

The Equine Digestive System



EQUINE NUTRITION # 2
CREATED FOR CANADIAN PONY CLUB
EDUCATION
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Nutrition is defined as the selection, preparation and ingestion of food to be used by the body.

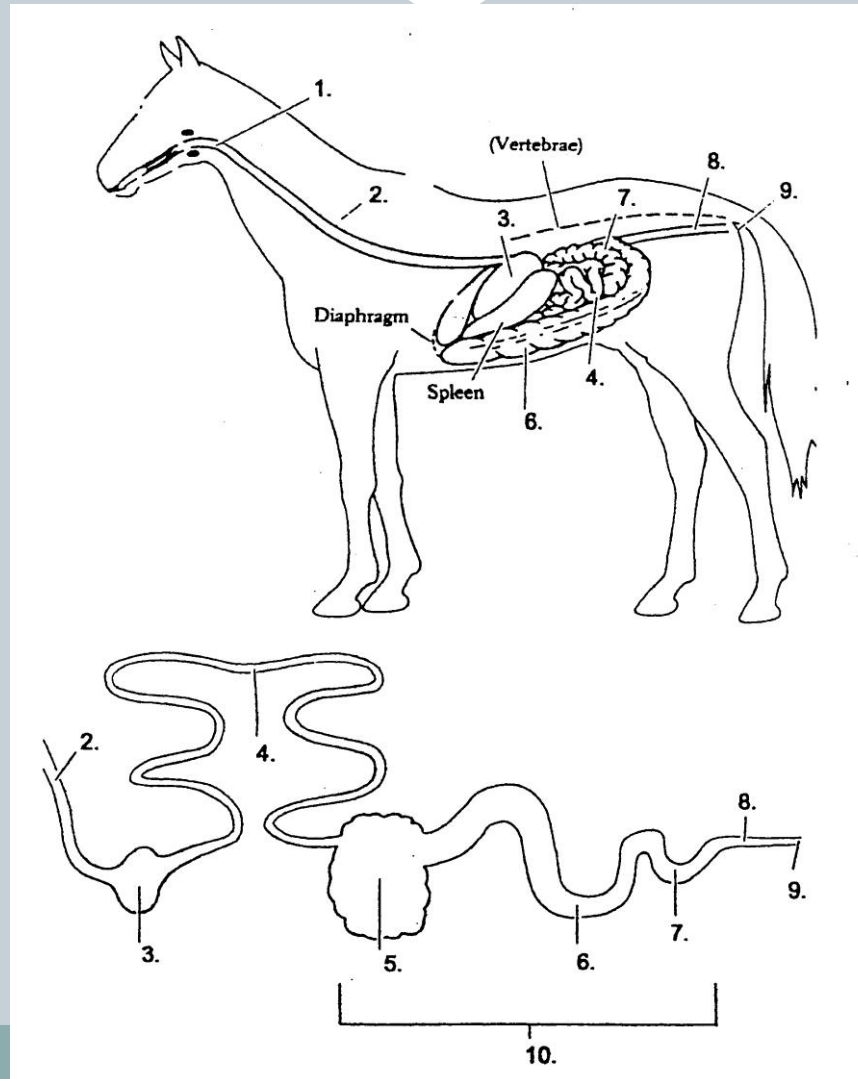
The function of the digestive system is to take in food, then break it down into small enough components so that the body can then extract the various nutrients required for utilization.



Good nutrition is the cornerstone of a healthy horse

The digestive system starts at the incisors and works its way through the horse to the anus

1. Pharynx
2. Oesophagus
3. Stomach
4. Small intestine
5. Cecum
6. Small colon
7. Large colon
8. Rectum
9. Anus



The digestive system is a tube that runs through the horse's body



- The digestive system is also known as the alimentary canal, the digestive tract, or the gastro-intestinal (GI) tract
- It consists of the:
 - Mouth
 - Pharynx
 - Esophagus
 - Stomach
 - Small intestine
 - Large intestine

Associated organs, etc.



- Teeth
- Tongue
- Salivary glands
- Liver
- Pancreas

The teeth



There are 12 incisors. Their job is to cut food like grass and help to bring it into the mouth. There are 24 molars. Their job is to grind the food. This is the primary site of mechanical digestion.



Saliva and other digestive enzymes are added in the mouth to start the process of chemical digestion.

SCIENCEPHOTOLIBRARY

Mouth



- **Lips**

- The lips are highly mobile and capable of relatively complex tasks (like opening stall doors, or sifting a preferred food from a less preferred food)
- The lips draw food into the mouth

- **Teeth**

- **Incisors**

- ✦ Cut/tear food

- **Molars**

- ✦ Mechanical digestion
- ✦ Horses chew at a rate of 70-90 rotations/min.
- ✦ As horses age, more structural substances are exposed

Initial parts of the GI tract (continued)



- **Tongue**
 - Acts as a conveyor belt
 - Forms food into a bolus (ball) in preparation for swallowing
 - When drinking water, the tongue is used in a similar manner to how a human uses a drinking straw
 - The tongue aids in mixing foods with saliva, thereby aiding in chemical digestion
- **Salivary glands**
 - Saliva is produced as a direct result of chewing
 - Saliva is secreted by three pairs of salivary glands:
 - ✦ The parotid, found under the base of the ear
 - ✦ The sublingual, found under the tongue
 - ✦ The mandibular, found at the back of the jawbone or mandible
 - Very acidic chemicals are introduced
 - ✦ Enzyme ptyalin converts starch to maltose

More initial parts of the digestive system



- **Soft palate**
 - Separates the nasal cavity from the back of the mouth
 - When the soft palate comes into contact with the bolus, it lifts, which triggers:
 - ✦ Closing of the windpipe (trachea)
 - ✦ This allows the bolus to pass through into the oesophagus
- **Pharynx**
 - The access portal to the oesophagus

Oesophagus



- The oesophagus is a 4 foot (1.3 m.) long tube
- It has ***one-way peristalsis***
 - Peristalsis = muscular contractions
- The food bolus flows along the oesophagus with the aid of saliva
- The **Pyloric sphincter**, where the oesophagus meets the stomach, is designed to prevent the return of digesta
 - Horses are unable to vomit due to the above adaptations

Structure and function



- In comparison with the cow, which has its most important digestive structures near the front, the horse has its most important digestive structures, those associated with fermentation, situated near the rear of the animal
- This allows the horse to not only run, but run far and fast

Stomach



- 8 L. capacity
- It has two main parts:
 - Separated by margo plicatus
 - ✦ Squamous or non-glandular
 - No protective mucous
 - pH higher in this area
 - ✦ Glandular
 - 1.5-2 pH
 - HCl produced
 - Digestive enzyme pepsin introduced
 - Protected by mucous layer

Enzymes present in the stomach



- There are three primary enzymes in the stomach:
- Pepsin
 - This breaks down protein into a more accessible form
- Rennin
 - This is primarily used to coagulate milk when drunk by foals
- Lipase
 - This starts down the breakdown of fats

The stomach

Squamous area

- higher pH
- No protective mucous

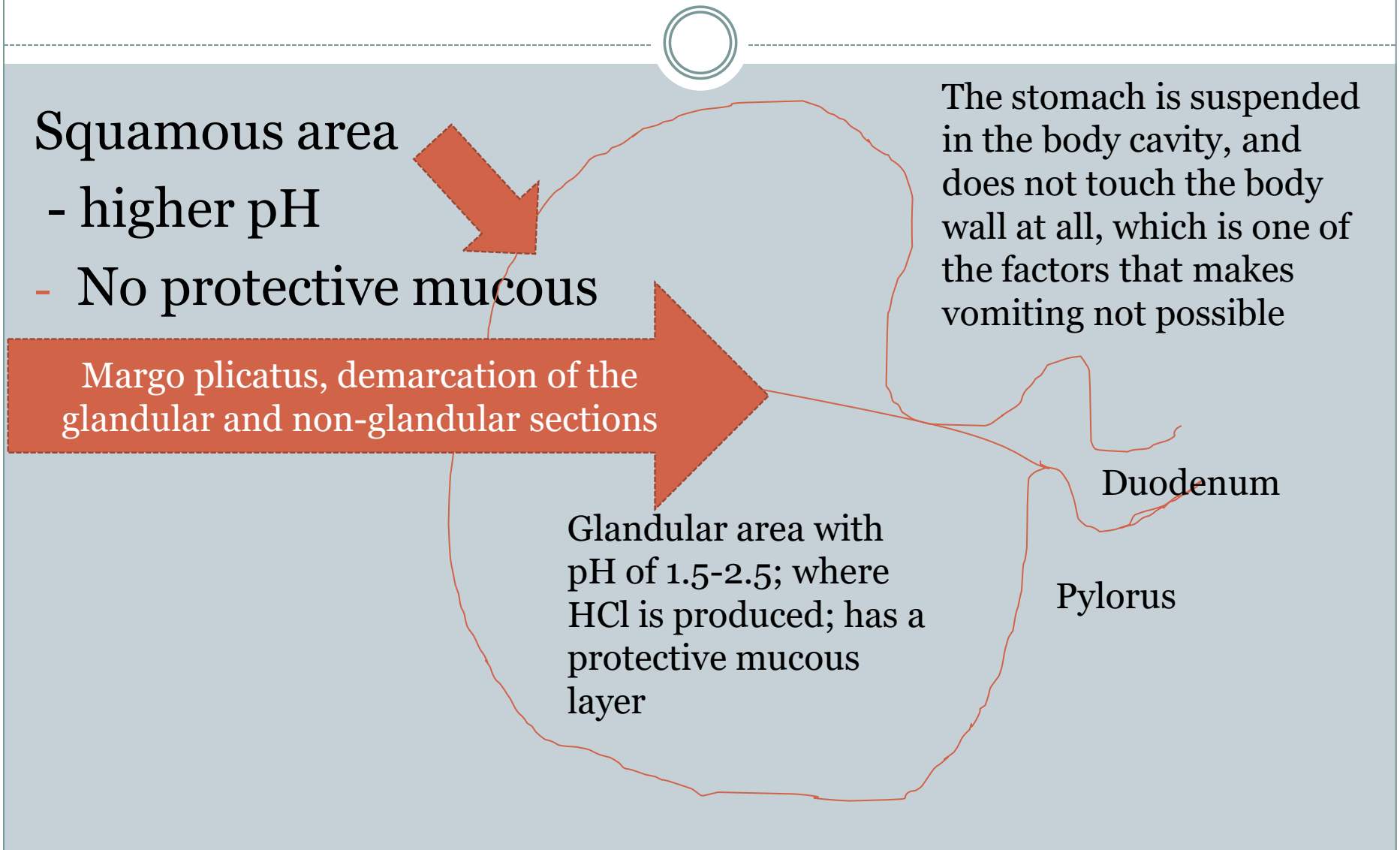
Margo plicatus, demarcation of the glandular and non-glandular sections

Glandular area with pH of 1.5-2.5; where HCl is produced; has a protective mucous layer

The stomach is suspended in the body cavity, and does not touch the body wall at all, which is one of the factors that makes vomiting not possible

Duodenum

Pylorus



Accessing nutrients

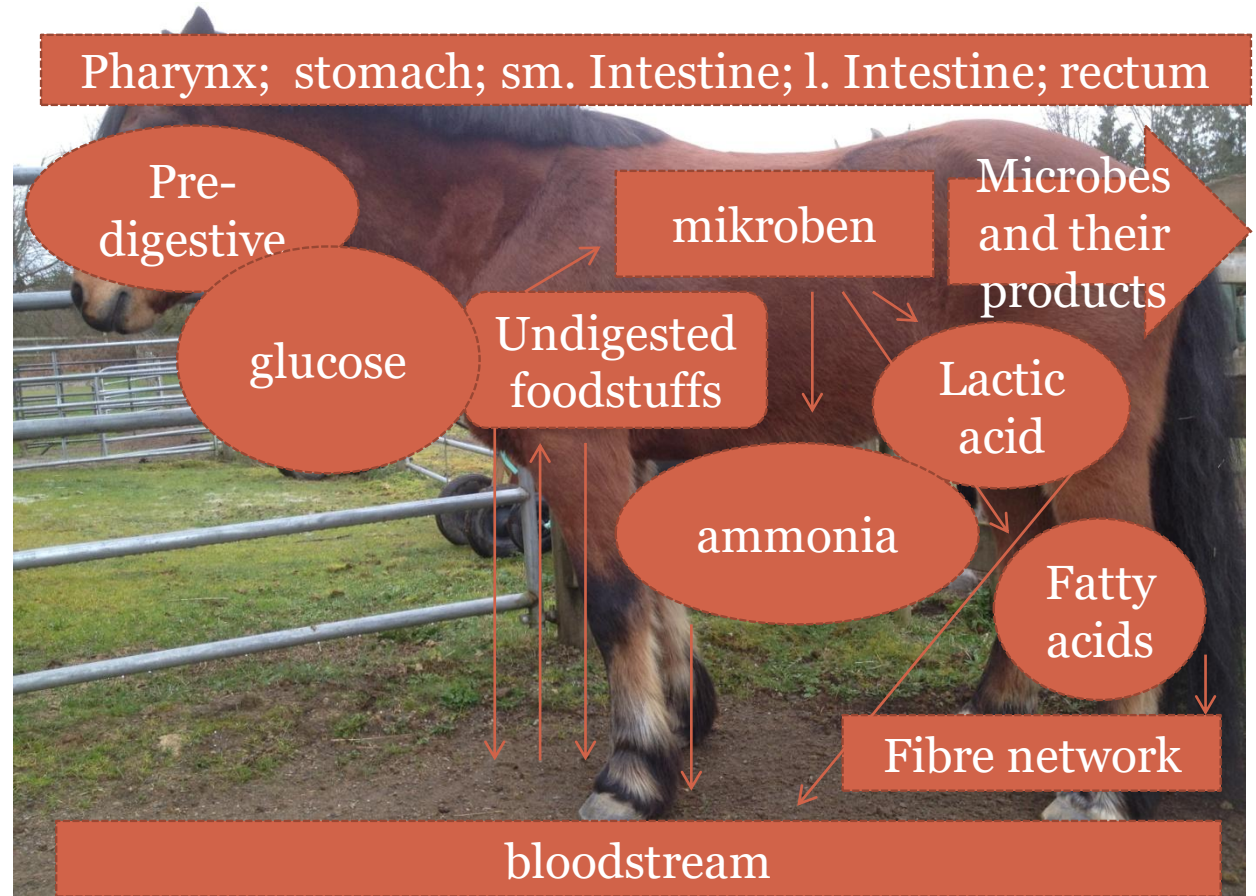


- The initial parts of the digestive tract (mouth to stomach) are primarily responsible for mechanical and chemical digestion
 - This breaks down nutrients into accessible components
 - ✦ This is referred to as enzymatic digestion
- The latter parts of the digestive tract (small and large intestine) are primarily responsible for absorption of nutrients
 - Nutrients are further broken down with the aid of micro-organisms present in the hind gut
 - ✦ This is referred to as microbial digestion
 - Nutrients are absorbed through the walls of the small and large intestine
 - They pass into the blood stream where they are distributed around the body by the circulatory system



Enzymatic digestion takes place in the foregut (stomach and small intestine)

Microbial digestion takes place in the hindgut (cecum, small colon, large colon)



Enzymatic and microbial digestion sites

Small Intestine



- A long, narrow tube 25 m. Long
 - - unorganized, loosely arranged
- 75% of GI tract in length
- 30% of GI tract in volume
- The small intestine is the site of nutrient absorption:
 - Proteins
 - Fats
 - Soluble carbohydrates
 - Minerals

Three parts of small intestine: the first two



- **Duodenum**

- 2.5-3.5 pH

- Neutralizing of digesta

- ✦ Digestive enzymes from pancreas, intestinal glands, and bile from the liver are added

- Bile emulsifies fats and oils

- Bile helps to neutralize the effect of acids by making the environment more alkaline

- ✦ Bicarbonate is secreted as a buffering agent

- ✦ Insulin is also found here

- **Jejunum**

- Absorption of nutrients that are digested by enzymatic digestion

- ✦ Starch

- ✦ Protein

- ✦ Fat

The final part of the small intestine



- Ileum
 - Site of absorption of minerals and vitamins
 - ✦ Calcium, phosphorous, B vitamins and fat soluble vitamins
- Important that pH is neutral before the large intestine
 - Facilitates transportation across cell wall
 - Optimal activity of enzymes to break down feed into constituents
 - ✦ Amylase degrades starch
 - ✦ Lypase degrades lipids

More about the small intestine



- Rate of passage of digesta through the small intestine is between 45 min. and 2 hours
- Peristalsis moves food via waves of muscular contractions
- The horse doesn't have a gall bladder
 - The horse still has the ability to digest fat and secrete bile

Foregut vs. hindgut



Foregut

- Mouth to small intestine
 - Site of digestion and absorption of all available carbohydrates and 60-70% of crude protein
 - ✦ Enzymatic digestion

Hindgut

- Large intestine
 - cecum to anus
 - Principle site of raw digestion
 - ✦ Microbial digestion

Large intestine (aka hindgut)



- Food passes from the small intestine through the ileo-caecal valve to enter the large intestine
- It is 7 m. long
- It has a capacity of 150 L.
- It comprises 60% of volume of GI tract
- It is a large tube that doubles back on itself
 - This makes it a common site for certain colics
- The digesta stays in the large intestine for around 24 hours
- There are three main parts:
 - Cecum
 - Small colon
 - Large colon

More about the large intestine



- No digestive enzymes are secreted in the large intestine
- Site of **microbial fermentation**
 - This occurs due to the presence of flora in the hindgut:
 - ✦ Bacteria
 - ✦ Fungi
 - ✦ Protozoa
- Site of:
 - absorption of water
 - digestion of fibre
 - synthesis and absorption of B vitamins
 - absorption of phosphorous

Cecum



- The Cecum is similar to the appendix in the human
- It is 1.2 m. long
- It has a capacity of 30 L.
- It comprises 15% of GI tract
- It has been likened to:
 - A large blind sack
 - A fermentation vat
- By products produced in cecum:
 - Heat (keeps horse warm)
 - Gas: fibre helps to move gas along
 - B vitamins like biotin are synthesized

Small Colon



- It is 3 m. long
- It is the site of re-absorption of water
 - Some minerals and nutrients may be absorbed here as well
- Fecal balls start to form

Large Colon



- Fibre digested through microbial fermentation
 - Microbes ferment, degrade, and ingest fibre, producing:
 - ✦ Gases
 - CO₂
 - methane
 - ✦ Volatile Fatty Acids (VFAs)
 - Fatty acids with a carbon chain of 6 carbons or fewer
 - Can be created through fermentation in the intestine
 - Can include:
 - Acetic Acid
 - Propanoic Acid
 - Butyric Acid



Bacteria consume fibre
in the hindgut

Another term you will
hear used to describe
these good bacteria is
'flora'

The different bacteria
present in the hindgut
are each specific to a
certain type of foodstuff

The use of long-lasting
penicillin can adversely
affect the bacteria
population in the
hindgut



Bacteria

Microbes



- There are +400 species present in the large intestine
- Primarily are there to break down fibre
- 6.7-7 pH
- Bicarbonate and phosphate salts are secreted into large intestine to maintain pH, coupled with absorption of VFAs



No less than 50% of the diet should be comprised of fibre

Fibre is necessary for many things: stimulating peristalsis, heating the horse when cold, etc.

Studies have found that horse need long stem fibre (hay as opposed to chaff, pellets, cubes, etc.) in order to have the most efficient digestive system



Horses need fibre as the main component of their diet

What should not be in the hindgut?



- Hind gut not designed for:
 - High starch foods
 - High sugar foods
 - High levels of fats
 - ✦ Excess fats can coat the fibre, making it inaccessible for breakdown
- Abrupt changes to food can cause:
 - Reduced digestibility
 - Colic
 - Laminitis



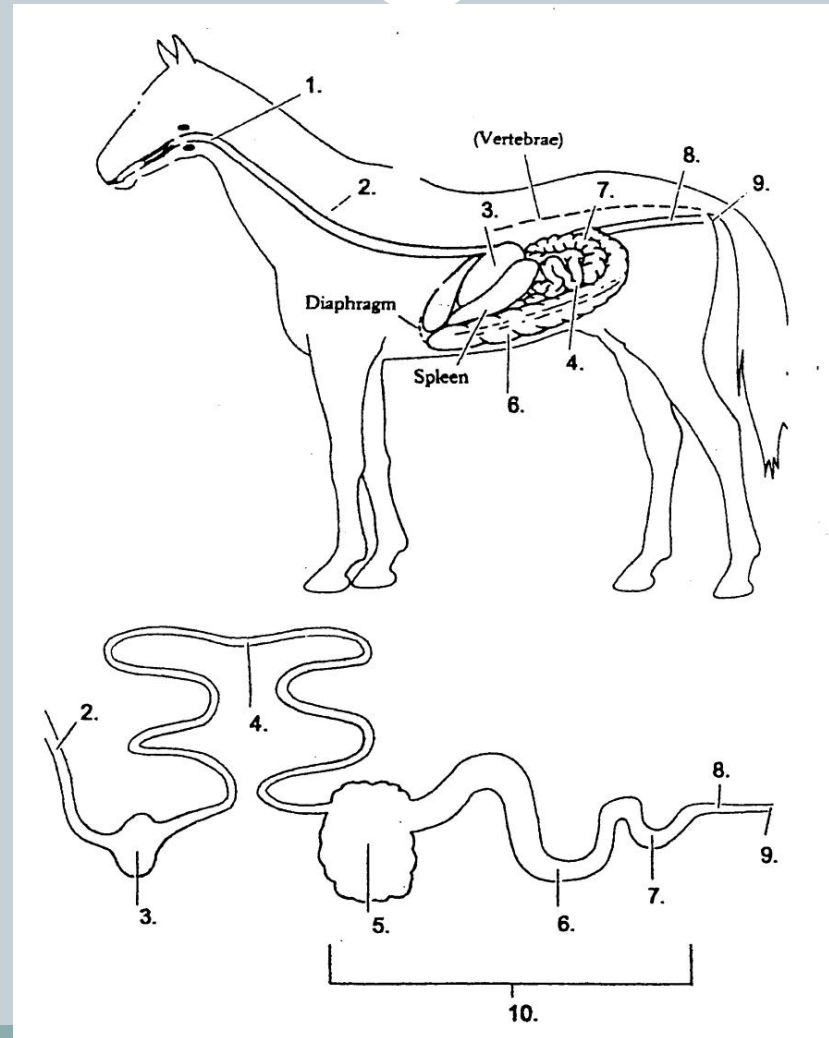
The rectum is a holding tank or storage facility for fecal matter

Once formed into boluses, fecal matter is expelled through the anus



Rectum and anus – the end of the road for the digestive tract

Label the parts of the digestive system



Questions



- 1. List the parts of the digestive system.
- 2. Referring to the anatomy of the stomach, why is it important to feed little and often?
- 3. What is the purpose of the small intestine?
- 4. List the parts of the small intestine.
- 5. What is the purpose of the large intestine?
- 6. What are VFAs?
- 7. What is peristalsis?
- 8. What is the difference between mechanical and chemical digestion, and where does each take place?