

Chapter 3
The Digestive System of
Ruminants and other
Grazing Animals

3.1 What is in this chapter?

This chapter is a background information chapter.

It provides a short and very basic description of a ruminants digestive system. A brief description is also given of the digestive systems of non-ruminant grazing animals such as found in horses, llamas and rabbits.

It is not necessary to read this chapter to gain a working knowledge of pasture feed budgeting however it will help to explain why grazing animals are able to get their nutritional requirements from eating pasture plants while animals like cats, dogs and humans cannot.

If this chapter is read in conjunction with Chapter 1 on Photosynthesis and Chapter 2 on Animal Nutrition, it will help tie together the special role a ruminants digestive system has in extracting the nutrients captured by plants through their processes of photosynthesis and nutrient uptake, and how ruminants can utilise these for conversion into high-quality proteins, vitamins, fats and energy.

3.2 Introduction

Grazing animals are of unique importance to humans by virtue of their ability to digest fibrous plants such as grasses and convert them into meat and milk which are rich in protein, fats, vitamins and minerals that humans can readily digest, live and thrive on. If it were not for this ability, a great deal of the photosynthetic energy captured by plants would be unavailable for human nutritional requirements since our digestive systems are poorly suited to extracting nutrition from such plants.

Grazing animals would be no better suited than humans to digest all the nutrient compounds available in grasses and forages, especially those in the fibrous (cellulose, lignin) portions of the plant if it were not for the aid of symbiotic microbes. All grazing animal species have evolved digestive systems that facilitate symbiotic relationships with microbes that reside within specialized areas of their digestive tract. These microbes help to supply the energy and protein needs of the grazing animal by breaking down the cellulose and other complex compounds in forage to simpler compounds that can then be digested by the grazing animal.

It is important too to appreciate the role that grazing animals have in nutrient recycling. Over 90% of the nutrients in grazed plants are returned to a grassland's ecosystem by the grazing animal in the form of soil fertility enhancing faeces and urine.

3.3 By Ruminant digestion

Ruminants, including cows, goats, sheep and deer have a specialised and efficient digestive system, one that uses symbiotic microbes that can digest most of the fibrous portion of pasture plants.

Ruminants have large complex four chambered stomachs (the rumen, reticulum, omasum, and abomasum) that are uniquely suited to extracting nutritional value out of the cellulose (structural) component of pasture plants – see figures 3.1 and 3.2.

The digestive process of a ruminant begins with it taking large bites of pasture which in the process of swallowing, are mixed with copious amounts of saliva. The saliva itself is a mild digestive juice which also serves to lubricate the passage of the bolus (ball of swallowed feed-stuff) down the throat into the rumen-reticulum, a two chambered part of a ruminants digestive system which essentially works as a combined entity.

The rumen-reticulum complex allows vast quantities of pasture to be temporarily stored. Here the food is mixed with additional saliva and separates into layers of solid and liquid material. The solid portion forms boluses or 'cud' and these are regurgitated at a later time for chewing to break down the particle size. After mixing with yet more saliva the cud is swallowed again. In cattle, this 'chewing of the cud' typically occurs about 6 to 8 times a day .

The chewed up cud (digesta) is re-swallowed and returns to the liquid portion of the rumen-reticulum where through the fermentation activities of micro-organisms, various component nutrients from the carbohydrate and protein portions of the pasture, including that of the otherwise difficult to digest structural cellulose portions are released in available forms for uptake into the ruminants bloodstream further down on into the digestive tract. The micro-organisms are predominantly bacteria but also include those of protozoa, fungi and yeast.

The reticulum and omasum function as strainers, by keeping large pieces of material from passing into the abomasum, or 'true stomach'. Overflow from the liquid portion of the digesta in the rumen-reticulum moves into the omasum, where water and many of the released minerals are taken up into the blood stream. The digesta then moves to the abomasum, which is the equivalent of a monogastric's (e.g. human or pig's) stomach.

All the vitamins the animal needs are synthesized by microorganisms, except vitamins A, D, and E. However, animals fed high quality hay or green pasture get their requirement of vitamins A and E. Vitamin D is supplied through exposure to sunlight, which is another advantage of pasture production. Amino acids are the building blocks of protein—a crucial nutrient for growth and reproduction in animals. Rumen microbes synthesize these building blocks from ammonia, a by-product of fermentation in the rumen. Given this fact, even poor quality forage can supply some protein for the grazing animal.

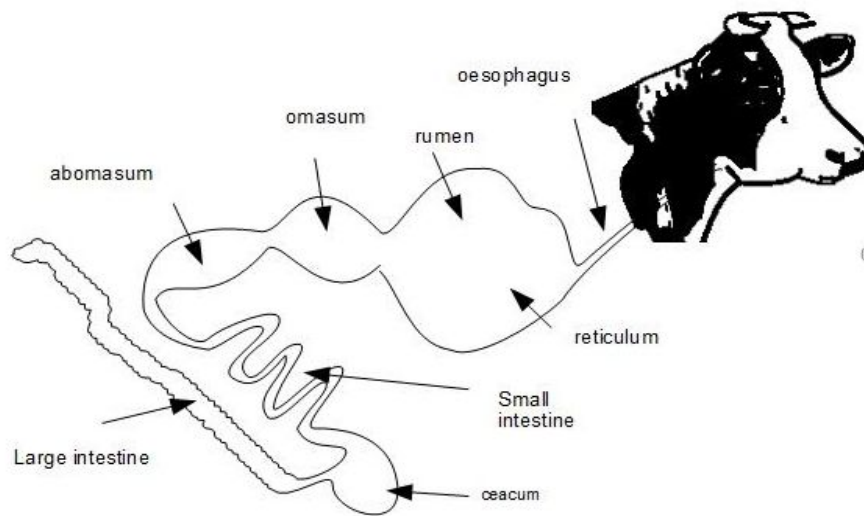


Figure 3.1 Stylised ruminant digestive system of a cow

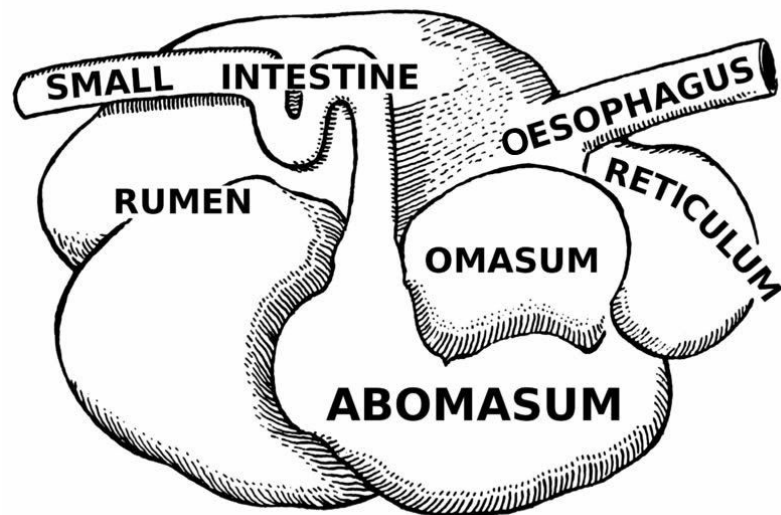


Figure 3.2: A more visual example of a ruminant's digestive system. Source: Wikipedia

The remainder of the digestive system practically parallels that as occurs in monogastric digestion systems – i.e. breakdown of the food in the stomach, absorption of nutrients within the small intestine, microbial activity and further nutrient uptake in the large intestines including the reclamation of water from the remaining digesta prior to collection as faeces within the rectum followed by defecation.

3.4 Pseudo-ruminant digestion

There are grazing animals that can digest cellulose and plant proteins by fermentation processes that are *not* true ruminants, that is, they do not have a four compartment stomach. Rather, they have modified areas of their monogastric digestive systems where microbial fermentation occurs -see figure 3.3 .

Such grazing animals are referred to as *pseudo-ruminants* or sometimes as *hind-gut fermenters*. These include many of the larger grazing species such as horses, camels, alpacas, and llamas which typically have an enlarged fermenter colon.

Smaller grazing animals such as rabbits and guinea pigs by contrast have enlarged caecum fermenter areas. While pseudo-ruminants are not quite as efficient as true ruminants, they are nonetheless still effective in utilising pasture as a feed source.

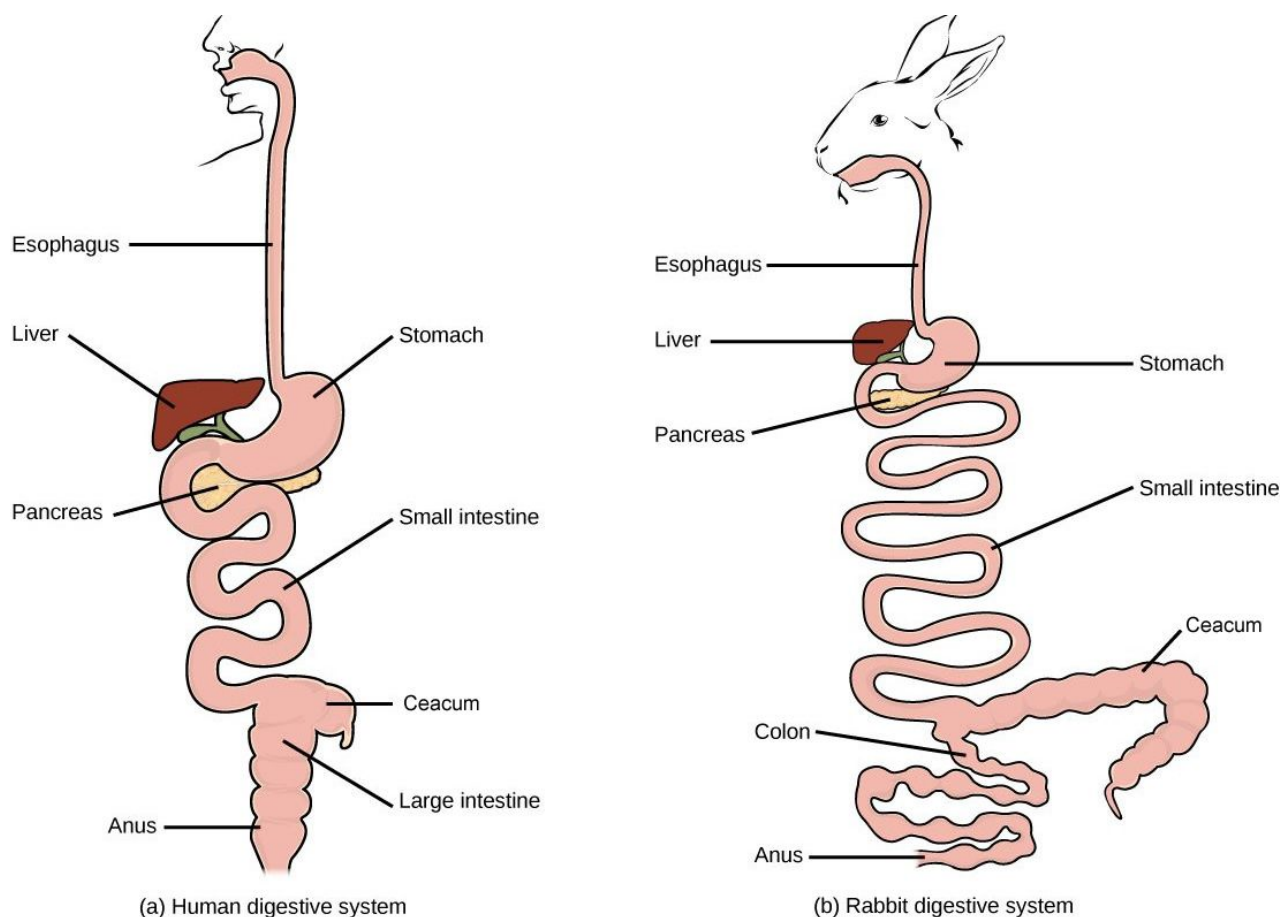


Figure 3.3 Comparison of a human digestive system with a rabbit's digestive system which are both monogastric digestive systems. However rabbits are 'hind gut fermenters' by virtue of the microbial activity that takes place in their much enlarged Ceacum. This allows rabbits to successfully extract many of the nutrients stored in the cellulose and lignin portions of plant material in their diet. Source: Adapted from Openstax College, Digestive Systems, <http://cnx.org/content/m44736/1.6/>

3.5 Key points to take from this chapter...

- Most grazing animals have evolved digestive systems that include microbes that can extract what would otherwise be unavailable energy and nutrients from the fibrous portion of forages.
- Ruminants (sheep, cows, deer, goats) possess the most efficient form of such digestive system for consumption of pasture plants by virtue of their specialised 'four compartment' stomachs.