Lesson 7: Nutrition

Providing a properly balanced ration is vital for care of the horse. Grain and hay must be clean and free from dust and molds. It is important to understand how the horse's digestive tract uses the nutrition that is provided.

Anatomy of the Simple Digestive Tract

Horses differ from cattle in that a cow has a four-chambered stomach, while the horse has only one. The horse's stomach holds about 8-16 quarts, depending on the size of the animal. Feed that is taken into the stomach passes through it very quickly, and not much digestion or absorption takes place in the stomach.

The horse's digestive system consists of the following organs: mouth, esophagus, simple stomach, small intestine, cecum, large intestine, colon, and rectum. The mouth is responsible for taking in and chewing (masticating) the feed; this is where digestion begins. The mouth also adds saliva to the feed to allow it to pass down the esophagus, which is the next organ in the digestive tract. The esophagus transports feed from the mouth to the stomach. After leaving the stomach, feed passes into the small intestine, which is about 70 feet long. To aid in the break down of the feed, enzymes are added from the

Table 7.1 - Light Horse Feeding Guide[1]

Credit: *Horses and Horsemanship*, p. 218. Used with permission.

Age, sex, and use	Daily allowance	Kind of hay
Stallions in breeding season (weighing 900-1,400 lb.)	3/4-1 1/2 lb. grain per 100 lb. body weight, together with a quantity of hay within same range	Grass-legume mixed; or 1/3-1/2 legume hay, with remainder grass hay
Pregnant mares (weighing 900-1,400 lb.)	3/4-1 1/2 lb. grain per 100 lb. body weight, together with a quantity of hay within same range	Grass-legume mixed; or 1/3-1/2 legume hay, with remainder grass hay (Straight grass hay may be used in the first half of pregnancy.)
Foals before weaning (weighing 100-350 lb. with projected mature weights of 900-1,4000 lb.)	3/4-1 1/2 lb. grain per 100 lb. body weight, together with a quantity of hay within same range	Legume hay
Weanlings (weighing 350-450 lb.)	1-1 1/2 lb. grain and 1 1/2-2 lb. hay per 100 lb. body weight.	Grass-legume mixed; or 1/2 legume hay, with remainder grass hay
Yearlings, second summer (weighing 450-700 lb.)	Good, luxuriant pastures. (If in training for other reasons without access to pastures, the ration should be intermediate between the adjacent upper and lower groups.)	
Yearlings, or rising 2-year-olds, second winter (weighing 700-1,000 lb.)	1/2-1 lb. grain and 1-1 1/2 lb. hay per 100 lb body weight.	Grass-legume mixed; or 1/3-1/2 legume hay, with remainder grass hay
Light horses at work; riding, driving, and racing (weighing 900-1,400 lb.)	• Hard use—1 1/4 - 1 1/3 lb. grain and 1-1 1/4 lb. hay per 100 lb. body weight • Medium use—3/4-1 lb. grain and 1-1 1/4 lb. hay per 100 lb. body weight • Light use—2/5 - 1/2 lb. grain and 1 1/4-1 1/2 lb. hay per 100 lb. body weight	Grass hay
Mature idle horses; stallions, mares, and geldings (weighing 900-1,400 lb)	1 1/2-1 3/4 lb. hay per 100 lb. body weight	Pasture in season; or grass-legume mixed hay

[1] With all rations and for all classes and ages of horses, provide free access to a mineral box as follows: (1) Where the pasture or hay is primarily grass, use a mixture containing 2 parts of calcium to 1 part of phosphorus; and (2) where the pasture or hay is primarily a legume, use a mixture containing 1 part of calcium to 1 part of phosphorus. To each of these mixes, add 1/3 salt (trace mineralized) to improve acceptability. if preferred, a good commercial mineral can be used. Self-feed salt separately.

liver and the pancreas. At the site where the large and small intestines meet, the cecum is connected. It is about 4 feet long and about one foot in diameter, which is much larger than that of a cow's, pig's, or human's. The cecum is also called the water gut. In the horse, it is where digestion (fermentation) continues and nutrients that are ready for absorption are absorbed.

After feed passes from the cecum, it goes through the large intestine, where more absorption takes place. In the colon, moisture from the feed is removed and the undigested feed is balled up and excreted through the rectum.

Colic

Colic is a generic term that simply means abdominal discomfort. This can be severe and even fatal for the horse. The horse's stomach is designed to take in feed frequently in small quantities. In the wild, the horse eats at an almost continual rate. Because of the horse's domestication, it does not always get the chance to eat as it would n the wild, and overfeeding is the main cause of colic. People feed the horses two or three larger meals, which sometimes causes intestines to become blocked (impacted). This can be serious or even fatal, if not promptly treated by a veterinarian.

Nutritional Requirements of the Horse

Each horse has different needs, depending on the size, age, and activity level (work load) of the horse. Other factors that affect nutritional requirements are breeding, location, weather conditions, stress, and quality of feed. Table 7.1 shows the recommended nutritional requirements of the different light horses.

Factors Affecting Digestion

In the horse, it takes about 24 hours to completely empty the stomach, as compared to the cow's, which takes about 72 hours. Outside factors influence this rate of digestion, such as stress, body condition, or feed quality. If a horse is being worked or becomes frightened, digestion slows down or may even stop temporarily. The horse processes much of its food in the cecum. The horse's simple digestive system does not break down as much food as a cow's (about 30 percent, compared to about 70 percent).

The Importance of Water

Of all the nutrients required by the horse, the cheapest and most important one is water. The horse can go much longer without feed than it can without water. If a horse lost only 20 percent of its body's water from dehydration, it would die. Water is necessary for the production of saliva, cell formation within the body's organs, as a medium to carry nutrition to the body's cells, temperature control, lubrication, and in chemical reactions.

In cool weather, a horse drinks approximately 0.5 gallons of water per hundred-weight daily. In hot weather, when working hard and when nursing, a horse needs about 1.5 gallons of water daily. Give the horse free access to clean water. However, do not let a horse drink heavily after or before doing heavy work or exercise, as this can cause foundering. Keep water fresh, cool in the summer, and about 40 degrees F in the winter.

Feed Types

There are many different types of feed available. They are grouped as grains, roughage, supplements, minerals, and vitamins. The one constant is that they all must be clean and free from dust and molds. The feed used will depend on cost, availability, and owner personal preferences. The most common grains fed to horses are oats and corn.

Many people buy feed that has been premixed with added vitamins and minerals. This has some advantages and some disadvantages. An obvious advantage is one of convenience. Many owners who have only a few animals do not have the equipment or storage facilities to mix their own rations. Another advantage is that they do not have to buy large quantities, so there is less money tied up in feed. Disadvantages are that they cannot control the exact amounts of ingredients in the ration, and premixed feed is more expensive to buy.

Hay needs to be clean and free from dust and molds, which may cause a horse to colic. Along with its grain, a horse only needs about 1 percent of its body weight in roughage per day. (See Table 7.1.)

In addition to the ration, horses should have access to a mineral box with either loose or block mineral. These

mineral feeders are usually freely available and are a combination mineral-vitamin-salt blocks.

The important thing is that all horses are different and will require different amounts of feed. All feed charts are meant to be used as guides when choosing a feed. Horses should be fed and watered, if water is not given free choice, at about the same time each day. It is important to avoid sudden changes in feed type or amount to avoid problems with colic or founder.

Determining What Feeds Are Used

The feed type used is decided by cost and availability. In some areas, certain feeds are not grown, and they are unavailable or too expensive to be practical. Medical condition is one factor affecting feed choice. After a horse has had colic, a veterinarian might put it on a bran mash until it has recovered. Likewise, if a mare is in heavy lactation, she may be put on a high protein diet.

Nutrition-Related Problems

There are many nutrition-related problems that a horse can experience. Probably the most common and serious two are colic and founder (laminitis). Both cause millions of dollars in losses yearly and are probably preventable in most cases. (See Lesson 5 for more on colic; review Lesson 6 for more information on founder.)

Epiphysis is a nutritional disease that sometimes affects young horses. It involves swelling around the growth plates of the long leg bones; the cause is believed to be malnutrition.

Vitamins are very important for good health and should be included in the horse's ration. For example, a lack of Vitamin D can cause rickets. However, overfeeding vitamins can be as harmful as the lack of vitamins. (Refer to Table 7.3.)

Horses can develop nutritional problems by ingesting toxic plants in their hay or in the field. It is a good idea to find out what plants grow in the area in order to get rid of any that could be harmful. Table 7.2 lists poisonous plants found in temperate North America; consult an Extension agent to help identify these plants.

Table 7.2 - Toxic Plants

Acorns
Bracken fern
Dallis grass
Hairy vetch
Horsetail
Locoweed
Nightshade
Oak
Onion
Red maple
Sorghum/Sudan
Sweet clover
Yellow star thistle

There are many other types of plants that can be toxic to the horse. Contact the veterinarian or Extension agent to find out what plants are a problem in the area.

One toxicity problem horses have is with alfalfa hay infested with blister beetles. These beetles contain a substance called cantharis. This toxin is very irritating to the horse's intestines, and if the horse eats enough of them, it can cause death. In areas that have problems with blister beetles, all hay should be checked for signs of the beetles.

Tying up syndrome is also called Monday morning sickness or azoturia. Symptoms include rapid pulse, sweating, muscle stiffening (especially in the hindquarters). The exact cause is unknown. Tying up is usually associated with heavy exercise followed by a rest period, during which high-energy feed is fed. In severe cases, permanent lameness can result. To lessen the chances of tying up, limit the amount of high-energy feed during rest periods. Treatment involves keeping the animal quiet, sheltered, and standing until a veterinarian can examine it.

Summary

In the wild, the horse was able to take care of all its needs and usually had few problems. The domesticated horse depends on people to provide all its nutritional needs. It is the responsibility of the owner to make sure the horse has the proper nutrition at all times.

Credits

Ensminger, M. Eugene. *Horses and Horsemanship*. 6th ed. Danville, IL: Interstate Publishers, Inc., 1990.

Table 7.3 - Horse Vitamin Chart

Credit: *Horses and Horsemanship*, pp. 194–199. Used with permission.

Vitamins which may be deficient under normal conditions				
	Conditions usually prevailing where deficiencies are reported	**Function of vitamin**	**Some deficiency symptoms**	**Practical sources of the vitamin**
Fat-soluble vitamins:				
A	• Extended drought, bleached hays. Stall feeding where there is little or no green forage or yellow corn. • Following great stress, as when race or show horses are put in training. • The younger the animal, the quicker vitamin A deficiencies will show up. Mature animals may store sufficient A to last 6 months.	• Promotes growth and stimulates appetite. • Assists in reproduction and lactation. • Keeps the mucous membranes of respiratory and other tracts in healthy condition. • Makes for normal vision. Prevents night blindness.	Loss of appetite, poor growth, reproductive problems, nerve degeneration, night blindness, lachrymation (tears, keratinization of the cornea and skin, uneven and poor hoof development, a predisposition to respiratory infection, incoordination, progressive weakness, convulsive seizures, certain bone disorders, and finicky appetite.	• Stabilized vitamin A. • Green grass. • Green grass or legume hay not more than 1 year old. • Carrots, yellow corn.
D	Limited sunlight and/or limited sun-cured hay, especially when the horse is kept inside most of the time.	Assimilation and utilization of calcium and phosphorus, necessary in normal bone development—including the bones of the fetus.	• Rickets in foals, osteomalacia in mature horses. Both conditions result in large joints and weak bones. • Rickets is characterized by reduced bone calcification, stiff and swollen joints, stiffness of gait, irritability, and reduction in serum calcium and phosphorus. • Osteomalacia results in bones which soften, become distorted, and fracture easily.	•Either vitamin D_2 (the plant form) or D_3 (the animal form is equally effective for the horse. • Exposure to sunlight. • Sun-cured hays.
E	More vitamin E may be destroyed or used by horses during times of stress or strain than can be obtained through normal feeds.	• As an antioxidant. • As an occasional replacement for selenium. Improves reproduction. Prevents anhidrosis.	• Lowered breeding performance in both mares and stallions. • Anhidrosis—a dry, dull hair coat; elevated temperature; and high blood pressure. Anhidrosis has been successfully treated by the oral administration of 1,000-3,000 IU of vitamin E daily.	• Alpha-tocopherol acetate, a stable form of vitamin E. • Wheat germ meal and wheat germ oil. • Green plants. • Green hays.
K	Following intestinal disorders.	Concerned with blood coagulation. It converts precursor proteins to the active blood clotting factors.	Increased clotting time of the blood and lowered level of prothrombin.	• Green pasture. • Well-cured hays. • Cereal grains. • Milk. • Menadione (vitamin K_3).
Water-soluble vitamins:				
Biotin	Sulfa drugs kill intestinal organisms; hense, when they are used an extended period, there may be a deficiency of biotin.	Biotin play an important role in the metabolism of carbohydrates, fats, and proteins.	In all animals, a deficiency of biotin will depress growth and cause a loss of hair and/or a dermatitis.	Alfalfa hay, blackstrap molasses, cottonseed meal, soybean meal, peanut meal, milk, wheat bran, synthetic biotin, and yeast (brewers', torula).
Choline	Ration low in methionine, an amino acid.	Prevention of fatty livers, the transmitting of nerve impulses, and the metabolism of fat.	Slow growth and fatty livers are the deficiency symptoms.	• Feed sources, such as alfalfa hay, blackstrap molasses, and cereal grains. • Body manufacture of choline from excess of the amino acid methionine. • Choline chloride. • Choline dihydrogen.
Folacin (Folic Acid)		In all vertebrates, folacin is essential for normal growth and reproduction, for the prevention of blood disorders, and for important biochemical mechanisms in each cell.	• Poor growth. • Anemia.	• Alfalfa hay, the oil meals (soybean, cottonseed, and linseed), skimmed milk, and wheat and wheat by-products. • Synthetic folacin, wheat germ, and yeast (brewers', torula).

Classes/Function	Nutrient requirements[1,2]			Nutrient allowances[1,2]			Comments
	Per horse daily	In ration A-F	Per ton ration A-F	Per horse daily	In ration A-F	Per ton ration A-F	
	(IU)	(IU/lb.)	(IU/ton)	(IU)	(IU/lb.)	(IU/ton)	• Vitamin A is not synthesized in the cecum. • Hay more than 1 year old, regardless of green color, is usually not an adequate source of carotene or vitamin A activity. • When deficiency symptoms appear, add stabilized vitamin A to the ration. • It is wasteful to feed more vitamin A than is needed. Also, exceedingly high levels more than an extended period of time may cause bone fragility, hyperostosis, and exfoliated epithelium.
Maintenance:							
1,000 lb. (454 kg) horse	22,725	909	1,818,000	26,134	1,045	2,090,700	
Gestation/Lactation:							
1,000 lb. (454 kg) mare	34,100	1,364	2,728,000	39,215	1,569	3,137,200	
Growth:							
450 lb. (204.5 kg) weanling	10,908	909	1,818,000	12,544	1,045	2,090,700	
Working:							
1,000 lb. (454 kg) horse	22,725	909	1,818,000	26,134	1,045	2,090,700	
Maintenance:							• The requirement is less when a proper balance of calcium and phosphorus exists in the ration. • When animals are exposed to direct sunlight, the ultraviolet light produces vitamin D from traces of cholesterol in the skin. Stabled horses exercised in the early morning will not get sufficient vitamin D. • Too much vitamin D may harm a horse. Toxicity is characterized by calcification of the blood vessels, heart, and other soft tissues, and by bone abnormalities. A toxic level of vitamin D has not been established in the horse, but a level 50 times the requirement may be harmful.
1,000 lb. (454 kg) horse	3,400	136	272,000	3,910	156	312,800	
Gestation/Lactation:							
1,000 lb. (454 kg) mare	6,825	273	546,000	7,849	314	627,900	
Growth:							
450 lb. (204.5 kg) weanling	4,368	364	728,000	5,023	419	837,200	
Working:							
1,000 lb. (454 kg) horse	3,400	136	272,000	3,910	156	312,800	
Maintenance:							Utilization of vitamin E is dependent on adequate selenium.
1,000 lb. (454 kg) horse	575	23	46,000	661	26	52,900	
Gestation/Lactation:							
1,000 lb. (454 kg) mare	900	36	72,000	1,035	41	82,800	
Growth:							
450 lb. (204.5 kg) weanling	432	36	72,000	497	41	82,800	
Working:							
1,000 lb. (454 kg) horse	900	36	72,000	1,035	41	82,800	
Maintenance:	(mg)	(mg/lb.)	(mg/ton)	(mg)	(mg/lb.)	(mg/ton)	• High levels of vitamin K will overcome bleeding due to dicoumarol. • Vitamin K is generally (1) widely distributed in normal feeds, and/or (2) synthesized in adequate amounts by the intestinal microflora of the horse.
1,000 lb. (454 kg) horse				8.0	0.32	640	
Gestation/Lactation:							
1,000 lb. (454 kg) mare				8.0	0.32	640	
Growth:							
450 lb. (204.5 kg) weanling				3.6	0.30	600	
Working:							
1,000 lb. (454 kg) horse				8.0	0.32	640	
Maintenance:							Biotin is closely related metabolically to folacin, pantothenic acid, and vitamin B-12.
1,000 lb. (454 kg) horse				2.5	0.1	200	
Gestation/Lactation:							
1,000 lb. (454 kg) mare				2.5	0.1	200	
Growth:							
450 lb. (204.5 kg) weanling				1.2	0.1	200	
Working:							
1,000 lb. (454 kg) horse				2.5	0.1	200	
Maintenance:							Choline content of normal feeds is usually sufficient.
1,000 lb. (454 kg) horse				500	20.0	40,000	
Gestation/Lactation:							
1,000 lb. (454 kg) mare				750	30.0	60,000	
Growth:							
450 lb. (204.5 kg) weanling				750	62.5	125,000	
Working:							
1,000 lb. (454 kg) horse				750	30.0	60.000	
Maintenance:							Folacin is widely distributed in horse feeds. Also, folacin is synthesized in the lower gut.
1,000 lb. (454 kg) horse				20	0.8	1,600	
Gestation/Lactation:							
1,000 lb. (454 kg) mare				30	1.2	2,400	
Growth:							
450 lb. (204.5 kg) weanling				36	3.0	6,000	
Working:							
1,000 lb. (454 kg) horse				30	1.2	2,400	

Vitamins which may be deficient under normal conditions				
	Conditions usually prevailing where deficiencies are reported	**Function of vitamin**	**Some deficiency symptoms**	**Practical sources of the vitamin**
Fat-soluble vitamins:				
Niacin (Nicotinic Acid, Nicotinamide)		Constituent of two important coenzymes. They are involved in the release of energy from carbobydrates, fats, and proteins, and in the synthesis of fatty acids, protein, and DNA.	• Reduced growth and appetite. • Skin rashes, diarrhea, nerve disorders.	• Green alfalfa. • Niacin is widely distributed in feeds; fermentation solubles and certain oil meals are especially good sources. • Synthetic niacin.
Pantothenic Acid (Vitamin B-3)		Part of coenzyme A, which plays a key role in body metabolism.	Poor growth, skin rashes, poor appetite, nervous disorders.	• Safflower meal, blackstrap molasses, wheat bran, and milk. • Calcium pantothenate.
Riboflavin (Vitamin B-2)	When green feeds (pasture, hay, or silage) are not available.	Riboflavin has an essential role in the oxidative mechanisms of the cells.	• Periodic ophthalmia (or moon blindess), characterized by catarrhal conjunctivitis in one or both eyes, accompanied by photophobia, and lachrymation. • Decreased rate of growth and feed efficiency. • Porous and weak bones; ligaments and joints impaired.	• Green pasture. • Green hay. • Milk and milk products. • Synthetic riboflavin. • Yeast.
Thiamin (Vitamin B-1)	• Poor-quality hay and grain. When sulfa drugs or antibiotics are given to the horse, the synthesis of B vitamins is impaired. • Consumption of bracken fern (*Pteris aquilina*) and horsetail (*Equisetum spp*) will cause thiamin deficiency due to the antithiamin compounds that they contain.	• In energy metabolism. Without thiamin, there would be no energy. • In the working of the peripheral nerves. • Promotes appetite and growth.	• A thiamin deficiency has been produced experimentally. • Decreased feed consumption (loss of weight), anemia, incoordination (especially in the hindquarters), lowered blood thiamin, elevated blood pyruvic acid, enlarged heart, and nervous symptoms.	• Wheat and wheat by-products. • Oilseed meals. • Oat grain and groats. • Thiamin hydrochloride. • Yeast (brewers', torula).
Vitamin B-6 (Pyridoxine, Pyridoxal, Pyridoxamine)		In its coenzyme forms, it is involved in a large number of physiologic functions, particularly protein, carbohydrate, and fat metabolism.	No deficiency symptoms of vitamin B-6 have been reported in the horse. So, it is thought to be synthesized in the cecum.	Green pasture, alfalfa hay, wheat bran, wheat germ, and yeast (brewers', torula).
Vitamin B-12 (Cobalamins)	• When few, or no feeds of animal origin are fed. • Where cobalt is not present in the feed, thereby precluding the synthesis of vitamin B-12 in the gastrointestinal tract.	• Coenzyme in several enzyme systems. • Closely linked with choline, folacin, and pantothenic acid.	Loss of appetite and poor growth.	• Protein supplements of animal origin. • Fermentation products. • Cobalamins, yeast.
Vitamin C (Ascorbic Acid, Dehydroascorbic Acid)	The vitamin C requirements of fish and humans have been observed to increase in periods of stress. it is conjectured that heavily stressed horses may require more vitamin C than they can synthesize.	• Formation and maintenance of collagen. • More rapid healing of wounds. • Sound bones.	No deficiency symptoms in horses noted. [1] In humans and monkeys, scurvy is the main deficiency symptom. In humans, sudden death from severe internal hemorrhage and heart failure is always a danger.	• Ordinary rations and body synthesis provide adequate vitamin C for horses. • Well-cured hays and green pastures are good sources of vitamin C.
Unidentified Factors	Since the U.S. foal crop is only around 50 percent, it is obvious that there is room for improvement, and perhaps unidentified factors are involved. Also, optimal results with horses during the critical periods (growth, gestation-lactation, and when under stress as in racing or showing) appear to be dependent upon providing unidentified factors through such ingredients as distillers' dried solubles, dehydrated alfalfa meal, condensed fish solubles, brewers' dried yeast, antibiotic fermentation residues, dried whey, and corn fermentation solubles.			

[2]Feed consumption of mature 1,000 lb (454 kg) horse estimated at 25 lb. (11.36 kg) per day. Feed consumption of a 450 lb. (204.5 kg) weanling is estimated at 12 lb. (5.45 kg) per day.

Classes/Function	Nutrient requirements[1,2]			Nutrient allowances[1,2]			Comments
	Per horse daily	In ration A-F	Per ton ration A-F	Per horse daily	In ration A-F	Per ton ration A-F	
	(IU)	(IU/lb.)	(IU/ton)	(IU)	(IU/lb.)	(IU/ton)	• There is some evidence that niacin is synthesized by the horse.
Maintenance:							
1,000 lb. (454 kg) horse				250	10.0	20,000	• The horse can convert the essential amino acid tryptophan into niacin. Hence, it is important to make certain that the ration is adequate in niacin; otherwise, the horse will use tryptophan to supply niacin needs.
Gestation/Lactation:							
1,000 lb. (454 kg) mare				250	10.0	20,000	
Growth:							
450 lb. (204.5 kg) weanling				250	20.8	41,600	
Working:							
1,000 lb. (454 kg) horse				250	10.0	20,000	
Maintenance:							• Grain is very deficient in pantothenic acid. • Of all the B vitamins, pantothenic acid is most likely to be deficient under stable (confinement) conditions.
1,000 lb. (454 kg) horse				250	10.0	20,000	
Gestation/Lactation:							
1,000 lb. (454 kg) mare				250	10.0	20,000	
Growth:							
450 lb. (204.5 kg) weanling				250	20.8	41,600	
Working:							
1,000 lb. (454 kg) horse				250	10.0	20,000	
Maintenance:							Lack of vitamin B-2 is not the only cause of moon blindness. Sometimes, moon blindness follows leptospirosis, and it may be caused by an allergic reaction.
1,000 lb. (454 kg) horse	22.8	0.91	1,820	40.0	1.6	3,200	
Gestation/Lactation:							
1,000 lb. (454 kg) mare	22.8	0.91	1,820	40.0	1.6	3,200	
Growth:							
450 lb. (204.5 kg) weanling	10.9	0.91	1,820	19.2	1.6	3,200	
Working:							
1,000 lb. (454 kg) horse	22.8	0.91	1,820	40.0	1.6	3,200	
Maintenance:							• Thiamin is synthesized in the lower gut of the horse by bacterial action, but there is some doubt as to its sufficiency. • When neither green pasture nor high-quality roughage is available, thiamin hydrochloride should be added to the ration. • Since carbohydrate metabolism is increased during physical exertion, it is important that B-1 be available in quantity at such times.
1,000 lb. (454 kg) horse	34.1	1.36	2,720	39.2	1.57	3,140	
Gestation/Lactation:							
1,000 lb. (454 kg) mare	34.1	1.36	2,720	39.2	1.57	3,140	
Growth:							
450 lb. (204.5 kg) weanling	16.4	1.36	2,720	18.9	1.57	3,140	
Working:							
1,000 lb. (454 kg) horse	56.8	2.27	4,540	65.3	2.61	5,220	
Maintenance:							Normally, horse rations contain adequate vitamin B-6. Also, it appears to be synthesized in the cecum. Yet, these sources may not be adequate for the maximum performance of the horse.
1,000 lb. (454 kg) horse				25.0	1.0	2,000	
Gestation/Lactation:							
1,000 lb. (454 kg) mare				25.0	1.0	2,000	
Growth:							
450 lb. (204.5 kg) weanling				6.0	0.5	1,000	
Working:							
1,000 lb. (454 kg) horse				25.0	1.0	2,000	
Maintenance:							It is reported that horses in poor nutritional condition showing anemia respond to the administration of vitamin B-12.
1,000 lb. (454 kg) horse				0.125	0.005	10	
Gestation/Lactation:							
1,000 lb. (454 kg) mare				0.150	0.006	12	
Growth:							
450 lb. (204.5 kg) weanling				0.084	0.007	14	
Working:							
1,000 lb. (454 kg) horse				0.150	0.006	12	
Maintenance:							Dietary need is clearly evident for humans, monkeys, guinea pigs, fruit-eating bats, and bulbul birds. However, vitamin C is probably required by other species, but synthesized in the body; the only question is whether the horse can synthesize enough vitamin C when under stress.
1,000 lb. (454 kg) horse				60	2.4	4,800	
Gestation/Lactation:							
1,000 lb. (454 kg) mare				100	4.0	8,000	
Growth:							
450 lb. (204.5 kg) weanling				45	3.75	7,500	
Working:							
1,000 lb. (454 kg) horse				100	4.0	8,000	

[1] As used herein, the distinction between "nutrient requirements" and "nutrient allowances" is as follows. In nutrient requirements, no margins of safety are included intentionally, whereas in nutrient allowances, margins of safety are provided in order to compensate for variations in feed composition, environment, and possible losses during storage or processing. The nutrient requirements in this table were adapted by the authors from *Nutrient Requirements of Horses*, 5th rev. ed., NRC-National Academy of Sciences, 1989. The nutrient allowances were developed by the author, based on experiments and experiences; it is intended that they are meet the nutrient requirements and provide adequate margins of safety, in addition.