The digestive system of the horse is different from that of the other farm animals. Although the horse has a single compartment stomach like man, the pig, and the dog, the horse can utilize roughages like the cow which is a ruminant. This is possible because the horse has a special type of intestine.

The digestive system is composed of the alimentary canal and its accessory organs. The alimentary canal is a hollow tube which extends from the mouth to the anus and has the following parts: mouth, pharynx, esophagus, stomach, small intestine, large intestine, and anus. Teeth, tongue, salivary glands, liver, and pancreas are the accessory organs.

Digestion is the process of preparation of food for absorption from the alimentary canal into the blood stream and elimination of the unabsorbed residue from the body. The digestive process includes the combined effects of mechanical, secretory, chemical, and microbiological factors. The mechanical factors are chewing (mastication), swallowing (deglutition), movements of stomach and intestines, and elimination of residue (defecation). The digestive glands secrete digestive juices. Bacteria and possibly protozoa are the microbial influences. Understanding the structure (anatomy) and function (physiology) of the unusual digestive system of your horse helps you appreciate proper feeding of your horse.

**MOUTH**

The mouth is the first part of the tract, and the first act of digestion is grasping of food (prehension) to convey it into the mouth. The horse’s upper lip is the main structure in grasping food because it is sensitive, strong, and mobile. In grazing the action of the lip places the grass between the front (incisor) teeth which cut the grass off. In manger feeding, the loose food is collected by the lips with the aid of the tongue. Water and milk are drawn into the mouth by suction caused by a negative pressure in the mouth created largely by the action of the tongue.

Mastication (chewing) is the mechanical reduction of food into finely divided particles which provide a greater surface area for the action of digestive juices. Mastication also mixes the food with saliva which moistens the food thus facilitating chewing and swallowing. This is especially helpful with dry foods such as hays. Saliva is a secretion from 3 sets of paired glands (parotid, submaxillary, and sublingual) and other small glands found in the mouth. Water makes up 99% of the horse’s saliva with the other 1% composed of inorganic salts (ions), and proteins. There are no enzymes in the saliva of the horse. The secretion of saliva in the horse is stimulated by the scratching (mechanical action) of food on the mucous membrane of the inner cheeks. It has been estimated that a horse will secrete about 10 gallons of saliva in 24 hours. Hay will absorb 4 times its weight of saliva while oats will absorb about its own weight: 6 lbs. hay + saliva = 24 lbs.; 6 lbs. oats + saliva = 12 lbs.

The horse is well equipped for chewing tough, coarse feeds with a set of 40 upper and lower teeth in the male: 12 incisors or front, 4 canines, and 24 premolars and molars or cheek teeth. Mares have 36 teeth since they usually do not have canine teeth which in the male are located in the space between the incisors and premolars. Jaw movement is vertical (up and down) and lateral (side to side). Because of this, the upper jaw is wider than the lower; therefore, mastication can occur on only one side of the mouth at a time. The cheek teeth wear sharp edges on the inside of the lower teeth and on the outside of the upper teeth because of the lateral movement. These sharp edges cause damage to the tongue and cheek resulting in the horse eating slowly and wasting feed. Floating the teeth will remove these sharp edges. An annual check-up will prevent this and other dental problems. The lower incisors serve another useful function—the detection of age. (see page 12)
The horse is a relatively slow eater and chews food thoroughly requiring 15-20 minutes to eat a pound of hay and 5-10 minutes to eat a pound of grain.

Deglutition (swallowing) is the complex act, involving a number of muscles and nerves, of conveying food from the mouth through the pharynx and esophagus to the stomach.

PHARYNX

The pharynx is a 6 inch muscular, funnel-shaped sac belonging to the digestive and respiratory tracts whose passages cross in this region. Food must move through the pharynx quickly so that it will not enter the larynx (windpipe) or be forced into the nasal passages. Once food and water enter the pharynx, it cannot return to the mouth due to the blocking action of the soft palate. Horses for this same reason cannot breathe through the mouth.

ESOPHAGUS

The esophagus is a muscular tube about 50 to 60 inches in length which extends from the pharynx down the left side of the neck to the stomach. Solid and semi-solid food moves down the esophagus by wave-like contractions (peristalsis), while liquids are squirted down. These movements can be seen by observing a horse eating and drinking. Choke can occur in horses when food, especially dry grain, and other materials become lodged in the esophagus. Food and water will be observed returning through the nostrils. Peristalsis is a one-way action in the horse from the pharynx to the stomach; because of this, it is very difficult for the horse to vomit. The act of vomiting usually results in the rupture of the stomach or pneumonia from the vomited material being forced into the larynx then to the lungs.

STOMACH

The opening of the esophagus into the stomach, the cardia, is closed by a powerful involuntary ring-like muscle (sphincter). This also reduces the occurrence of vomiting since it is very difficult for material to pass from the stomach back into the esophagus. The horse has the smallest stomach compared with other farm animals. With only a capacity of 8 to 17 quarts, the horse should be fed portions of the daily ration 2 or 3 times daily rather than one large feeding.

Several types of glands and specialized cells are found in the stomach walls. Gastric juice and mucus secretions are produced by these specialized glands and cells. Gastric juice contains hydrochloric acid (HCl) and two enzymes, pepsin and gastric lipase. Pepsin is the enzyme which helps digest proteins. Gastric lipase helps digest fats into constituent fatty acids and glycerol; however, fat digestion is mainly by pancreatic lipase in the small intestine. Hydrochloric acid (HCl) activates pepsin and cooperates with pepsin in the breakdown of protein. The rate of secretion of gastric juices is a continuous process with the rate increasing when food is eaten.

In the horse's stomach food has a tendency to arrange itself in layers. The first food passes into the bottom region of the stomach with subsequent food lying on or around the first food to form layers. The partially digested food does not leave the stomach until it has reached two-thirds of its capacity. Excess food consumed beyond the capacity of the stomach along with partially digested food pass on into the intestine. The emptying of the stomach is a continuous process during digestion. It requires a 24 hour fast to completely empty a horse's stomach. Stomach movement due to muscular contraction mixes the food with gastric juices and passes the ingesta into the duodenum.

When to water a horse has always been an important question. It has long been recommended never to water a horse during or immediately following eating because the water will wash food out of the stomach. This is not true. Drinking during or following a meal has no harmful effect on digestion since most of the water passes directly from the esophageal opening to the intestine opening which are located quite close together due to the U-shaped form of the stomach.

Horses are prone to digestive disorders originating in the stomach. Feeding ground grains which are easily packed into a doughy mass, sudden changes in feeding, failure to reduce the grain ration during idle periods, and ingestion of excessive amounts of water are a few causes of stomach disorders.

SMALL INTESTINE

The small intestine is 70 feet in length and 3 to 4 inches in diameter; it extends from the stomach to the large intestine; it has three parts—the duodenum, jejunum, and ileum. The capacity of the small intestine is 48 quarts. The material leaving the stomach and entering the small intestine is known as chyme, and it is a fluid or semi-fluid. Two main types of factors influencing digestion in the small intestine are movements of the intestinal wall and secretions from the pancreas (pancreatic juice), the liver (bile), and the intestinal glands (intestinal juice).

The pancreatic juice is produced by the pancreas gland and contains several enzymes. Trypsin (activated trypsinogen) converts proteins and partly hydrolyzed proteins into peptides and amino acids. Pancreatic lipase hydrolyzes fats to fatty acids and glycerol, and pancreatic amylase which breaks down starch to maltose. Bile, a secretion from the liver, activates pancreatic lipase, assists in fat emulsification, and aids in absorption of fatty acids. The bile duct and pancreatic duct empty into the 3 to 4 feet long duodenum
about 5 to 6 inches from the pylorus, the stomach opening into the intestine. In other farm animals, bile is temporarily stored in a gallbladder. The horse does not have a gallbladder; there is a direct secretion of bile into the small intestine from the liver.

Simple tubular glands are found throughout the small and large intestine which secrete the sugar digesting enzymes—maltase, sucrase, and lactase. Each of these enzymes attacks the individual sugar with the name similar to its own (maltose, sucrose, and lactose). The enzyme breaks the sugar into glucose which can be absorbed. These simple tubular glands also secrete a lipase similar to pancreatic lipase.

Absorption of many nutrients (Amino acids, sugars, fatty acids, minerals, and vitamins) occurs in the small intestine which is well equipped with small projections called villi. Villi increase the surface area which enhances absorption. Intestinal movements mix the ingesta with the digestive secretions, enhance absorption, move the material through the intestines, expel the residues, and assist in the flow of blood and lymph through the vessels of the intestinal wall.

The great length of the small intestine leads to many problems such as twisted or telescoped intestine.

**LARGE INTESTINE**

Material which is not or cannot be digested in the small intestine passes into the large intestine which is divided into the cecum, large colon, small colon, rectum, and terminates at the anus. The important digestive action of the cecum and colon is due to the presence of bacteria and possibly protozoa (one celled animals) which (1) digest cellulose, the fibrous part of roughages, and other carbohydrates such as starch and sugars to produce energy yielding volatile fatty acids; (2) synthesize B-vitamins; and (3) synthesize amino acids. Absorption of volatile fatty acids apparently occurs in the colon.

B vitamins are definitely synthesized by the bacteria of the large intestine; however, in certain situations the absorption of most of them may not be adequate to meet the need of the horse. On normal diets, B vitamin deficiency does not occur in the horse so adequate quantities of B vitamins are available either (1) in the feed (diet) or (2) by bacterial synthesis.

**CECUM.** The cecum, blind gut, lies between the small intestine and large colon. Its average length is 4 feet with a capacity of 28 to 32 quarts. It extends into the right flank. The presence of food in the stomach causes an emptying of the cecum into the large colon. Because of the microorganism digestive action in the cecum, it is a functional appendix.

**LARGE COLON.** The large colon with a diameter of 8 to 10 inches is 10 to 12 feet long and has a capacity of 80 quarts. The large colon extends from the cecum to the small colon where it terminates in a funnel shaped restriction. Because it is usually expanded with food, impactions may occur. Impactions occur also in the cecum and small colon.

**SMALL COLON.** The small colon extends from the large colon to the rectum. It is from 10 to 12 feet in length with a diameter of 3 to 4 inches. Water is reabsorbed from the contents of the small colon and the characteristic balls of feces are formed. Feces is the waste matter of digestion and contains water, indigestible and undigested food residues, cells sloughed off of the intestinal wall, and remains of digestive secretions.

**RECTUM.** The rectum extends 1 foot in length from the small colon to the terminal part of the digestive tract, the anus.

A horse normally voids 33 to 50 lbs. of feces per day. Vigorous horses defecate 5 to 12 times daily.
You probably feed your 4-H horse a supplement. You know that the supplement will make your colt grow faster and be healthier. The horse will be in "better shape" than if you just let him graze.

You know this because you know something about animal nutrition. Animals need many different kinds of nutrients. Different animals need different kinds and amounts of nutrients. This is where the science of animal nutrition comes in. Part of the animal nutritionist's job is to find out what nutrients animals need.

In feeding experiments, different feed ingredients are tried. In the laboratory, feeds are analyzed. Nutritionists search for the best combination of feeds for the kind of horse being fed. For mares nursing foals, the feed must help produce milk. For a pregnant mare, the feed is designed to help produce a healthy foal. For a young horse, feed is designed for growth and development as well as maintenance and energy.

After experiments are conducted, they are checked and rechecked. Then the results are used to make recommendations to horse owners. This means good rations for a minimum cost to horse owners. It also assures you that your horse is fed in a way to meet the needs of his body in the type of work that he is doing.

KIND OF NUTRIENTS

There are many different chemicals in feeds. Animals need some of them in large amounts—others are needed only in tiny amounts. Some have not been discovered or named yet.

These feed constituents are divided into five main types of nutrients. Each type has a different job in the animal's body. The five types are (1) energy nutrients (carbohydrates and fats), (2) proteins, (3) vitamins, (4) minerals, and (5) water.

None of these is more important than the others. All are essential. But with the exception of water, the energy nutrients usually make up the greatest bulk of feed.

Energy nutrients are the body's fuel. In fact, they are even chemically similar to fuels we use—gasoline, oil and coal.

After digestion, the energy nutrients are carried by the blood to the cells of the body. In reactions very much like burning, they are used by the cells for energy. Energy or fuel is required to power the movements of muscles—walking, a beating heart, breathing, blinking eyes and contractions of the digestive system. At the same time, heat is produced to maintain body warmth.

The main energy nutrient is carbohydrate. There are many carbohydrates. Even the relatively simple ones are complex compounds. All carbohydrates are made up of carbon, hydrogen and oxygen. Carbon is the key to carbohydrates. This element can behave in several different ways. As a result, there are thousands of possible combinations of carbon, hydrogen and oxygen.

 Sugars and starches are carbohydrates. They are relatively simple. Cellulose is one of the more complex carbohydrates.

The sugars and starch are easy to digest. They have a high "feeding value" because very little of them pass through the body undigested. Grains such as corn and oats contain much sugar and starch.

Cellulose is chemically a carbohydrate. It makes up the fiber in plants. Grass has much cellulose. Cellulose is hard to digest. For most animals it has a low feeding value; however, ruminants (cattle and sheep) can digest large amounts of cellulose with the aid of bacteria in the rumen. The caecum or large intestine of the horse functions similar to the rumen in cattle and sheep.

Another group of energy nutrients is the fats and oils. Fats and oils are chemically alike. Their main difference is that fats are solid at body temperature; oils are liquid. Both are usually called fats.

Like carbohydrates, fats are made up of carbon, hydrogen and oxygen. They are also used to provide energy for movement and heat. Fats contain a higher percentage of carbon and hydrogen atoms than carbohydrates do. Thus, the energy in fats is more concentrated. Fat has 2.25 times more energy per gram than carbohydrate.
THE PROTEINS

While carbohydrates and fats supply energy, proteins supply the material from which body tissue is made. They are the bricks and mortar from which bodies are built.

Proteins are highly complex. In addition to carbon, hydrogen and oxygen, they contain nitrogen. Some proteins also contain sulfur. A few contain phosphorus or iron.

Like carbon, nitrogen can be combined with other chemical elements in different ways. The various combinations result in many different proteins. Each protein is made up of several nitrogen compounds called amino acids. These amino acids are the “building blocks” from which proteins are made. The chemical arrangement of the amino acids determine the quality of the protein.

During digestion, proteins are broken down into amino acids. These are absorbed from the intestine into the blood stream and carried to all parts of the body. Then they are recombined to form body tissue.

Proteins that are eaten eventually become muscle, internal organs, bone and blood. Skin, hair, hooves, and many other parts of the body are also made of protein. If an excess of protein is fed, the nitrogen portion of the protein can be separated from the rest of the nutrient and be discarded in the urine. The remaining materials can then be converted into energy by the animal.

NO TWO PROTEINS ARE ALIKE EVEN IF MADE OF THE AMINO ACIDS!

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THE VITAMINS

Although animals need large amounts of both energy and proteins, other nutrients are just as vital, but are needed in much smaller amounts. The vitamins are such a group.

For a long time, people noticed that certain diseases were caused by the lack of certain foods. Then modern science began analyzing the foods. They were found to contain small amounts of certain complex chemicals. Other foods did not contain them.

These nutrients were called vitamins, or “vital amines”. They are essential to normal body functioning.

The vitamins are not chemically alike. Each one also has a different job in the body. Still, they are all classed together under the term vitamins. This is because they are all organic compounds. (They contain carbon). Also, all of them are needed only in very small amounts.

Vitamin A is responsible for the health of the eye and the tissue of nasal passages, lungs and digestive system. Vitamin D is responsible for the strength and proper development of bones and the mineral balance in the blood. Other vitamins have just as important functions.

Some animals require only certain vitamins in their feed, whereas others can manufacture some of their own. Feeds are a good source of certain vitamins. Carotene in green grass is a good source of vitamin A. Sunshine and sun-cured hay are good sources of vitamin D.

THE MINERALS

Like vitamins, minerals are usually needed only in small amounts. Unlike vitamins, they are inorganic—they do not contain carbon. Iron, copper, phosphorus, calcium, and magnesium are examples of minerals.
Minerals are important in the chemical reactions of the body. Without them, many life processes could not take place. Without iron in the blood, for instance, oxygen could not be carried to the body's cells. For animals such as horses that are very active, the oxygen carrying capacity of the blood is a very vital factor in their daily life. A race horse uses tremendous quantities of oxygen during a race.

Without calcium and phosphorus proper bone and tooth formation would not take place. These are examples of the need for minerals.

**WATER AS A NUTRIENT**

The last item on our list of nutrients is so common that we seldom think of it as a nutrient. But water is the largest single part of nearly all living things. The body of a colt is three-fourths water, while an adult is approximately 50 percent water.

Water performs many tasks in the body. It makes up most of the blood, which carries nutrients to the cells and carries waste products away. Water is necessary in most of the body's chemical reactions. In addition, water is the body's built-in cooling system. It regulates body heat. It acts as a lubricant.

Life on earth would not be possible without water. An animal can live longer without food than without water.

**FINDING OUT WHAT'S IN FEEDS**

Research has provided the information that is available about the different kinds of nutrients. The scientist has developed methods by which the amount of each nutrient in a feed can be accurately determined. Knowing the nutrient content of a feed is very important to livestock raisers.

Water is one of the nutrients that is fairly easy to determine. Simply take a sample of a feed and weigh it. Then heat the feed sample slightly above the boiling point of water. Hold it at this temperature until the feed stops losing weight. Then weigh the feed. This weight is subtracted from the weight before heating. The difference between the two weights represents the amount of water driven off by the heat. To find the percentage of water, divide the dry weight by the original weight.

Another fairly simple analysis is to find out how much mineral is in the feed. Recall that minerals are inorganic chemicals. As such they will not burn. When a feed is completely burned, a whitish-gray ash is left. If the weight of this ash is divided by the original weight of the feed before burning, the percent mineral, or ash, is obtained.

The chemical analysis gets more complicated when you are determining how much protein is in a feed. Recall that protein is made up of carbon, hydrogen and oxygen plus nitrogen. Scientists have learned that protein is about 16 percent nitrogen. Using certain chemical tests, the amount of nitrogen in a feed can be determined. Multiplying this amount by 6.25 (16 percent nitrogen divided into 100=6.25) gives the amount of crude protein in a feed. It is called crude protein because it includes all nitrogen compounds. There may be some nitrogen compounds in the feed which are not true proteins.

Another test is for the amount of fat in a feed. Since fat dissolves in ether, a sample of the feed is heated in ether for several hours. Then the feed is removed, and the ether is evaporated. The residue that is left is the fat, or ether extract.

It is important to know the fiber content of feeds. This is because fiber is hard to digest. Therefore, feeds with a high fiber content are less nutritious.

To find the fiber content, some of the feed is dissolved in a weak acid or alkali. Fiber (very complex carbohydrates) will not dissolve; it is left over. Any material that the weak acids or alkali will not dissolve is considered to be indigestible by animals. Keep in mind that the cells in the lining of the stomach secrete a weak solution of hydrochloric acid.

If the percentage of water, minerals, fat, fiber and protein are added together, the total will be something less than 100 percent. This difference is referred to as the nitrogen-free extract. This extract includes the more soluble carbohydrates, sugars, starch and some cellulose. All of these are readily digested in the digestive tract.

When the amounts of different nutrients in a feed are known, the quality or feeding value of the feed can be easily determined. By adding the digestible organic nutrients (protein, nitrogen-free extract and fat x 2.25), we can tell the "energy value" of a feed TDN—total digestible nutrients—is the term used.
A great variety of feeds may be used satisfactorily for horses. In different parts of the world, horses are fed elephant grass, bamboo leaves, dried fish, turnips, beets, leaves of limes and grapevines, and lawn clippings. As a general rule, we should choose feeds that are suitable and readily available at the most economical cost. Therefore, we may say that the ABC's of choosing feeds for horses are based on knowledge of nutrient content and function of the horse, combined with experience of the horse owner.

In this lesson we learn about the content of energy, proteins, minerals, vitamins, and fiber or bulk contained in some of our most important feeds for horses. Also, we learn about correction factors to consider, such as quality, suitability, availability, cost, and convenience.

We gain experience by applying these ABC's to provide economical, satisfactory rations when we have a thorough understanding of the digestive system of the horse, the nutrients and their importance, and balancing rations for the horse.

**TYPES OF FEEDS**

We can conveniently classify feeds into three main types: (1) roughages, (2) concentrates, and (3) mixed feeds. Roughages include pasture forages, hays, silages, and byproduct feeds that contain a high percentage of fiber. Concentrates are the energy-rich grains and molasses, the protein- and energy-rich supplements and byproduct feeds, vitamin supplements, and mineral supplements. Mixed feeds may be either high or low in energy, protein, or fiber; or they may provide "complete" balanced rations.

**ROUGHAGES**

Wild horses live on roughage today as their ancestors did 55 million years ago when they were five-toed animals the size of a fox. Roughages are still important for active horses and may serve as the only feed for idle horses. Proper use of good quality roughages reduces the quantity of expensive concentrates needed and provides a plentiful supply of vitamins and minerals.

There are three main forms of roughages: (1) dry roughages, (2) silages, and (3) pastures. Dry roughages include hay, straw, and artificially dehydrated forages, which contain about 90 per cent of dry matter. Silages are formed from green forages such as grass, alfalfa, sorghum, and corn preserved in a silo at dry matter contents of 20 to 50 per cent. Green, growing pastures provide forage that has a high water content and only 20 to 30 per cent of dry matter.

There are two basic types of roughages: (1) grasses, and (2) legumes. The grasses are generally higher in fiber and dry matter than legumes. The legumes are generally higher in proteins, energy, vitamins, and minerals.

Soil fertility, soil type, and climate influence the productivity and nutrient content of the various grasses and legumes. But the most important factor affecting the nutrient composition of grasses and legumes is stage of maturity.

As a plant grows older, it becomes less leafy, more stemmy, more fibrous, and less digestible. Timothy hay cut before bloom has about 160 per cent more digestible protein and 35 per cent more TDN than mature timothy. Mineral and vitamin levels are also higher in immature grasses and legumes, whether these roughages are in the form of pastures, silage, or hay.
DRY ROUGHAGES

In general, the best hay for horses is a good quality grass-legume mixed hay. A good quality pure legume or pure grass hay is satisfactory if it is fed properly.

Grass hays such as timothy, oat, brome, bermuda, wheatgrass, native western mountain, etc. of equal quality have similar nutrient values. Prairie hay is much lower in protein than most other grass hays. The legume hays (alfalfa, soybean, peanut, lapeseda, and clovers) are generally higher in protein, energy, calcium, and phosphorus than grass hays. Mixtures of grasses and legumes are intermediate in nutrient content. Because the calcium level in legumes is about six times higher than the phosphorus level, a supplemental source of phosphorus might be needed to balance the Ca:P ratio in a ration high in legumes.

If we learn to identify the grasses and legumes by their leaves and blossoms, we can do a more intelligent job of buying. Also, the head of grasses and the bud or bloom of legumes can tell us the state of maturity at which the hay was cut. Horses refuse and waste more late cut hay, which is already low in nutrient content.

Leafiness of hay is an important guide to feeding value because most of the nutrients are carried in the leaves. For hay to grade U.S. 1 or U.S. 2, 25-40 percent of its weight must be leaves. Leafiness is influenced by kind and species of forages, stage of maturity when cut, weather conditions while growing and while curing, and curing procedures. Leaves are shattered and lost when hay is raked or baled too dry.

Color of hay is another indication of quality and nutrient content. Good hay is a bright leafy green. Overly mature hay is pale, yellow, or brown. Hay that was rained on when it was nearly cured may be faded in color because of additional drying time and exposure to sunlight and air. This exposure destroys the carotene or vitamin A value. Heavy rain on nearly dry hay leaches carbohydrates or energy value from the hay and also causes a loss of these nutrients from fermentation. Hay that is baled before it is dry enough will lose nutrients through fermentation or “heating” in the bale, which sometimes starts a fire from spontaneous combustion. Even if it does not start a fire, heat of fermentation is energy value lost and produces a dull, dark hay that is usually dusty with moldiness inside the bale. Such hay is unacceptable for horses; therefore open and examine several bales of a prospective purchase if there is any question about its quality. Tight, clumpy, misshapen bales are subject to suspicion.

Odor of hay will vary according to species of grasses and legumes but should always be aromatic and pleasant. Lack of odor indicates over-maturity, bleaching, leaching, or old hay which probably has lost most of its vitamin A value. A stale, musty, unpleasant odor indicates that excessive fermentation has occurred.

Dust is objectionable in any feed for horses. It not only reduces the palatability of the feed, but also can cause heaves and other respiratory trouble. Good timeliness tends to be most dust-free of the hays. Pure legume hays tend to be more dusty than grass or mixed hays. Dustiness can be reduced by sprinkling the hay or other feed with water or water and molasses just before it is fed.

Dehydrated roughages such as alfalfa leaf meal or pellets are made by processing lush-growing, highly nutritious forage through a heated dryer called a dehydrator. These dehydrated meals or pellets are usually rich in vitamin A value, B vitamins, and high quality proteins. They are used mostly as vitamin and protein supplements, but their high fiber content classes them as roughages.

SILAGES

Good quality silages are a suitable replacement for up to half of the hay or pasture allowance. Remember that about three pounds of silage are equivalent to

![Protein % in Horse Feeds](image)

![Total Digestible Nutrients in Horse Feeds (%)](image)
one pound of hay because of the difference in dry matter content. However, spoiled, moldy, or frozen silages cause digestive upsets in horses. Silage that contains dead rats, birds, etc. can cause fatal botulism poisoning in horses.

PASTURES

Pastures can reduce feed costs and provide plenty of vitamins and good quality proteins. They are important for mares and foals, and night pastures especially are good for pleasure horses. However, an exercise lot with a few blades of grass is not a pasture. Such a lot or an overgrazed pasture of short forage can be a serious source of internal parasite infestation.

Horses should be rotated to “fresh” pasture every two weeks if possible. This will reduce internal parasite infestation and also increase the productivity of pastures, particularly if the pastures are small.

Understocked, overgrown, coarse, and unpalatable pastures are sometimes clipped to freshen them up, during the growing season.

Pasture forages are quite laxative in early spring. Legumes are more laxative than grasses. Therefore, laxative feeds such as linseed oil meal or wheat bran should be removed from the ration when horses first go on pasture, and their daily time on pasture should be short at first.

CONCENTRATES

Corn, oats, barley, and milo (sorghum grain) are the most important energy-rich grains. They contain about 70 to 80 percent of TDN (total digestible nutrients) including 7 to 10 percent of digestible protein. Wheat bran, rice bran, wheat middlings, rye middlings, and rice polish are byproduct feeds from the grain milling industry. The brans are somewhat laxative and bulky and usually contain about 65 percent of TDN of which 8.5 to 14 percent is digestible protein. Soybean oil meal, cottonseed oil meal, peanut oil meal, and linseed oil meal are called “protein supplements.” They have about 75 to 80 percent TDN and 30 to 46 percent digestible protein. Mineral concentrates include: salt, or sodium chloride (NaCl); iodized salt (NaCl plus iodine); ground limestone, which supplies calcium (Ca); steamed bone meal and dicalcium phosphate for calcium and phosphorus; and others. All of the vitamins can be obtained in concentrated form, singly and in various combinations.

Corn is similar to the other grains in nutrient content but is the richest in TDN and the lowest in protein, fiber, calcium, and phosphorus. Corn is the most readily available and most economical grain in most sections of the country. It can be used to full advantage if its deficiencies are offset by (1) good quality legume or grass-legume hay or pasture, (2) a suitable grain milling byproduct feed, or (3) a protein supplement.

It is used in most mixed feeds and also as ear corn, shelled corn, or cracked corn. Cracking improves its digestibility, but finely ground corn is more apt to cause colic unless it is mixed with a bulky feed.

Oats are somewhat higher in protein than corn, much higher in fiber and much more bulky, and about 15 percent lower in energy. Nutrient content of oats varies considerably according to proportion of fibrous hull to nutritious grain. Rolled or crimped oats is more digestible than whole oats. Oats with a grass hay such as timothy may be inadequate; some grass-legume roughage along with some corn or barley will assure a more complete ration. Oats are usually the most expensive feed grain in terms of cost per unit of nutrient. However it is the safest and easiest to feed and goes well with other grains that tend to cause colic.

Barley rolled or ground medium fine is worth about 10 percent more per pound than crushed oats. Since barley may cause colic if fed alone, it should be mixed with at least 15 percent bran or 25 percent oats.

Milo (grain sorghum), like barley, should be crushed or ground and fed with bran or oats. It then has TDN and protein values intermediate between barley and corn.

Molasses is a concentrated appetizer and dust settler. It is sticky, sweet, and smells good. It contains 54 percent of TDN, very little minerals, no fiber, and no digestible protein. Unit cost of TDN is usually as high or higher than the cost of the same amount of energy as grain. However, either cane or sugar beet molasses is nearly always included at levels of 5 to 15% in commercially mixed rations.

Protein Supplements. A protein-rich supplement is needed when: (1) the roughage being fed is of poor quality, or (2) the pregnant or lactating mare or young stock requires extra protein to balance the ration. High-protein feeds that are commonly used for horses are: soybean oil meal, linseed oil meal, cottonseed oil meal, and peanut oil meal. Protein quantity and quality in soybean and peanut oil meals is higher than in linseed and cottonseed oil meals. Linseed oil meal is the lowest of these in protein and usually is not the most economical source of protein; but it is used for its laxative quality and to improve the luster and bloom of hair coats. Although these protein supplements are high in energy value also, feeding excessive amounts is useless, expensive, and causes digestive upsets.

Byproduct feeds. Certain byproducts from the milling industry are useful, economical horse feeds. Wheat bran and rice bran are highly palatable and slightly laxative; therefore they improve rations of grass hay and corn, barley, or milo. The brans are especially good sources of two B vitamins, thiamine and niacin, and supply fair amounts of protein and energy. Wheat middlings, rye middlings, and rice polish are lower in fiber and higher in energy than the brans; they may cause colic and other digestive upsets if they comprise more than 25 percent of the concentrate ration.
Your 4-H horse project offers an opportunity for you to learn how to balance a ration. To accomplish this, you must be accurate in your addition, multiplication, division and subtraction. You will be working with percentages, so be sure and watch decimal placings.

You can use Nutrient Requirement Tables in two ways: (1) to check the ration being fed to see if it is balanced, and (2) to formulate an adequate ration for your horse.

Follow This Procedure in checking through the example ration and in working out a ration for your horse on the blank sheet:
1. Determine the age, weight and type of work your horse is doing.
2. Fill in Section 3 of the enclosed work sheet from Table 1, Daily Nutrient Requirements of Horses.
3. List available feeds in Section 1 of your work sheet, giving attention to each column. If you have actual analysis on your feeds, use these. If not, take average analysis from Table 2.
4. Weigh the amount of each feedstuff being fed daily. If a mixed feed is being used, you can either find out the amount of each feed ingredient that is in the mixture or use analysis of the mixture from the feed tag.
5. Multiply each figure in Section 1 by the pounds fed daily (Section 2, column 1). Record the results in the appropriate columns of Section 2 on your work sheet.
6. Add the columns in Section 2. This gives the total amount of each nutrient in your horse ration.
7. Check these totals against the "Daily Nutrient Requirements" listed in Section 3 of your work sheet. If the "requirement" is more than the totals in your ration, you will know that your ration is inadequate. Your next step is to find a feed ingredient that is a good source of the deficient nutrient and either substitute this new feedstuff for one you are now using or add this new ingredient to your horse ration. After doing this, you should refigure your totals to be sure other nutrients are not out of balance. Excesses of some nutrients can interfere with use of others in addition to being a waste of feed and money. For example, excess calcium can prevent complete utilization of phosphorus in a ration.

Table 1. Daily Nutrient Requirements of Horses Based on mature weight of 1000 to 1200 lbs.

<table>
<thead>
<tr>
<th>Feed</th>
<th>Digestible Protein %</th>
<th>Digestible Nutrients g</th>
<th>Calcium grams per lb</th>
<th>Phosphorus grams per lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>400 pound weanling—(age about 6 months)</td>
<td>11 to 12</td>
<td>1.0 to 1.2 8.0 to 9.0</td>
<td>33.0</td>
<td>21.0</td>
</tr>
<tr>
<td>600 to 700 pound yearling</td>
<td>13 to 14</td>
<td>1.6 to 1.8 9.0 to 10.0</td>
<td>33.0</td>
<td>21.0</td>
</tr>
<tr>
<td>800 to 1000 pound 2 year old</td>
<td>15 to 16</td>
<td>1.3 to 1.5 10.0 to 11.4</td>
<td>17.0</td>
<td>17.0</td>
</tr>
<tr>
<td>1000 lb. mature idle horse—(less than 1 hour riding daily)</td>
<td>16 to 17</td>
<td>0.6 to 0.8 6.0 to 8.1</td>
<td>12.0</td>
<td>12.0</td>
</tr>
<tr>
<td>1000 lb. horse—light work—1 to 3 hours riding daily</td>
<td>16 to 17</td>
<td>0.8 to 1.0 8.0 to 11.0</td>
<td>24.0</td>
<td>21.0</td>
</tr>
<tr>
<td>1000 lb. horse—medium work—3 to 5 hours riding daily</td>
<td>19 to 20</td>
<td>0.9 to 1.1 11.0 to 14.0</td>
<td>24.0</td>
<td>21.0</td>
</tr>
<tr>
<td>1000 lb. horse—hard work—more than 5 hours riding daily</td>
<td>22 to 23</td>
<td>1.2 to 1.4 14.0 to 17.0</td>
<td>24.0</td>
<td>21.0</td>
</tr>
<tr>
<td>1000 lb. breeding stallion (moderate breeding)</td>
<td>20 to 22</td>
<td>1.6 to 1.7 13.0 to 15.0</td>
<td>60.0</td>
<td>40.0</td>
</tr>
<tr>
<td>1000 lb. bred mare—light work</td>
<td>18 to 20</td>
<td>1.1 to 1.3 10.0 to 12.0</td>
<td>24.0</td>
<td>24.0</td>
</tr>
<tr>
<td>1000 lb. lactating mare</td>
<td>28 to 30</td>
<td>1.9 to 2.1 18.0 to 20.0</td>
<td>40.0</td>
<td>40.0</td>
</tr>
</tbody>
</table>

*Horses can use carotene to produce Vitamin A at the rate of 400 International Units of Vitamin A from 1 mg. of carotene.

Table 2. Average Nutrient Content of Feeds

<table>
<thead>
<tr>
<th>Feed</th>
<th>Digestible Protein %</th>
<th>Digestible Nutrients g</th>
<th>Calcium grams per lb</th>
<th>Phosphorus grams per lb</th>
<th>Carotene milligrams per lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentrates</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rolled Oats</td>
<td>11.0</td>
<td>75.0</td>
<td>0.41</td>
<td>1.95</td>
<td>0.0</td>
</tr>
<tr>
<td>Corn No. 2</td>
<td>7.8</td>
<td>85.0</td>
<td>0.09</td>
<td>1.22</td>
<td>1.3</td>
</tr>
<tr>
<td>Rolled Milo</td>
<td>9.3</td>
<td>83.0</td>
<td>0.14</td>
<td>1.22</td>
<td>0.0</td>
</tr>
<tr>
<td>Rolled Barley</td>
<td>10.6</td>
<td>80.0</td>
<td>0.41</td>
<td>2.13</td>
<td>0.0</td>
</tr>
<tr>
<td>Wheat Bran</td>
<td>12.3</td>
<td>65.0</td>
<td>0.63</td>
<td>5.90</td>
<td>1.2</td>
</tr>
<tr>
<td>Wheat Middlings</td>
<td>14.2</td>
<td>75.0</td>
<td>0.22</td>
<td>1.86</td>
<td>1.4</td>
</tr>
<tr>
<td>Soybean Oil Meal</td>
<td>42.0</td>
<td>78.0</td>
<td>1.27</td>
<td>2.77</td>
<td>0.0</td>
</tr>
<tr>
<td>Linseed Meal</td>
<td>30.0</td>
<td>75.0</td>
<td>1.60</td>
<td>3.20</td>
<td>0.0</td>
</tr>
<tr>
<td>Molasses</td>
<td>0.0</td>
<td>53.7</td>
<td>3.35</td>
<td>0.36</td>
<td>0.0</td>
</tr>
<tr>
<td>Roughages (Hays)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timothy (bright)</td>
<td>4.6</td>
<td>51.0</td>
<td>1.04</td>
<td>0.91</td>
<td>10.0</td>
</tr>
<tr>
<td>Oat Hay (green)</td>
<td>5.0</td>
<td>47.3</td>
<td>0.95</td>
<td>0.86</td>
<td>14.0</td>
</tr>
<tr>
<td>Wheat Hay (green)</td>
<td>3.8</td>
<td>46.7</td>
<td>0.95</td>
<td>0.86</td>
<td>14.0</td>
</tr>
<tr>
<td>Smooth Brome</td>
<td>6.1</td>
<td>46.3</td>
<td>1.63</td>
<td>1.18</td>
<td>16.7</td>
</tr>
<tr>
<td>Crested Wheatgrass</td>
<td>5.4</td>
<td>51.0</td>
<td>1.00</td>
<td>0.60</td>
<td>2.2</td>
</tr>
<tr>
<td>Kentucky Blue Grass</td>
<td>6.5</td>
<td>51.0</td>
<td>1.00</td>
<td>0.94</td>
<td>20.0</td>
</tr>
<tr>
<td>Prairie Hay</td>
<td>3.7</td>
<td>43.1</td>
<td>2.80</td>
<td>0.56</td>
<td>14.0</td>
</tr>
<tr>
<td>Clover-Timothy</td>
<td>5.5</td>
<td>46.2</td>
<td>4.00</td>
<td>0.86</td>
<td>6.1</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>12.4</td>
<td>50.3</td>
<td>6.50</td>
<td>1.06</td>
<td>16.8</td>
</tr>
<tr>
<td>Ladino Clover</td>
<td>13.0</td>
<td>44.8</td>
<td>6.20</td>
<td>1.60</td>
<td>73.1</td>
</tr>
<tr>
<td>Red Clover</td>
<td>7.5</td>
<td>44.3</td>
<td>6.13</td>
<td>0.86</td>
<td>16.7</td>
</tr>
<tr>
<td>Mixed Grass Hay</td>
<td>5.1</td>
<td>53.8</td>
<td>2.65</td>
<td>0.80</td>
<td>9.0</td>
</tr>
<tr>
<td>Reed Canary Grass</td>
<td>4.8</td>
<td>45.1</td>
<td>1.63</td>
<td>0.82</td>
<td>7.0</td>
</tr>
<tr>
<td>Oat Straw</td>
<td>0.7</td>
<td>44.7</td>
<td>0.86</td>
<td>0.45</td>
<td>0.0</td>
</tr>
</tbody>
</table>

*Convert Carotene to International Units of Vitamin A by multiplying by 400.
**BALANCING HORSE RATIONS - WORK SHEET**

**Animal**  Mature Horse  **Weight** 1050  **Age** 7  **Work Classification** Medium

### Section 1

<table>
<thead>
<tr>
<th>Feed</th>
<th>Digestible Protein %</th>
<th>T.D.N. %</th>
<th>Calcium grams per lb.</th>
<th>Phosphorus grams per lb.</th>
<th>Vitamin A International Units per lb. of feed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timothy</td>
<td>4.6</td>
<td>51.0</td>
<td>1.04</td>
<td>0.91</td>
<td>4000</td>
</tr>
<tr>
<td>Barley</td>
<td>10.6</td>
<td>80.0</td>
<td>0.41</td>
<td>2.13</td>
<td>-</td>
</tr>
<tr>
<td>Molasses</td>
<td>0.0</td>
<td>53.7</td>
<td>3.35</td>
<td>0.36</td>
<td>-</td>
</tr>
</tbody>
</table>

### Section 2

**Quantity of Nutrients in Feeds Being Used**

<table>
<thead>
<tr>
<th>Feed</th>
<th>Lbs. fed</th>
<th>Digestible Protein lbs</th>
<th>T.D.N. lbs.</th>
<th>Calcium gm.</th>
<th>Phosphorus gm.</th>
<th>Vitamin A I.U.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timothy</td>
<td>12</td>
<td>0.55</td>
<td>2.1</td>
<td>12.5</td>
<td>10.9</td>
<td>48000</td>
</tr>
<tr>
<td>Barley</td>
<td>5</td>
<td>0.53</td>
<td>4.0</td>
<td>2.1</td>
<td>10.7</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>17</td>
<td>1.08</td>
<td>16.1</td>
<td>14.6</td>
<td>21.6</td>
<td>48000</td>
</tr>
</tbody>
</table>

### Section 3

**Daily Nutrient Requirements**

(Based on air-dry feed containing 90 percent dry matter)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1050# Mod. Work</td>
<td>19 to 20</td>
<td>0.9 to 1.1</td>
<td>110 to 140</td>
<td>24.0</td>
<td>21.0</td>
<td>18000</td>
</tr>
</tbody>
</table>

### Section 4

**Balancing Ration and Meeting Requirements**

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total from Section 2</td>
<td>17</td>
<td>1.08</td>
<td>16.1</td>
<td>14.6</td>
<td>21.6</td>
<td>48000</td>
</tr>
<tr>
<td>Ration deficiency</td>
<td>2 to 3</td>
<td>-</td>
<td>0.9 to 1.1</td>
<td>9.4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Supplement Molasses</td>
<td>3</td>
<td>-</td>
<td>1.6</td>
<td>10.1</td>
<td>1.1</td>
<td>-</td>
</tr>
<tr>
<td>Balanced ration</td>
<td>20</td>
<td>1.08</td>
<td>11.7</td>
<td>24.7</td>
<td>22.7</td>
<td>48000</td>
</tr>
</tbody>
</table>
# BALANCING HORSE RATIONS - WORK SHEET

**Animal** ______________________  **Weight** _______  **Age** _______  **Work Classification** ______________________

## Section 1  Composition of Feeds

<table>
<thead>
<tr>
<th>Feed</th>
<th>Digestible Protein %</th>
<th>T.D.N. %</th>
<th>Calcium grams per lb.</th>
<th>Phosphorus grams per lb.</th>
<th>Vitamin A International Units per lb. of feed</th>
</tr>
</thead>
</table>


## Section 2  Quantity of Nutrients in Feeds Being Used

<table>
<thead>
<tr>
<th>Feed</th>
<th>Lbs. fed</th>
<th>Digestible Protein lbs.</th>
<th>T.D.N. lbs.</th>
<th>Calcium gm.</th>
<th>Phosphorus gm.</th>
<th>Vitamin A I.U.</th>
</tr>
</thead>
</table>


## Section 3  Daily Nutrient Requirements (Based on air-dry feed containing 90 percent dry matter)

|-----------------------|----------|-------------------------|-------------|-------------|---------------|----------------|


## Section 4  Balancing Ration and Meeting Requirements

<table>
<thead>
<tr>
<th>Total from Section 2</th>
<th>Ration deficiency</th>
<th>Supplement</th>
<th>Balanced ration</th>
</tr>
</thead>
</table>
HEALTH AND SANITATION PRINCIPLES
IMPORTANT IN HORSE CARE

Donald J. Bolech
University of Vermont

There are good reasons why you should be concerned with maintaining the proper health of your horses or ponies.

First, you have a responsibility to all animals entrusted to your care to protect them from injury, sickness and pain.

Secondly, any time your horse is ill it will prevent you from using him.

Thirdly, if your horse needs treatment, it will usually cost you time and money.

If we take the horse industry as a whole, we find that thousands of dollars are lost each year because horse owners did not follow the prescribed practices of good breeding, feeding, management, and disease prevention. This is sad, indeed, since the knowledge and materials necessary to prevent most of these losses are readily available.

Animal scientists have discovered many practices which horse owners find beneficial in the maintenance of healthy horses. There are many fine drugs, vaccines, disinfectants and other products manufactured today that can be used successfully to help keep horses healthy. Fortunately, the people in veterinary medicine are ready and willing to help in the wise use of these materials and in helping you to set up a sound health program for your horses.

There are many preventive measures which are good common sense ideas with scientific principles behind them. Some of the more important ones are listed below.

1. Feed your horses a nutritionally balanced ration, in sufficient quantities in the correct manner.

The scientific basis for this recommendation is:

A horse’s well-being depends largely on its nutrition. If the level of nutrition is high, the body defenses against diseases will be stronger. This also applies to the problems of internal parasites. Unsoundnesses of the feet and legs are sometimes traced to deficient rations. The same is true of other abnormalities such as infertility and abortion. It is possible to overfeed horses and by so doing create serious problems. A horse may founder, become temporarily infertile or aggravate respiratory problems from being over-fed. Some of these troubles are caused from feeding moldy or dusty feed or from feeding or allowing access to cold water too soon after heavy work.

2. Provide clean, healthful quarters for your horses.

The scientific basis for this recommendation is:

Disease organisms often grow and thrive in organic waste. Flies and insects as well as vermin, which also harbor disease, thrive under filthy conditions. Removing the source (reservoir) of the disease organism lessens the chances of disease.

If your horse is kept in a clean environment, his body will not be constantly fighting to ward off disease. Therefore, he will make better use of his feed, will feel better and perform better because of less stress from disease.

Horses do best when allowed plenty of freedom to exercise and plenty of clear fresh air, provided there are no drafts. Most respiratory troubles develop from keeping horses in tight barns which are too warm and humid.

3. Carry out a planned immunization and parasite control program.

The scientific basis for this recommendation is:

Contagious diseases are caused by microorganisms, mostly bacteria and viruses. However, your horses can develop defenses against many microorganisms. These defenses are the antibodies in the blood.

By vaccinating your horses against specific diseases they will build up their antibody defenses against possible invasion by microorganisms.

The secret of successful immunization is to have a methodical plan, developed in consultation with your veterinarian and then to carry it out before disease strikes. Vaccination after your horses have been exposed to disease will seldom give them enough time to build up their defenses to a large enough degree. You might sustain serious losses in such a case.

Horses are often inoculated against tetanus since this organism is usually present in horse stables.

Internal parasites can cause stunting, illness and even death if not controlled. They are particularly harmful to foals and colts up to two years of age. Periodic examination of fecal samples from your young horses by your veterinarian will give you information on the extent of the problem.

The most scientific way to prevent disease and parasitism in your horses is to plan a total immunization and parasite control program with your veterinarian. You must have your horses vaccinated at the right time, with the right vaccine and by the best method to be sure they will build up an immunity. You must also treat for parasites at the proper time and with the proper material in the prescribed way to successfully protect your horses.


The scientific basis for this recommendation is:

Correct diagnosis of illness or abnormal conditions in your horses is necessary before they can be treated intelligently. Improper treatment based merely on supposition can result in loss of time and money or even the animals involved.

A diagnosis requires much specialized knowledge and many procedures. Veterinarians have this knowledge and also the equipment necessary to make the study. If they lack in either facilities or knowledge in a special situation, they can call on the state diagnostic laboratories and scientists for assistance.

5. Keep your horses well exercised, groomed and feeling fit.

The scientific basis for this recommendation is:

If your horses are confined and cannot exercise by themselves they will lose muscle tone, they may
become stiff or lame and their digestive systems will not function as effectively. Horses in their natural state had the opportunity for unlimited exercise in a clean, outdoor environment. This enabled them to keep fit which meant they were better equipped to ward off disease and unsoundnesses.

6. Consult your veterinarian. Plan a disease prevention and parasite control program with him.

The scientific basis for this recommendation is:

Preventing disease is more effective than treating your horses after they become sick.

Your local veterinarian is best qualified to help outline a disease control program. He is trained in his field and he is acquainted with the major disease problems in your particular area.

By keeping in constant touch with your veterinarian he knows the history of your horse or horses and will be in a better position to make an accurate and rapid diagnosis.

Disease prevention will probably be most effective when you and your veterinarian work together in all phases of the disease prevention program.
An infectious disease is one caused by the presence in or on an animal body of a living foreign organism, which by its presence creates a disturbance leading to the development of symptoms.

A contagious disease is one that may be transmitted from one animal to another by direct or indirect contact. All contagious diseases are also infectious, but it does not follow that all infectious diseases are contagious. For example, tetanus, caused by organisms which live in the soil, is infectious but not contagious since it is not transmitted directly from one animal to another.

Some infectious diseases are highly contagious. Some are slightly contagious and a few are not contagious at all. How contagious a disease is depends upon how the disease organisms are eliminated from the body of the diseased animal, their opportunity for reaching others and their ability to produce disease in the new hosts.

Disease-causing organisms vary greatly in their ability to produce disease. When the ability to produce disease is great, the organisms are referred to as virulent.

Animals also vary in their ability to resist or repel disease-producing organisms. An animal’s ability to resist a particular organism is known as immunity. The immunity of an animal may vary from slight to absolute.

Sometimes animals develop disease-resisting properties within their bloodstream. These properties repel the invading organism. Sometimes these properties are strong enough to remain for the life of the animal (permanent immunity). Other times they pass in a few months or a year (temporary immunity). Vaccination is a means of artificially stimulating the immunity of the animal without giving it actual disease. To do this the virulence of organisms is lowered until it no longer possesses the ability to actively cause disease but can stimulate the development of immune properties in the body of the host animal. These live but attenuated organisms are known as a vaccine. Other times the organisms are completely killed and the products of their growth used to stimulate immunity. This preparation is known as a bacterin.

Because disease-producing organisms reach a host animal does not always mean that the animal will develop disease. Sometimes the animal’s resistance is high enough or the virulence low enough that the organisms are destroyed by the host. This process is continually going on as organisms capable of producing disease are constantly present. If something happens to lower the resistance of the animal or to raise the virulence of the organism, then a disease process can start. If the host and invading organisms reach a standoff, the infection makes little or no headway but persists for a long time. This is known as a chronic infection.

If the invading organisms rapidly overcome the resistance of the animal, then death usually ensues unless rapid resistance to the organism is developed by the host or suitable treatment is received. These cases are known as acute.

During the course of any disease many organisms escape from the host. Sometimes they are eliminated with blood, or from an abscess. Sometimes they are passed out with droplets of moisture which accompany a cough or a sneeze as in respiratory infections. Sometimes the organisms are eliminated through fecal material or urine as in intestinal or urinary infections. (The virus of rabies is eliminated through the salivary glands and usually enters the body of the new host through a bite or wound and is not normally spread otherwise.)

Occasionally an animal and the infected organism will reach the point where the organism is unable to cause serious damage to the host, yet the host is unable to eliminate the organism. This situation may continue throughout the lifetime of the animal. Such animals are capable of shedding organisms causing disease in contact animals. We refer to these animals as carriers. Carriers may not show symptoms of disease but are a source of great danger to others who lack the same amount of resistance. The carrier is one of the great problems of control of many infectious diseases. Animals that are obviously diseased may be recognized, but there is no simple way of recognizing carriers.

There are many sources of infection for your animals. We usually think of direct contact with the diseased individual.

Disease may also occur when inanimate objects carry infection from one animal to another. This can occur in a trailer, a railroad stock car or truck contaminated with the fecal material and not properly cleaned and disinfected.

Contact with apparently healthy disease carriers is a major hazard. These carriers may infect others directly or indirectly as readily as the obviously diseased animal.

Infection from soil. Certain organisms live in the soil and are able to produce disease in animals if chance carries them to the tissues (example: tetanus). Disease may be contacted from food and water that has been contaminated by a diseased animal (Example: leptospirosis).

Air-borne infections occur when droplets of moisture are sneezed or coughed into the air (example: strangles or respiratory infections).

Some infections are carried by bloodsucking insects (example: Equine encephalitis or sleeping sickness).

Disease Prevention. Most contagious diseases can be prevented by. (1) avoiding contact with sick animals, (2) preventing indirect contact by using clean trucks. Insist on new grain sacks for purchased feed. Keep visitors from other stables with manure or dirty clothing from contacting your animal, his feed or water supply. Use private water pail at fairs or shows, etc. (3) Raise your animal’s resistance by good feeding.
sensible use and care and vaccination when indicated.

Normal use of the animal prevents completely isolated or 100% protection from exposure. Therefore you should strive to raise the resistance of your animal by keeping him well nourished and in a good state of health. Do not allow an animal to become too tired or to chill. Chilling might occur from riding for long distances in cold, windy, uncovered trucks or being tied in a cold rainstorm. Such stresses greatly lower an animal’s resistance to disease.

Always provide clean drinking water, and when horses are gathered in large groups, water your horse from an individual bucket, drawing the water directly from the tap, not dipping it from the trough. Many people go to the bother of providing their own water bucket at fairs or shows then make the mistake of filling the bucket from a common trough.

Vaccination will raise an animal’s resistance to many diseases. Strangles (distemper), tetanus (lockjaw) are examples. Your veterinarian can advise you as to diseases common in your area that can be prevented by vaccination.

General information concerning common diseases of horses is presented in table 1.

For additional information of diseases of horses, contact your veterinarian.

<table>
<thead>
<tr>
<th>COMMON EQUINE DISEASES</th>
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<tbody>
<tr>
<td><strong>Disease</strong></td>
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<tr>
<td>Equine Encephalitis</td>
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<td>Strangles (Distemper)</td>
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<td>Tetanus (Lockjaw)</td>
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<td>Azoturia (Monday Morning Sickness)</td>
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<td>Laminitis (Founder)</td>
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Have you ever been aggravated by swarms of mosquitoes, irritated by ticks and chiggers, or agitated by fleas? These discomforts and many more are experienced by some horses for extended periods of time because of external parasites.

A parasite is defined as "a plant or animal living on, in, or with another living organism (its host) at whose expense it derives food and shelter." External parasites of horses usually bite (with the exception of certain flies) and/or suck blood for food, and use body temperature and the hair of the host for comfort and shelter.

Foals and young growing horses are especially susceptible to all types of parasites, which may result in temporary or permanent lack of development.

External parasites are a problem to many horses. They are often associated with improper nutrition, mild forms of disease, stress, and sometimes conditions of general neglect. External parasites are easier to eradicate or control than internal parasites, but response to treatment may be disappointing unless a total health program is practiced.

The most common external parasites are (1) flies, (2) lice, (3) mites, (4) ticks, and (5) a fungus causing ringworm. Both ringworm and mange mites are communicable to man.

Flies
Flies are a constant source of annoyance to horses, making them restless and ill at ease. The house fly and face fly feed on skin, nasal and eye secretions, or debris, but do not bite. The tenaciousness of the feeding face fly makes its presence particularly annoying to horses. They are commonly found in the northern half of the United States.

Horn flies, stable flies, and deer and horse flies are biting insects that suck blood. Since they show a preference, some horses are severely harassed by these pests. Biting flies can be vectors of serious diseases such as encephalomyelitis.

Blow flies are common to large areas of the United States, and effect damage by laying eggs in wounds. One type hatches into maggots which feed on dead tissue, retarding healing and enlarging the wound. The other type hatches into screwworms, which feed on live tissue, causing severe damage and sometimes death. Both types are easily eradicated by cleaning the wound and applying a proper medicant.

Control
Fly control is best effected by removal of waste and decaying vegetable material. Manure should be stored in covered containers or spread thinly (for rapid drying) on fields not used by horses.

Remove moist hay, straw, garbage, and grain frequently during warm weather. Use screens when practical.
Life Cycle

The four stages of the life cycle are the egg, the larva, the pupa, the adult. House, stable, and horn flies commonly lay their eggs in manure or occasionally in decaying vegetation or any moist collection of spilled grain. Face flies lay their eggs in fresh manure on pastures. Horse and deer flies deposit eggs in the mud of swamps, salt marshes, or on vegetation near water.

Treatment

Successful treatment of flies varies from one part of the country to another and will be influenced by the degree of immunity they have established for a specific product. For this reason a qualified person should be consulted for recommendation in a given area. Regardless of the area, pesticides should be considered poisonous and should be regarded with extreme caution. Read the directions carefully and follow them closely. Do not permit sprays to contaminate feed or surfaces that horses will lick. Do not store them where they may accidentally get into feed. Baits are effective but poisonous and should be placed out of reach of horses because many contain enough sugar to induce their consumption. Strands or cords treated with insecticide and hung in stables are often effective. Daily sponging or spraying may be necessary to give protection from horse flies and face flies. For those insecticides commonly used and recommended for your area, contact your local county agent or veterinarian.

Lice

Lice that infest horses are of both the biting and sucking kind. Long hair is conducive to maximum reproduction and spread of lice, thus they are often observed in poorly groomed and poorly housed horses, especially in early spring. Symptoms include rubbing, biting, general unthriftness, and patches of skin denuded of hair.

Life Cycle

The adult lice attach their eggs to the hair, usually close to the skin (the so-called nits). Here they hatch in from 11 to 20 days. The young lice reach maturity and the female begins laying eggs when she is 11 to 12 days of age. Lice live their entire lives on the host, and can exist only about three days when off the host animal.
Mites

Mites are microscopic creatures that cause horse mange. Positive identity is difficult because skin scrapings must be examined carefully under a microscope. Three genera exist—Sarcoptes, Psoroptes, or Chori- optes. Sarcoptic mites burrow under the skin scurf where they lay eggs and reproduce. Chorioptic type may cause foot mange resembling scratches, although all three may cause mange on any part of the body.

Symptoms include irritation, itching, inflammation, loss of hair, crusty scab formation, and folding of the skin.

Life Cycle

Female mites lay from 10 to 25 eggs during the laying period, which lasts from 12 to 15 days. After this period the female dies in the burrow. Eggs hatch in 3 to 10 days into young mites. After passing through several molts, they reach maturity and are ready to begin egg laying again in from 10 to 12 days.

Treatment

Mange is difficult to eradicate in any species of animal. Experience indicates that infested animals should be re-treated every 7 days in order to gain control. Dusts are not effective. Spraying or thorough wetting with a brush-washing technique is necessary to reach the well-hidden mites. Your county agent or veterinarian are your best sources for information regarding the prevailing regulations for the kinds and use of insecticides.

Ticks

Ticks are a problem to horses in many parts of the country. Like other biting insects, they are vectors of some serious diseases. Piroplasmosis recently infected over one hundred horses in the southeastern part of the United States. In 1960, the red tick, carrier of African horse fever, was identified for the first time in this country, in zoo animals in Florida.
Life Cycle

The four stages include the egg, the six-legged larva or seed tick, the eight-legged nymph, and the adult. Transition from one stage to the next occurs by molting. The number of generations produced annually varies from one every two or more years up to four or five per year, depending on the species. All ticks attach to the host and feed on blood.

Treatment

In areas where ticks are a serious problem, dipping entire animals must be resorted to. If only a few ticks are found, swab them with cotton dipped in alcohol or chloroform. Since ticks breathe by means of spiracles or holes found on the abdomen, this tends to anesthetize or suffocate them. Several insecticides are available. Follow the recommendations of your county agent or veterinarian regarding their use.

Ringworm

Ringworm is caused by various species of fungi, arranged in circles on the skin. If penetration is deep enough, severe itching results; and secondary infection may lead to abscesses. The lesions are usually covered with greyish crusts through which short hairs protrude.

Treatment

If only a few lesions are present, soften crusts with warm soap and water and remove; dry the area, and paint with tincture of iodine daily for one to two weeks. If lesions are extensive, contact your veterinarian, since there are many new fungicides more effective than iodine. When treating or handling infected horses, use rubber gloves and wash hands thoroughly after treatment. All scrapings should be carefully disposed of. Children are particularly prone to ringworm infections.

Under the best management conditions horses harbor some parasites. Their effect is not spectacular or may be unnoticed, but they decrease work efficiency and cause discomfort. Heavy infestations render horses useless and may cause death or permanent damage. For these reasons a total health program should be effected.

PRECAUTIONS

Most insecticides are poisonous to man and other animals; particularly concentrates prior to dilution for application. All precautions on the labels should be followed for their use and storage. Read the label carefully! Avoid contamination of feed and water with insecticides.
According to Webster's Dictionary, a parasite is a plant or animal living in, on, or with another living organism (its host), at whose expense it obtains food and shelter. More than 150 different kinds of parasites have been found to infest horses. Almost all horses harbor some parasites. External types include lice, flies, ticks, mange, and ringworm. The internal types, which we will deal with in this lesson, include strongylies or blood worms, ascarids, stomach worms, pinworms, and bots.

Every horse owner should have his animal on a parasite-prevention and control program. In order to draw up such a program, it is important to know the life cycle of the various worms so that proper preventive and treatment procedures can be followed.

**Economic Importance**

The effect of the presence of worm parasites are not usually spectacular. However, they do cause decreased work efficiency, poor utilization of food, are one of the causes of colic, may be the cause of intermittent lameness, may cause a chronic cough and bronchitis, and occasionally death due to blood clot. Some adult worms produce toxins that destroy red blood cells, leading to an unthrifty anemic condition. Immature worms migrating through body tissues open the way for bacteria and fungi to enter, causing other serious diseases.

**Prevention of parasitism**

Internal parasites gain entry to the animal body in the form of eggs, larvae, or adults. This may be largely prevented by various forms of management which break the life cycle of the parasite. Those worms already present will have to be killed by drugs, depending on the kind of parasite present. The following practices have been found to be effective in reducing parasite numbers:

1. Do not feed hay or grain on the floor. This prevents contamination of feeds with manure, which may contain large numbers of parasite eggs or larvae.

2. Do not allow horses to obtain water from barnyard pools or water holes on pasture, since manure drainage into these areas makes them a source of internal parasites.

3. Clean stalls and reseed as often as possible so that there will be less chance of internal parasites getting on feeds from fecal material.

4. If the stall floor is of earth, remove ten to twelve inches once or twice yearly and replace with clean soil.

5. Remove manure from premises daily and either spread on a field where horses will not graze for a year or where the field will be plowed and reseeded before horses have contact with it.

6. If manure must be left near the barn, keep in a covered pit where it can heat and thus kill parasite eggs and larvae. This will also prevent fly breeding.

7. Small, heavily used pastures tend to build up a heavy parasite load. Small exercise yards should not contain pasture grasses which encourage animals to eat contaminated material. It is best to have them gravelled.

8. Rotate pasture plots as frequently as possible to break the life cycle of the parasites.

9. Flies should be prevented from breeding by keeping surroundings free from manure, wet straw, and bedding.

10. Grain should be kept in covered containers away from flies, birds, and rodents, which may carry parasites from farm to farm.

**Treatment**

Treatment is a necessary but small part of the total parasite control program. Major emphasis should be on prevention. Even though adult worms are eliminated from the animal, damage has already been done by larval migration through body tissue. All drugs used for worming are dangerous and must be used with extreme care. In most cases, it would be best to have your veterinarian perform this service.

A regular program for worming horses should be adopted in cooperation with your veterinarian. Horses should be wormed in the fall after the first killing frost, and again in the spring before they go out to pasture. If strongylies are a particular problem, continuous low-level feeding of phenothiazine should be considered.

In some areas, worm control programs are organized on a community or county basis. Since some of these parasites are transmitted by insect vectors, area action tends to reduce the possibility of this type of transfer. Such projects should be considered with your veterinarian, your county agent, or your 4-H club leader.

**Bot Flies**

There are at least three species of horse bot flies. It is their habit to hover about the horse, and then quickly darting toward the animal they glue individual eggs to the hair in a matter of seconds. The female of the common bot usually lays up to 500 eggs. Eggs are usually deposited on the hair of the forelegs, although they may be deposited on the mane, shoulders, belly, chin, and occasionally the flanks.
The horse tends to lick or bite itself where the eggs are attached, thus stimulating hatching, and the newly-hatched larvae are taken into the horse's mouth in this manner. Some larvae burrow into the tongue and migrate through the body tissues until they finally arrive in the stomach where they attach to the stomach wall. They arrive in the stomach in from three to four weeks. They mature in the stomach in from ten to eleven months, at which time they release their hold on the stomach wall and pass out with the animal's feces. Mature larvae burrow into the ground and change into pupa stage. In from fifteen to seventeen days the mature bot fly emerges from the pupa case and mates to begin the cycle again.

Stomach Worms

There are at least ten different types of stomach worms, four of which are known to cause lesions, resulting in an inflammation of the stomach wall. The larval forms of the larger stomach worms are thought to be responsible for a skin disease of horses called "summer sores." The larger stomach worms are approximately an inch to an inch and a half in length. Adult worms in the horse's stomach lay eggs which are passed out with the manure and picked up by maggots (larval forms) of the house fly or small stable fly. The stomach worm eggs hatch in the head region of the adult fly where they had come to rest as the fly matured. Horses probably swallow infested flies accidentally, or larval worms may leave the flies while they are feeding on the moisture around the horse's lips. Once in the horse's mouth, they are readily swallowed and mature into adult worms in the horse's stomach to repeat the cycle.

Ascarids (intestinal worms)

Adult worms in the small intestines deposit eggs which pass out with the manure. During warm weather, embryos develop within the eggs and are infective in about two weeks. Embryonating eggs are swallowed by grazing horses, the embryos are liberated in the small intestine, penetrate the gut wall, and are taken by the blood stream to the heart and lungs. After about one week's period, the larvae escape from the lungs, migrate up the trachea to the throat region where they are once again swallowed and the worms develop to maturity in the small intestine. Adults are approximately nine to twelve inches in length.
Strongyles (blood worms, palisade worms)

The horse strongyles are a large group of approximately forty species infesting horses. Most of them are less than an inch in length and scarcely visible to the unaided eye. They are usually found firmly attached within the host, sucking blood. Female worms deposit large numbers of eggs which leave the horse with the manure. After the eggs hatch, the larvae molt twice before becoming infective. Infective larvae climb to the upper portions of pasture grasses and are usually swallowed by horses during grazing. Larvae migrate to various organs within the body, depending somewhat upon the species. Those that favor the walls of the arteries are responsible for certain types of lameness and even death due to embolism by restricting or blocking blood flow in the arteries.

Pinworms

Pinworms are approximately two to three inch long white-appearing worms with long slender tails. They are frequently seen in the feces of infected animals. The worms mature in the large intestines, and females full of eggs proceed outward through the small colon and the rectum, sometimes crawling out of the anal opening. The irritation causes infested animals to rub themselves against posts and other objects. Adult worms in this manner are crushed, at times leaving the eggs glued to the anal region. Normally, however, the eggs develop in manure and are picked up during grazing or feeding by horses to repeat the cycle. The vigorous rubbing of the posterior parts results in the loss of hair and occasionally injury may result in secondary infection. Fourth stage larvae are also found attached to the mucosa of the colon and are voracious feeders.
GLOSSARY

Anemic (a nē'mık). Deficient in red corpuscles of the blood; a state causing paleness, weakness, heart palpitation.

Bronchitis (brŏn kŏ'tĭs). Inflammation of the bronchial tubes (extensions of the windpipe).

Colic (kŏl'ık). An acute abdominal pain; may be caused by a great variety of disorders.

Embolism (ĕm'ŏlizm). The lodging of an abnormal or foreign particle, such as an air bubble or blood clot, in a tube or canal of the circulatory system, which tube being too small to permit its passage.

Embryos (ĕm'ĕrōz). Organisms in the early stages of development, as before hatching from the egg.

Insect vector (vĕk'tërr). An insect which carries and transmits disease-causing microorganisms.

Larva (lär'vā). The immature, wormlike form into which certain insects hatch from the egg.

Maggot (măg'ūt). A soft-bodied, grublike, footless larva of an insect, as of the housefly; applied especially to forms living in decaying matter.

Molt (mōlt). To cast off or shed the hair, feathers, horns, outer layer of skin, etc., being replaced by new growth.

Parasite (păr'ə sīt). A plant or animal living in, on, or with another living organism (its host), at whose expense it obtains food and shelter.

Pupa (pū'pä). An intermediate, usually motionless, form assumed by metabolic insects after the larval stage, and maintained until the beginning of the adult stage; a chrysalis.

Trachea (tră'kē ā). The main tube of the respiratory system; the windpipe.

NOTES


