The Digestive System of Farm Animals

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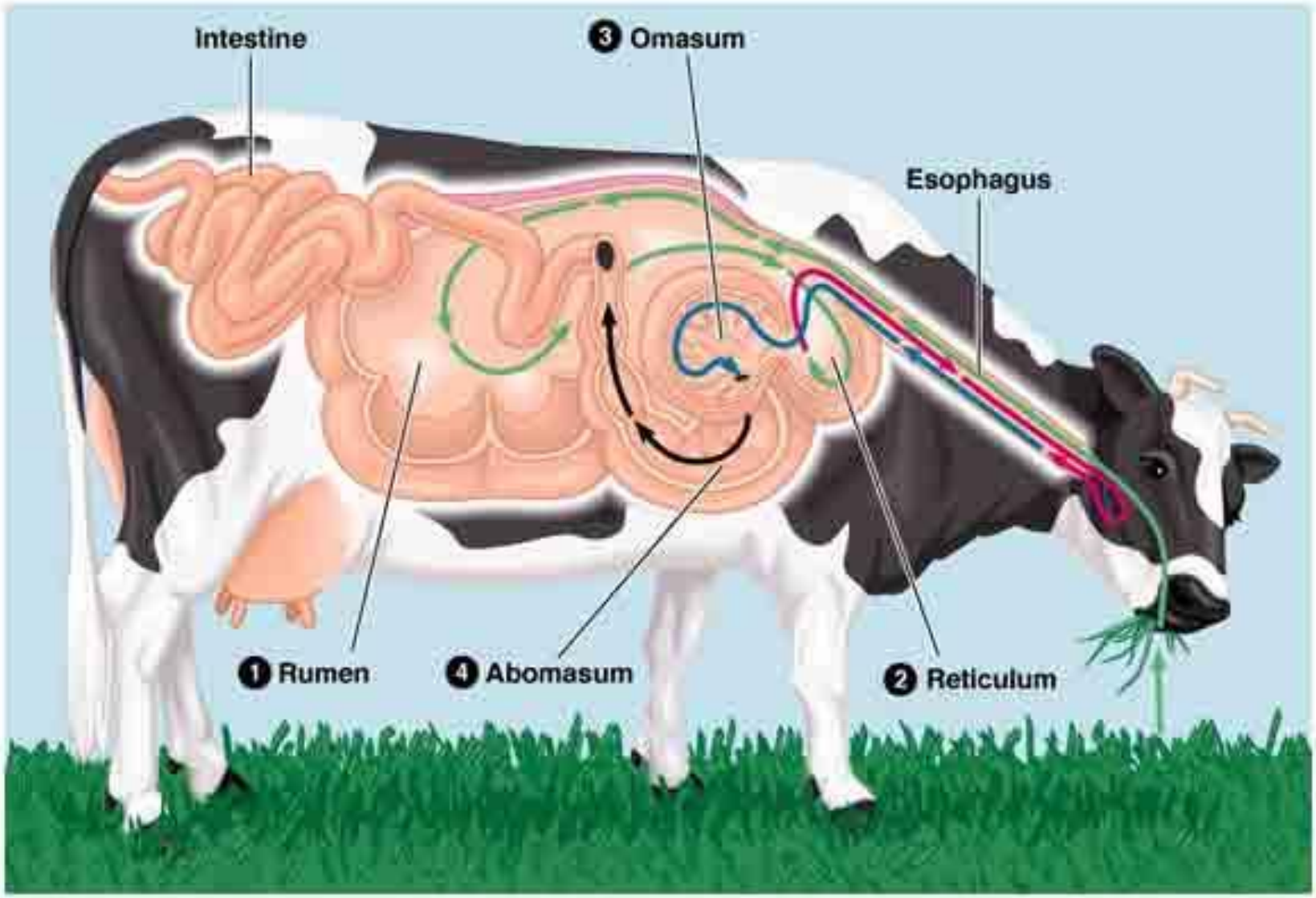
Process of Digestions

- Ruminants like goats, sheep, cows and bison have a very special way of digesting their food.
- Because the food they eat, such as grass, leaves, and hay isn’t very nutritious, they have to get the most out of what they eat.
- Ruminants are unable to digest plant material directly, because they lack enzymes to break down cellulose in the cell walls. But they manage to live solely on plant material whose nutrients are found in the cellulose.
- Ruminants have developed a very clever and complex method for getting the most out of their food. Their digestive systems are as unique and special as they are different from ours.

- Ruminants need to be able to take in large amounts of food in order to survive.
- When a ruminant eats something, it is chewed and swallowed and passes into the rumen, or first stomach. This stomach begins the digestion process, using microorganisms to help in breaking down the food so that the animal can get the nutrients from it.
- Ruminants can store large amounts of food in their rumens. When the ruminant has finished eating, he will usually go lay down to further digest his food.


Intestine
3 Omasum
Esophagus
1 Rumen
4 Abomasum
2 Reticulum
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- The next step is called “rumination.”
- The food that is stored in the rumen is passed in small amounts into the second stomach or reticulum.
- The reticulum is labeled as number 2 in the diagram below. From the reticulum the small packets of food are passed back into the mouth so that it can be broken down more. This is often referred to as “chewing the cud.”
- Chewing the food again, allows the ruminant to get as much nutrition as possible from its food.

- The re-chewed food is then swallowed and it passes into the third stomach or omassum which is labeled as number 3 on the figure.
- The food in the omassum is broken down into even smaller pieces by powerful muscles.
- After spending some time in the omassum, the food passes to the fourth stomach or abomassum which is labeled as number 4.

- The abomassum is most similar to your own stomach. Here the food is broken down by strong digestive enzymes, particularly one called lysozyme.
- The food then travels through the intestines where water is removed from the food and nutrients are absorbed.
- The water that is absorbed is filtered through the kidneys and passed from the body. What remains passes out of the body as waste.

Rumen Management

Rule of Thumb

Feed the rumen microorganisms correct, and you will feed the ruminant correct!

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Rumen microorganisms

- The rumen contains a unique family of microorganisms.
- We call these the ruminal “bugs”.
- The ruminal bugs consist primarily of bacteria, fungi, and yeast.
- Working together, these bugs are responsible for the digestion of feed fiber.
- In a properly fed ruminant, these bugs flourish and provide an important source of protein to the animal, called microbial protein.

Microbes give the cow:

- labor to digest feed
- a source of protein
- a source of volatile fatty acids
- the ability to digest forage

On the other hand, cows provide microbes with:

- water
- warmth
- grinding (cut chewing) of feed
- anaerobic (no oxygen) conditions

There are three main groups of rumen microbes:

- ***Bacteria*** carry out most of the digestion of sugars, starch, fiber, and protein for the cow.
- ***Protozoa*** swallow and digest bacteria, starch granules, and some fiber.
- ***Fungi*** make up only a small fraction of the rumen microbial population, but they appear to be important in splitting open plant fibers to make them more easily digested by the bacteria.

Many different species

- There are probably thousands of species of rumen bacteria, but only two dozen have been studied in detail.
- It appears that each cow has her own population of rumen bacteria; this seems to vary more between cows rather than within one cow fed substantially different diets.
- Identifying microbial populations may provide clues to improving animal performance.

Almost all rumen microbes are anaerobic

They will:

- only grow in an oxygen-free environment.
- New microbes are constantly being produced in the rumen (under adequate conditions) while old ones are passed on down through the cow's digestive tract.
- One type of rumen bacteria can double its population in 11 minutes!

When you feed your cow you're really feeding the microbes in her rumen

- The cow cannot directly utilize most feed components, even simple sugars.
- She relies on rumen microbes to convert feeds to volatile fatty acids (VFAs) that the cow absorbs and uses to make energy and milk.
- About two-thirds of feed digestion and 90 percent of fiber digestion takes place in the rumen – all with the aid of microbes.

Rumen microbes help cows *digest* feed

- But they are also an important ***source*** of feed for cows.
- They’re typically about 55 percent protein; on some rations the microbes provide half of the total dietary protein need of the cow.

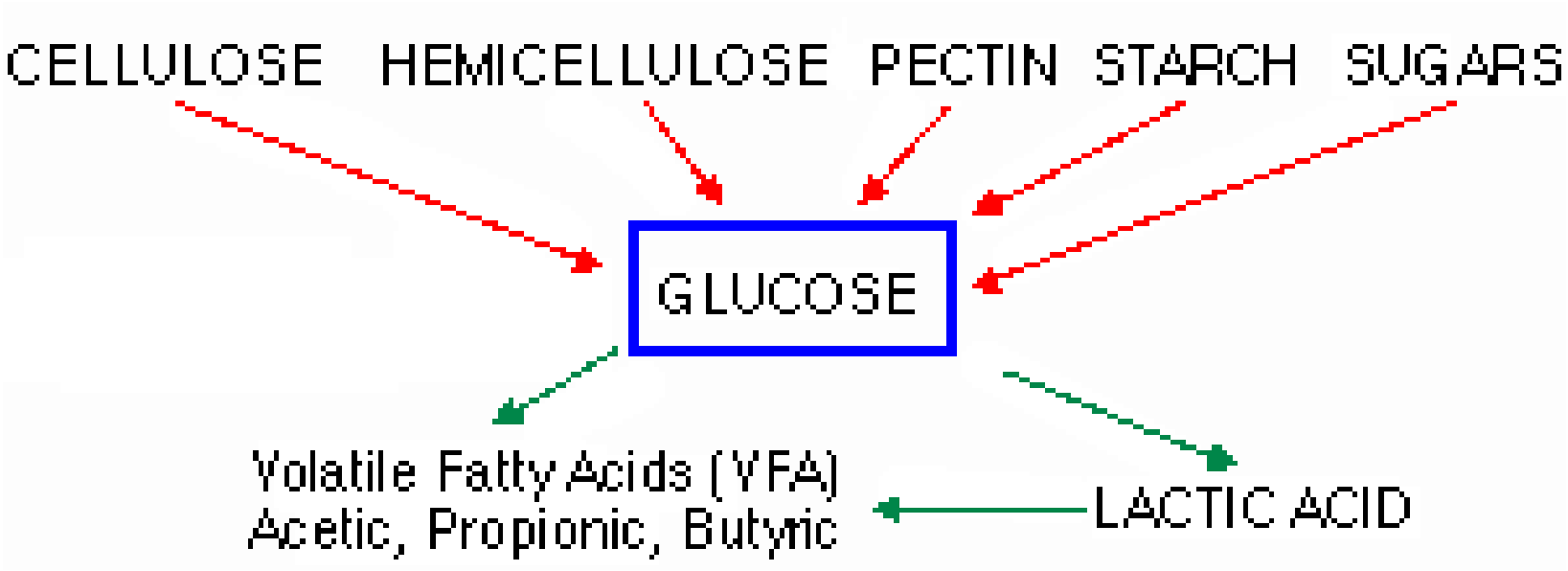
- Even more amazing is the fact that rumen microbial protein has almost the perfect mixture of amino acids – one that has not been duplicated in any ration.
- Rumen microbes are a particularly rich source of lysine and methionine, two amino acids that are difficult to supplement in dairy cattle rations.
- Most rumen bacteria attach themselves to feed particles, and fiber digestion will only occur by attached microbes.

- This allows cows and other ruminants to make use of feeds, like alfalfa and grasses, that people can’t eat.
- Many of these plants are grown on land that isn’t suitable for other crops.
- Thus, cattle produce food from land that might otherwise be under utilized.
- Cows are also useful consumers of by-products from human food production (like citrus or beet pulp) and from grain ethanol production (distillers grains).

Energy

Digestion of energy feeds in the rumen.

- Simple and complex carbohydrates (fiber) are digested by rumen microbes and converted into volatile fatty acids.
- The volatile fatty acids, which consist mainly of acetic, propionic, and butyric acids, are the primary energy source for ruminants.


CELLULOSE HEMICELLULOSE PECTIN STARCH SUGARS
GLUCOSE
Volatile Fatty Acids (VFA)
Acetic, Propionic, Butyric
LACTIC ACID

- When large amounts of forage are fed, the formation of acetic acid predominates (60 to 70 percent of total) with lesser amounts of propionic (15 to 20 percent) and butyric (5 to 15 percent) acids occurring.
- However, when grain feeding is increased or when finely ground forages are fed, the proportion of acetic acid may decrease to 40 percent, while the amount of propionic acid may increase to 40 percent.
- Such a change in volatile fatty acid production generally is associated with a reduction in milk fat test.

- Approximately 30 to 50 percent of the cellulose and hemicellulose is digested in the rumen by the microbial population.
- Sixty percent or more of the starch is degraded, depending on the amount fed and how fast ingested materials move through the rumen.
- Most sugars are 100 percent digested within the rumen.

- The volatile fatty acids are absorbed from the rumen into the blood stream and transported to body tissues, including the udder, where they are used as sources of energy for maintenance, growth, reproduction, and milk production.
- The cow derives 50 to 70 percent of its energy from the volatile fatty acids produced in the rumen.

Protein and nonprotein nitrogen utilization in the rumen.

- Some of the protein consumed by the cow escapes breakdown in the rumen **(figure HYPERLINK)**.
- Protein undergoing fermentation is converted to ammonia, organic acids, amino acids, and other products.
- Approximately 40 to 75 percent of the natural protein in feed is broken down.

- The extent of breakdown depends on many factors including solubility of the protein, resistance to breakdown, rate of feed passage through the rumen, and others.
- Many rumen micro-organisms require ammonia (breakdown product of protein) for growth and synthesis of microbial protein.
- Ammonia also may be provided from NPN sources such as urea, ammonium salts, nitrates, and other compounds.

- Rumen microbes convert the ammonia and organic acids into amino acids that are assembled into microbial protein.
- Excess ammonia is mostly absorbed from the rumen into the blood stream, but small amounts may pass into the lower digestive tract and be absorbed.
- Feed protein (that escapes breakdown in the rumen) and microbial protein pass to the abomasum and small intestine for digestion and absorption.

Fat digestion

- Most of the digestion and absorption of fat occurs in the small intestine.
- Rumen micro-organisms change unsaturated fatty acids to saturated acids through the addition of hydrogen molecules.
- More saturated fat is absorbed by cows than by simple-stomach animals.
- Feeding large quantities of unsaturated fatty acids can be toxic to rumen bacteria, depress fiber digestion, and lower rumen pH.

Vitamin synthesis

- The rumen micro-organisms manufacture all of the B vitamins and vitamin K.
- Vitamin synthesis in the rumen is sufficient for growth and maintenance.
- Under most conditions, cattle with functioning rumens do not require supplemental B vitamins or vitamin K in the diet.
- Niacin (B3) and thiamine (B1) may be needed under stress conditions.

Capacity

Rumen capacity will differ with breed, age of maturity and maintenance requirements and therefore the balance of forage, energy and protein will also differ, however the physiology remains the same.

- Large capacity 100-200lts with 3 ‘zones’, gas - liquid - solid
- Optimum digestion is at pH 6.2-6.5
- 50 - 150 litres of saliva produced daily to buffer acids

- Mixes contents of the rumen through rumination by contracting 1-3 times per minute.
- Cattle should spend 6-8 hours/day cudding
- Each cud bolus should be chewed at least 30 times before swallowing
- Most digestive problems originate from the rumen, so make diet changes gradually
- The rumen can take up to 21 days to acclimatise to new rations
- Mimic nature and grazing as far as possible by feeding little and often

Rumen stability

Increasing dry matter in-take and facilitating the animal to ruminate and cud producing saliva to buffer the rumen, therefore enhancing rumen health and FCE.

- Correct formulation and structure of the ration
- Correct forage/fibre to concentrate ratio
- Good accessibility and palatability
- The best use of high quality feeds, (physical, not necessarily nutritionally),

- It can take the rumen up to 21days to fully acclimatize to new feeds and rations, so any nutritional change needs to be managed efficiently to allow for stability.
- Accurate, effective and palatable rationing increases production and reduces cost; every business’s prerequisite.

Calf Digestive System

- At birth and during the first few weeks of life, the rumen, reticulum, and omasum are undeveloped.
- In contrast to the mature cow, in the calf, the abomasum is the largest compartment of the stomach **(table HYPERLINK)**.
- At this stage of life, the rumen is nonfunctional and some feeds digested by the adult cannot be used by the calf.

- During nursing or feeding from a bucket, milk bypasses the rumen via the esophageal groove and passes directly into the abomasum.
- Reflex action closes the groove to form a tube-like structure which prevents milk or milk replacer from entering the rumen.
- When milk is consumed very rapidly, some may overflow into the rumen.
- As long as the calf remains on milk, the rumen remains undeveloped.

- When calves begin consuming grain and forage, a microbial population becomes established in the rumen and reticulum.
- End products of microbial fermentation are responsible for the development of the rumen.
- This occurs as early as 3 weeks of age with most feeding programs.
- Cud inoculation is not necessary to initiate rumen development.

- If grain feeding with or without forage is started during the first few weeks of life, the rumen will become larger and heavier with papillae development, and will begin functioning like the adult's when the calf is about 3 months of age.