Ruminant Digestive Function

Ruminant livestock include cattle, sheep, and goats. Ruminants have a unique digestive system that allows them to better utilize energy from fibrous plant material than other herbivores. Unlike monogastrics such as Horse, swine and poultry, ruminants have a digestive system designed to ferment feedstuffs and provide precursors for energy for the animal to utilize use of high roughage feedstuffs such as forages.

Anatomy of the ruminant digestive system includes the mouth, tongue, salivary glands, esophagus, 4- compartment stomach (rumen, reticulum, omasum, and abomasum), pancreas, gall bladder, small intestine, and large intestine.

A ruminant uses its mouth and tongue to harvest forages during grazing or to consume harvested feedstuffs. Cattle harvest forages during grazing by wrapping their tongue around the plants and then pulling to tear the forage for consumption. On average, cattle take from 25,000 to over 40,000 bites to harvest forage while grazing each day. They typically spend over one-third of their time grazing, one-third of their time ruminating (cud chewing), and slightly less than one-third of their time idling where they are neither grazing nor ruminating.

The roof of the ruminant mouth is a hard/soft palate without incisors. The lower jaw incisors work against this hard dental pad. Saliva aids in chewing and swallowing, contains enzymes for breakdown of fat and starch, and is involved in nitrogen recycling to the rumen. Saliva's most important function is to buffer pH levels in the reticulum and rumen. A mature cow produces up to 50 quarts of saliva per day, but this varies depending on the amount of time spent chewing feed, as that stimulates saliva production.

Ruminants eat rapidly, swallowing much of their feedstuffs without chewing. The esophagus functions bi-directionally in ruminants allowing them to regurgitate their cud for further chewing, if necessary. The process of rumination or "chewing the cud" is when forage and other feedstuffs are forced back to the mouth for further chewing and mixing with saliva. This cud is then re swallowed and passed into the reticulum. Then the solid portion slowly moves into the rumen for fermentation while most of the liquid portion rapidly moves from the reticulorumen into the omasum and then abomasum. The

solid portion left behind in the rumen typically remains for up to 48 hours and forms a dense mat in the rumen where microbes can use the fibrous feedstuffs to make precursors for energy.

The ruminant stomach occupies almost 75 percent of the abdominal cavity, filling nearly all of the left side and extending significantly into the right side. The rumen is the largest stomach compartment, holding up to 40 gallons in a mature cow. The reticulum holds approximately 5 gallons in the mature cow. Typically, the rumen and reticulum are considered one organ because they have similar functions and are only separated by a small muscular fold of tissue. The omasum and abomasum hold up to 15 and 7 gallons, respectively, in the mature cow.

The rumen is home to a population of microorganisms that 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. The animal for energy later uses these VFAs.

The reticulum called the "honeycomb" because of the honeycomb appearance of its lining. It sits underneath and towards the front of the rumen lying against the diaphragm. Ingesta flow freely between the reticulum and rumen. 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 ruminant consumes a nail, wire, or other sharp heavy object, it is very likely that the object will be caught in the reticulum.

The rumen lined with papillae for nutrient absorption and divided by muscular pillars into sacs. The rumen acts as a fermentation vat by hosting microbial fermentation. About 50 to 65 percent of starch and soluble sugar consumed is digested in the rumen. Rumen microorganisms (primarily bacteria) function:

- Digest cellulose from plant cell walls,
- Digest complex starch,
- Synthesize protein from non-protein nitrogen,
- Synthesize B vitamins and vitamin K.

Rumen pH typically ranges from 6.5 to 6.8. The rumen environment is anaerobic

(without oxygen). Gases produced in the rumen include carbon dioxide, methane, and hydrogen sulfide. The gas fraction rises to the top of the rumen above the liquid fraction. The omasum is spherical in shape and connected to the reticulum by a short tunnel. It contain many folds or leaves which resemble pages of a book. These folds increase the surface area, which increases the area that absorbs nutrients from the feed and water. Water absorption occurs in the omasum. The abomasum is the “true stomach” of a ruminant. The compartment is most similar to a stomach in a non-ruminant. The abomasum produces hydrochloric acid and digestive enzymes such as pepsin (breaks down proteins) and receives digestive enzymes secreted from the pancreas such as pancreatic lipase (breaks down fats). These secretions help prepare proteins for absorption in the intestines. The pH in the abomasum generally ranges from 3.5 to 4.0. The abomasum secretes mucous to protect its wall from acid damage. The small and large intestines follow the abomasum as further sites of nutrient absorption. The small intestine is a tube up to 150 feet long with a 20-gallon capacity in a mature cow. Digesta entering the small intestine mix with secretions from the pancreas and liver which elevate the pH from 2.5 to between 7 and 8. This higher pH is needed for enzymes in the small intestine to work properly. Bile from the gall bladder is secreted into the first section of the small intestine to aid in digestion. The intestinal wall contains numerous "finger-like" projections called villi that increase intestinal surface area to aid in nutrient absorption. The large intestine functions to absorb water from material passing through it and then to excrete the remaining material as feces from the rectum. The cecum is a large blind pouch at the beginning of the large intestine that serves little function in a ruminant, unlike its role in horses. The colon is the site of most of the water absorption in the large intestine. Immature ruminants such as young, growing calves from birth to about 2 to 3 months of age are functionally non-ruminants. The reticular (esophageal) groove present in these young animals is formed by muscular folds of the reticulum. It shunts milk directly to the omasum and then abomasum, bypassing the reticulum and rumen. The rumen in these animals must be inoculated with rumen microorganisms. This is thought to be accomplished through mature ruminants licking calves and environmental contact with these microorganisms.

Cattle rearing

Demand for dairy and meat products is increasing worldwide. Governments encourage the milk and meat production of cattle, and sometimes also of buffaloes, sheep or goats. While some countries have a tradition of milk production and consumption, elsewhere dairy farming and the consumption of dairy products is rather new.

The difficulties faced the animal resources in Iraq:

1- Productivity of animals is low as a result of bad management and environmental factors and the genotype. Two ways to improve the productivity

a) Improve the environmental factors such as feeding, improve the quality and quantity of feed stuffs, better rearing, better management and health status.

b) Improve the genetic traits by crossing and selection.

2- Feeding : The main problem in animal rearing and caring is mal-nutrition causing deficiency as a result of low quantity and quality of feedstuff,

It should overlap the difficulties by using :

a) Natural grazing with improving the grazing land

b) Green forages should prepare and improve their qualities by using agricultural machinery, irrigation and fertilizers.

c) Concentrate diet should be used with a favorable price with better quality.

3- Animal hygiene: There is no control on many animal diseases which affect the animal productivity such as mortality or lack production, we can limited it by improving the plan for veterinary services by planning a complete program for disease protection and provide a better people and pharmacological drugs and vaccination programs.

4- Rearing and management of farm animals, to improve the productivity, best methods and systems should be used, better housing, machinery, artificial insemination.

5- People work in farm animals of low education and bad management. It needs good agronomists and veterinarians and educated people work in farm animals.

6- Marketing of animals products, should be improved by storage methods, selling, planning factories for milk and meat product.

7- Research in animal farm, should be improved by doing many researches and plans for improving animal production.

8- Agriculture rulers' is badly need more information for the owners by using radio, television, internet fairs and leaflets using records and computer.

Animal health

Taking good care of animal health does not only mean treating an animal when it is sick. It also means helping the animal to avoid becoming ill.

The effects of the disease may take longer to heal. So, production losses may continue to be suffered after the animal has seemingly recovered. Examples of such production losses are retarded growth in calves and reduced milk production of cows after illness.

❖ Disease prevention

Most diseases can be prevented by the same measures that enhance production! General preventive measures are:

- Hygiene: Cleaning and disinfecting.
- Water: Always ensure free access to clean and fresh
- Good feed and regular feeding.
- Shelter for protection against bad weather (rain, wind and cold or intensive sunshine).
- Regular light exercise.
- A peaceful environment (avoid unrest and stress).
- Quarantine. This means isolating sick animals (during their illness) and newcomers (for about six weeks) from the rest of the herd. This measure helps to avoid the spread of contagious diseases to other animals.

Other diseases require other specific measures.

- Vaccinations.

When an animal is vaccinated against a specific disease, the body of the animal will react to it, but the animal does not develop the disease. Sometimes a vaccination against a disease will protect the animal all its life against this disease, but most vaccinations have to be repeated after a certain amount of time to ensure protection.

NOTE: Vaccinations are not available for all diseases.

- Preventive treatment.

Sometimes we know a certain disease always occurs at the same time of the year. In

some cases it can be useful to treat animals with medicine before we actually see the sickness in them. This will prevent them from becoming weak and avoid production losses. For example, preventive treatment against worms can be given before and after the rainy season.

If you find something unusual about your animal(s), you should call for veterinary assistance. to prevent, recognize and treat the most common diseases in their area.

❖ Isolate and take special care of sick animals

It is strongly recommended to isolate unhealthy animals from the remainder of the herd. Beware of all body excretions and secretions (such as dung, urine, milk, blood and aborted material). They may contain the infectious agent and transmit the disease to other animals. Some diseases (such as tuberculosis, brucellosis and rabies) may even cause problems for humans. Therefore, make sure you take proper hygiene measures (cleanliness and disinfection). Sick animals need special care. Provide them with shade and protection against wind, fresh clean water and good quality feed.

Farming systems

There are many ways of keeping animals for production. The one you choose depends very much on the circumstances in your area, climate, type of vegetation, market for selling the product, availability of labour and local traditions. These systems are defined according to the way the animals are fed, because this is one of the most important aspects of cattle raising.

1. **Grazing system**.

In this system, the animals graze on natural or improved pasture. This system could be used if you have enough land, but not much time for more labour intensive milk or beef production.

2. **Grazing with supplementary feeding.**

Here we find the same way of grazing as above, but the animals' diet is supplemented with fodder crops and/or with concentrates. Supplementary feeding is usually done when the animals are brought home to stay the night in a pen or in a shelter, or when they are being milked.

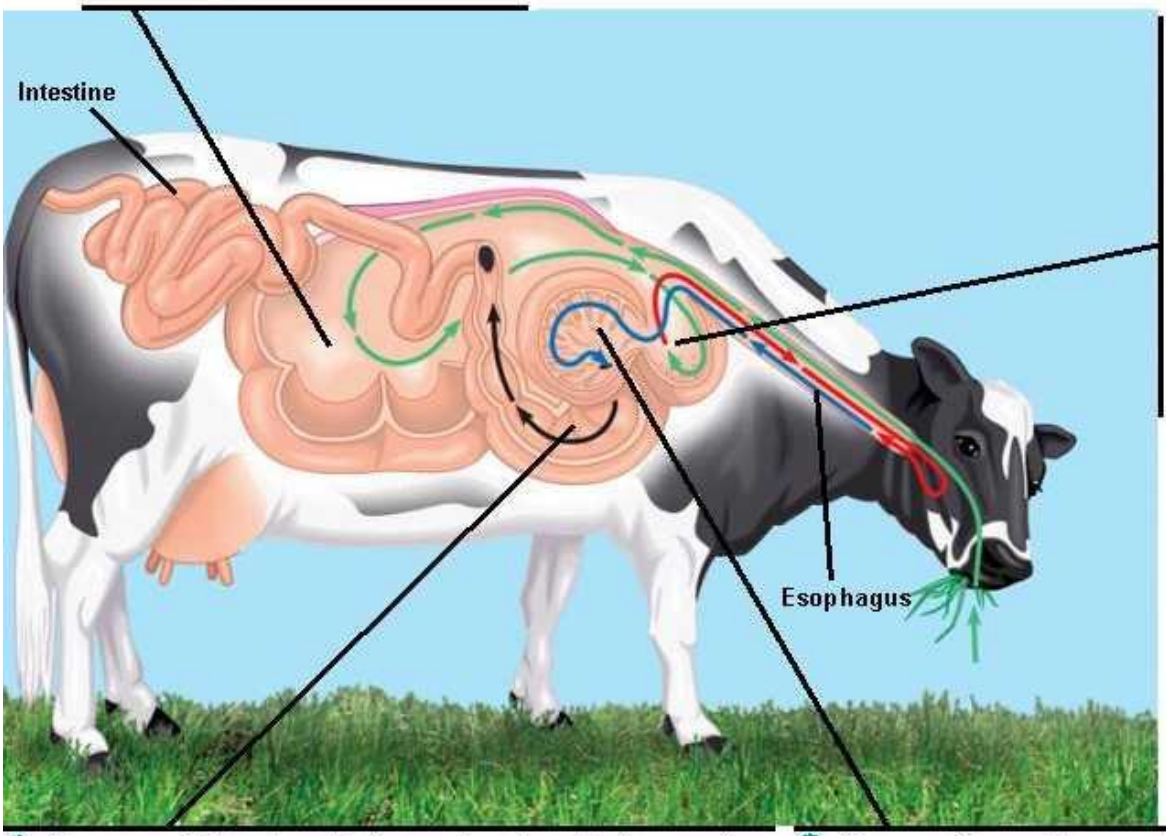
3. Zero grazing.

the animals stay in one place only and all the feed is brought to them. This means that not only the supplementary feed has to be bought or cultivated, and brought to the animal, but also the roughage (grass, hay etc.)

Calves and heifer Rearing: Rearing the calves and heifer is one of the main facts of diary cattle management and could be used as a base for flock size. There is a need for replacement in the flock yearly (25%) should be replaced as a result of:

1- Failure of reproductive system.
2- Abnormalities udder such as mastitis.
3- Mortality.
4- Aging

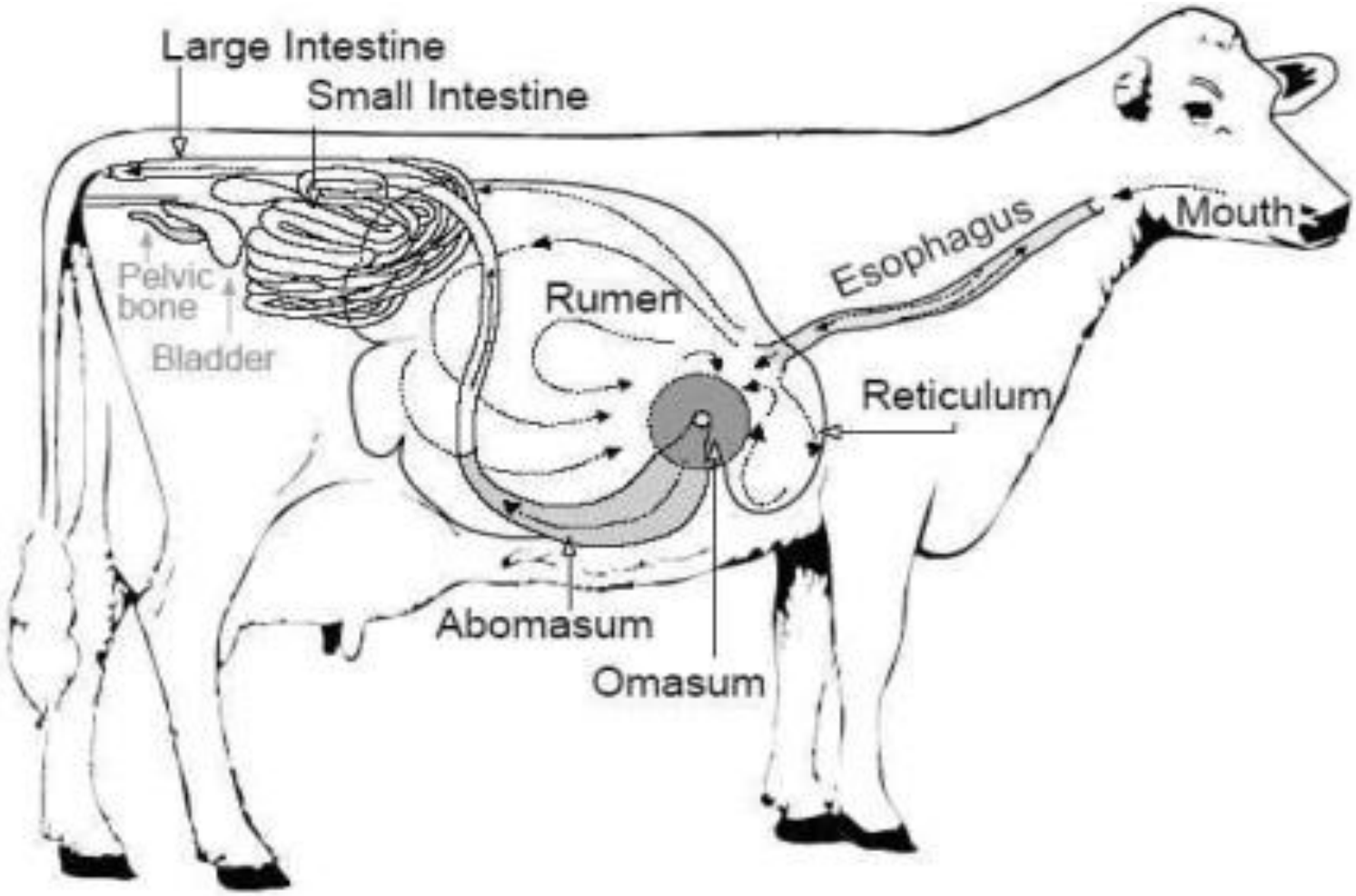
1 Rumen. When the cow first chews and swallows a mouthful of grass, boluses (green arrows) enter the rumen.

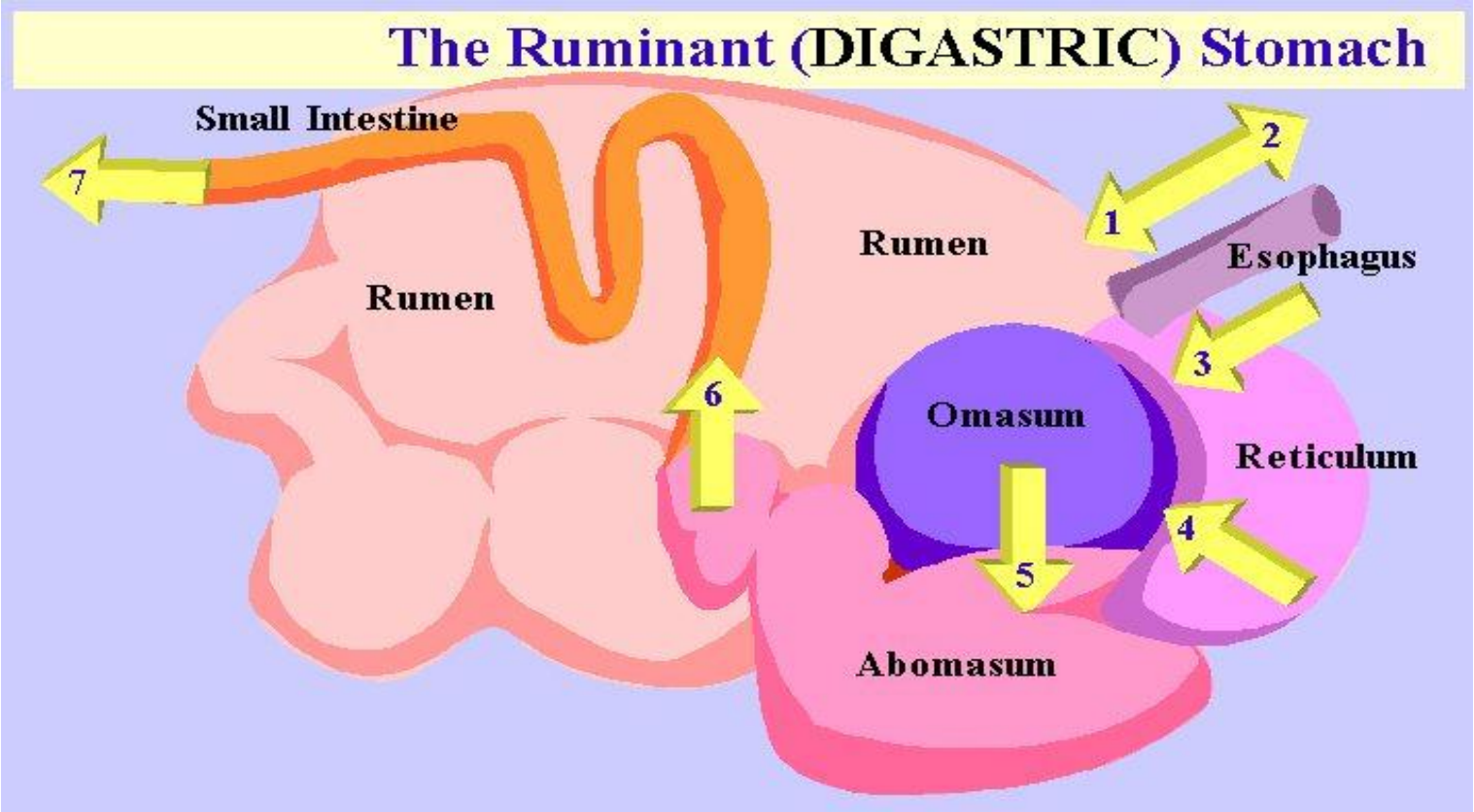


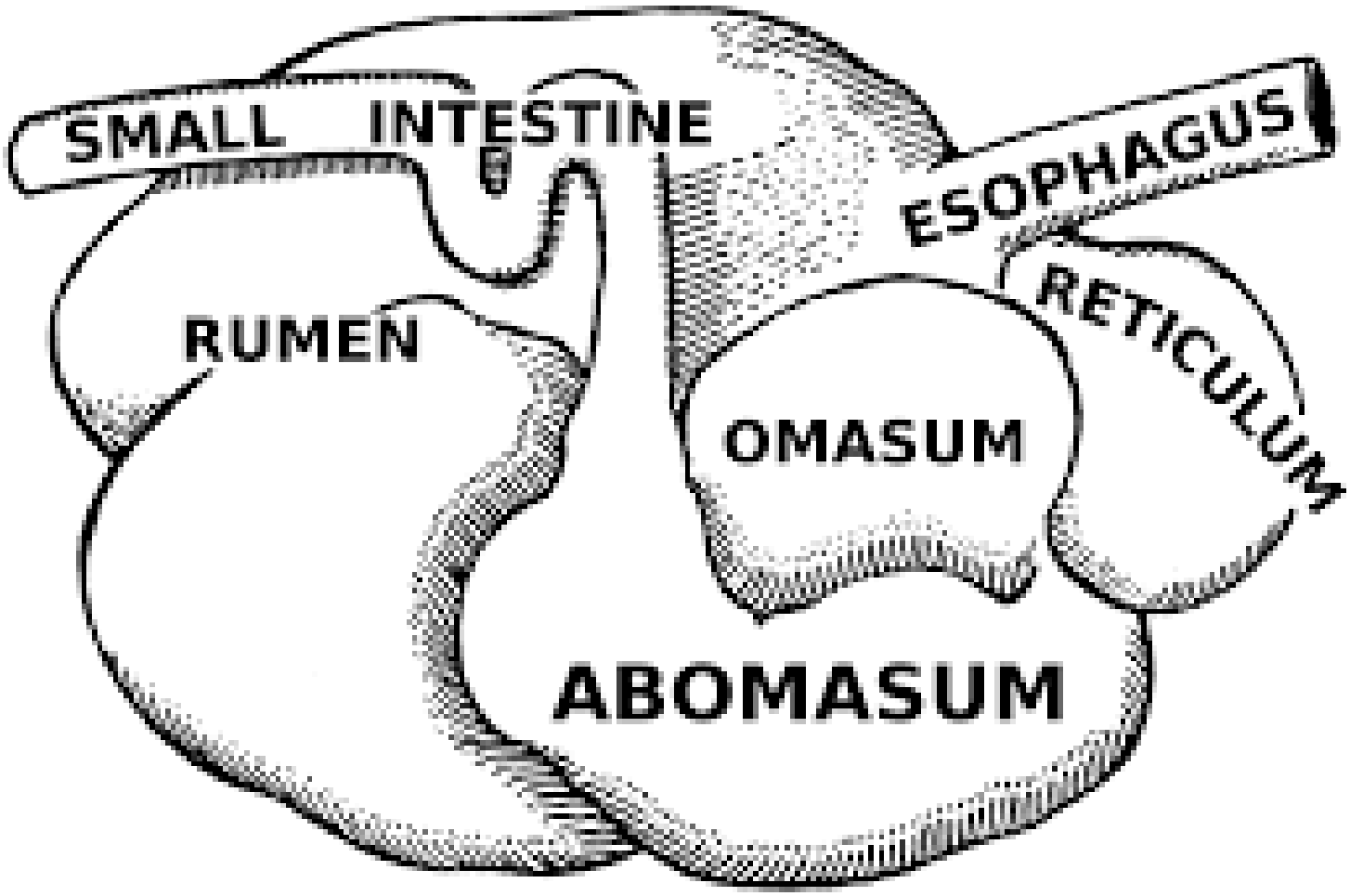
2 Reticulum. Some boluses also enter the reticulum. In both the rumen and the reticulum, symbiotic prokaryotes and protists (mainly ciliates) go to work on the cellulose-rich meal. As by-products of their metabolism, the microorganisms secrete fatty acids. The cow periodically regurgitates and rechews the cud (red arrows), which further breaks down the fibers, making them more accessible to further microbial action.

4 Abomasum. The cud, containing great numbers of microorganisms, finally passes to the abomasum for digestion by the cow's own enzymes (black arrows).

3 Omasum. The cow then reswallows the cud (blue arrows), which moves to the omasum, where water is removed.







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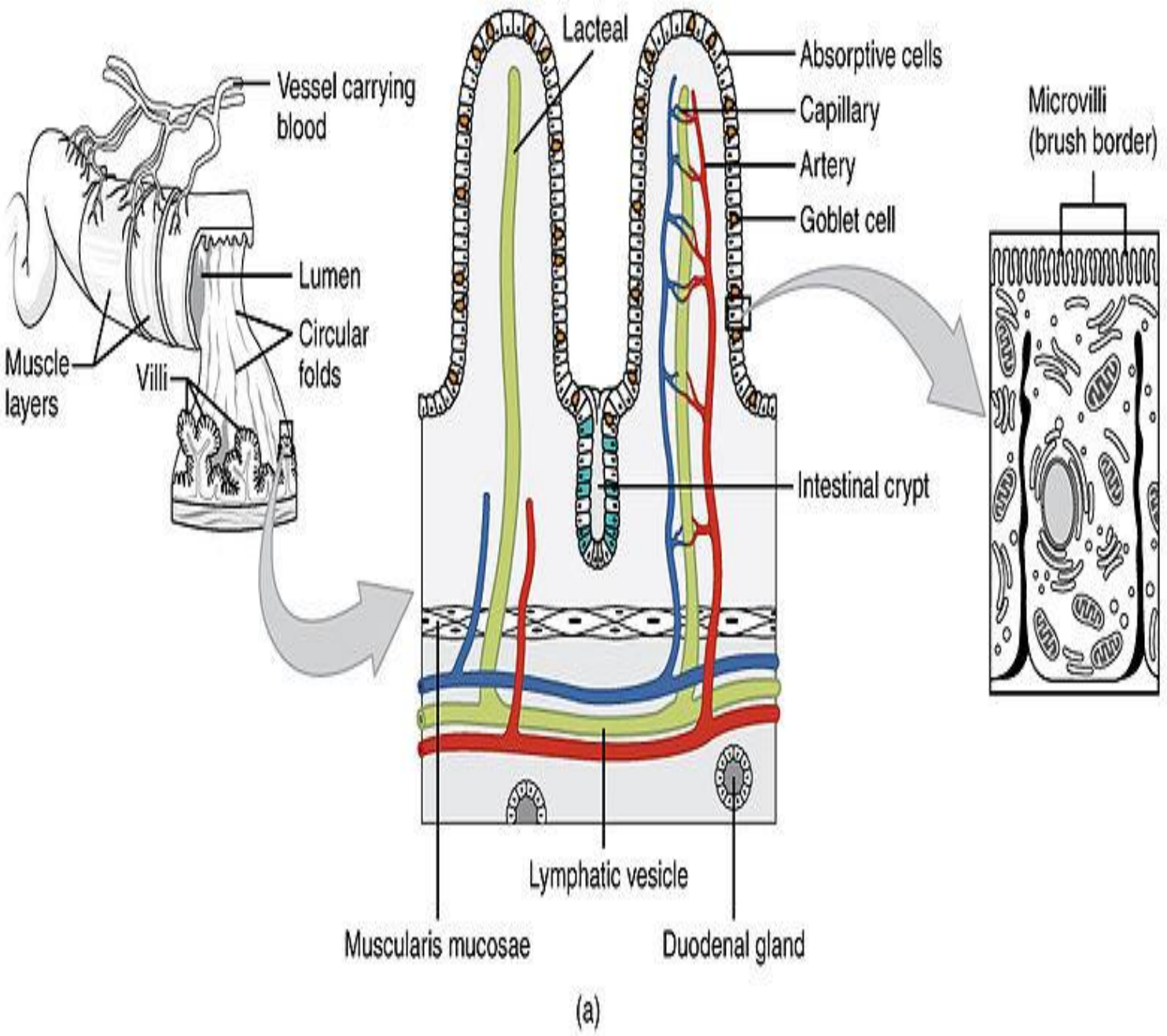
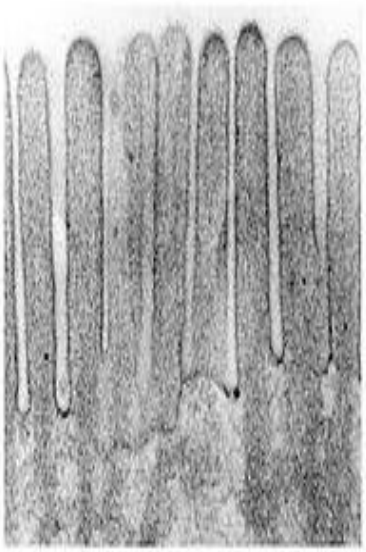

Vessel carrying blood
Lumen
Circular folds
Muscle layers
Villi
Lacteal
Absorptive cells
Capillary
Artery
Goblet cell
Intestinal crypt
Lymphatic vesicle
Muscularis mucosae
Duodenal gland
Microvilli (brush border)

(a)

(b)

(c)



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