

Ruminant Digestive System

In contrast to an animal with a monogastric digestive system, a ruminant has four stomach compartments and can utilize some feeds more efficiently than a monogastric animal. Ruminants are important to the animal industry because they can use hay and pasture productively.

Parts of the Ruminant Digestive System

Two common livestock species have a ruminant digestive system. Cattle, both dairy and beef, and sheep are ruminants. The digestive parts and their functions are similar in both species.

Some of the parts of the ruminant digestive system are the same as those of the monogastric digestive system, but other parts are very different. As in the monogastric digestive system, food enters into the system through the mouth and then passes through the esophagus to the stomach. In the ruminant, the stomach is divided into four compartments, called the rumen, reticulum, omasum, and abomasum. Depending on the type of feed, it may pass through all or some of these compartments as it moves through the stomach. When the stomach completes its functions, the feed moves to the small intestine and proceeds through the cecum, colon, and rectum of the large

intestine to the anus. The digestive system of cattle is illustrated in Figure 2.1.

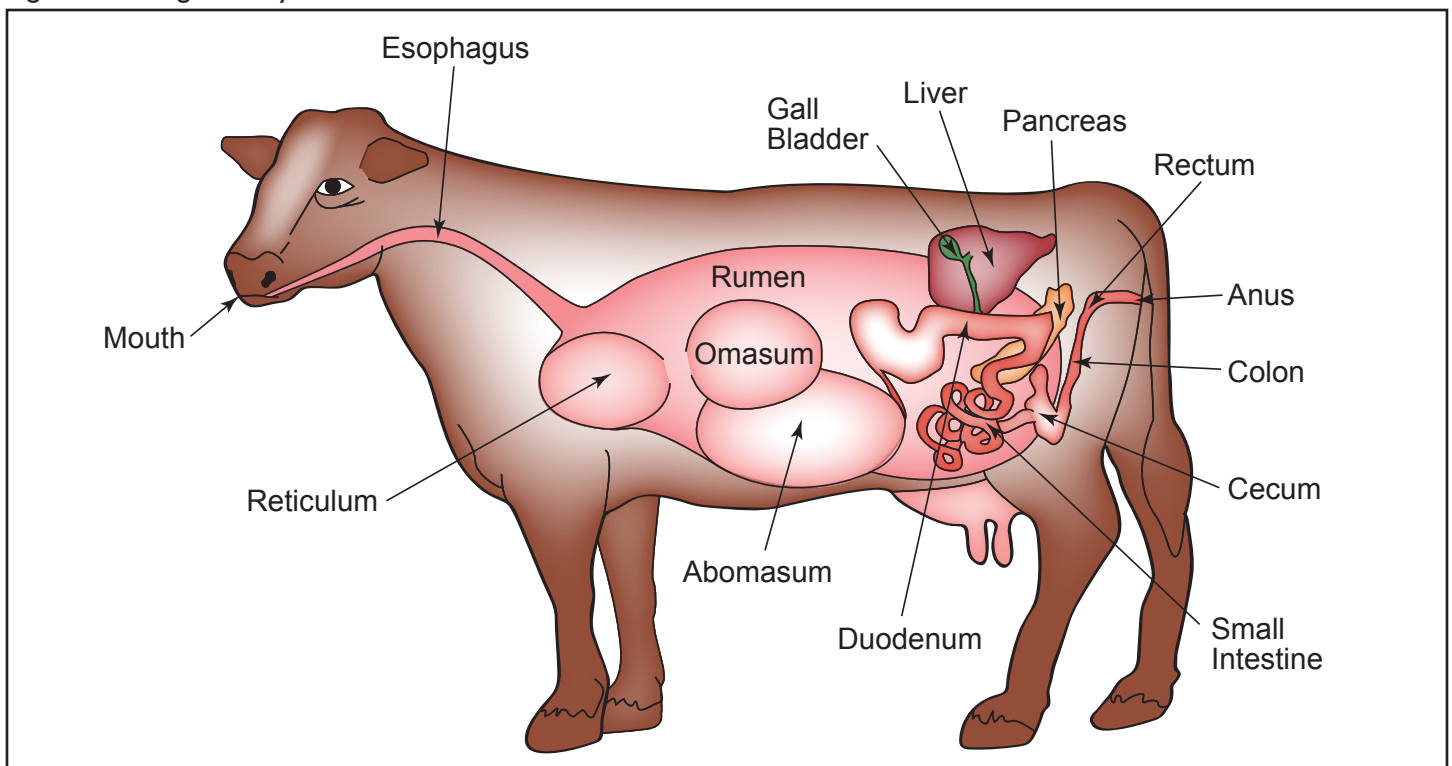
Functions of the Parts

Each of the parts of the ruminant digestive system aids in the process of extracting the nutrients needed by the animal from feed. Although the parts of the system have some similarities in function to those of the monogastric digestive system, the process of digestion is much more complex due to structure of the stomach.

Mouth – The mouth carries feed into the digestive system. In cattle, the tongue grabs the grass or other feed and brings it into the mouth. The tongue also moves feed to the throat. The cow has front teeth only in the lower jaw, with a dental pad in the upper jaw; when grass is pulled into the mouth, the teeth cut the grass against the dental pad. The mouth also has upper and lower back teeth for chewing cud and other types of feed. Sheep use their lips to bring food into the mouth when grazing.

Esophagus - Feed is transported back and forth from the mouth to the stomach through the esophagus.

Figure 2.1 - Digestive System of Cattle



Introduction to Animal Nutrition

Stomach – Like the monogastric stomach, the main function of the stomach of the ruminant is to break down feed. Each of the four stomach compartments has its own unique function. Figure 2.2 illustrates the four compartments of the stomach.

Rumen – The rumen, which is also called the paunch, is the largest of the stomach compartments. It helps to break feed down so that it may be digested.

Reticulum – The reticulum is also called the honeycomb because of the texture of the inner wall of the compartment. It pumps roughage back to the mouth through the esophagus for rumination, which is the racing of feed in the form of the cud. The reticulum also works with the rumen in the breakdown of feed.

Omasum – The function of the omasum, or manyplies, is not fully understood. However, scientists have found that the omasum absorbs some water and is involved in the absorption of nutrients.

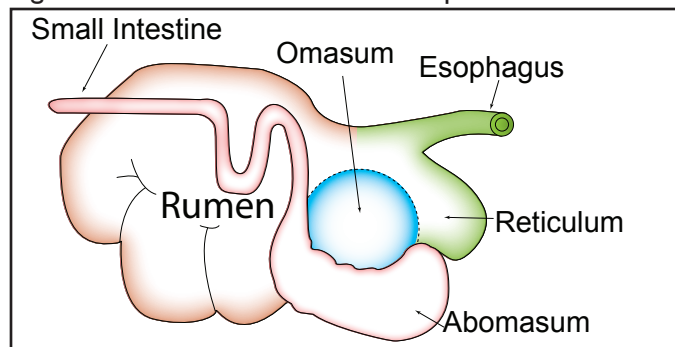
Abomasum – The abomasum is referred to as the true stomach. Its functions are very similar to those of the monogastric stomach. In the abomasum, digestive juices containing acids and enzymes are added to aid in digestion.

Small intestine – In the first portion of the small intestine, called the duodenum, the digestive process started in the stomach continues. Nutrients are absorbed into the bloodstream through the walls of the remainder of the small intestine. Once the nutrients enter the bloodstream, they travel throughout the body to fuel life processes.

Large intestine – The large intestine consists of three parts, the cecum, colon, and rectum. Within the large intestine of the ruminant, the cecum plays a minor role in the further breakdown of roughage. The colon absorbs water and forms undigested wastes into feces, some absorption of nutrients also takes place. The feces are stored in the rectum before being passed out of the body.

Anus – The anus is the opening through which undigestible solid wastes exit from the body. Any portion of the

Figure 2.2 - Ruminant Stomach Compartments



feed not absorbed into the bloodstream is excreted through the anus.

The Digestive Process

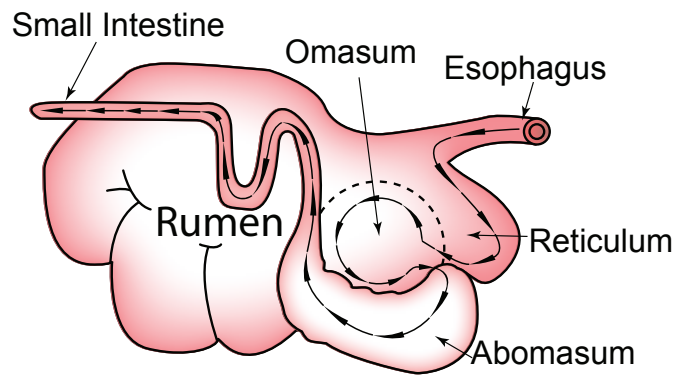
In ruminants, the breakdown of the nutrients in feed into a usable form is very complex. It involves not only the digestive juices and enzymes found in the monogastric system, but the activity of microorganisms found in the stomach. In addition, feed may take one of several paths as it passes through the stomach, depending on the nature of the feed.

In contrast to the monogastric digestive system, the process of digestion does not begin in the mouth in the ruminant, since enzymes are not present in the saliva of ruminants. Instead, digestion begins in the stomach.

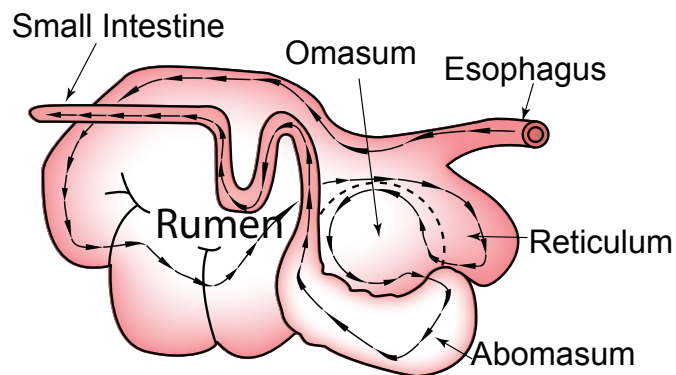
Before feeds pass into the omasum and abomasum, they move through either the reticulum or the rumen and reticulum. Three types of microorganisms are present in the rumen and reticulum—bacteria, protozoa, and fungi. These microorganisms help break down feed for digestion. Bacteria have the most important role in digestion. Some bacteria break down the more easily digestible sugars and starches. Other bacteria ferment the fiber found in roughage like hay, grass, and silage to break it down for use by the body. A second type of microorganism, protozoa, also aids the ruminant in digestion by storing sugars and starches, forming some microbial proteins from proteins in the diet, and fermenting fiber. The role of fungi, the final type of microorganism, is not clearly understood, but they play a role in the digestion of fiber. The action of all the microorganism converts sugars, starches and fiber into fatty acids.

Ruminant Digestive System

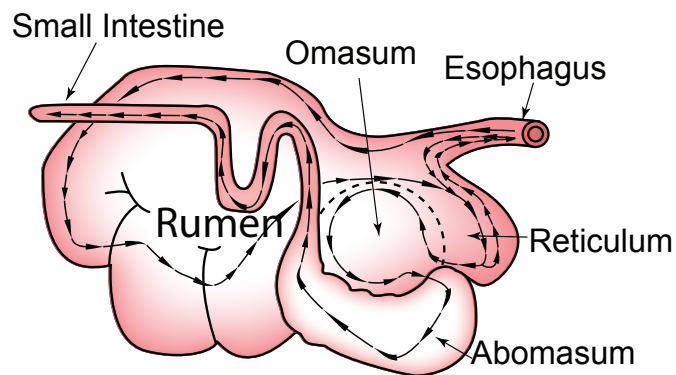
Figure 2.3 - Three Possible Routes of Feed



Ground Concentrates or Cud



Light Grain



Forages

Introduction to Animal Nutrition

In the stomach, feed may follow one of three routes, depending on the type of feed (see Figure 2.3). In the case of a ground concentrate or cud, the feed passes through the reticulum where the microorganisms act on it. It then passes through the omasum, where fatty acids are absorbed, to the abomasum. In the abomasum, gastric juices containing hydrochloric acid and the enzymes pepsin, rennin, and lipase are added to digest proteins and fats.

Light grains, such as oats and barley, require a slightly more complicated path to be utilized most efficiently. They first pass into the rumen, in which muscular action breaks the feed into smaller pieces. The microorganisms then assist in digestion, and the fatty acids that are produced are absorbed by the rumen. When the grain is sufficiently broken down, it passes through the reticulum and omasum into the abomasum.

The third route is that taken by forages. The combination of the action of the microorganisms and the path through the rumen and reticulum are what allows ruminants to better utilize forages, which have a high fiber content. As the forage passes into the rumen and reticulum, muscular action helps to break it down. The microorganisms then act on the pieces. After the microorganisms operate on the forage for a period of time, it moves to the reticulum. If the forage then needs to be broken down some more, the reticulum pumps it up through the esophagus into the mouth as cud to be chewed to break it into smaller pieces. After the cud has been chewed, the remains are again swallowed and enter the reticulum. They then pass to the omasum and abomasum.

After passing through the abomasum, the feed enters the small intestine. In the duodenum, pancreatic juices are added, which include the enzymes trypsin, chymotrypsin, lipase, and amylase (of which only a small amount is present). As in the monogastric system, trypsin and chymotrypsin act on proteins, lipase on fats, and amylase on starches. Bile from the liver is also added in the duodenum for the digestion of fats. Intestinal juices are added in the rest of the small intestine. The enzymes peptidase, lactase, sucrase, and maltase are found in the intestinal juices; peptidase works on proteins, while maltase, sucrase, and lactase work on sugars and starches. Maltase and sucrase are present in small amounts in ruminants.

Summary

A ruminant digestive system like that found in cattle and sheep has many parts that are similar to the monogastric digestive system. However, the stomach of the ruminant has four compartments instead of only one. These compartments are the rumen, reticulum, omasum, and abomasum. The structure of the stomach and microorganisms found in the rumen and reticulum enable the ruminant to digest forage much more efficiently than animals with a monogastric system.

Credits

Baker, Andy. *Animal Science (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1996.

Gillespie, J. R. *Modern Livestock & Poultry Production*. 5th ed. Albany, NY: Delmar Publishers, 1997.

Ridenour, Harlan E. *Livestock Nutrition and Feeding (Student Manual)*. 2nd ed. Ohio State University: Ohio Agricultural Education Curriculum Materials Service, 1991.

Ross, C. V. *Modern Sheep Production*. Englewood Cliffs, NJ: Prentice-Hall 1989.

Warren, D. M. *Small Animal Care and Management*. Albany, NY: Delmar Publishers, 1995.