The Equine Digestive System

A young filly in a stall at a high-class boarding stable lay down in her stall, got up, and lay down again, with dull, glassy eyes. She tried to roll before the caretaker caught her and haltered her, walking her slowly until the veterinarian could come to see her. When the veterinarian arrived, she listened to the filly’s gut sounds with the stethoscope to see if they were abnormal, and diagnosed the filly as having a case of colic (a disease of the digestive system*), which can result from improperly digested feed. The veterinarian gave a dose of mineral oil and some anti-inflammatory pain relief medicine to the filly to help move the feed through her digestive system and to relieve the pain experienced by the filly. She also instructed the caretaker to feed the filly only hay until the next day.

Knowledge of the equine digestive system helps horse people make informed choices regarding the nutrition of their horses. Horses are monogastric herbivores whose digestive system is anatomically developed for them to ingest small amounts of forage in a continuous manner.

Horses eat relatively simple-looking feeds containing complex chemical substances. These substances must undergo dramatic changes through the act of digestion before the horse can use feeds as energy sources for bodily functions. Digestion is the process of mechanical and chemical breakdown of feed into simple chemical structures. These chemical structures are mostly soluble in water, and they are absorbed through the mucous membranes lining the intestinal tract. The digestive system of the horse is quite unique. The system has a relatively small but efficient stomach for grain utilization and a large cecum and colon for roughage utilization. The purpose of the digestive system of the horse is to process feedstuffs into their component nutrients for absorption and utilization by the body.

The alimentary canal (digestive system) is a hollow tube greater than 100 feet in length. The tube begins at the mouth and ends at the anus. This muscular tube loops on itself many times. The tube varies in size from about one inch in diameter at the small intestine to eight inches in diameter at the large colon. The compo-

* Underlined words are defined in the Glossary of Terms.
nent parts of the alimentary canal are the mouth, pharynx, esophagus, stomach, small intestine, large intestine, rectum, and anus. The cecum, ventral and dorsal colons, transverse colon, small colon, and rectum compose the large intestine. The alimentary tract, with the help of its accessory organs—the teeth, tongue, salivary glands, liver, and pancreas, prepares feed for absorption and eliminates the waste.

Few feeds eaten by horses are in simple forms ready to be absorbed and utilized. Most feeds require substantial change by mechanical, secretory, chemical, and microbial action. Mechanical actions include mastication (chewing), deglutition (swallowing), intestinal movements, and defecation (elimination of waste).

**ANATOMY OF THE DIGESTIVE SYSTEM**

**Mouth**

The mouth is the first section of the alimentary canal. In the horse, the mouth is long and cylindrical and it contains 24 molar and 12 incisor teeth (in a mature horse). In addition, the mouth includes the tongue and three pairs of large salivary glands. Prehension is the grasping and moving of feed into the mouth by a sensitive, mobile upper lip. This action in the horse is so precise that horses can graze grass almost into the ground and can sort and select hay from a manger.

Digestion begins in the mouth. The feed is masticated by the teeth, which serves to reduce feed particle size. The mouth also moistens the feed with saliva. In the mature horse, about 85 pounds (10 gallons) of saliva is secreted daily. Saliva wets feedstuffs, thereby making for easier passage through the esophagus. Saliva contains an enzyme (amylase) that helps digest carbohydrates. Horses produce large amounts of saliva while chewing; however, they do not produce saliva unless they are chewing. Horses do not salivate at the mere sight of feed.

**Pharynx**

The pharynx is in the upper back part of the horse’s mouth where the digestive and respiratory tracts cross. The pharynx is muscular, has a funnel shape, and serves to guide feed into the esophagus. Once in the pharynx, feed or water cannot return to the mouth because of the blocking action of the soft palate. The epiglottis closes at the same time to prevent passage of feed into the lungs.

**Esophagus**

The esophagus is a 4 to 5-foot muscular tube extending from the mouth, down the left side of the neck, through the diaphragm, and to the stomach. The major function of the esophagus is to convey feed and water to the stomach by progressive waves of muscular contractions. The technical name for the contractions is peristalsis. These waves are normally irreversible. Extreme muscle tone occurs at the lower end of the esophagus. This muscle tone makes it extremely difficult for horses to expel gases through eructation. A horse’s stomach would rupture before vomiting would occur.

**Stomach**

The stomach is a U-shaped sac near the diaphragm at the front of the abdominal cavity. A powerful muscle (the sphincter) regulates the opening of the esophagus into the stomach and makes vomiting almost impossible.
The stomach of the horse is small compared to that of other animals. The stomach makes up only 10% of the total capacity of the entire digestive tract. A stomach capacity of only two to four gallons requires that a horse eat two or three times daily rather than just one time. Because feed moves rapidly through the stomach, frequent feeding in small amounts is more efficient and better satisfies the horse’s appetite. The rate of passage in the stomach is rapid in comparison to other areas of the digestive tract.

The stomach briefly serves as a reservoir for ingested feed while subjecting it to gastric digestion. Gastric juices, secreted from the glands in the mucous membrane of the stomach, contain hydrochloric acid and two enzymes—pepsin and gastric lipase. Pepsin is a protease—an enzyme that helps digest protein into amino acids. Gastric lipase helps digest fat into fatty acids and glycerol.

The digestive process is continuous, but greatly increases upon receiving feed. When two-thirds full, the stomach begins to pass feed into the small intestine. The stomach continues to do so as long as eating continues. If a horse eats an abnormal amount of feed at one time, some of the feed leaves the stomach without sufficient digestive action. This condition can lead to decreased digestive efficiency.

The stomach is the site of a number of digestive disorders. Moldy feeds, finely ground mashes, sudden changes in feed, and feast-and-famine situations can lead to digestive disorders. Furthermore, parasites can cause digestive disorders in the horse. Very little nutrient absorption occurs in the stomach of the horse. Proteins and carbohydrates are only partially digested in the stomach.

**Small Intestine**

The small intestine is a 2-inch by 60-foot tube that holds approximately 12 gallons. It connects the stomach to the large intestine. The small intestine of the horse contains three parts (duodenum, jejunum, and ileum) that make up about 30% of the digestive tract capacity. The small intestine is folded into many loops and
coils. The rate of passage in the small intestine is fairly rapid. Feedstuffs usually pass through the small intestine in about 2.5 to 4 hours. A fan-shaped membrane (mesentery) suspends the small and large intestines from the loin region of the back. The blood supply of the intestines enters through the mesentery artery. Unfortunately, this location is where bloodworms choose to lodge and feed. Bloodworms can cause blood clots, resulting in colic and often death.

The small intestine and its accessory organs, the pancreas and liver, supply most of the enzymes for digestion. Peristalsis of the intestinal wall mixes the fluid contents of the small intestine. The contents of the small intestine are about 92% to 95% water.

Pancreatic juice (secretion from the pancreas) contains the enzymes trypsin, pancreatic lipase, and amylase. Trypsin converts protein into amino acids. The small intestine absorbs the amino acids. The small intestine is the primary site of protein digestion and absorption of amino acids. A horse can digest and absorb about 60% to 70% of the protein consumed before it reaches the large intestine.

Pancreatic lipase breaks down fats to glycerol and fatty acids. The liver secretes bile, which helps break down fat, aids in fatty acid absorption, and activates pancreatic lipase. Pancreatic amylase breaks starch down to maltose, a simple sugar that is easy to digest.

The horse digests most soluble carbohydrates in the small intestine. The end products of carbohydrate digestion are glucose and volatile fatty acids. A horse absorbs these products for energy.
Villi, small projections in the small intestine, greatly increase the surface area of the small intestine for absorption of nutrients into the bloodstream. The small intestine absorbs a host of nutrients, such as simple sugars (glucose), fatty acids, amino acids, minerals, and vitamins.

**Large Intestine**

The large intestine, composed of the cecum, large colon, small colon, and rectum, moves undigested material from the small intestine to the anus for elimination. The large intestine has many other functions as well. The large intestine makes up about 50% to 60% of the total capacity of the digestive tract. With a combined capacity of 30 to 35 gallons, this 25-foot-long tube has a considerable amount of bacterial action occurring within itself. The large intestine is designed for the utilization of plant fiber for energy. After **ingesta** leaves the small intestine, it enters into the cecum. The enlarged cecum serves as a fermentation vat and provides an environment for billions of bacteria and protozoa to thrive and produce enzymes that break down fibrous plant structures for digestion.

Structural carbohydrates, such as **cellulose**, along with other carbohydrates that escaped digestion in the small intestine are fermented in the large intestine. The large intestine can digest cellulose, starch, and sugars into volatile fatty acids, which may supply up to 25% of the energy used by the horse. Except in extreme stress conditions, bacterial action in healthy adult horses produces their daily B vitamin requirements. Furthermore, vitamins E and K are synthesized and absorbed in the large intestine.

Bacteria in the large intestine produce some amino acids. However, the bacteria in the large intestine produce more fatty acids for energy than they do amino acids for protein synthesis. The cecum is the primary site of water absorption.

The rate of passage in the large intestine is considerably slower than in other portions of the digestive tract. The average rate of passage in the large intestine is approximately 36 to 48 hours.

**Rectum**

The rectum connects the small colon to the anus and it receives feces that the small colon has formed into characteristic balls. In addition, the rectum also reabsorbs water as does the cecum. From 40 to 50 pounds of feces is voided eight to twelve times daily by horses consuming standard diets of grain and hay. The shape, size, and consistency of feces provide an indication of the general health of the horse. If the feces are dry and hard, the horse may be deficient in water or protein. If the feces are soft, the horse may be sick or consuming a diet that is too laxative.

**DIGESTIVE SYSTEM DYSFUNCTION**

Horses are predisposed to digestive disorders because of the complicated nature of the digestive system. A horse’s digestive system is susceptible to twisting and impaction of the large intestine. A horse’s digestive system is also very sensitive to the gases produced by microbial digestion. If rapid fermentation occurs, excessive gas or lactic acid may be produced to cause colic or laminitis.
Colic

The term “colic” describes many painful digestive disturbances with various causes. Improper feeding methods can induce colic in a horse. For instance, feeding a horse too much grain or abruptly changing a horse’s diet can cause colic. Generally, colic is caused by gaseous products that are a part of microbial digestion. In some cases, these gases may cause swelling in the horse’s digestive tract.

When a horse ingests low quality, poorly digestible feedstuffs, impaction of the cecum and colon can result. Because changing a horse’s ration too abruptly can cause digestive disturbances, a horseperson should allow one to two weeks to slowly change from one feedstuff to another.

Laminitis

Laminitis occurs when the lamina of the inner hoof wall become inflamed. Rapid changes in a horse’s diet can cause certain types of bacteria in the cecum to die. When large numbers of bacteria die, they release large amounts of endotoxins. These toxins enter the bloodstream and decrease the amount of blood flow to the lamina. A common cause of laminitis is when horses are switched from winter hay to lush green pastures in the spring. The sudden change in the digestibility of the forage consumed causes laminitis to occur.

SELECTED WEB SITES FOR INFORMATION ON THE EQUINE DIGESTIVE SYSTEM

http://aged.ces.uga.edu/crossword/Horse_Digestion_and_Nutrition.htm  
http://lam.vet.uga.edu/LAM/LM000021.htm  
http://ohioline.osu.edu/b762/b762_5.html  
http://www.ansi.okstate.edu/course/3543/Slides.html (click on “horse” for slide show)  
http://www.ca.uky.edu/agripedia/glossary.html (scroll to “digestive system - horse”)  
http://www.horseandfarmmagazine.com/Digestion.html  
http://www.ianr.unl.edu/pubs/horse/g1350.htm  
http://www.merricks.com/digestion.html

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REFERENCES


GLOSSARY OF TERMS

**Absorption** – Process of taking in by various means.

**Amino acids** – The building blocks of protein.

**Carbohydrates** – Any of a group of neutral compounds composed of carbon, hydrogen, and oxygen, including sugars and starches, which are used immediately for growth or stored for future use.

**Cellulose** – A complex carbohydrate that is the main component of the cell walls of plants.

**Digestive system** – The alimentary canal and digestive glands regarded as an integrated system responsible for the ingestion, digestion, and absorption of food.

**Enzyme** – A substance that increases the rate of a chemical reaction.

**Eructation** – The act of expelling gas from the stomach through the mouth.

**Gastric digestion** – Chemical breakdown of feedstuffs by the stomach.

**Gastric juices** – The digestive fluid secreted by the glands in the mucous membrane of the stomach.

**Herbivore** – A plant-eating animal.

**Ingesta** – Substances that have been taken into the body by way of the digestive tract.

**Masticated** – Having been grinded and chewed by the mouth.

**Microbial action** – Digestion by very minute organisms.

**Monogastric** – Having only one stomach, or one stomach compartment.

**Mucous membranes** – A membrane that lines the cavities in the body and connects the inside of the cavity to the outside.

**Muscle tone** – Development of strength and firmness of muscles.
Peristalsis – Successive waves of involuntary muscle contraction passing along the walls of the intestine or other hollow muscular structures that force the contents onward.

Rate of passage – The time required for something to move through an area.

Secretory – Products produced by glands in the body that aid in digestion.

Soluble – Able to be dissolved.

Volatile fatty acids – Acetic, butyric, and propionic acids produced by microbial digestion of carbohydrates.

**SELECTED STUDENT ACTIVITIES**

**MULTIPLE CHOICE**: Place the letter of the correct answer in the space provided at the left of each number.

___ 1. The mechanical action of mastication is defined as _____.
   a. swallowing  c. elimination of waste
   b. chewing  d. obtaining feed

___ 2. The term deglutition refers to _____.
   a. chewing  c. obtaining feed
   b. swallowing  d. microbial action

___ 3. The process of defecation refers to _____.
   a. elimination of waste  c. swallowing
   b. obtaining feed  d. chewing feed

___ 4. The first section of the alimentary canal is the _____.
   a. pharynx  c. esophagus
   b. mouth  d. cecum

___ 5. Horses produce saliva when they _____.
   a. see feed  c. chew
   b. want to  d. drink water

___ 6. The pharynx _____.
   a. is muscular  c. guides feed into the esophagus
   b. is funnel shaped  d. all of the above

___ 7. The term peristalsis refers to the action of _____.
   a. elimination of waste  c. abnormal behavior
   b. progressive waves of muscular contractions  d. swallowing
8. A horse vomits ______.
   a. when there is gas present in the stomach  
   b. when he eats too much  
   c. never  
   d. when he cannot belch

9. Compared to other farm animals, the stomach of a horse is _____ in size.
   a. larger  
   b. relatively the same  
   c. smaller  
   d. none of the above

10. The stomach of the horse makes up _____% of the entire digestive tract.
    a. 10  
    b. 30  
    c. 40  
    d. 60

11. The small intestine of the horse makes up _____% of the entire digestive tract.
    a. 10  
    b. 30  
    c. 60  
    d. 75

12. The small intestine is the primary site for ________ digestion and ________ absorption.
    a. protein; amino acid  
    b. carbohydrate; glucose  
    c. both a and b  
    d. none of the above

13. The large intestine of the horse makes up _____% of the entire digestive tract.
    a. 20-30  
    b. 30-40  
    c. 50-60  
    d. 70-80

14. In the horse, the _____ is the primary site of water absorption.
    a. stomach  
    b. small intestine  
    c. cecum  
    d. anus
ADVANCED ACTIVITIES

1. Using selected Web sites, research information on the equine digestive system and then prepare a PowerPoint slide program of that information for presentation to the class.

2. Invite an equine veterinarian to your class to discuss dysfunctions of digestive systems of horses.