DIGESTIVE SYSTEM OF CATTLE

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A. Classification of animals based on their diet

Generally, animals are classified into groups based on their type of diet.

1) Herbivores **-** Animals that consume primarily plant materials.

2) Carnivores - Animals that eat other animals.

3) Omnivores **-** Animals that eat a combination of plant and animal matter.

B. Classifying animals based on their digestive physiology

1) Non-ruminant animals

Non-ruminant animals, or monogastrics, are animals with a single-chambered stomach, unlike the multi-compartment systems of ruminants. They rely on enzymatic digestion rather than fermentation to break down food, making them efficient at digesting concentrates rather than high-fiber forage. Examples include pigs, poultry, horses, dogs, and humans.

2) Ruminant animals

A ruminant is a hoofed, herbivorous mammal that digests plant-based food by softening it within a specialized four-compartment stomach, then regurgitating the semi-digested mass (cud) and chewing it again.

Ex. Cattle, sheep, goats, deer, giraffes.

1) They are called Ruminants, because they ruminate **(chew the cud).**

2) There are major modifications of the GI tract relating to the stomach area, which is divided into four compartments

3) A few species ‘s stomach has only three compartments (Omasum absent), thus classified as pseudo-ruminants. Ex. Camel

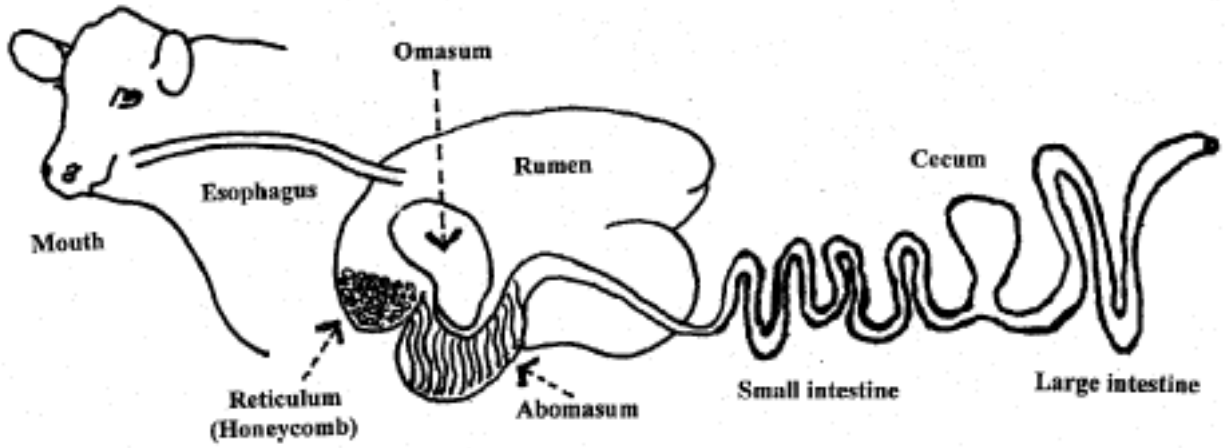
4) In herbivores, 20% or more of the diet may consist of substances that can be digested only by the action of microorganisms.

5) Ingested feed is subjected to very extensive pregastric microbial fermentation:

a) Most of the ingesta (60 to 75%) are fermented by microbes before being exposed to the gastric and intestinal digestive processes.

b) Thus, very different system vs a typical non-ruminant animal.

6) The symbiotic relationship between microorganisms and host is developed to the highest degree in ruminants simply because the rumen provides the favorable environment.



MOUTH

The mouth of ruminants is a specialized for the grazing and efficient plant fiber digestion, Characterized by lacking of upper incisors and using a **upper dental pad** instead, alongside strong chewing pre-molar and molar teeth. The use their strong tongues and lower teeth to tear, rather than bite, food which is later re-chewed as cud, lubricated with high volumes of saliva.

Mouth performs ***prehension*** which Refers to seizing and conveying of food to the mouth. Vary among different animals, but the lips, teeth, and tongue are the principal organs of this function.

ESOPHAGUS

The ruminant oesophagus is a specialized mascular tube that facilitates bidirectional transport of feed, allowing ruminants to move food from the mouth to rumen and regurgitate "cud" back to the mouth for further chewing. It is made up of four layers - a) an outer connective tissue, b) a layer of muscle, c) submucosa, and d) mucosa.

The bolus can be moved in both directions in the ruminants, and the process is called "rumination."

STOMACH

1. Rumen

The rumen is the largest compartment of the cow's stomach. Fiber, starch, sugar, and proteins are fermented by the microbes (Bacteria, Protozoa and fungi) to form volatile fatty acids (VFA), microbial protein and gases such as CH_4, NH_3, CO_2. The capacity of an adult dairy cow's rumen is about **184 liters (49 gallons)** and the reticulum is about **16 liters (4.25 gallons**). There

are1,000,000,000 to 10,000,000,000 bacteria per ml, 1,000,000 protozoa per ml, and a variable amount of fungi. The cow does not secrete any of her own acids or digestive enzymes in the rumen. Rather, all rumen digestion is done by the microbes. It is because of the rumen and its microbes that dairy cows can digest plant fibers, such as hemicellulose and cellulose. This allows the dairy cow to convert forages and industrial byproducts that humans cannot digest into nutritious foods for humans. Mammalian enzymes and acids cannot digest fiber. The rumen wall (or mucosa) is a major site of nutrient absorption. It is convoluted to give it tremendous surface area for absorption. **Rumen papillae** (thousands of finger-like projections on the inside surface of the rumen) are responsible for absorbing the volatile fatty acids from the rumen for use by the cow. Volatile fatty acids (VFA's) are absorbed from the rumen and used as an energy source for the cow. Microbial protein (the actual bodies of the microbes) is not absorbed from the rumen. It absorbed from the cow's intestine and is used as a source of quality protein for the cow.

2. Reticulum

The reticulum is located in front of the rumen and it is known for its characteristic **"honeycomb"** surface. The capacity of an adult dairy cow's reticulum is about **16 liters (4.25 gallons**). If a cow accidentally eats hardware, such as screws or nails, it usually ends up lodged at the bottom of the reticulum. If the hardware punctures through the reticulum wall, it causes the often deadly "hardware disease".

3. Omasum

The omasum is the third stomach compartment. It holds only about 8 liters (2 gallons) in the adult cow. It is made of many **"leaves" of tissue** which serve to absorb water for the cow. These leaves also work as a filtration system for the cow to only allow fine particles of digested feed and some fluid to pass on to the abomasum.

4. Abomasum

The abomasum is the fourth stomach compartment. It is also called the **"true stomach".** It holds about 27 liters (7 gallons). This compartment has basically the same function as the stomach in simple stomached (monogastric) animals, such as pigs and humans. It is here that the cow's own stomach acids and enzymes are used to further breakdown ingested feed before it passes into the small intestine.

THE SMALL INTESTINE

- The small intestine is divided into three parts, **duodenum, jejunun and ileum**, because histological or microscopic structural difference.
- The doudenum is the first part of the small intestine. It is closely attached to the body by a short mesentery, the mesoduodenum. Ducts from the pancreas and liver enter the first part of the duodenum.

- The jejunum is indistinctly separated from the duodenum. It begins approximately where the mesentery starts to become rather long. The jejunum and ileum are continuous, and there is no gross demarcation between them.
- The ileum is the last part of the small intestine. It enters the large intestine at the leo-ceco colic junciion.
- The small intestine is the chief site of absorption in most of the domestic animals. The mucus membrane of only the small intestine consists of numerous tiny finger 1ike projections known as **villi**. Animals with the most rapid digestive and absorptive processes have a more highly developed system of villi to provide a greater surface area for absorption. Each villus is further surrounded by innumerable fingerlike projections known as **microvilli** for the sake of unimaginable greater surface area for the absorption of nutrients. Villi undergo rhythmic (pumping) contractions, pendulum movements and tonic contractions and is controlled by a hormone, villikinin and thus aids in absorption
- The duodenum receives both bile from the gall-bladder and pancreatic secretions from the pancreas via a duct which at the point of entry into the duodenum is common to both organs since the bile duct and pancreatic duct fuse some 2-3 cm from this point.
- Bile consists largely of bile acids and bile pigments, with small amounts of cholesterol, leci thin, electrolytes and protein.
- The secretions of the pancreas include the proteolytic enzymes trypsinogen (converted to the active form, trypsin, by enterokinase secreted by the duodenum), chymotrypsinogens and pro- carboxypeptidases (both activated by trypsin) and carboxypeptidase. Proteolytic enzyme constitute some 70% of the total protein secreted by bovine pancreas. Also present in the pancrea- tic secretions are DNA ase, RNA ase, pancreatic lipase. These enzymes together with the pepsin secreted by the abomasum are responsible for the degradation of the microbial cells entering the region of the gastro intestinal tract posterior to the reticulo-rumen and also of the feed protein which have escaped reticulo-ruminal degradation (bypass amount).

LARGE INTESTINE-

- In the ruminant the large intestine consists of the **cecum colon and rectum**.
- This cecum has one blind end that projects caudally. Cranially, it is continuous with the colon. This junction is marked by the entrance of the ileum at the ileo-ceco-colic orifice.
- The colon passes forward between the two layers of mesentary which support the smalI intestine. Here it is arranged in coils, the **ansa spiralis**.
- After leaving the ansa spiralis the colon crosses to the left side and continues caudally to the **rectum and the anus**, the terminal part of the digestive tract.

ACCESSORY DIGESTIVE ORGANS

The Salivary Glands

- The main salivary glands consist of three pairs of well defined glands viz., **parotid, mandibular, and sublingual.**

- The other salivary glands include labial, buccal, lingual and palatine glands. The dog has also a zygomatic salivary gland near the eye.
- The secretion of the saliva in ruminants is continuous, but the rate is greatly increased by stimuli associated with feeding, rumination and the presence of coarse feeds. An adult human may produce about 1.5-2 liters of saliva daily. In cattle total volume may range from 100-- 200 liters per day or sometimes equivalent to the volume of the rumen.
- The saliva of rumjnants tends. to be slightly alkaline (pH about 8).
- Contains **no enzymes**, but has an additional importance, i.e., provides N, P, Na for rumen microbes.
- Also, highly buffered (particularly rich in HCO3 & PO4), which aid in maintaining an appropriate pH in the rumen.

The uses of saliva in digestion are manyfold, including the following

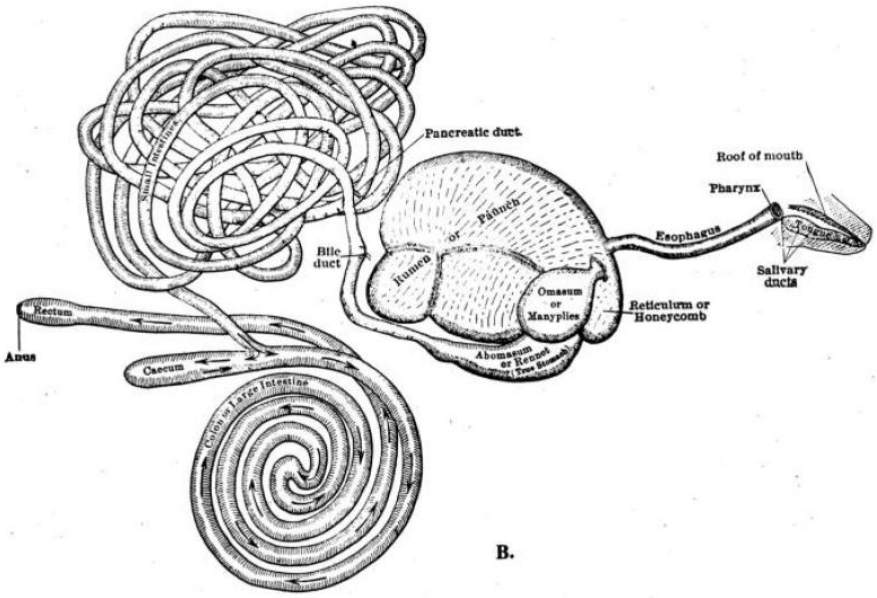
1. Lubricant
2. Buffering capacity
3. Nutrients for rumen microorganiems- Saliva contains considerable amounts of urea mucin, phosphorus, magnesium and chloride which all are utilised by rumen microbes.
4. Prevention ot frothing- Gas can accumulate in the rumen and may cause bloat condition when eruction process is impaired. Saliva -acting as a surfactant
5. Taste-
6. Protection- The membrane within the mouth must be kept moist

The Pancreas

The second main accessary digestive gland is the pancreas. It weights 350 to 500 gram in the ox, and 50-70 gram in the sheep and goat. The pancreas is a dual organ. Its exocrine portion forms the great maSs of the gland and secretes pancreatic juice into the duodenum. The endocrine tissue consists of the tiny spherical islets of langerhans which account for less than 1% of the whole. The mixed exocrine and endocrine gland is elongated. The pancreas is a soft, lumpy organ with a large head, long body and tapering tail.

The Liver and Biliary System

The liver is the largest gland in the body. It is an important organ of intermediate metabolism. It has also an exocrine section, the bile, which is conveyed to the duodenum by the ducts of the liver, which convey bile from and within the liver to duodenum, and the gall bladder which stores and concentrates bile. All domestic animals **except the horse** have this gall bladder.


Pancreatic duct
Roof of mouth
Pharynx
Bile duct
Esophagus
Salivary ducts
Rumen
Omasum or Manyplies
Reticulum or Honeycomb
Abomasum or Rennet
Rectum
Anus
Caecum
Colon or Large Intestine

B.