

physiology of digestive System

Function:-

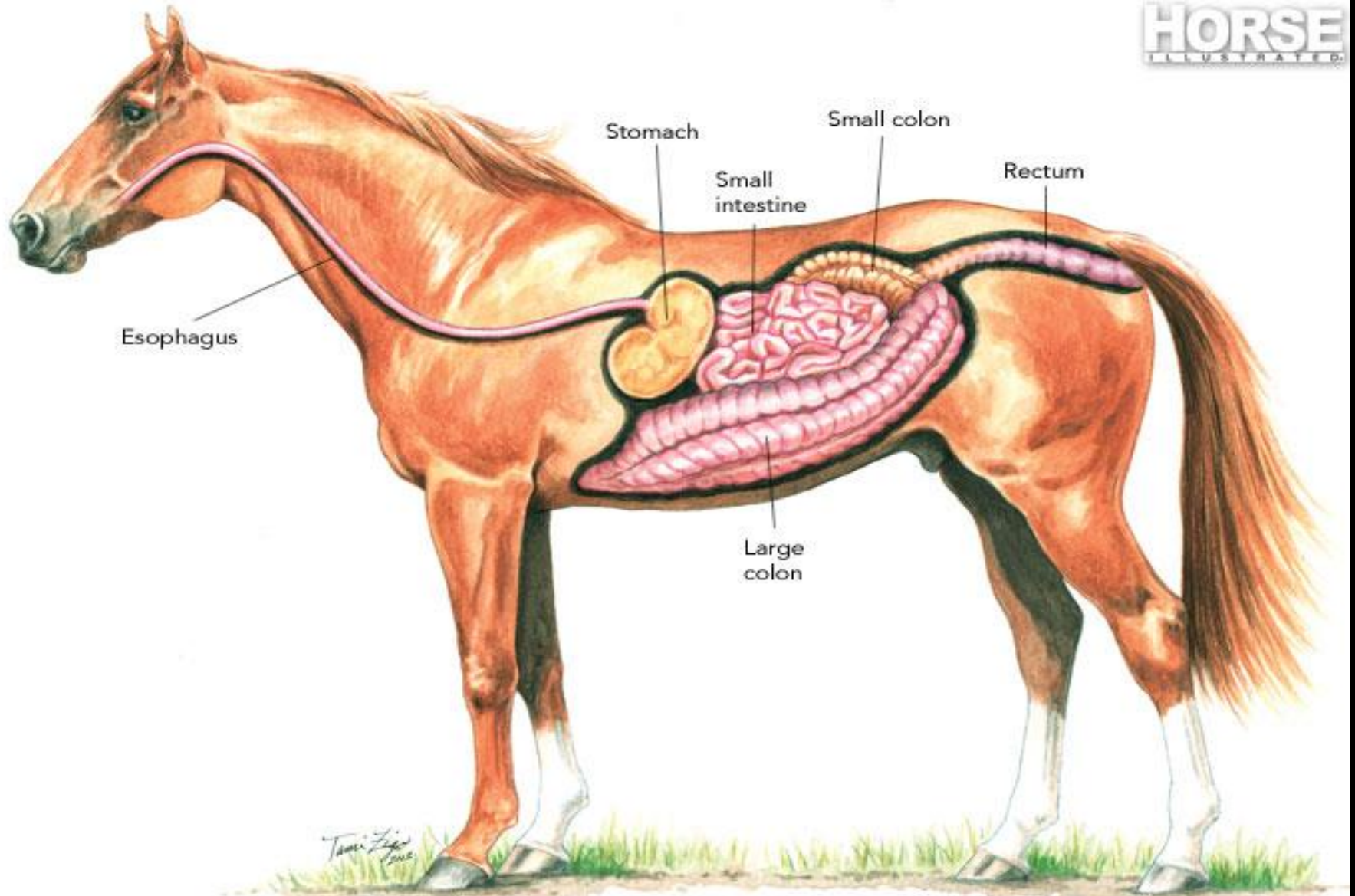
- 1- Obtain resources from the external environment like Water, Minerals, Nutrients (Lipids, Carbohydrates, Proteins) and Vitamins
- 2- Break down large particles into smaller ones transfer materials from external environment → blood → cells

Anatomy of digestive tract:-

oral cavity, pharynx, esophagus, stomach, small intestine
large intestine and anus

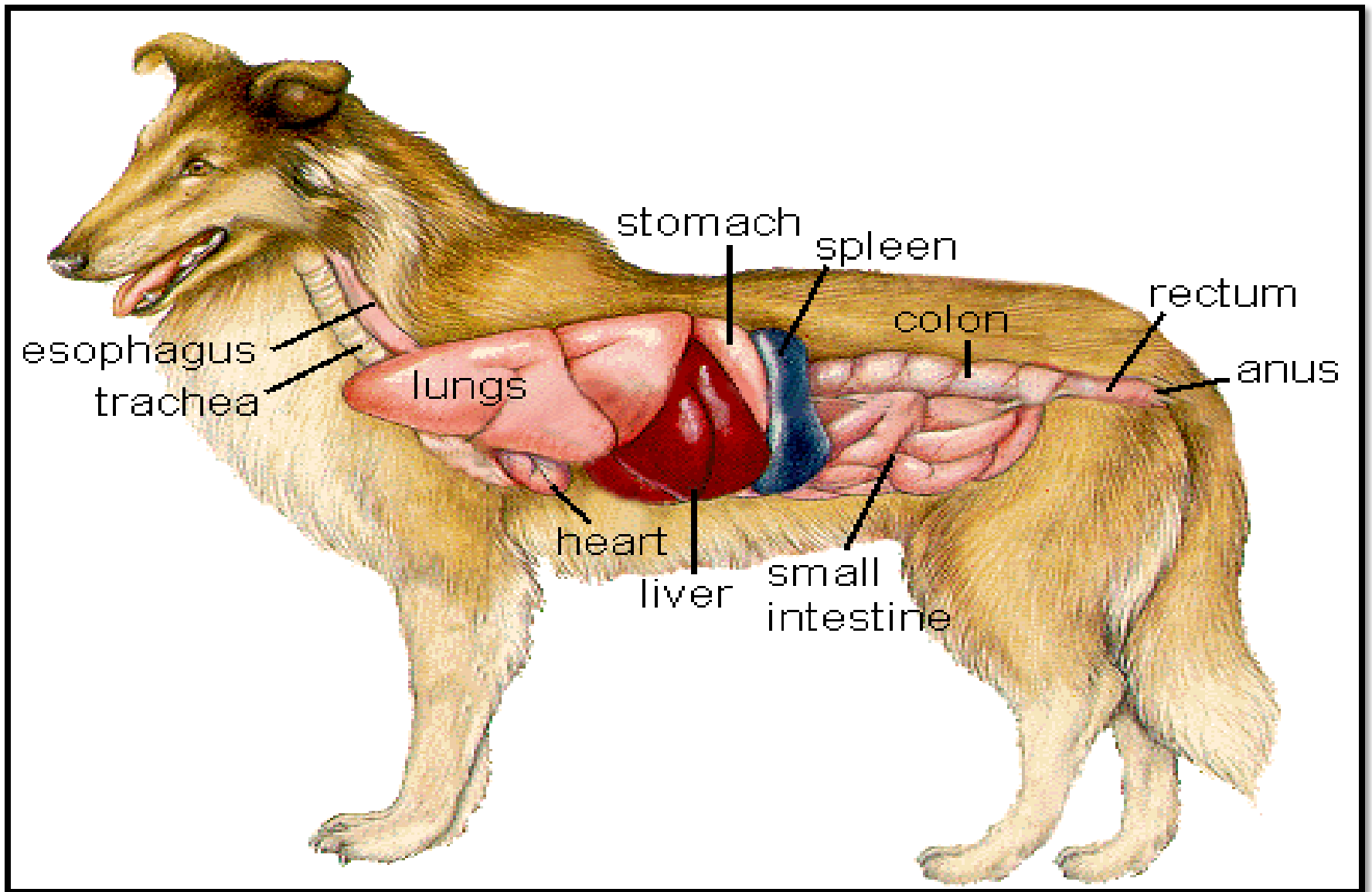
Digestive tract in hours

HORSE
ILLUSTRATED

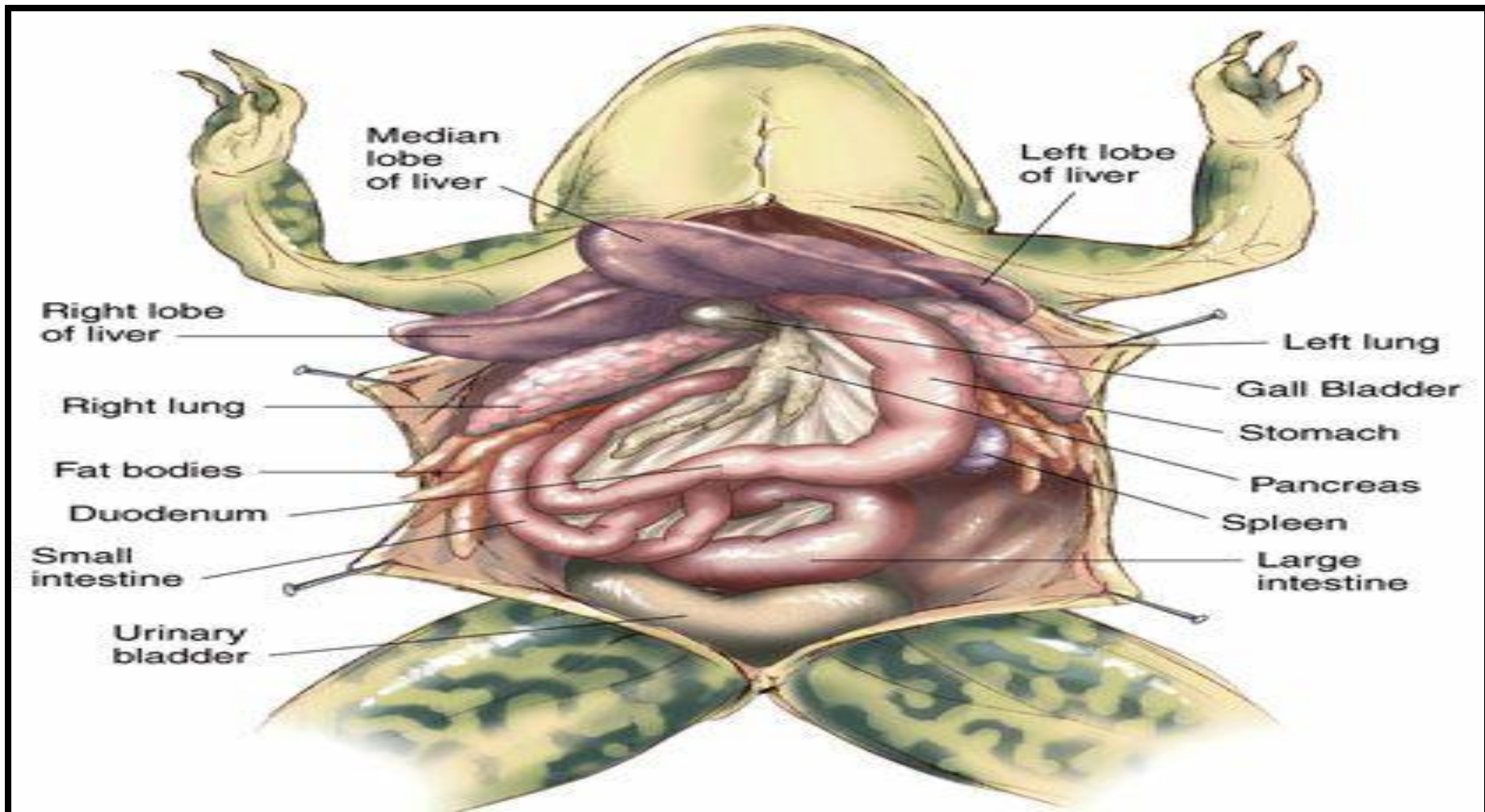


Tami Zigo
2012

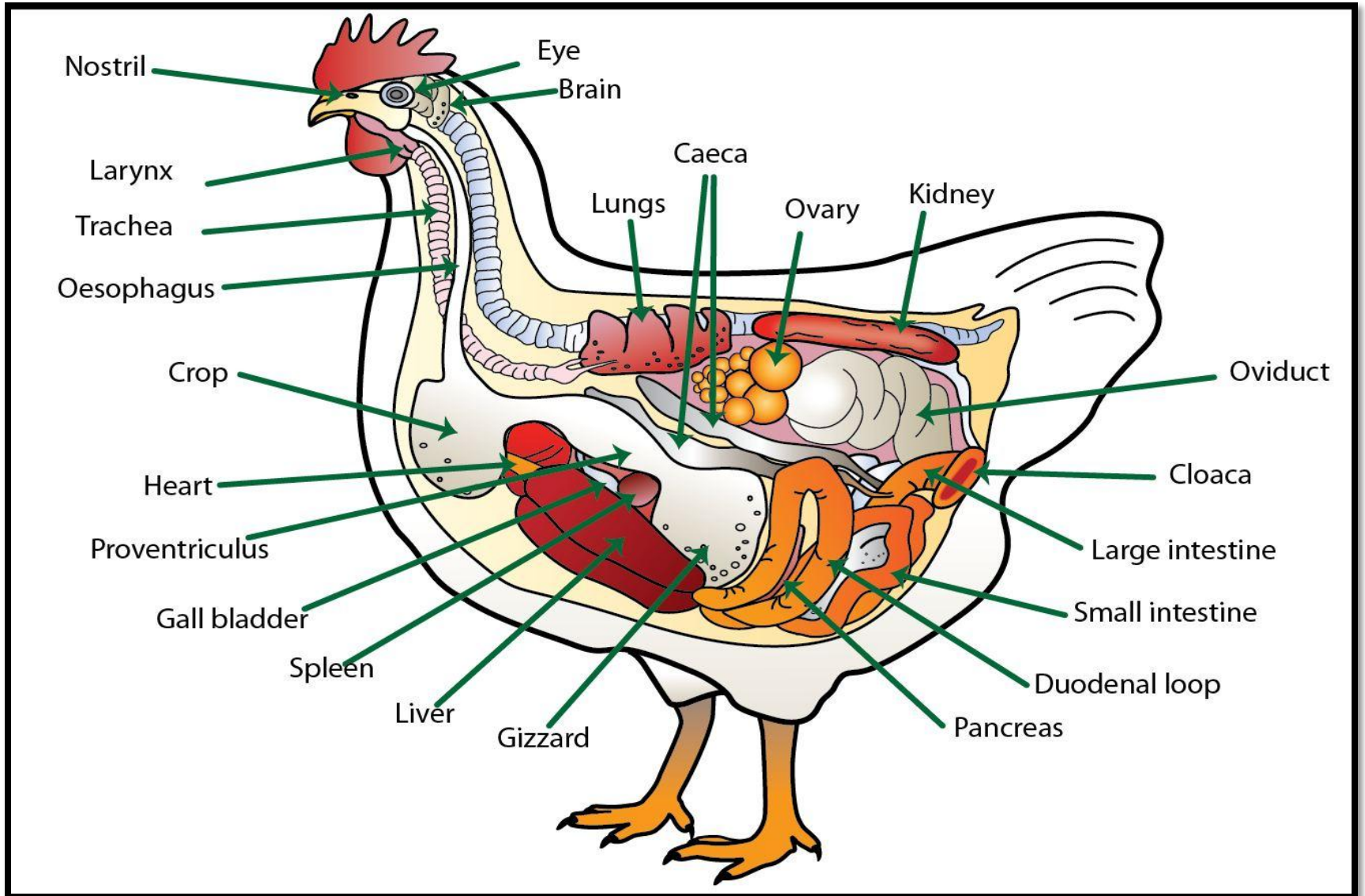
Digestive tract in dog



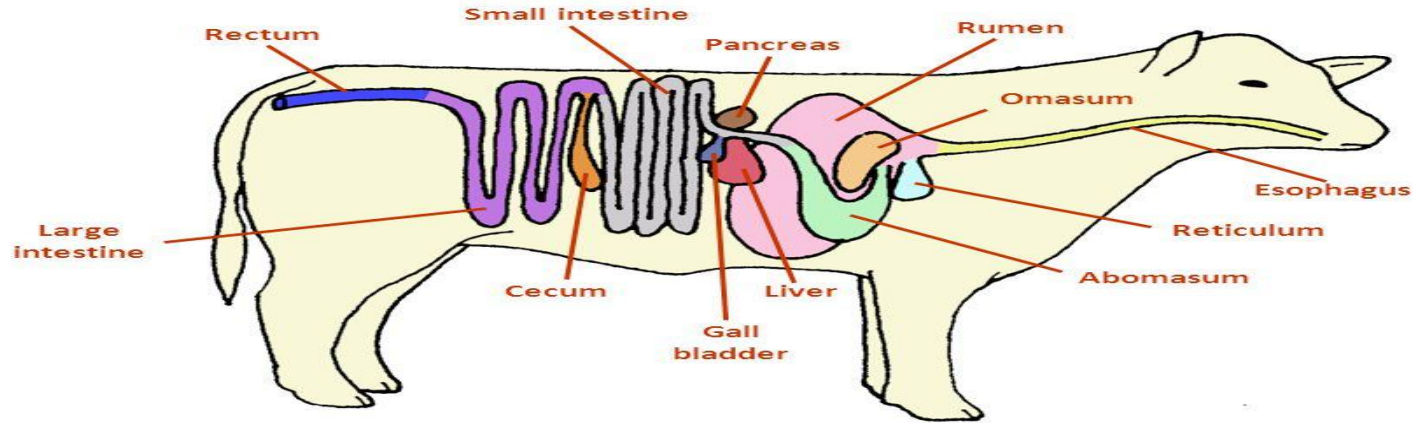
Digestive tract in frog



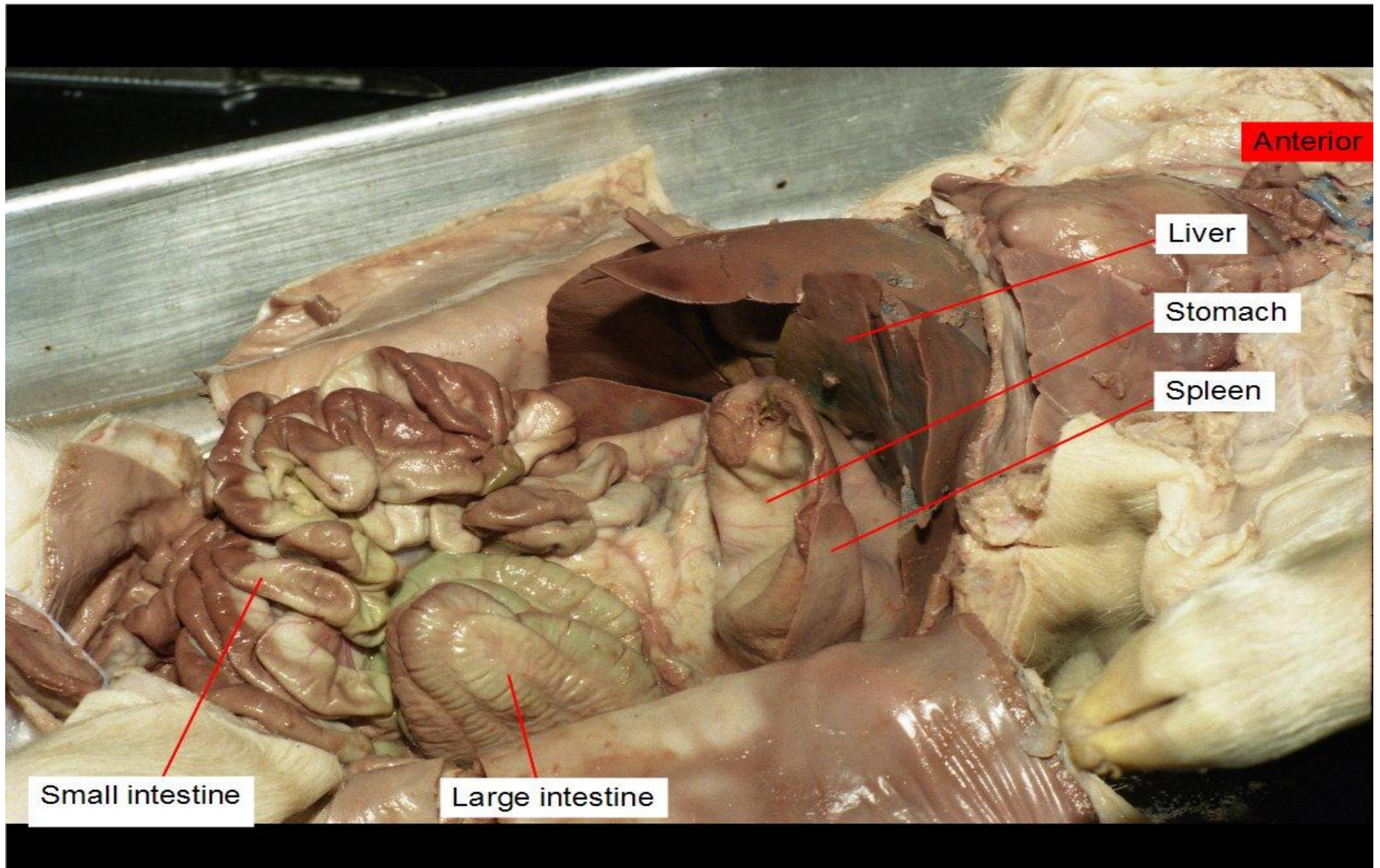
Digestive tract in bird



Digestive Tract - Cattle



Digestive tract in sheep & goat



Gastrointestinal physiology:-

The major processes occurring in the GI system are that are

- 1. Motility**
- 2. Secretion**
- 3. Digestion**
- 4. Absorption**

1- Motility

The gastrointestinal tract generates motility using smooth muscle , there are two type of contractions patterns

A- The Tonic motility :-

Its contractions are occur in the sphincters of the tract, as well as in the anterior stomach.

B- phasic contractions motility :-

It's a periods of both relaxation and contraction, occurring in the posterior stomach and the small intestine, and are carried out by the muscularis externa, these patterns of GI contraction as a whole can be divided into two distinct patterns.

- 1. Peristalsis** : The contractions occur directly behind the bolus of food that is in the system, forcing it toward the anus into the next relaxed section of smooth muscle.
- 2. Segmentation** : This process is carried out by the longitudinal muscles relaxing while circular muscles contract at alternating sections thereby mixing the food. This mixing allows food and digestive enzymes to maintain a uniform composition.

2- Secretion

- Every day, seven liters of fluid are secreted by the digestive system. This fluid is composed of four primary components: ions, digestive enzymes, mucus, and bile. About half of these fluids are secreted by the salivary glands, pancreas, and liver, which compose the accessory organs and glands of the digestive system. The rest of the fluid is secreted by the GI epithelial cells.
- Release of substances to enhance breakdown of food called **digestive juices** which contended from enzymes, bile salts, mucus, etc. released by exocrine glands into GI tract.
-
- Must break bonds with enzymes (various organs) Enzyme function aided by
 - HCl (stomach)**
 - Bile (liver)**
 - NaHCO₃ (pancreas)**

3- Digestion

Physical and chemical break down nutrients into absorbable unit

1- Physical digestion (chewing, mixing)

2- Chemical digestion (enzyme catalyzed)

polysaccharides → monosaccharides

proteins → amino acids

fats → glycerol + fatty acids

3- Digestion

A. Carbohydrate (polysaccharides) metabolism:-

- The carbohydrates (starch) breakdown in to oligosaccharides by pancreatic amylase, but the other carbohydrates pass undigested into the large intestine and further handling by intestinal bacteria.
- The most poly-saccharides, such a scellulose, are not digested at all, despite being made of multiple glucose units.

3- Digestion

B. Protein metabolism:-

The biochemical processes responsible for the synthesis of proteins and amino acids, and the breakdown of proteins (and other large molecules, too) by catabolism. Which is the breakdown of proteins into amino acids and simple derivative compounds, for transport into the cell through the plasma membrane and ultimately for new proteins via the use of ribonucleic acids (RNA) and ribosomes, or undergo amino acid catabolism to be converted to other compounds via the Krebs cycle

3- Digestion

C- Lipid metabolism

- The lipids (fats) are degraded into fatty acids and glycerol.
- The pancreatic lipase breaks down triglycerides into free fatty acids and monoglycerides.

4- Absorption

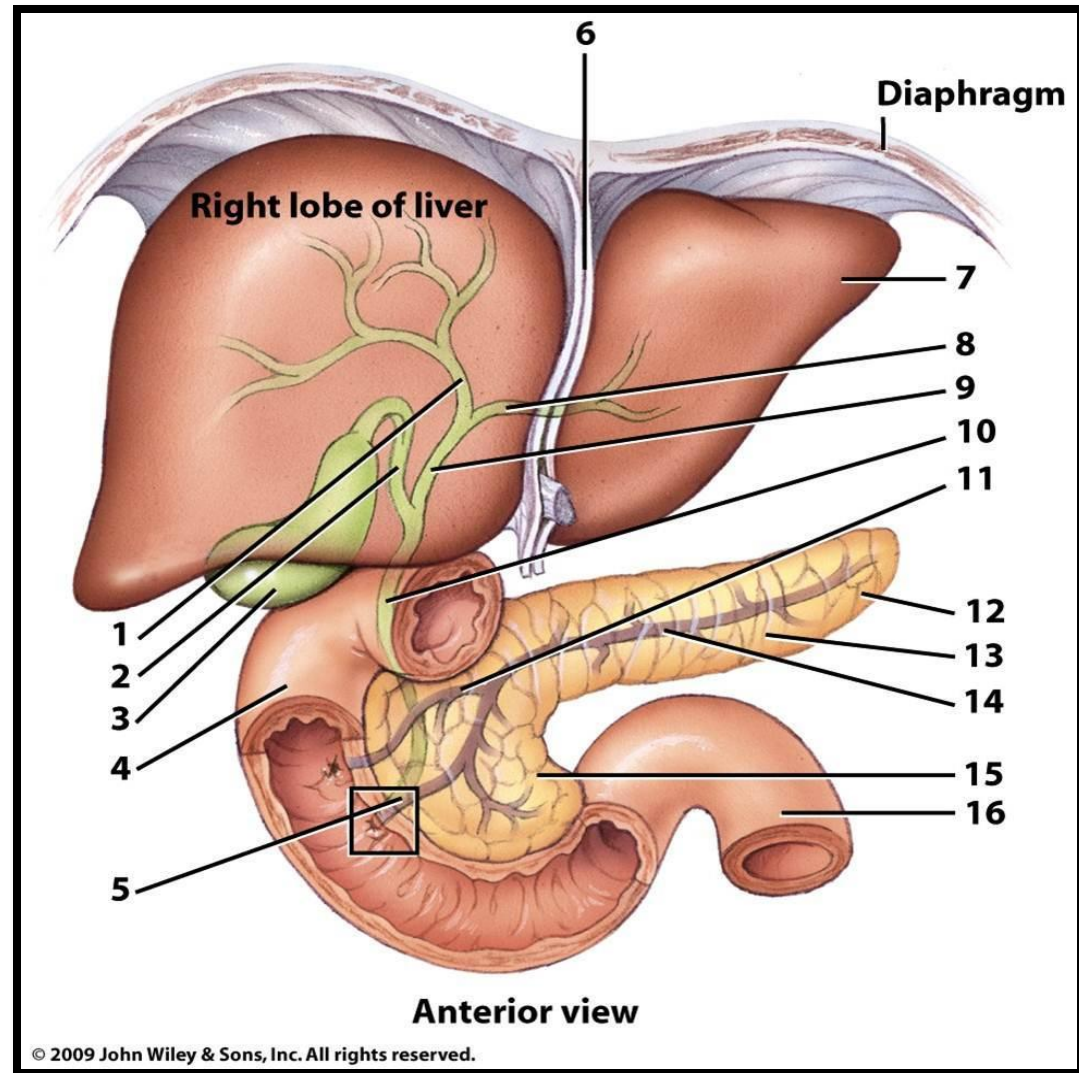
- Digested food is now able to pass into the blood vessels in the wall of the intestine through either diffusion or active transport.
- The small intestine is the site where most of the nutrients from ingested food are absorbed. The inner wall, or mucosa, of the small intestine is has finger-like pieces of tissue called villi .
- The functions of the villi are to increase the amount of surface area available for the absorption of nutrients,
- Each villus has a network of capillaries and fine lymphatic vessels called lacteals close to its surface. The epithelial cells of the villi transport nutrients from the lumen of the intestine into these capillaries (amino acids and carbohydrates) and lacteals (lipids).
- The absorbed substances are transported via the blood vessels to different organs of the body where they are used to build complex substances such as the proteins required by our body.
- The material that remains undigested and unabsorbed passes into the large intestine.
- Absorption of the majority of nutrients takes place in the jejunum.

Absorption

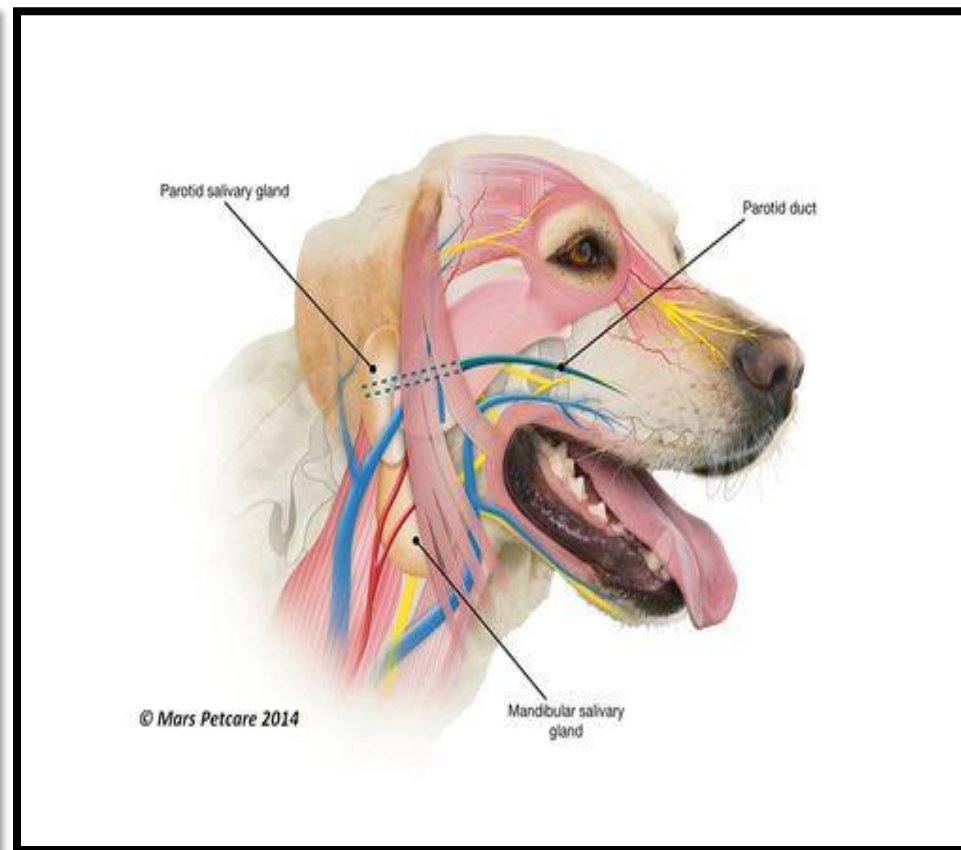
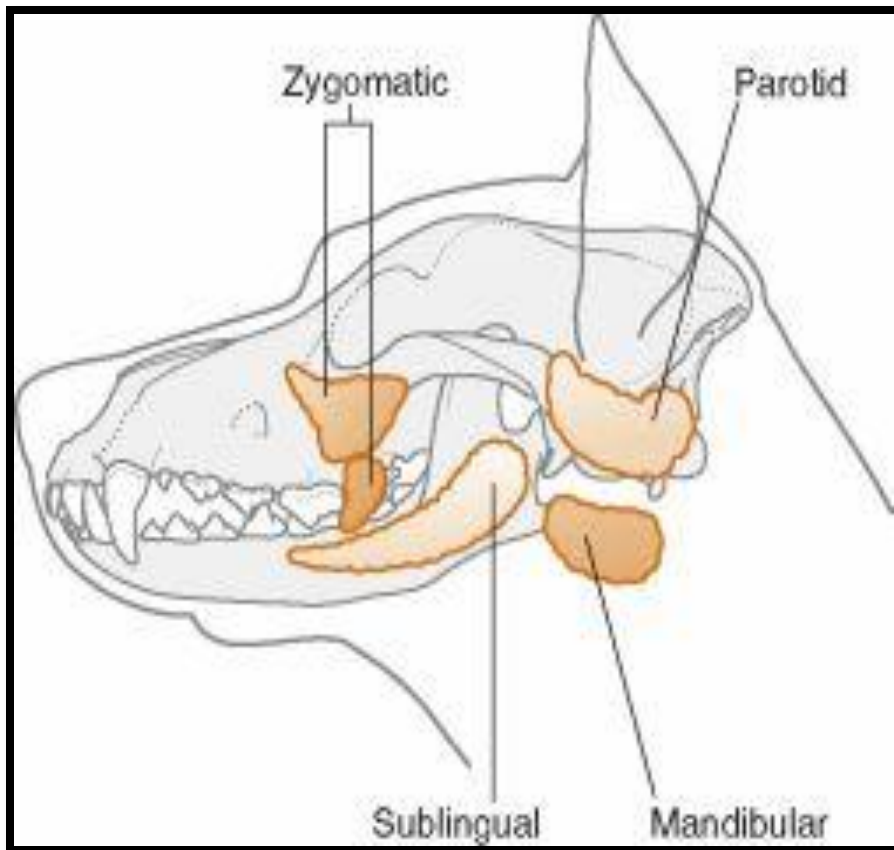
- The Carbohydrates and Proteins digested into monosaccharides and amino acids / small peptides and transported into blood entering hepatic portal system.
- The pancreatic lipases break emulsified fat → free fatty acids and monoglycerides to absorbed by intestinal epithelium, and reform the triglycerides in this epithelial cells to → combined with protein to form *chylomicrons which* released into submucosa → lymphatic system → transported to blood

Accessory organs

1. salivary glands
2. pancreas
3. liver
4. gall bladder



salivary glands



- The **salivary glands** in mammals are exocrine glands, glands with ducts, that produce saliva , amylase and digestive enzyme that breaks down starch into maltose and glucose.

Salivary glands

- 1. Parotid glands :-** Its a pair of major salivary glands wrapped around the mandibular ramus in humans. It is the serous type of gland
- 2. Submandibular glands:-** Its a pair of major salivary glands located beneath the lower jaws, superior to the digastric muscles. The secretion produced is a mixture of both serous fluid and mucus.
- 3. Sublingual glands :-**Its a pair of major salivary glands located inferior to the tongue. The secretion produced is mainly mucous in nature
- 4. Minor salivary glands:-** There are 800-1000 minor salivary glands located throughout the oral cavity within the submucosa of the oral mucosa.

The Saliva

The Saliva is a watery substance located in the mouths of humans and animals, secreted by the salivary glands. The saliva is 99.5% water, while the other 0.5% consists of electrolytes, mucus, glycoproteins, enzymes, antibacterial,

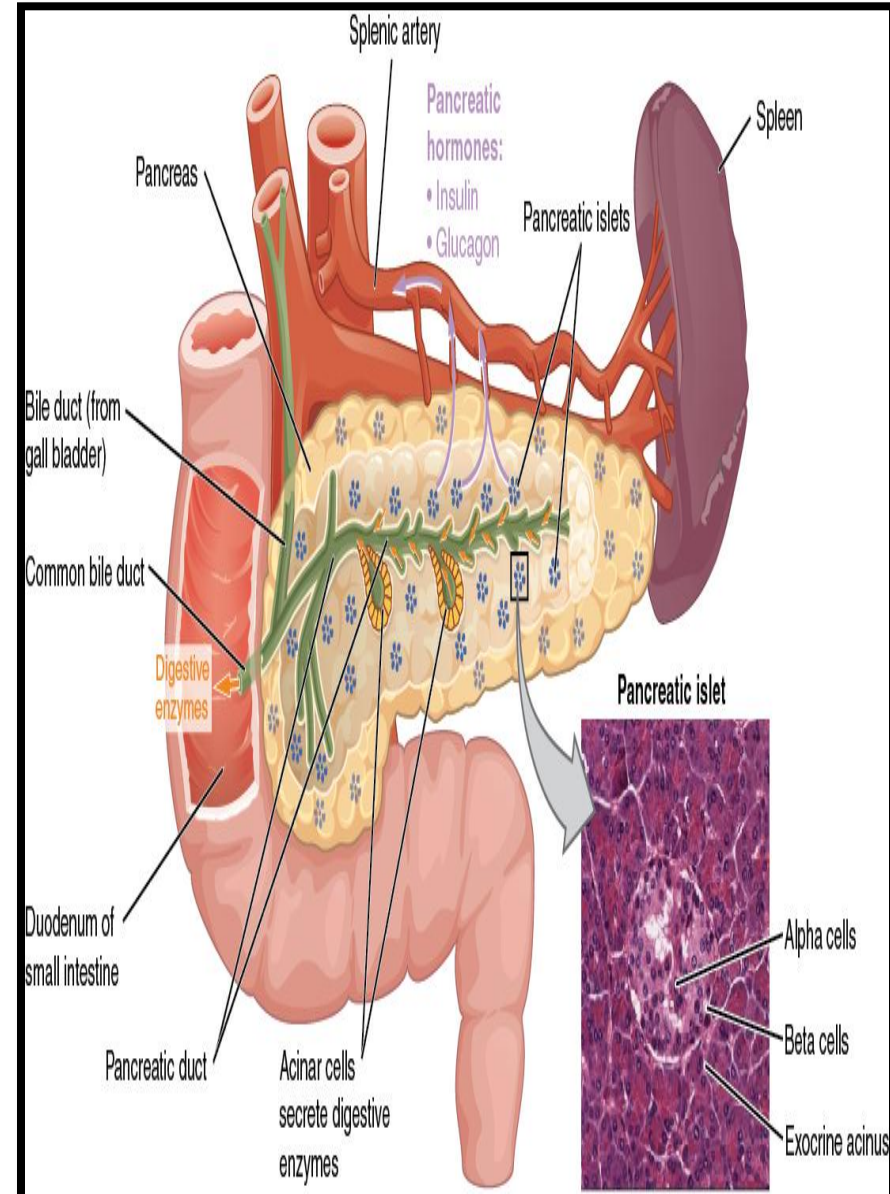
Functions

1. **Maintenance of oral hygiene.**
2. **Lubricant of the **bullets**.**
3. **Digestion** :. by enzyme amylase, which is breaking down starch into simpler sugars such as maltose and dextrin.
4. **Ion reservoir, buffer function** : typically pH 6.2–7.4. This prevents minerals in the dental hard tissues from dissolving.
5. **Role in taste**: Saliva secretes carbonic anhydrase (gustin).
6. **Wound licking** : The saliva can be help to heal wounds in some species.

Pancreas

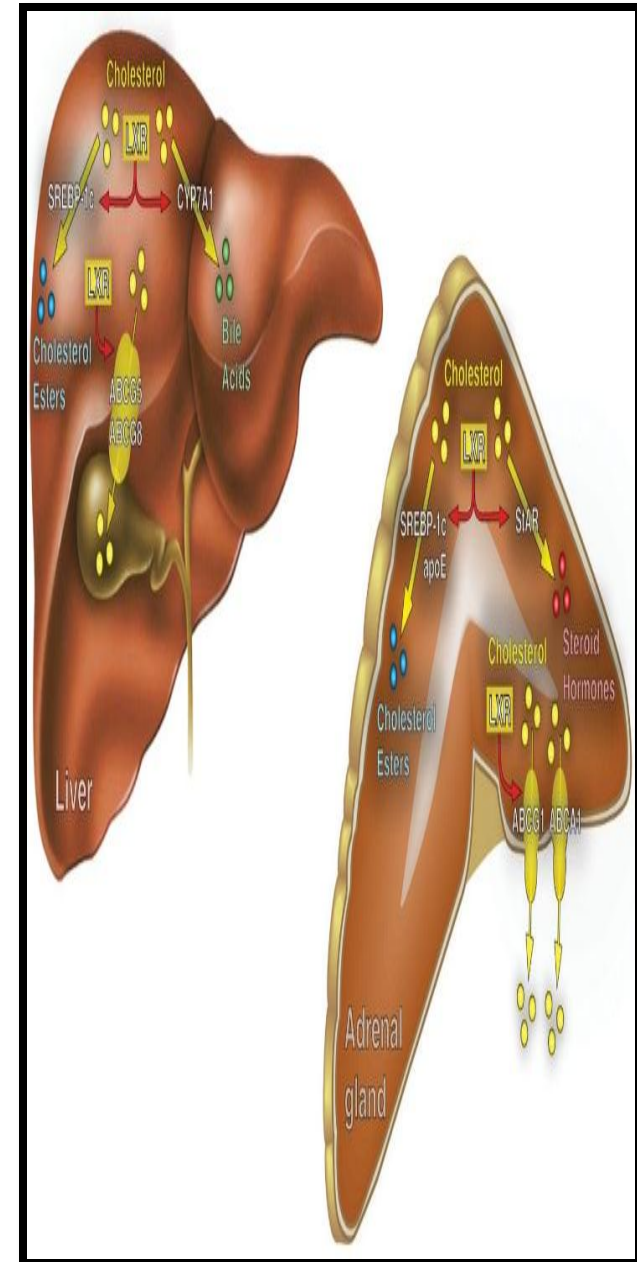
Exocrine cells secrete *pancreatic juice* into duodenum are:-

1. **Amylase** - breaks down starch
2. **Trypsinogen**- converted to trypsin by enterokinase breaks down polypeptides
3. **lipase** - digests triglycerides
4. **Proteases and Nucleases**
5. **NaHCO₃ (alkaline)** - neutralizes stomach acidity



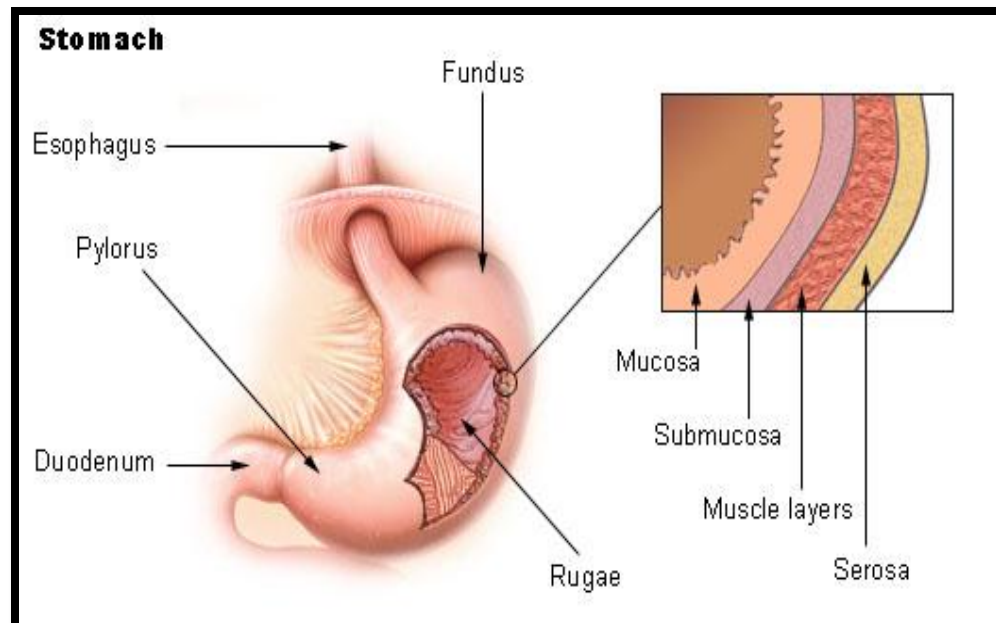
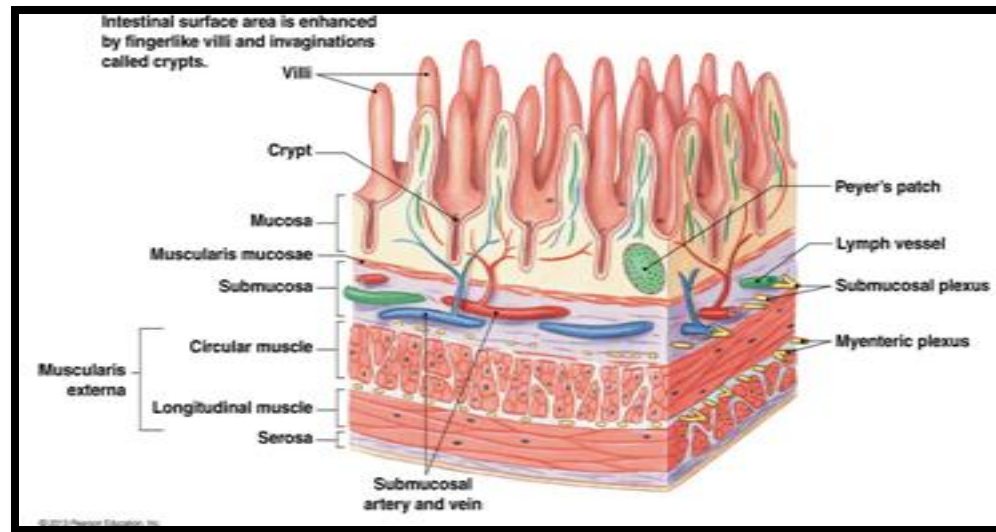
Liver

1. secretes bile
 - Stored in gall bladder, secreted into duodenum
 - Bile salts used for lipid absorption
 - Bilirubin secretion
2. metabolic processing of absorbed materials
 - Nutrient-rich blood from villi flows into *hepatic portal system*
 - processed by liver prior to general circulation
3. degradation of waste, hormones and drugs.
4. synthesizes plasma proteins
5. stores glycogen, fats, minerals and vitamins



Gastrointestinal Tract Structure

- **Mucosa** (lumen side)
 - Epithelial tissue.
- **Submucosa**
 - Elastic connective tissue contains lymph and blood vessels.
- **Muscularis**
 - Smooth muscle.
- **Serosa**
 - Outer layer of connective tissue
 - Secretes serous fluid



1- Mouth

Ingestion

- Bringing food into the body
- Tongue taste buds detect chemical composition of food

Mastication

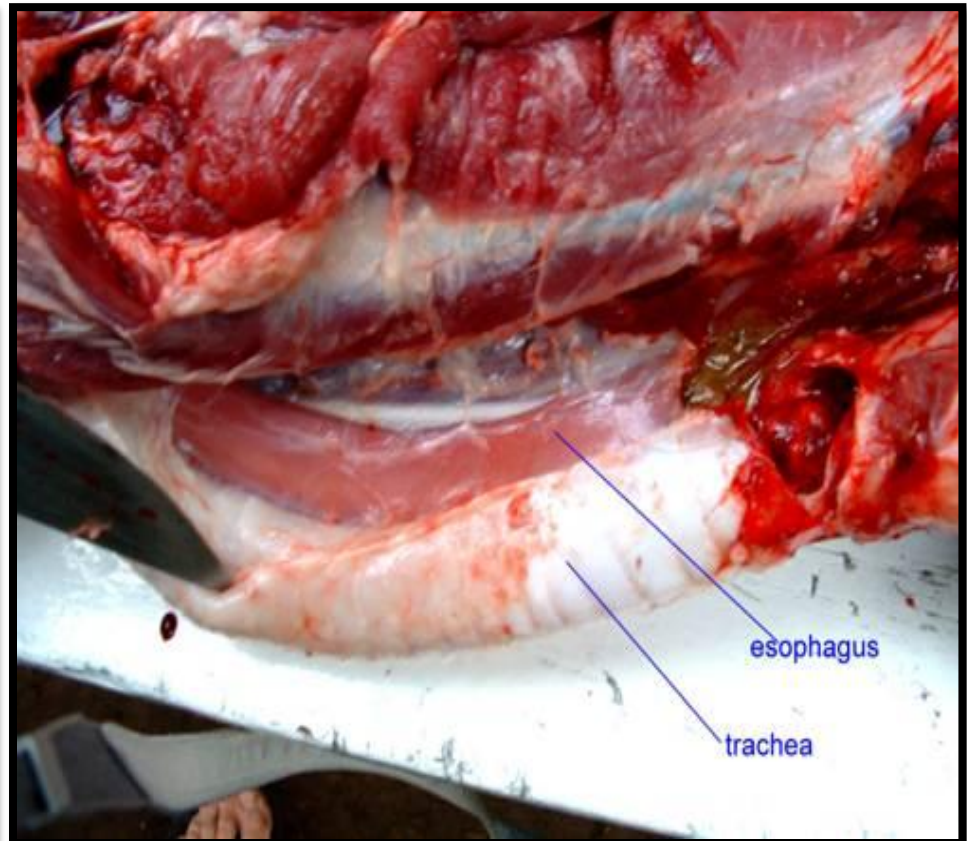
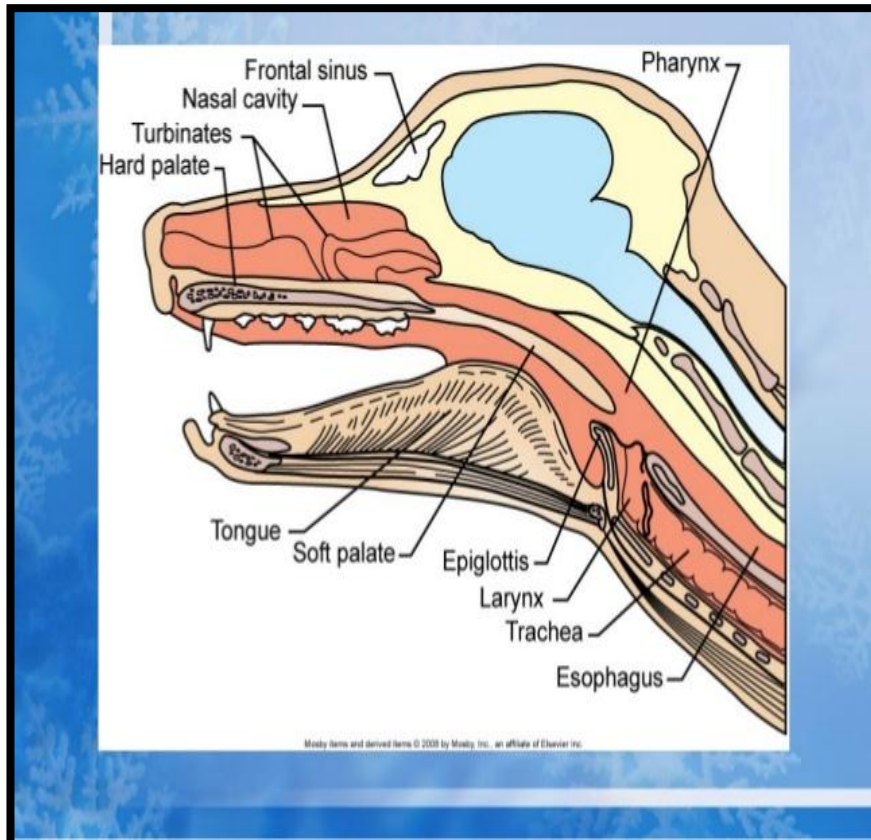
- Chewing (physical digestion) by teeth and tongue

Chemical digestion

- Saliva which moistens food, *amylase* - breaks down starch into maltose and *lysozyme* - antibacterial agent

2- Pharynx and Esophagus

- Transport food and water to stomach, secretes mucus
 - **deglutition** (swallowing) reflex moves food to stomach
- Movement of food bolus in esophagus (and rest of GI tract) via peristalsis



3- Stomach

- The **stomach** is a muscular, hollow, dilated part of the digestive system which functions as an important organ of the digestive tract in vertebrates. It is involved in the second phase of digestion, following mastication (chewing).
- It secretes protein-digesting enzymes called proteases and gastric acid to aid in food digestion.
- Through the smooth muscular contractions before sending partially digested food (chyme) to the small intestines.

Stomach Mucosal Cells

1- Goblet cells (mucus neck cells):

– Sec. of the Mucus

The Gastric Mucosal Barrier → Mucus that protects stomach epithelium

2- Parietal cells:

– Sec. of the gastric acid HCl → Kills bacteria and denatures proteins

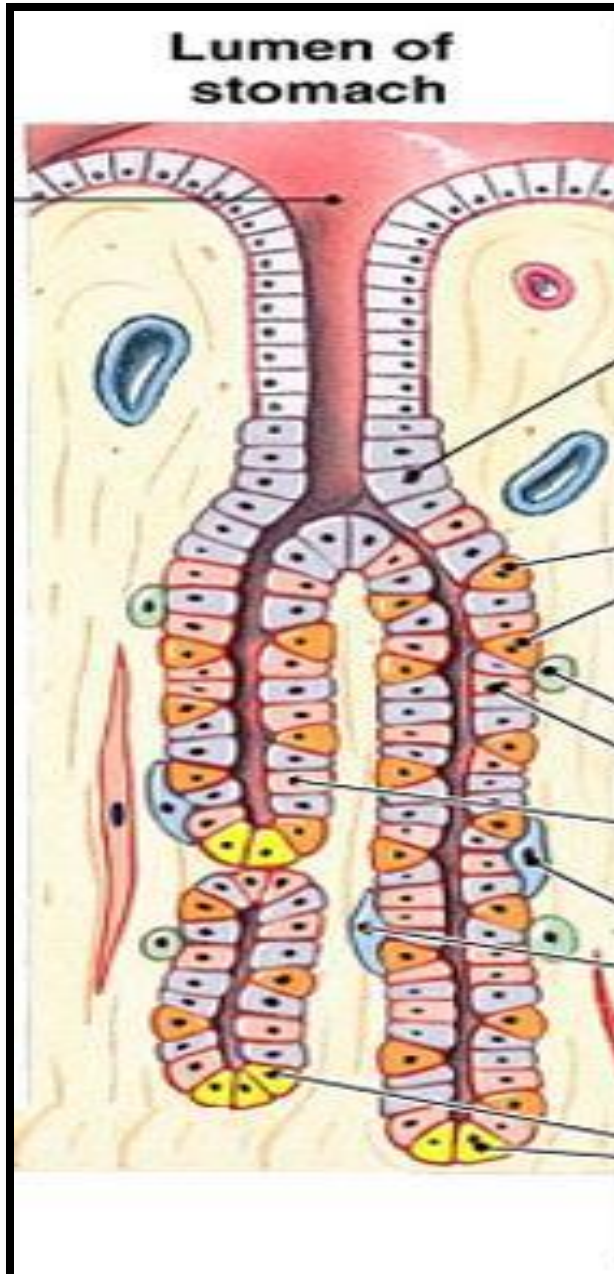
_ Sec. of Intrinsic factor (Ca⁺⁺ absorption)

3- Chief cells :

Sec. of the Pepsinogen & Gastric lipase

Pepsinogen activated by HCl → pepsin which breaks down proteins

Stomach Mucosal Cells



The diagram illustrates the stomach mucosal cells lining the lumen. The lumen is the central cavity where food is processed. The cells are arranged in a columnar pattern, with different types of cells secreting various substances into the lumen. The cells are color-coded: mucous neck cells (pink), parietal cells (orange), enterochromaffin-like cells (green), chief cells (yellow), D cells (blue), and G cells (purple).

<i>Cell Types</i>	<i>Substance Secreted</i>
Mucous neck cell	Mucus (protects lining)
	Bicarbonate
Parietal cells	Gastric acid (HCl)
	Intrinsic factor (Ca ⁺⁺ absorption)
Enterochromaffin-like cell	Histamine (stimulates acid)
Chief cells	Pepsin(ogen)
	Gastric lipase
D cells	Somatostatin (inhibits acid)
G cells	Gastrin (stimulates acid)

Ruminant

- **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.
- The process typically requires the fermented ingesta (cud) to be regurgitated and chewed again.
- The process of rechewing the cud to further break down plant matter and stimulate digestion is called **ruminatio**n.
- Ruminating mammals include cattle, goats, sheep, giraffes, yaks, deer.



Ruminant

1-The Rumen:-

It's a larger part of the reticulorumen, which is the first chamber in the alimentary canal of ruminant animals. It serves as the primary site for microbial fermentation of ingested feed.

2- Reticulum:-

It's smaller part, and a first chamber in the alimentary canal of a ruminant animal. When cleaned and used for food, it is called "tripe".

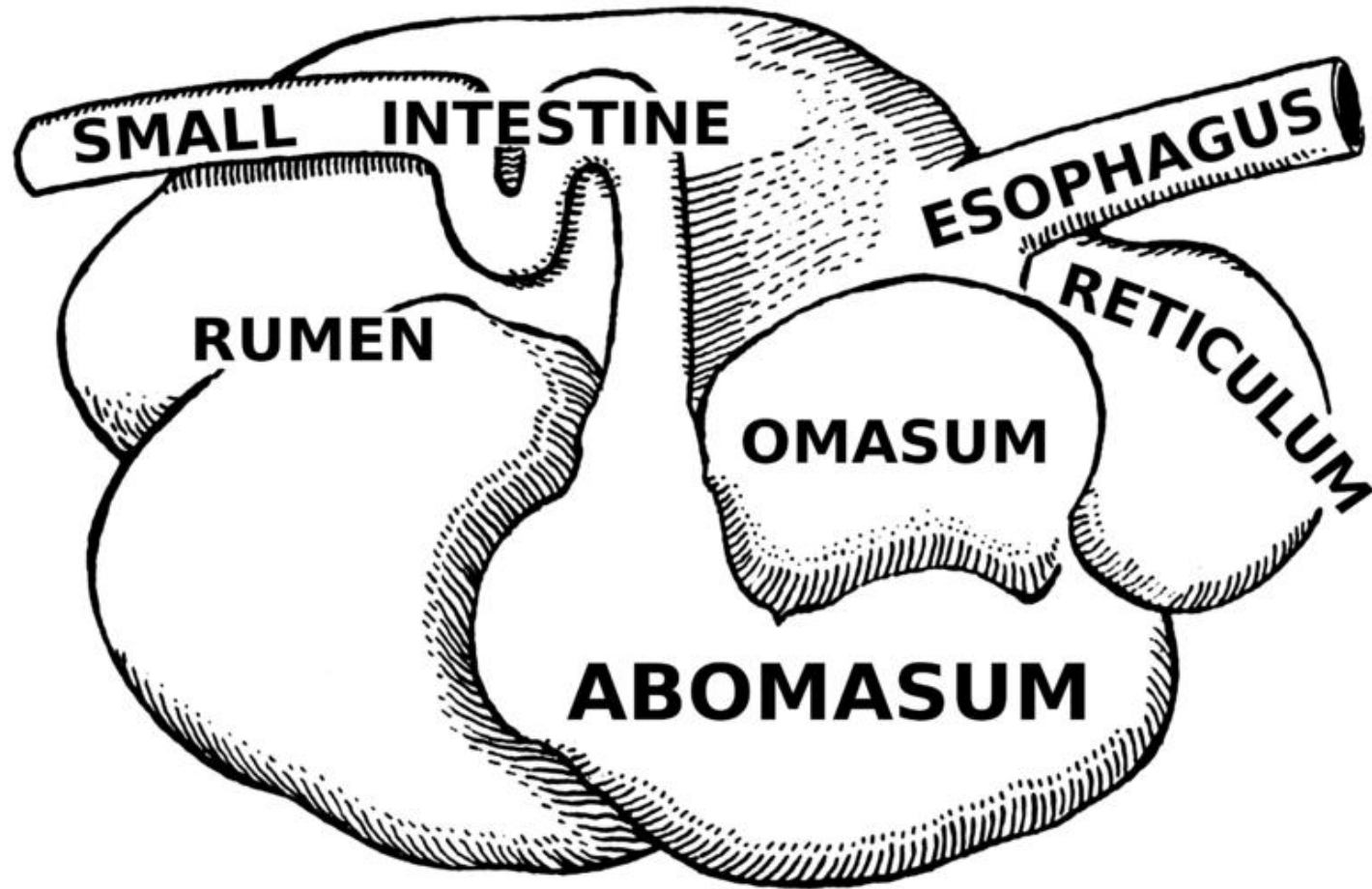
3- Omasum :-

Its functions are absorption of water, magnesium, and the volatile fatty acids produced by rumen fermentation, that have not been absorbed into the bloodstream.

4- Abomasum:-

It is a secretory stomach similar in anatomy and function as the monogastric stomach. It serves primarily in the acid hydrolysis of microbial and dietary protein, preparing these protein sources for further digestion and absorption in the small intestine.

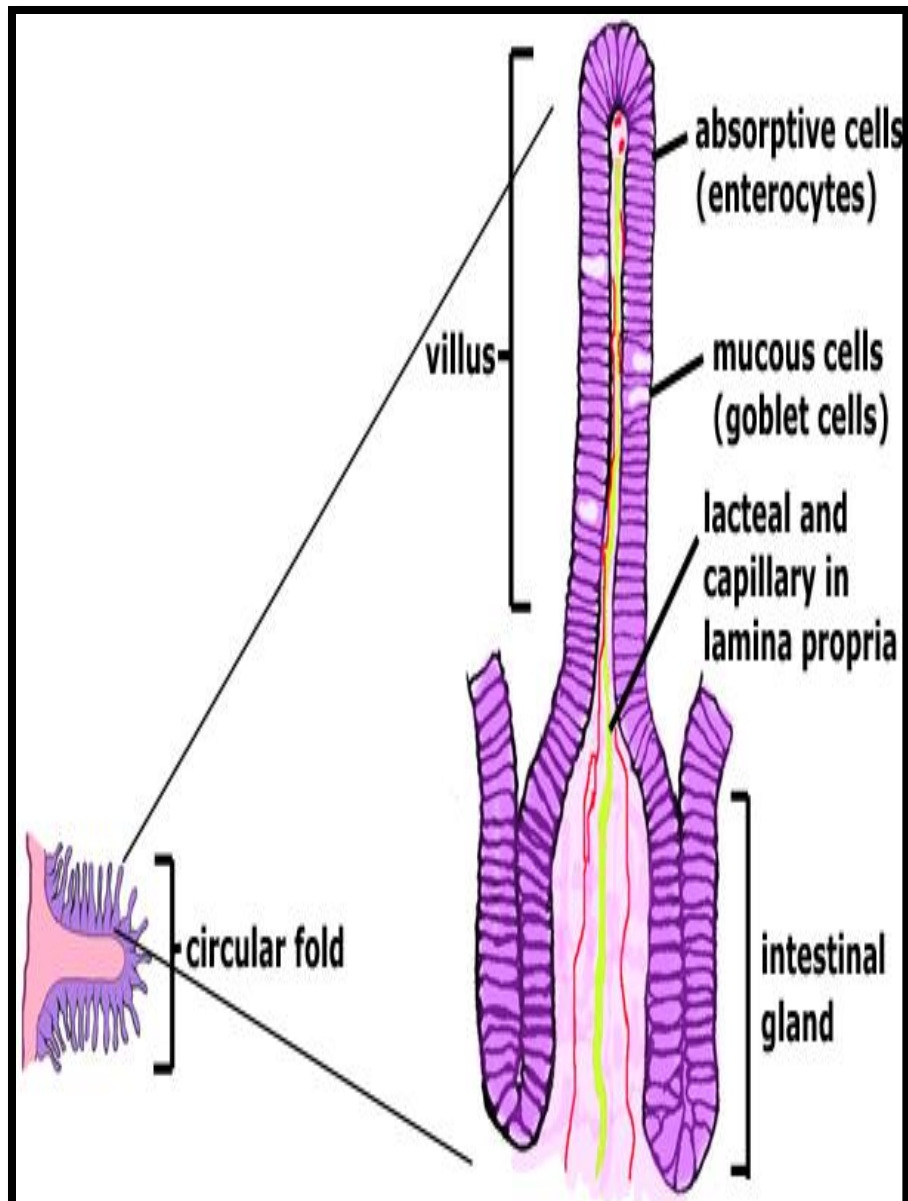
Ruminant



Small Intestine

- The **small intestine** or **small bowel** is the part of the gastrointestinal tract between the stomach and the large intestine, and is where most of the digestion and absorption of food takes place. The small intestine has three distinct regions – the duodenum, jejunum, and ileum. The duodenum receives bile and pancreatic juice through the pancreatic duct, controlled by the sphincter of Oddi. The primary function of the small intestine is the absorption of nutrients and minerals from food.
- Most chemical digestion occurs here and most absorption occurs here
- Large surface area
 - Plicae – folds in mucosa
 - Villi – fingerlike projections
 - Capillaries, central lacteal (absorption)
 - Microvilli ("brush border") on epithelium
 - hydrolyze disaccharides, polypeptides, etc. (*enterokinase* - activates trypsin (pancreatic enz.)

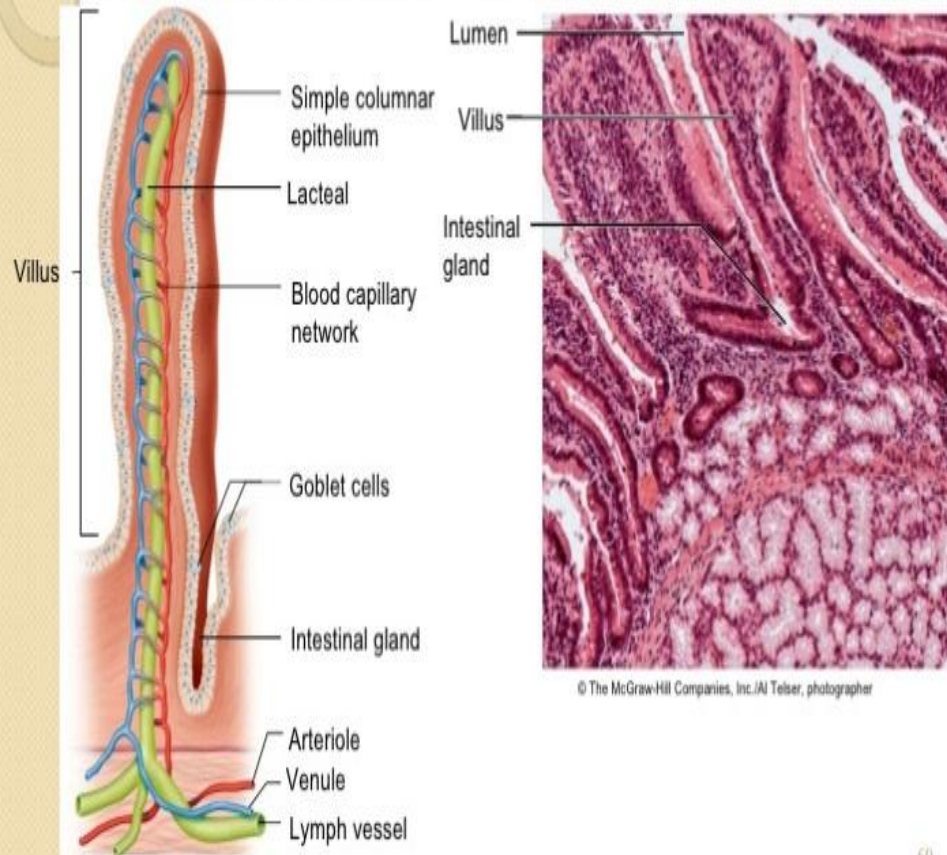
Small Intestine



Structure of the Small Intestinal Wall

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Large Intestine

- The **large intestine**, also called the **large bowel**, is the last part of the digestive system in vertebrates. Water is absorbed here and the remaining waste material is stored as feces before being removed by defecation.
- combination of the cecum, colon, rectum, and anal canal, it begins in the right iliac region of the pelvis, just at or below the waist, where it is joined to the end of the small intestine. It then continues up the abdomen, across the width of the abdominal cavity, and then down to its endpoint at the anus.
- main function is to store undigested material (feces)
- 30% dry weight of feces = bacteria (E. coli) live in large intestine (produce vitamin K)
-