

AGA 2110

THE DIGESTIVE SYSTEM

INTRODUCTION

- ❑ The digestive system is one of the largest organ systems in an animal's body
- ❑ It consists of a group of organs that form a closed tube-like structure called the **gastrointestinal tract** (GI tract) or the alimentary canal

INTRODUCTION

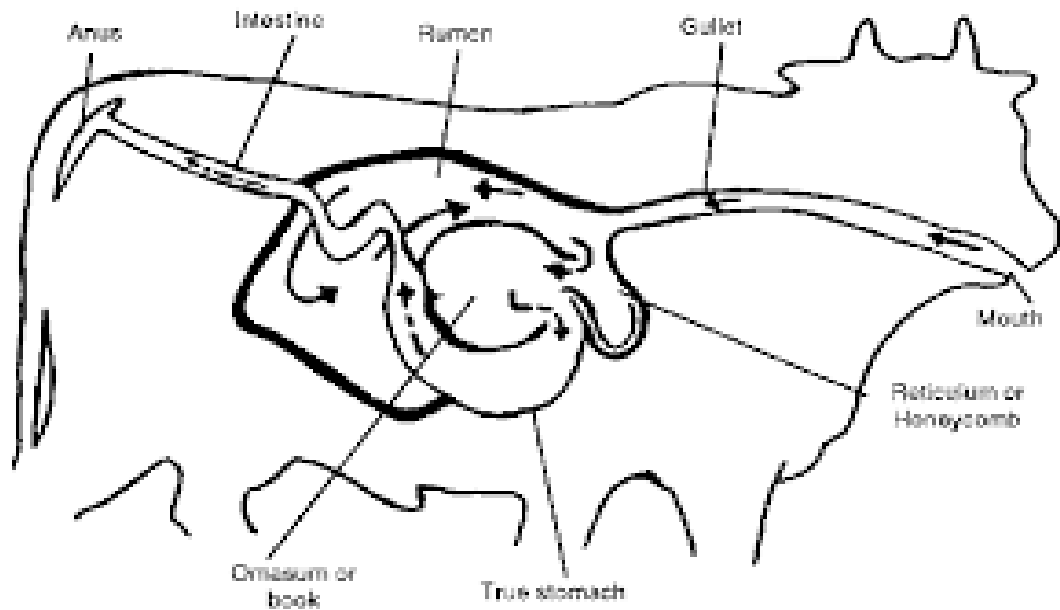
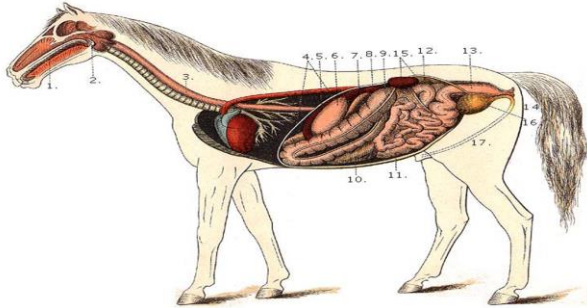
- ❑ The functions of the digestive system can be summarized as follows:
 - ✓ **ingestion** (eat food, taking food into the mouth)
 - ✓ **digestion** (breakdown of feed)
 - ✓ **absorption** (extraction of nutrients from the food),
 - ✓ and **defecation** (removal of waste products)

KEY TERMS

- ❑ **Digestion** is the process of breaking down feed into simple substances that can be absorbed by the body.
- ❑ **Absorption** is the taking of the digested parts of the feed into the bloodstream.
- ❑ The **digestive system** consists of the parts of the body involved digestion & absorption of feed. This system also moves the digested feed through the animal's body.

THE DIGESTIVE SYSTEM (TRACT)

- The alimentary canal is a muscular tube lined with **mucous membrane** that is continuous with the external skin at the mouth & at the anus.



SUBDIVISIONS OF THE DIGESTIVE SYSTEM

- ❑ The organs that make up the digestive system are;
- ✓ Mouth
- ✓ Tongue
- ✓ Pharynx
- ✓ Esophagus
- ✓ Stomach (or forestomach in ruminants)
- ✓ Small intestine
- ✓ Large intestine
- ✓ Anus
- ✓ Accessory glands (salivary glands, liver and pancreas)

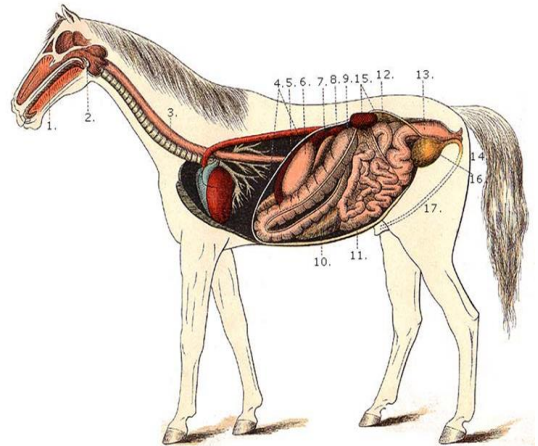
THE DIGESTIVE SYSTEM (TRACT)

- ❑ The primary functions of the digestive system are;
- i. **Prehension** - the act of taking hold or grasping.
- ii. **Mastication** - chewing
- iii. **Digestion & absorption of food**
- iv. **elimination of solid wastes.**

The digestive system breaks down various nutrients found in feed into molecules that can be used by the cells of the body

POSITION OF THE DIGESTIVE SYSTEM

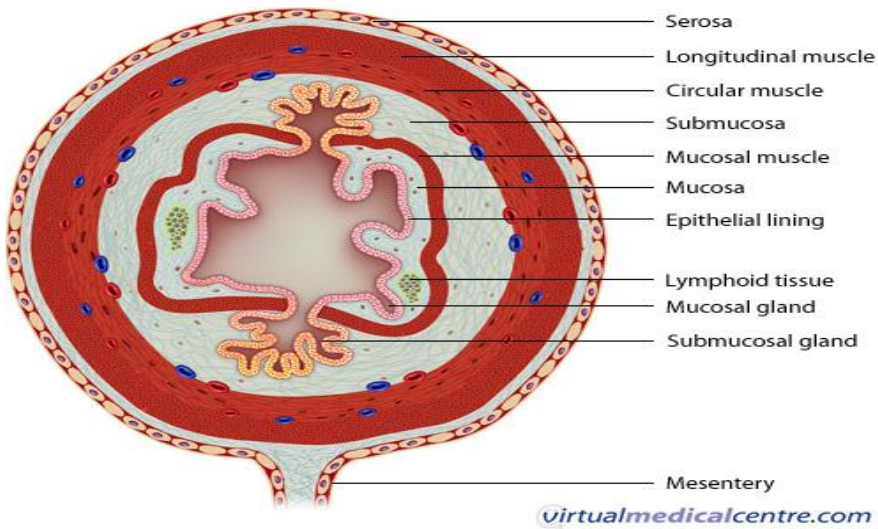
- ❑ Outside the cavities - oesophagus
- ❑ lie within the abdominal & pelvic cavities
- ❑ Within the cavity they are lined by a serosa (serous membrane) called peritoneum
- ❑ Peritoneum is of 2 parts
 - i. Viscera peritoneum – lines organs
 - ii. Parietal peritoneum – lines walls



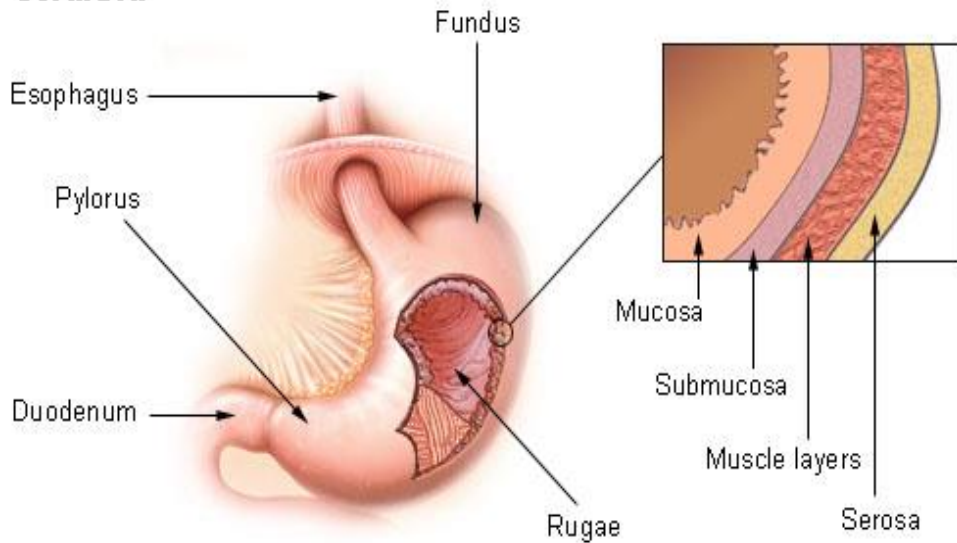
WALLS OF THE DIGESTIVE TRACT

- ❑ Comprises four (4) layers, or tunics.
- ❑ These are, from inside to outward
 - i. Tunica mucosa,
 - ii. Tunica submucosa
 - iii. Tunica muscularis,
 - iv. Tunica serosa

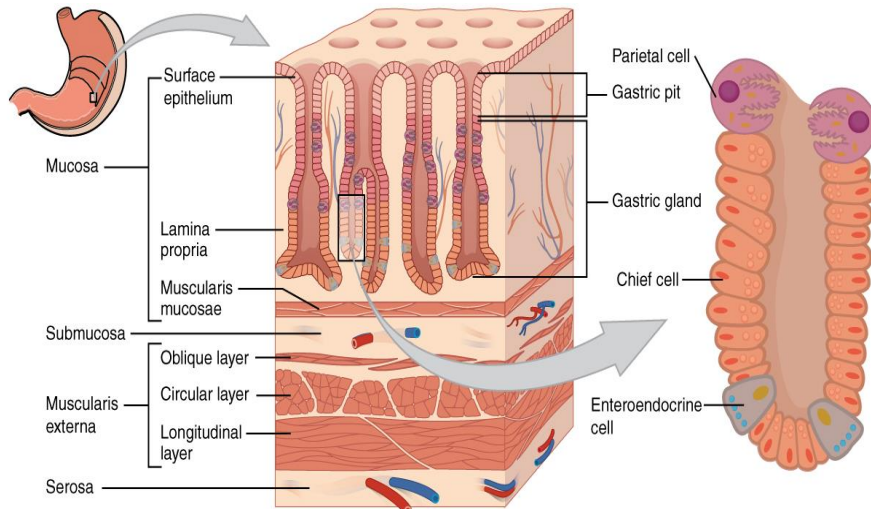
LAYERS OF THE WALLS OF THE DIGESTIVE TRACT



Stomach



WALLS OF THE DIGESTIVE TRACT



TUNICA MUCOSA

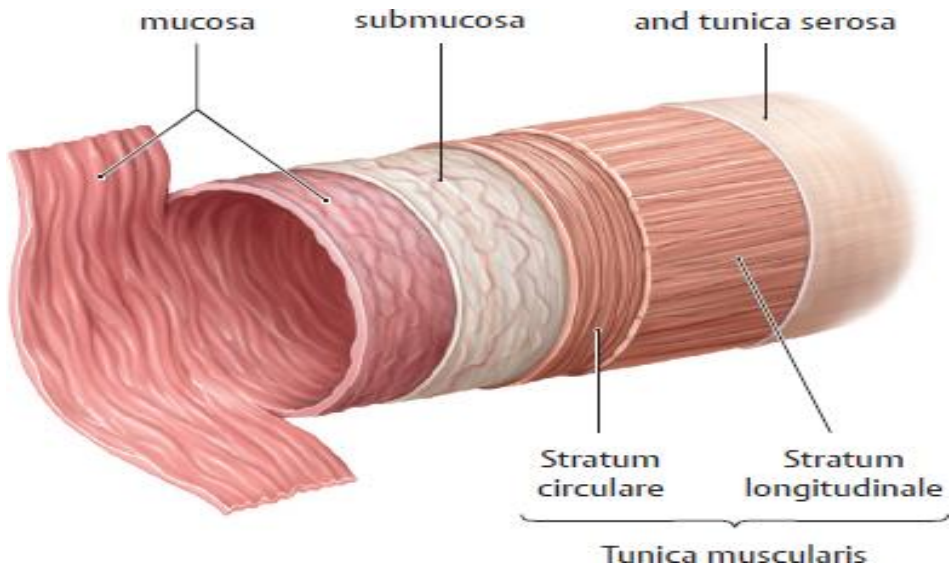
- The layer closest to the space (the lumen) inside the digestive tract.
- From **mouth to stomach** – lined by **stratified squamous**
- From the **stomach to anus** – lined by **simple columnar epithelium**

TUNICA SUBMUCOSA

- Is a layer of loose connective tissue
- Contains **blood vessels & nerves**.
- In some locations, glands of the digestive tract can be found in the submucosa, as can lymphatic nodules

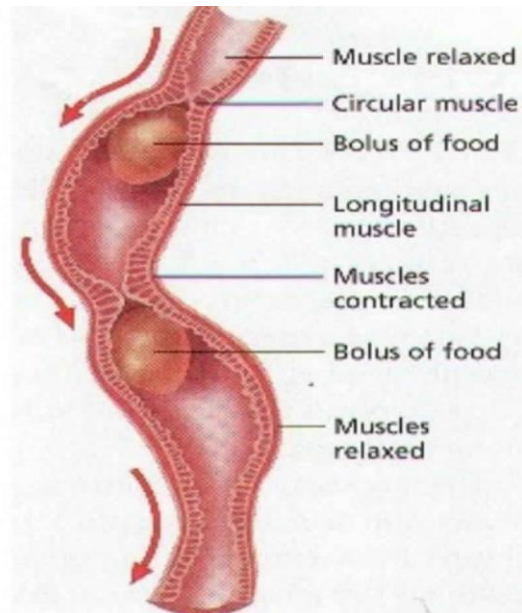
TUNICA MUSCULARIS

- Well developed
- The deeper layer has fibers that encircle the gut
- The more superficial muscle layer assumes a longitudinal arrangement.
- Arrangement of muscle layer
 - ✓ circular
 - ✓ longitudinal



Peristalsis

- series of involuntary wave-like muscle contractions which move food along the digestive tract



TUNICA SEROSA/ TUNICA ADVENTITIA

- Outermost layer
- Lines part of digestive tract which lies within the cavities
- Parts outside the cavities are lined by **tunica adventitia** ie
 - ✓ thoracic and cervical parts of the esophagus
 - ✓ distal end of the rectum and anal canal

THE MOUTH

- Also referred to as oral cavity
- It's a site of reduction of food particle size
- Houses teeth & tongue that assist in digestion
- Salivary enzymes are added to digesta in the mouth

PHYSIOLOGY

SALIVA

- Saliva consists of water, electrolytes, mucus, & enzymes.
- Role of saliva is to soften and lubricate the ingesta to facilitate mastication and swallowing.
- Saliva has 2 types of enzymes
 - i. **Lysozyme** is a salivary enzyme with antibacterial actions.
 - ii. The starch-digesting enzyme **amylase** is present in the saliva of omnivores

PARTS OF THE DIGESTIVE SYSTEM

THE TONGUE

- Is a mass of muscle covered by mucous membrane
- Divided into 3 parts
 - i. **Apex – most rostral part**
 - ii. **Body**
 - iii. **Root**
- Tongue is mobile & attached to the hyoid apparatus & mandible
- Covered by thick keratinized stratified squamous epithelium.
- Surface has large number of projections called **papillae** which contain taste buds



TONGUE PAPILLAE



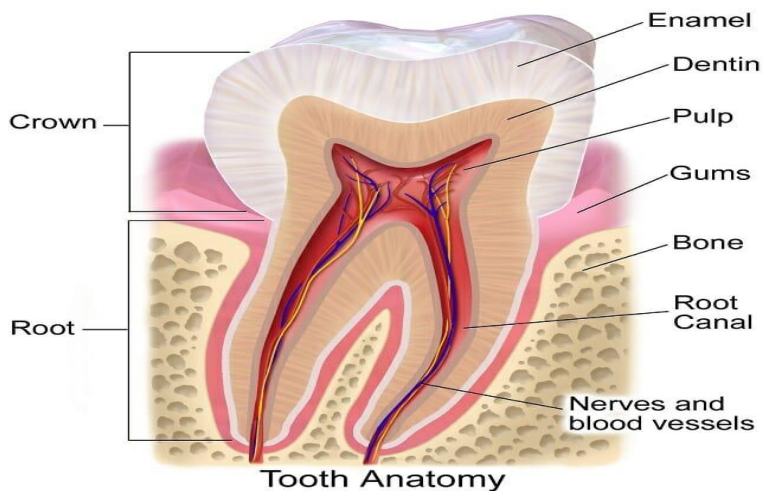
THE TEETH OF FARM ANIMALS

- Farm animals develop a set of **deciduous teeth** (baby teeth or milk teeth)
- Milk teeth fall out and are replaced with **permanent teeth**.
- As growing teeth emerge from the gums, they are said to **erupt**.
- The age of animals with a full set of permanent teeth can be estimated through examination of the wear pattern of the occlusal surfaces.

TOOTH

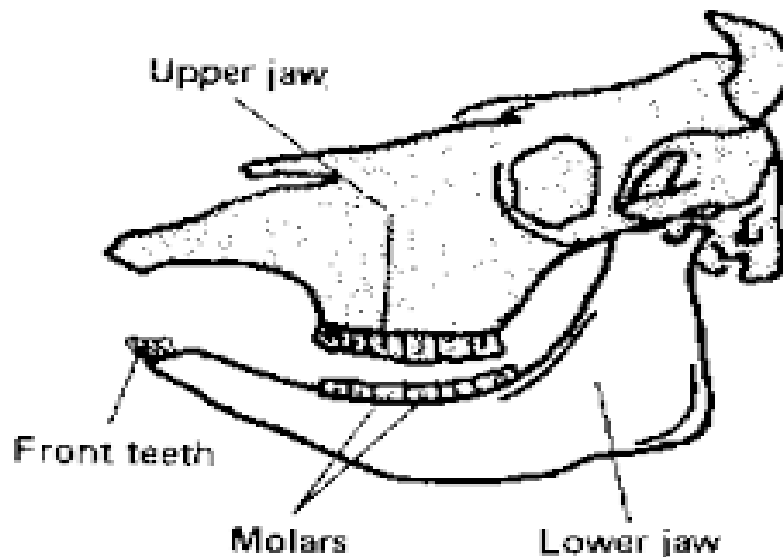
- ❑ Has 2 parts
 - i. A tooth - is anchored in a socket of bone called an ***alveolus***
 - ii. **Crown** is the visible part of the tooth above the gums
- ❑ Most of the tooth's substance is made up of mineralized substance called ***dentin***
- ❑ At the center of the dentine is the dental cavity (houses the nerves & blood vessels and connective tissue)
- ❑ ***dental pulp*** - The connective tissues, nerves, and blood vessels of the tooth reside in this cavity and constitute the dental pulp
- ❑ Superficial to the dentin is a layer of **enamel – hardest substance in the body**

STRUCTURE OF A TOOTH



THE TEETH

- ❑ Teeth are arranged in two dental arcades
 - i. one associated with the mandible
 - ii. one with the incisive and maxillary bones
- ❑ A gap in each arch between the front teeth (incisors) and the cheek teeth is called **diastema**
- ❑ Farm animals have various types of teeth specialised for different types of pre-hension & mastication



TYPES OF TEETH

- Incisors** – front teeth designated as (I) in dental formulars
- Canine teeth** (C)
- Cheek teeth comprise premolars (P), and Molars (M)
- Only Premolars are preceded by deciduous teeth

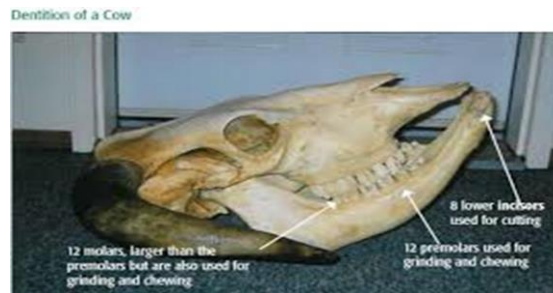
TYPES OF TEETH

- Incisors** - Cutting
- Canines** – grip and tear flesh
- Premolars** – grinding & chewing
- Molars** – grinding & chewing

TYPES OF TEETH

INCISORS

- ❑ Ruminants lack incisors in the upper dental arcade instead have a **dental pad**
- ❑ The dental pad is lined with mucous membrane (dense, keratinized)



THE TEETH

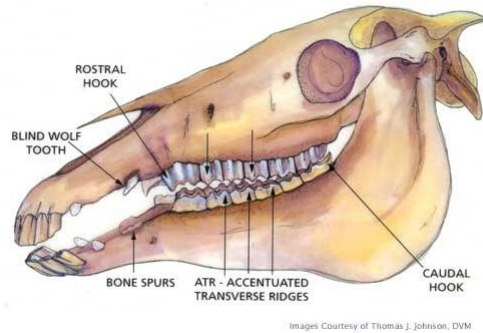
CANINE TEETH (C)

- ✓ Ruminants have no canine teeth
- ✓ Pigs – large. In boar, they are called **tusks**. Lower tusk is large than the upper. Its open rooted (grows throughout life)



HORSE - PREMOLARS

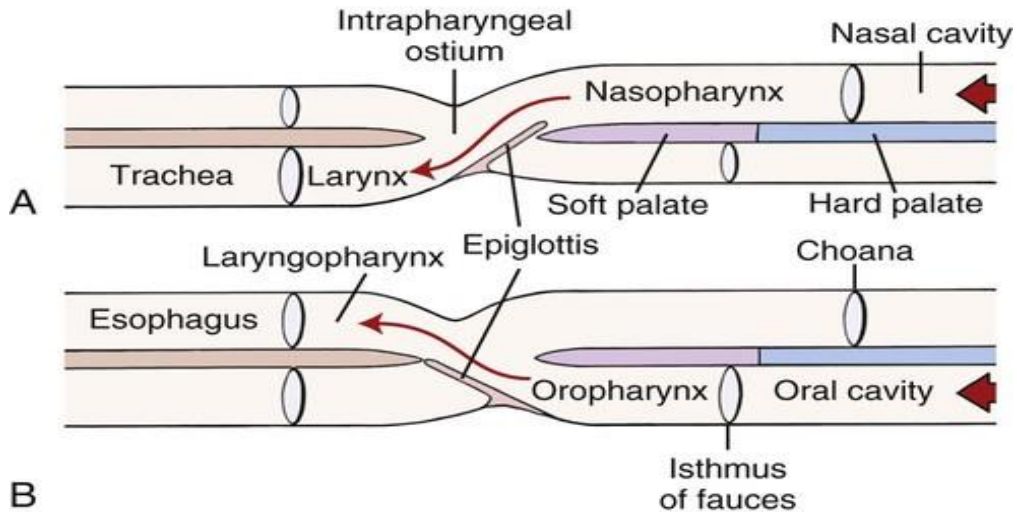
- ❑ Horse – 1st premolar is usually absent & when present is small only seen in the upper arcade, its called **wolf tooth**



THE PHARYNX(pl. pharynges)

- ❑ Is the common passage for **food** and air
- ❑ Lies caudal to oral & nasal cavities
- ❑ Lined by mucous membrane & surrounded by muscles
- ❑ The muscles of the walls of the pharynx are responsible for the orderly directing of air, food, and liquids.
- ❑ Air from the nasal cavity is directed into the ventral larynx and food & liquids are directed into the dorsal esophagus.

THE PHARYNX(pl. pharynges)



ESOPHAGUS

- ❑ The esophagus is a muscular tube
- ❑ Connects the pharynx & the stomach
- ❑ In birds, caudal part is specialised to form the crop

THE STOMACH

- ❑ Muscular chamber
- ❑ Secretes gastric juices
- ❑ Different lining of stomachs - Esophageal-like epithelia & Glandular epithelia

THE STOMACH – SPECIES VARIATIONS

- ❑ **Ruminant stomach** – has 4 chambers/compartments:
rumen, reticulum, omasum, abomasum
- ❑ Pigs & Horses – Have **single stomach**
- ❑ Birds – have 2 parts (proventriculus & gizzard)
proventriculus – glandular part
gizzard – ‘grinding mill’

COMPONENTS OF THE INTESTINES

❑ The small intestines is divided into:

✓ duodenum

✓ jejunum

✓ ileum

❑ The large intestine is divided into:

✓ Colon

✓ cecum

✓ and rectum

ROLES OF THE SMALL INTESTINE

❑ **DEODENUM**

✓ Pancreas secretes digestive enzymes that mix with the food

✓ These enzymes break down the largest molecules of food

✓ also neutralize stomach acid

❑ **JEJUNUM**

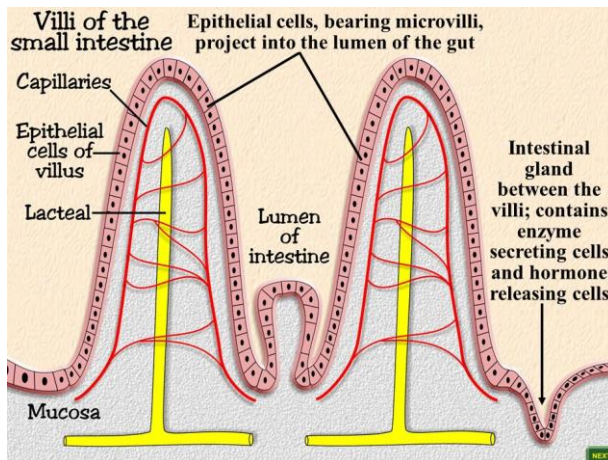
✓ absorbs most of the nutrients: simple sugars, fatty acids, minerals, amino acids, and vitamins.

ROLES OF THE SMALL INTESTINE

☐ ILEUM

- ✓ This is where the final parts of digestive absorption take place.
- ✓ The ileum absorbs bile acids, fluids, and vitamin B12.

SMALL INTESTINE



ROLES OF LARGE INTESTINE

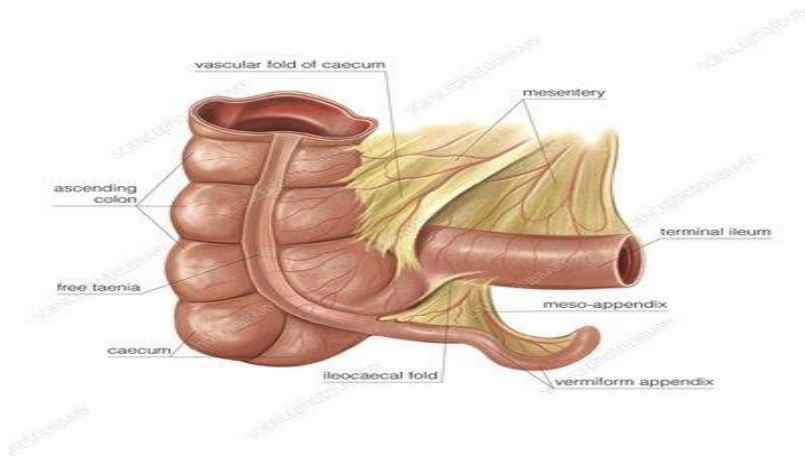
❑ Large intestines roles

- ✓ absorbs remaining water
- ✓ contains bacteria microbes that finish digestion
- ✓ produce vitamins the animal needs to grow and remain healthy
- ✓ to eliminate any undigested and unabsorbed food from the system in the form of waste.

COMPONENTS OF THE INTESTINES

- ❑ Mesentery – fold of membrane (fanlike) that attaches the intestines to the abdominal wall and holds them in place
- ❑ Mesentery allows blood vessels, lymphatics and nerves to supply the intestines

MESENTERY



CLASSIFICATION OF ANIMALS ACCORDING TO THE DIET

1. Different species of animals have digestive tracts adapted to the most efficient use of the feed they consume

1. HERBIVORES.

- ✓ Animals such as **cattle, sheep, horses,** and **rabbits**
- ✓ depend entirely on plant material for food

2. CARNIVORES

- ✓ species, such as dogs & cats, which depend almost entirely on the flesh of other animals for food.

3. OMNIVORES

- ✓ Species such as swine, poultry, and humans, which consume both flesh and plants.

THE ACCESSORY GLANDS

- Accessory glands (salivary glands, liver and pancreas)
- Role is to supply secretions to the digestive tract & provide for digestion within the lumen
- These secretions are in addition to those supplied by the many glands of the stomach and intestine
- Secretions supplied are;
 - ✓ electrolytes
 - ✓ water
 - ✓ digestive enzymes
 - ✓ bile salts.

THE ACCESSORY GLANDS

1. SALIVARY GLANDS

- Salivary glands are serous, mucous, or mixed, depending on their secretion.
- A serous secretion is a watery, clear fluid as compared with
- A mucus secretion is a viscous which acts as a protective covering throughout the digestive tract.
- A mixed gland secretes both serous and mucous fluids

THE ACCESSORY GLANDS

1. SALIVARY GLANDS

- Named based on location

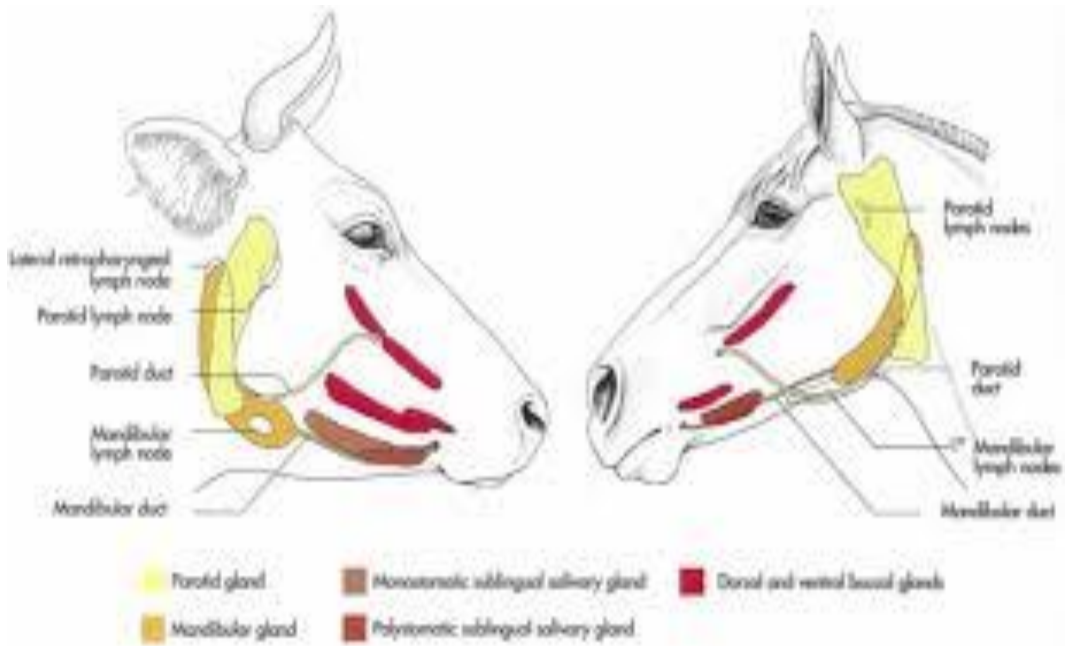
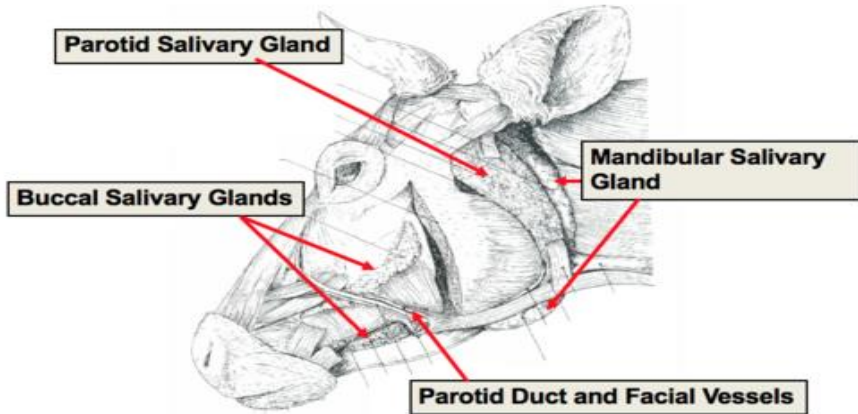
THE ACCESSORY GLANDS

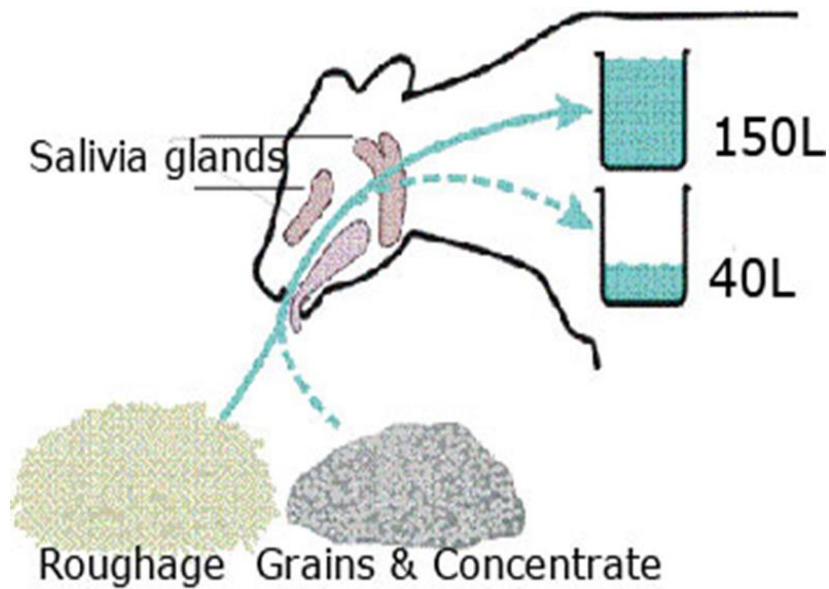
1. SALIVARY GLANDS

- consist of 3 pairs of well-defined glands
- The larger glands are
 - ✓ Parotid
 - ✓ Mandibular
 - ✓ and sublingual salivary glands.
- These glands are connected to the oral cavity by excretory ducts

SALIVARY GLANDS

Salivary Glands of the Cow





THE ACCESSORY GLANDS

2. THE PANCREAS

- ❑ Located near the 1st part of the duodenum & appears as an elongated gland of loosely connected aggregated nodules
- ❑ Lies close to the common bile duct or the duct empties directly into the common bile duct so that a mixture of bile & pancreatic juice enters the duodenum

THE ACCESSORY GLANDS

2. THE PANCREAS

- The pancreatic gland has both endocrine & exocrine functions:
- It produces hormones (endocrine) & digestive secretions (exocrine).

EXOCRINE FUNCTION OF THE PANCREAS

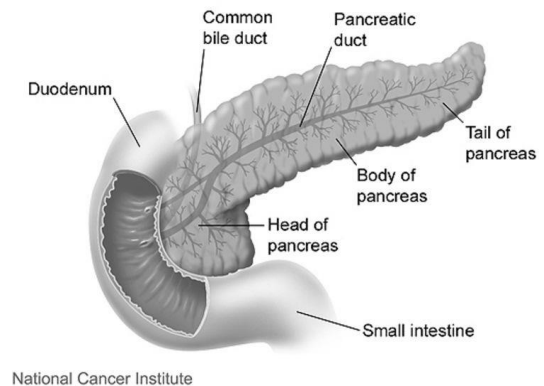
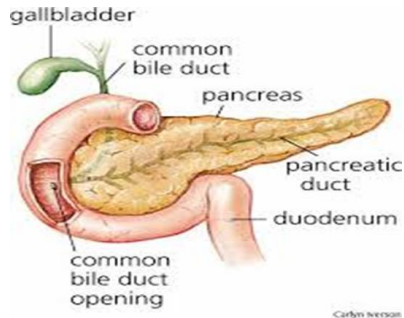
- Secretes sodium bicarbonate & digestive enzymes into the deodenum.
- Enzymes - **trypsinogen** & **chymotrypsinogen, amylase, lipase**

THE ACCESSORY GLANDS

2. THE PANCREAS

- The endocrine portion are the pancreatic islets (former islets of Langerhans)
- Pancreatic islets are isolated groups of cells scattered throughout the gland.
- The cells are of 2 types;
 - i. **Beta cells produce insulin**
 - ii. **Alpha cells produce glucagon.**
- Secretions from alpha and beta cells are made directly into the blood

THE PANCREAS

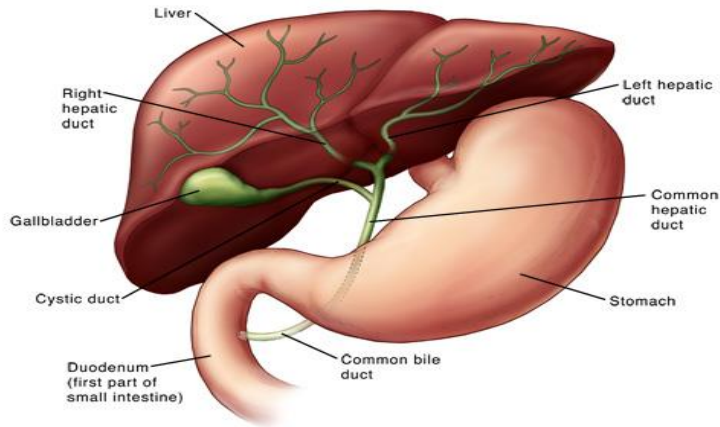


THE ACCESSORY GLANDS

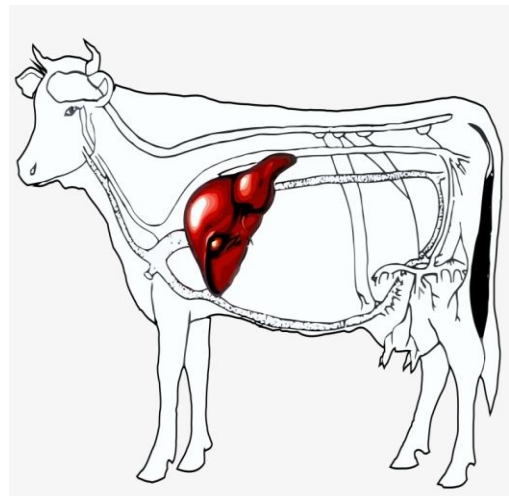
3. THE LIVER

- Largest gland in the body
- lies caudal to the diaphragm – attached to the diaphragm by the **falciform ligament**
- Usually on the right side of the body**
- divided into lobes
- the gall bladder lies between the lobes and is connected to the liver by a duct
- The other duct connects liver to the deodenum

LIVER & GALL BLADDER



THE LIVER



THE ACCESSORY GLANDS

- ❑ Liver cells (hepatocytes) are responsible for bile formation.
- ❑ Bile is a greenish-yellow salt solution consisting primarily of;
 - ✓ bile salts
 - ✓ Cholesterol
 - ✓ phospholipids (lecithins)
 - ✓ and bile pigments (bilirubin).
- ❑ Bile salts assist in digestion & absorption of lipids (triglycerides), and the production & secretion of these salts is the most important digestive function of the liver

THE ACCESSORY GLANDS

FUNCTIONS OF THE LIVER

- i. Bile production & secretion
- ii. Storage of glycogen, vitamins & minerals
- iii. Synthesis of plasma proteins eg albumin & clotting factors
- iv. Processing (Metabolism) of nutrients from the digestive tract
- v. Filter blood coming from the digestive tract before passing it to the rest of the body
- vi. Detoxifies chemicals and metabolises drugs

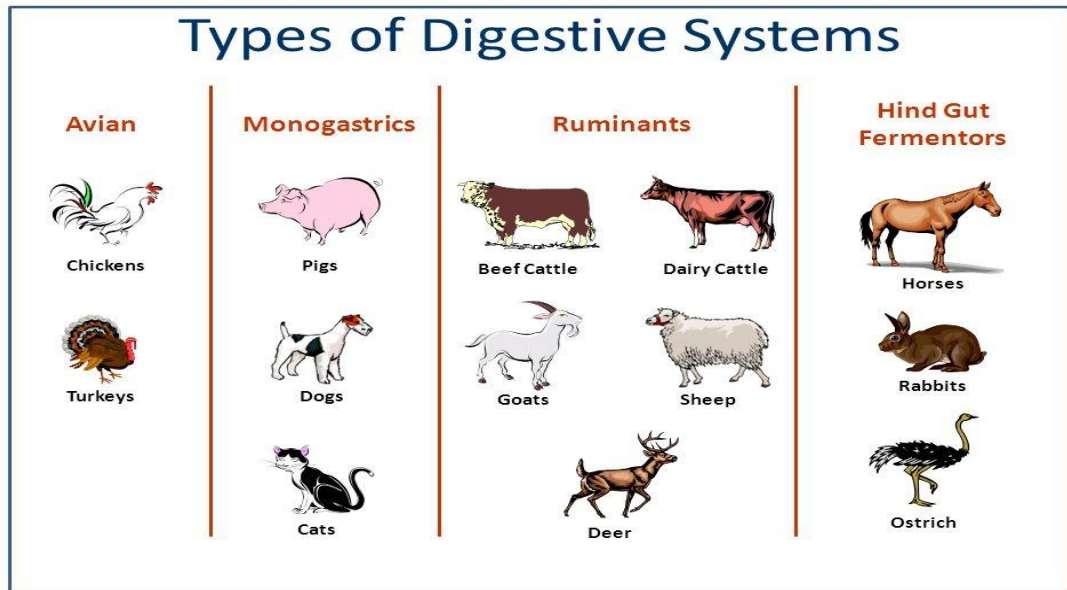
PHYSIOLOGY

- ❑ Simple Stomach releases gastric juice
- ❑ Gastric juice contains water, **hydrochloric acid**, **mucus**, intrinsic factor, pepsinogen
- ❑ The pH of gastric juice in mammals can be 2 or less
- ❑ Pepsinogen (an inactive form of the enzyme pepsin and a component of gastric juice) is activated by the low pH.
- ❑ A layer of mucus protects the epithelial lining of the stomach

CLASSIFICATION OF FARM ANIMALS ACCORDING TO THE ANATOMY OF THE DIGESTIVE SYSTEM

Farm animals are classified into four (04) groups based on the anatomy of their digestive systems

1. **Monogastric animals** – simple stomach
2. **Modified Monogastric animals (Avian)** – has two stomachs
3. **Ruminant herbivores (Foregut fermenters)** – stomach with 4 compartments
4. **Non- ruminant herbivores (Hindgut-fermenters)** – simple stomach but large & complex large intestine

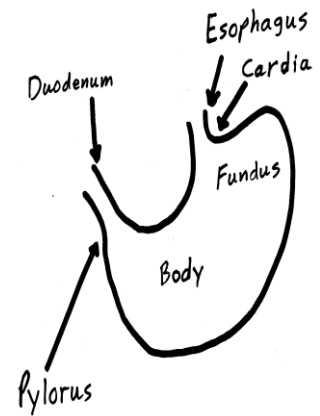


1. MONOGASTRIC

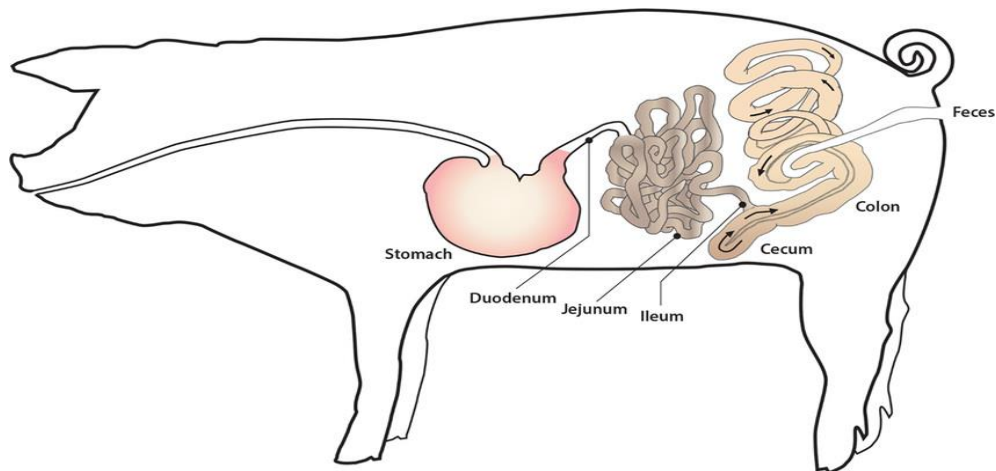
- Have one simple stomach
- The stomach secretes acid, resulting in a low pH of 1.5 to 2.5. The low pH destroys most bacteria & begins to break down the feed materials.
- Animals with this type of digestive system are better adapted to eat rations high in concentrates.
- Concentrates are highly digestible feedstuffs that are high in energy & low in fiber. They are typically 80- 90% digestible.
- Common concentrates are cereal grains & oil meals. Cereal grains include corn, wheat, barley, and oats.
- Oil meals include soybean meal, linseed meal, and cottonseed meal.

MONOGASTRIC ANIMALS

- ❑ Swine is a monogastric animal, which means they have a single stomach.
- ❑ Basically glandular
- ❑ Secretions produced; mucus, Hcl & enzymes
- ❑ Swine have a digestive system that is anatomically and physiologically similar to the human digestive system

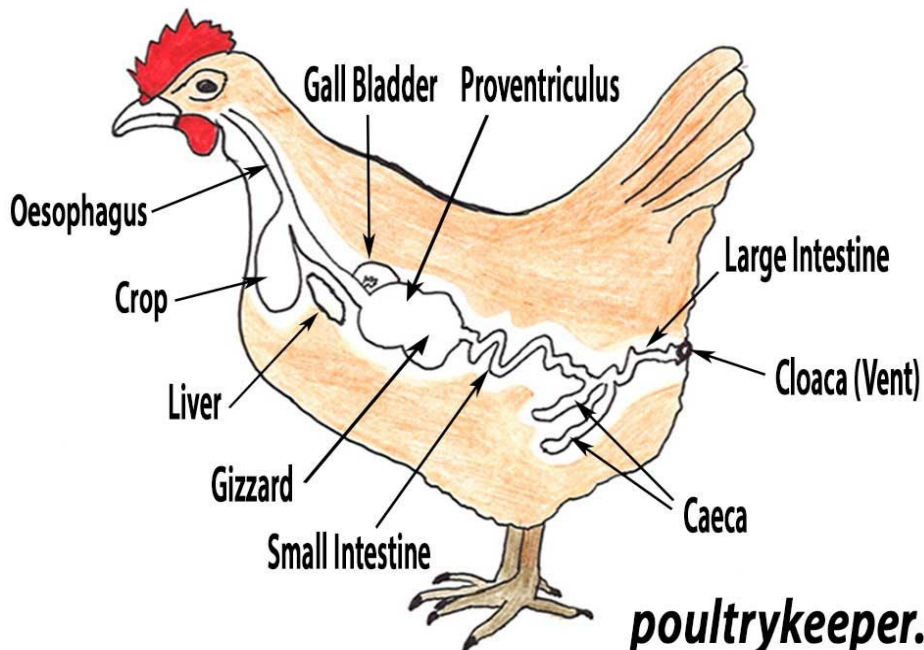


PIG DIGESTIVE SYSTEM



AVIAN DIGESTIVE SYSTEM – KEY FEATURES

- ❑ Found in poultry
- ❑ Birds have no teeth therefore do not chew food
- ❑ Mechanical digestion of feed is done by **beak & gizzard**
- ❑ Salivary glands are present & well developed in species which consume dry food.
- ❑ **The crop** is a dilation of the esophagus
- ❑ The crop is for storage of food. Food here is also soaked



poultrykeeper.com

AVIAN DIGESTIVE SYSTEM – KEY FEATURES

- Proventriculus** is located between the crop & gizzard
- Proventriculus** secretes gastric secretions HCl and pepsinogen as well as mucus.
- The gizzard is a very muscular organ, which normally contains grit or stones that function like teeth to grind the food



AVIAN DIGESTIVE SYSTEM – KEY FEATURES

- Food moves from the gizzard to the s/intestine & then to the large intestine.
- The non-digestible food components then travel into the cloaca
- Urine is also emptied into the cloaca.
- Undigested material is then passed out of the body through the vent
- Digestion in avian system is very rapid

AVIAN DIGESTIVE SYSTEM – KEY FEATURE

- ❑ **Ceca** are paired structures, are located at the junction of the small & large intestine. Here microbial digestion of cellulose occurs
- ❑ **Cloaca** – Last part of the GIT. It is a common opening to the digestive, urinary & reproductive tracts in birds.

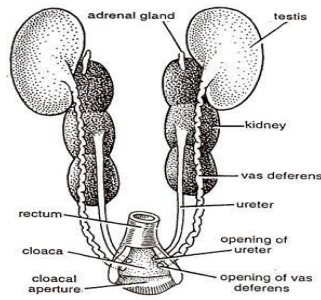
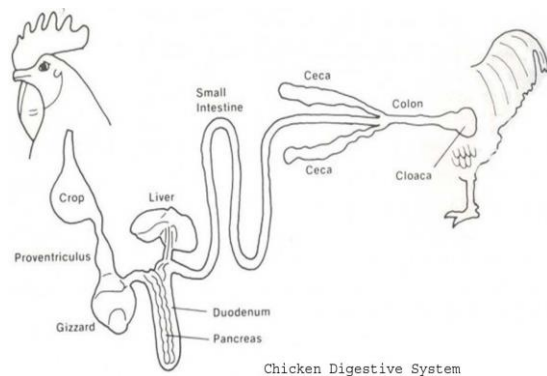


Fig. 11. Male urinogenital system of pigeon.

AVIAN DIGESTIVE SYSTEM

- ❑ The beak
- ❑ The oesophagus
- ❑ Crop
- ❑ Proventriculus
- ❑ Gizzard
- ❑ Small intestine
- ❑ Large intestine
- ❑ The caeca are a pair of tubes that allow fermentation of undigested food to take place



Chicken Digestive System

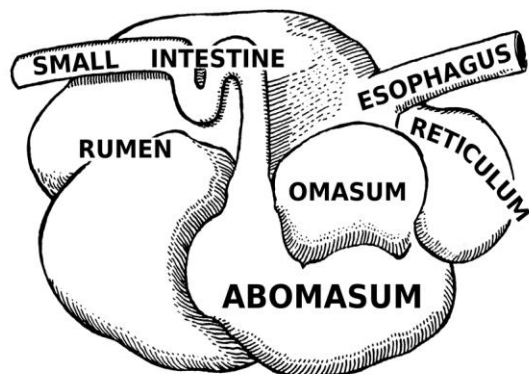
THE RUMINANT HERBIVOURES

- Ruminants are also called **foregut fermenters**
- Cattle, Sheep, Goats, Deer
- Animals with complex digestive systems
- Capable of digesting material with a high fiber concentration eg grass
- Uses microbial fermentation
- Ruminants are mammals that are able to acquire nutrients from plant-based food by fermenting it in a specialized stomach prior to digestion, principally through microbial actions.

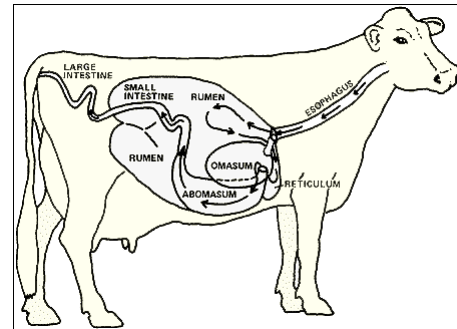
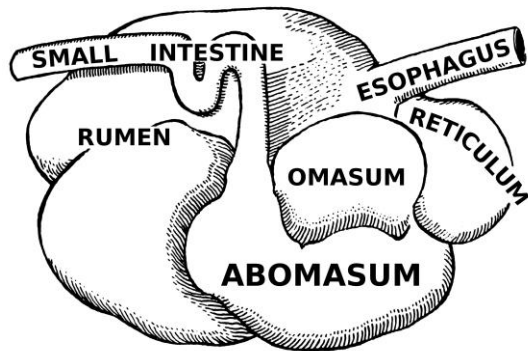
COMPARTMENTS OF RUMINANT STOMACH

Ruminant stomach

1. Rumen
 2. Reticulum
 3. Omasum
 4. Abomasum
- Rumen, reticulum & omasum are called **forestomach**
 - Forestomach** - Lined with non-glandular epithelium

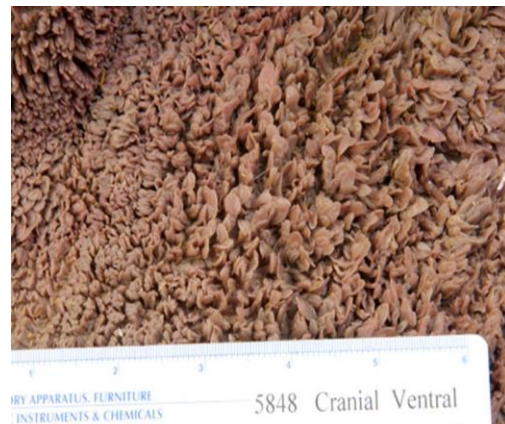


THE RUMINANT (FOREGUT FERMENTERS)



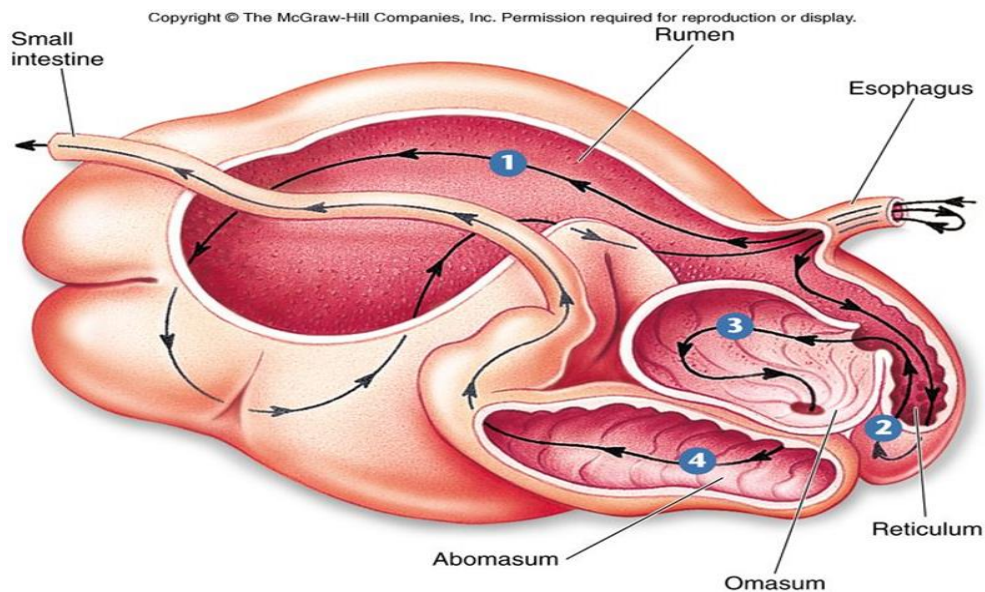
1. RUMEN

- Largest of the 4 parts
- 184 L
- The reticulum & the rumen are separated by the **ruminoreticular** fold
- Rumen almost entirely filled the left abdominal cavity



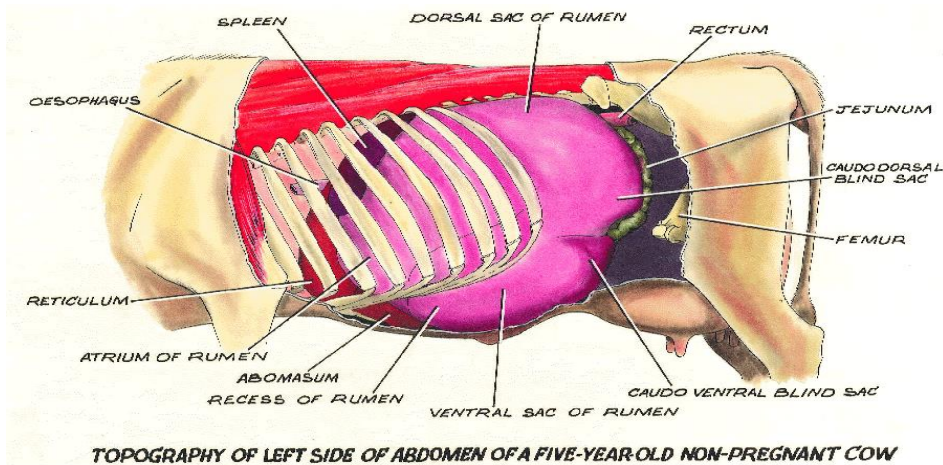
RUMEN FUNCTION

- ❑ Has microorganisms include bacteria, protozoa, and fungi.
- ❑ The purpose of these microbes is to ferment and break down plant cell walls into their carbohydrate fractions and produce volatile fatty acids (VFAs) from these carbohydrates.
- ❑ These VFAs are later used by the animal for energy.



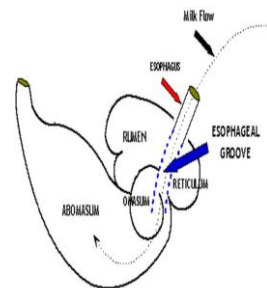
1. RUMEN

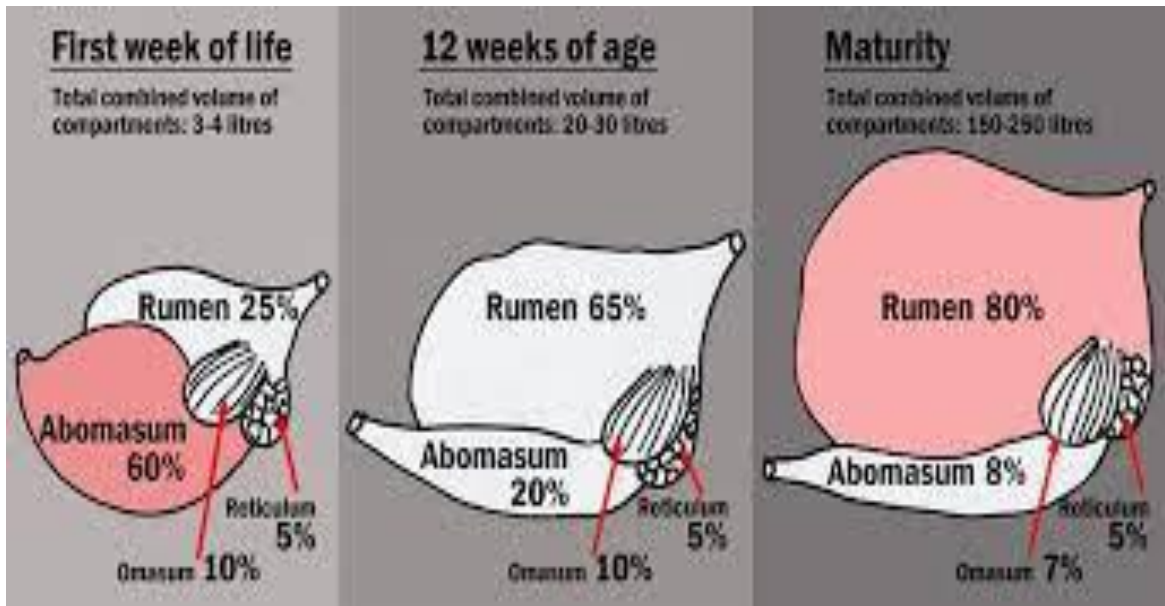
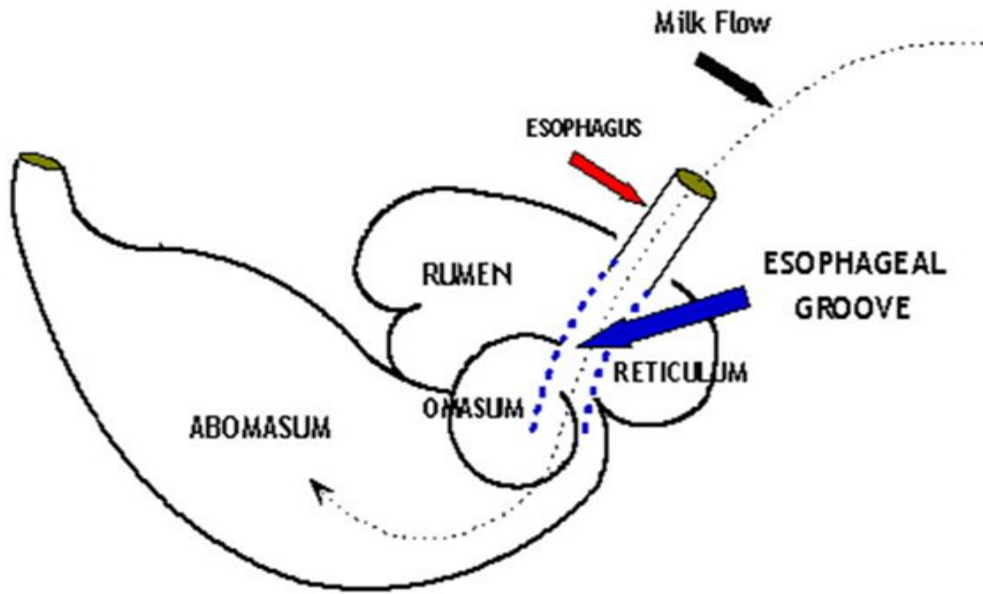
- ❑ Left abdominal cavity filled the rumen



SUCKLING RUMINANTS

- ❑ Rumen & reticulum are relatively undeveloped
- ❑ Milk is channelled by the oesophageal or reticular groove to the **omasum and abomasum**
- ❑ Solid food stimulates enlargement of rumen & reticulum





2. RETICULUM

- ❑ Most cranial part
- ❑ Found in front of the rumen
- ❑ 16L capacity
- ❑ Inside mucosa is thrown into ridges giving it a honey-combed appearance
- ❑ Muscular wall continuous with rumen



RETICULUM

- ❑ The main function of the reticulum is to collect smaller digesta particles and move them into the omasum while the larger particles remain in the rumen for further digestion.
- ❑ The reticulum also traps and collects heavy/dense objects consumed by the animal.
- ❑ When a nail, wire, or other sharp heavy object is consumed by a ruminant, it is very likely that the object will be caught in the reticulum.
- ❑ During normal digestive tract contractions this object can penetrate the reticulum wall, and make its way to the heart, where it can lead to hardware disease. The reticulum is sometimes referred to as the “hardware stomach”.

4. ABOMASUM (TRUE STOMACH)

- also called the true stomach
- a glandular lining
- 27 L
- Secretes HCl & digestive Enzymes



3. OMASUM

- 3rd compartment
- 8L capacity
- Spherical in shape
- Inside thrown into broad longitudinal folds or leaves similar of the pages in a book (Bible)
- Absorbs water and other substances from digestive contents.
- Feed material (ingesta) between the leaves will be drier than ingesta found in the other compartments.

3. OMASUM



SYMBIOTIC RELATIONSHIP BETWEEN THE MICROBES & THE RUMINANT ANIMAL

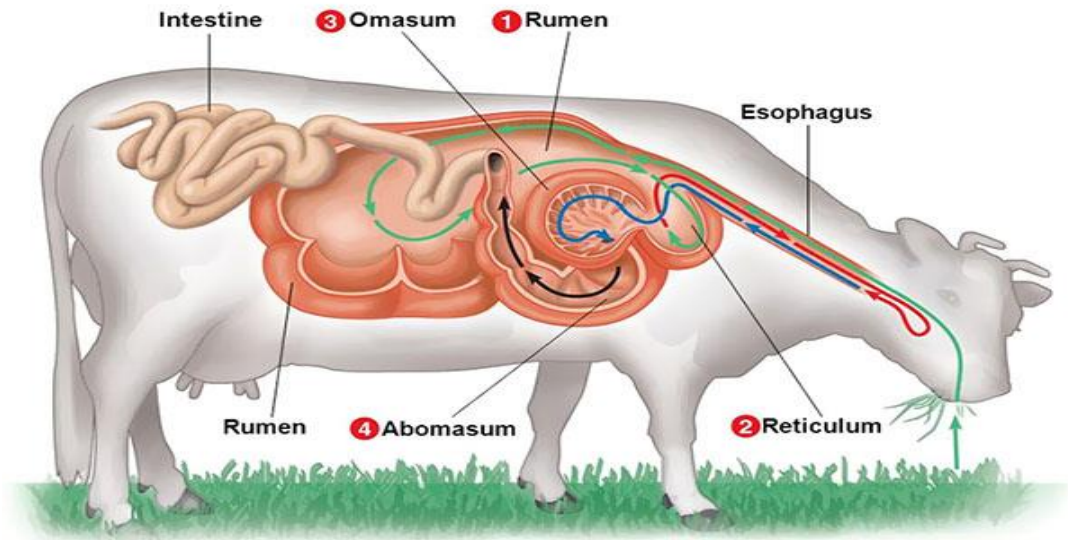
Microbes provide to the ruminant

- i. Dig of cellulose & hemicellulose
- ii. Provision of high quality protein (microbial protein)
- iii. VFA (volatile fatty acids) – propionic acid, acetic acid & butyric acid
- iv. B VITAMINS
- v. Detoxification of toxic compounds

Ruminants provide to microbes

- i. Housing (rumen environment)
- ii. Garbage removal (removal of waste products eg CO₂ and methane)
- iii. Nutrients (feed contains all nutrients eg carbohydrates, proteins, vitamins etc)
- iv. Optimum environment for growth (anaerobic, pH of 5.8-6.8, temp 39°C)

RUMINATION



Four Steps of Rumination

- **Regurgitation** - Reverse peristalsis carries food to mouth
- **Remastication** - Liquid squeezed from bolus and swallowed Bolus chewed
- **Reinsalivation** - Adding more saliva
- **Redeglutition** - Swallowing bolus and liquids

PURPOSE OF RUMINATION

- ✓ Allows animal to forage & eat feed rapidly & then store for later digestion
- ✓ Reduces particle size. Only small particles leave reticulorumen
- ✓ Increases surface area for microbial attachment & digestion/fermentation.
- ✓ Breaks down impervious plant walls
- ✓ Further stimulation of saliva flow (saliva serves to buffer rumen)

Rumination Time

Average times for a grazing animal

- ✓ Eating (grazing) – 8 hours
- ✓ Ruminating – 8 hours
- ✓ Resting – 8 hours

Ruminating time is quite variable (high variation)

- ✓ Reducing forage: concentrate decreases rumination
- ✓ Reducing particle size of forage decreases time spent ruminating

REDUCING PARTICLE SIZE OF INGESTED FEEDS

CHEWING DURING EATING (MINIMAL)

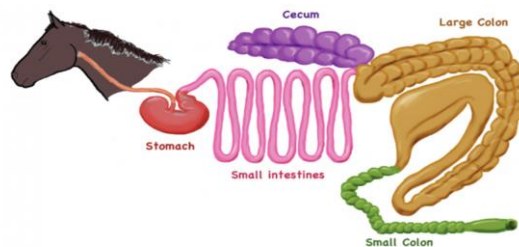
- ✓ Preparation for swallowing
- ✓ Release soluble constituents
- ✓ Damage plant tissues for microbial attachment

CHEWING DURING REMASTICATION (EXTENSIVE)

- ✓ Decrease particle size for passage
- ✓ Damage plant tissues for microbial attachment
- Microbial digestion
- Reticuloruminal contractions

NON-RUMINANT HERBOVORES (HINDGUT FERMENTERS)

Hindgut fermenters generally have a cecum and large intestine that are much larger and more complex than those of a foregut or midgut fermenter.

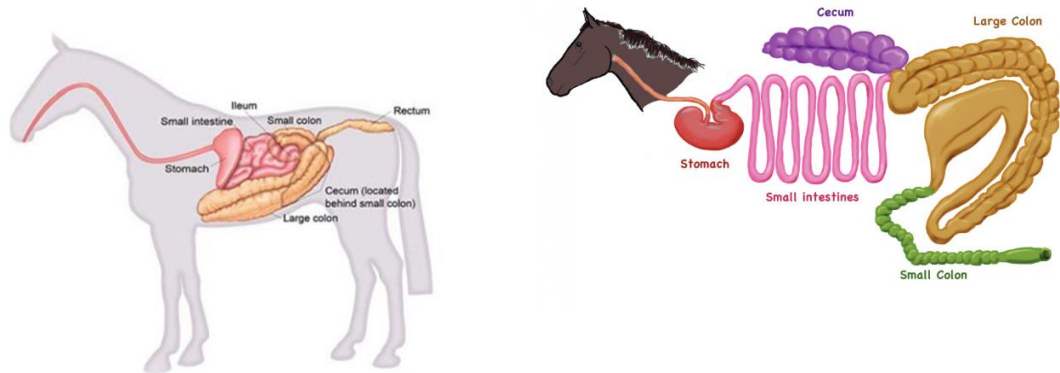


NON-RUMINANT HERBOVORES (HINDGUT FERMENTERS)

- Hindgut fermenters generally have a cecum and large intestine that are much larger and more complex than those of a foregut or midgut fermenter.
- Horses are classified as non-ruminant herbivores.
- This means they have the capacity to break down the cellulose and hemicellulose components in forages without the four-chambered stomach that cattle have but break down the cellulose in the cecum
- Horse's large intestine occupies 60 of the abdominal cavity

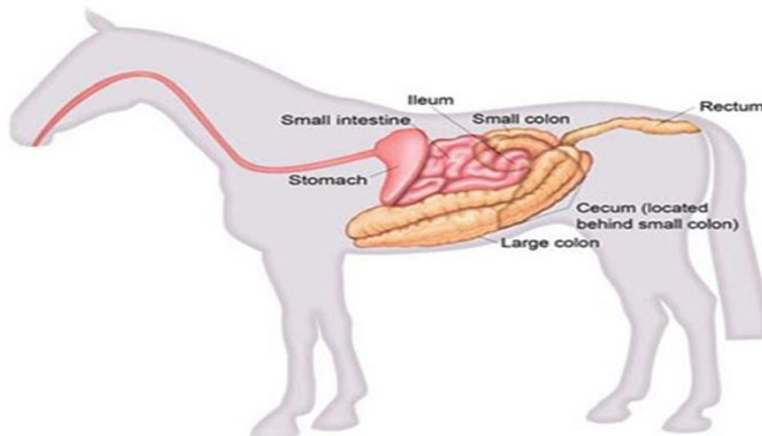
HORSE DIGESTIVE SYSTEM

Has Enlarged cecum & large colon

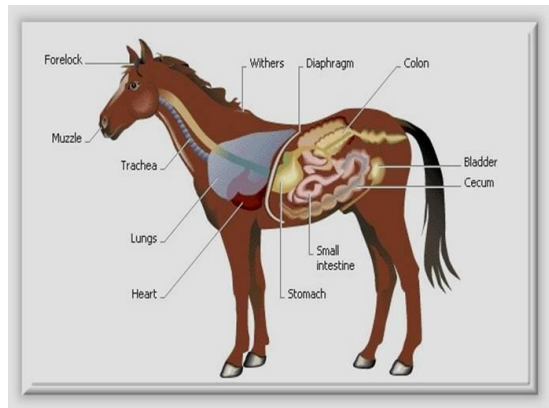
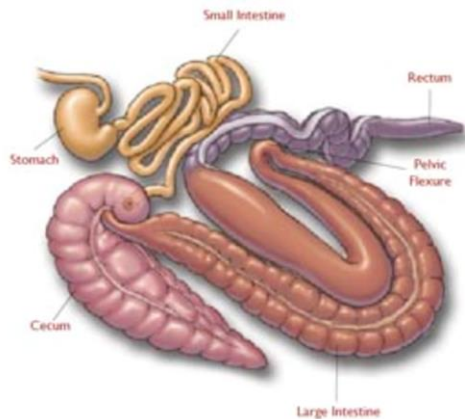


HORSE DIGESTIVE SYSTEM

Has Enlarged cecum & large colon



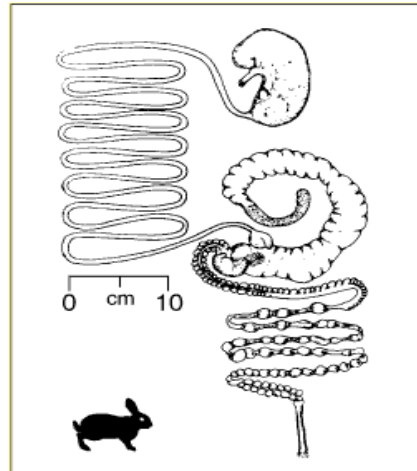
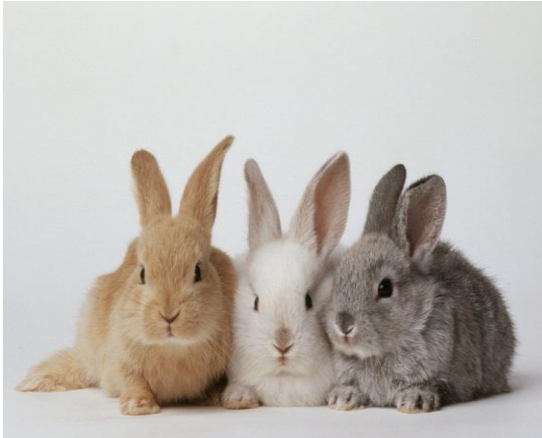
HORSE DIGESTIVE SYSTEM



HINDGUT FERMENTATION

- ❑ The hindgut of the horse comprises the **cecum, large colon, small colon and rectum**.
- ❑ The cecum consists of 12-15% of tract capacity and the colon 40-50% of tract capacity.
- ❑ The major functions of the hindgut are the microbial digestion (fermentation) of dietary fiber (structural carbohydrates primarily from forages in the horse's diet).
- ❑ Important end-products of the fermentation are volatile fatty acids (**acetic, propionic and butyric**) which can serve as an energy source for horses fed mostly forages such as pasture or hay.
- ❑ Fermentation also produces methane, carbon dioxide and water, as well as most of the B-vitamins and some amino acids. Another function of the hindgut is water reabsorption.

THE GASTROINTESTINAL TRACT OF A RABBIT



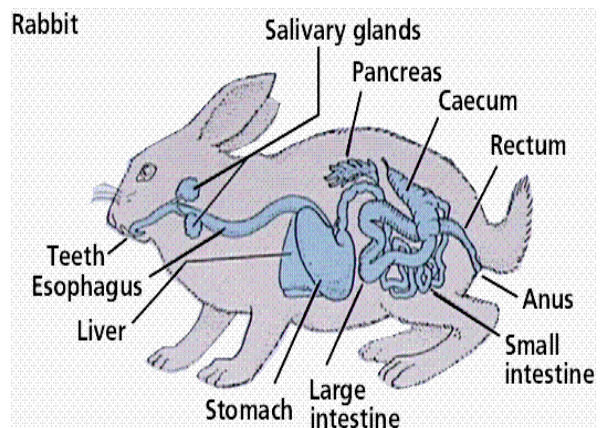
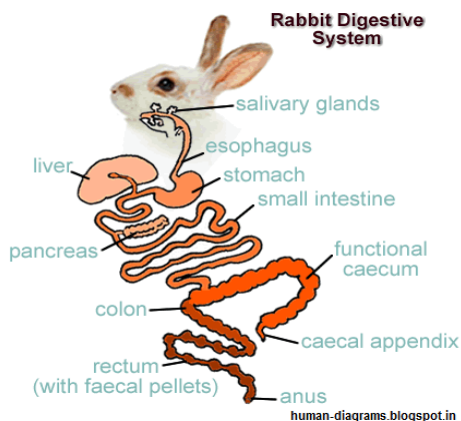
THE GASTROINTESTINAL TRACT OF A RABBIT

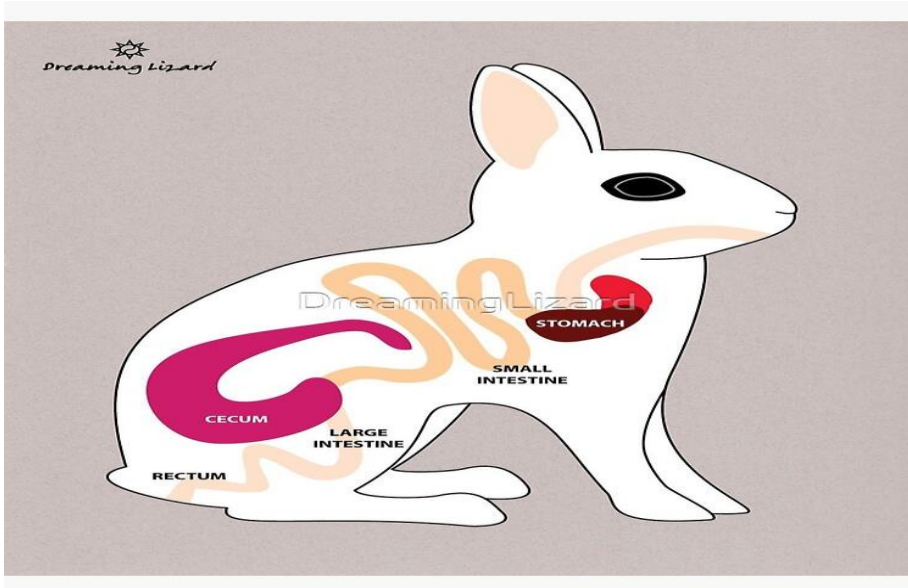
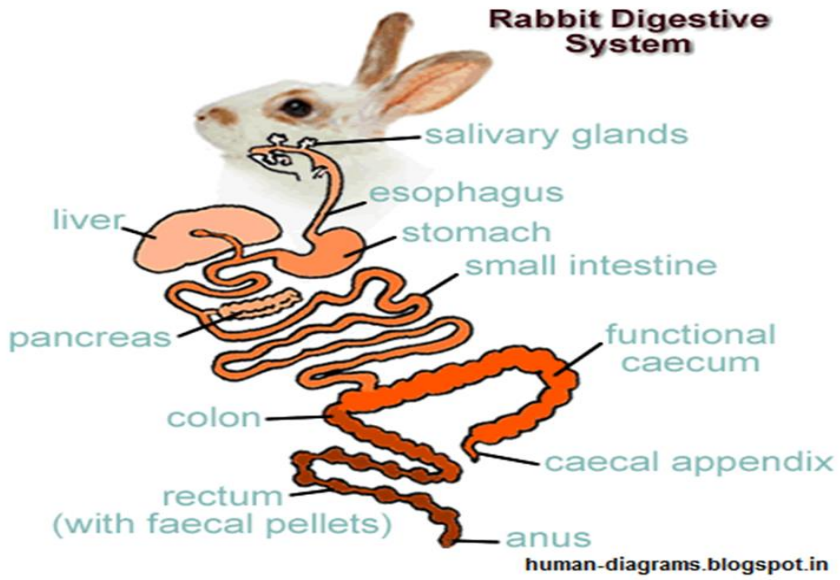
- Rabbits are herbivores, they eat plant material
- They have a specialized gastrointestinal (GI) tract to accommodate that diet.
- Did you know rabbits can eat up to 30 times per day and ingest 2-8 grams of food per meal?
- Did you know rabbits produce 2 types of feces and ingest one type?

THE GASTROINTESTINAL TRACT OF A RABBIT

- ❑ The rabbit's digestive system is well designed for the digestion of the large quantity of forage typical in its herbivorous diet.
- ❑ The digestive system occupies a large proportion of the body cavity and is fully developed in the nine week-old rabbit.
- ❑ Approximately 88% of the digesta (digestible material in the digestive system) is contained in the stomach & caecum.
- ❑ The caecum, the largest organ of the digestive system, has a capacity ten times that of the stomach, and comprises approximately 40% of the gastrointestinal tract.

THE GASTROINTESTINAL TRACT OF A RABBIT





PATH OF DIGESTION IN RABBITS

- Feed travels from the stomach to the small intestine, where it encounters enzymes which aid in digestion and absorption of nutrients from proteins, sugars and starches.
- From the small intestine, feed travels to the large intestine
- The beginning of the colon, called the proximal colon, separates the food material into digestible & indigestible material.
- The digestible material is then moved backwards into the cecum & the indigestible material is formed into fecal balls and moved out of the GI tract.
- From the indigestible material, where there is significant water resorption, followed by excretion of the feces.
- The digestible material travels to the cecum, where the microbial breakdown of fiber occurs.

DIGESTION IN THE CECUM

- The cecum contain microorganisms and digests feed material via fermentation
- The cecum functions to breakdown digestible fibers and starches via fermentation
- The products of feed fermentation are volatile fatty acids, vitamins and microbial proteins
- The volatile fatty acids are then absorbed through the cecal wall while the microbial protein and vitamins are formed into cecotropes and eliminated rectally so the rabbits can ingest them.

RABBIT FAECES

- The rabbit will produce 2 types of feces, the hard-feces & the soft **cecotropes**
- The hard feces pass during or shortly after eating.
- The smaller and softer **cecotropes** are often passed at night or at least 4 hours after eating. The rabbits will ingest these directly from the anus.
- The cecotropes contain good bacteria (microbial protein) and nutrients and are critical to keeping the GI tract healthy and functioning.

Caecotrophy, commonly known as coprophagy,

- It is the ingestion of specially produced soft faecal pellets, which are usually produced at night in the domestic rabbit.
- The soft fecal pellets are called caecotropes and are produced in the cecum through microbial fermentation.
- Caecotropes are rich in microbial protein and B vitamins
- Caecotrophy is similar to the chewing of cud in cattle, and is sometimes referred to as “pseudo-rumination”
- The rabbit is much less efficient at digesting fibre.
- Microbial activity in the ruminant affects the food before it reaches the main regions of digestion & absorption, but microbial activity in the rabbit takes place on the undigested residues of food

Rabbit feces

Cecotropes



Rabbit feces in the garden, by Tripp Feasteron / Flickr

Cecotropes



Cecotropes and hard feces, by Connie / kopperhome.com

