since the B gene for black dominates the b gene for red, the foal will be black.

His phenotype (outward appearance) will resemble the stallion. Both would be black. But their genotypes are different. The foal is Bb and the stallion is BB.

What then would happen if a black stallion that had a Bb genotype were bred to a red (bb) mare?

Two possible kinds of sperm would be produced by the Bb stallion. Half of the sperm would have the B gene and half would have the b gene.

It would be a 50:50 chance whether the B sperm or the b sperm united with the b egg from the mare. The genotype of the foal would be either Bb or bb. Thus half the foals from such a mating would be black and half would be red.

 Suppose a Bb stallion were mated to a Bb mare. Both the mare and the stallion would be black, but both would carry a recessive gene (b) for red. Half the sperm would carry the B gene. Half the sperm would carry the b gene. The same would be true for the eggs.
Chances are 25 percent that the foal would have the BB genotype, 50 percent that it would have the Bb genotype, and 25 percent that it would carry the bb genotype.

Theoretically, of 100 such matings were made, 75 of the foals would be black. Twenty-five would be red. Of the 75 black foals only 25 would be truly black (BB) and 50 would carry a recessive red gene.

What would happen if a red (chestnut) stallion were bred to a red (chestnut) mare? In this case all the eggs and all the sperm would carry the b gene. All foals from such matings would be red.

There are also several other pairs of genes that control other coat colors in horses. The many possible combinations of these genes cause the many different color patterns we see.

INHERITANCE OF SEX

We can use a similar analysis to show how the sex of a foal is determined.

In horses, there is one pair of chromosomes which does not exactly match. One is called the x chromosome and the other, the y chromosome. Stallions have one x and one y chromosome. Their sex genotype is xy. Mares have two x chromosomes. Their genotype is xx. (The small letters x and y do not indicate that either is dominant or recessive.)

In reduction division in the stallion, half the sperm contain an x chromosome and half contain a y chromosome. In the mare all egg cells contain x chromosomes.

If a sperm carrying an x chromosome fertilizes the egg, the foal will have xx genotype. It would develop as a female. If a sperm carrying a y chromosome happens to fertilize the egg, the foal would be xy. It would be a stallion.

The chances are 50:50 for the foal to be male or female.

COMPLICATIONS

So far we have seen how inheritance works in its simplest form. This basic system forms the pattern for all inheritance. Complications arise when characteristics are influenced by more than one pair of genes.

Most of the important traits in horses, such as conformation, temperament, physical performance, size, musculature, and longevity, are influenced by many genes. With 33 pairs of chromosomes and hundreds of genes involved, it is impossible to know a horse’s complete genotype.

Furthermore, all gene pairs do not work as completely dominant and recessive. We see this in certain kinds of flowers. When the red flowering plants pollinate a white flowering plant, the flowers on the new plant are pink instead of red or white. In horses, the palomino color pattern is similar to this.

Finally, many things besides the genetic make-up affect a horse. He may have the genes for running fast, but unless he is fed properly, well-trained, and protected from injuries he may never win a race.

A horse with genes for just average temperament that is properly cared for may have a better disposition than one with good genes that is treated badly.

Much remains to be learned about inheritance in horses. The present-day popularity of horses should provide the incentive for further scientific study in this field.