# Rumen development

The goal for rearing healthy dairy heifers successfully and economically is to quickly develop the calf's rumen to be able to digest solid feeds and reduce her nutritional dependence on milk.

## *Gut development*

There are many health and management advantages in encouraging early rumen development as the ruminant calf is less likely to suffer digestive upsets and scours, with mortality risk much reduced. Milk, even at manufacture prices is the most expensive feed for calves, while pasture is the cheapest. Roughage feeds (pasture, hay) should be available from birth with concentrates (grain, calf pellets) fed to develop the rumen and support growth.

Grown cattle have a stomach divided into four working parts (Figure 1):

- the rumen (paunch)
- reticulum (honeycomb)
- omasum (bible)
- abomasum (true stomach).

The rumen is very large compared with the other sections.

In the very young calf (birth to 3 weeks), the abomasum is the major functional compartment, making up 80% of the total stomach. The other compartments grow quickly once the calf begins eating dry feeds. Figures 1 and 2 illustrate the relative size differences of the four stomach compartments for a very young calf and a mature animal.

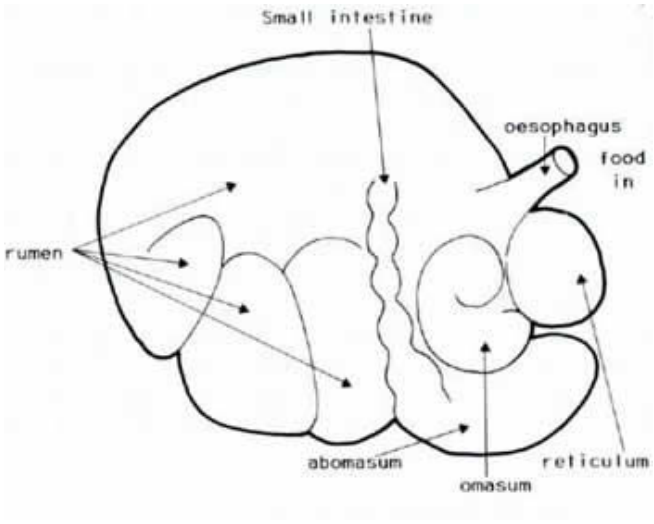


**Figure 1.** The stomach of a mature cow.

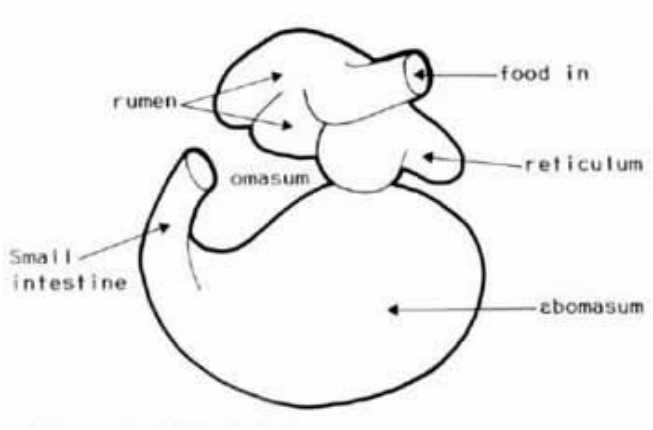


**Figure 2.** The stomach of a newborn calf.

Before the rumen develops, milk flows directly to the abomasum via the oesophageal groove (a fold in the alimentary tract, which directs liquids to the abomasum), by-passing the rumen, reticulum and omasum. At this stage, liquid feeds containing milk proteins, fats and simple sugars are the only useful feeds digestible by the calf.

The time taken by the calf to change from using just the abomasum to efficiently using all four stomachs depends on the type of food it is given. If milk is freely available for a long time, the calf will have only a small appetite for dry feeds and stomach development will be slow. This pre-ruminant phase is most critical in the calf's development. Small digestive upsets can lead to scours (diarrhoea), then dehydration, threatening survival or long-term performance. Conversely if feeding management encourages the calf to eat solid feeds, enhanced rumen development reduces dependence on liquid milk to supply essential nutrients, reducing this risk.

By 1 week of age, the calf should be encouraged to eat some grain and hay or pasture. At this time the rumen, reticulum and omasum will begin to develop.

By 1 month of age, calves should be eating substantial quantities of grain and good quality pasture or hay. Calves will become less dependent on milk, risk of scours is reduced, calves can be weaned earlier, and labour and rearing costs are lowered.

## *Nutrient requirements*

A calf's food and nutrient requirements depend on its age, size and health. Calves require liquid food for at least the first 4 weeks of life. Dairy replacement calves can be fed and reared to complete weaning around 2 months of age or earlier if desired. The following food components are essential:

### Protein

Proteins supply amino acids essential for normal growth and development. The early weight gain of calves is mainly due to an increase in body protein tissues, for example, muscle, internal organs. Only some forms of protein are useful to the very young calf.

Milk protein (casein) is most readily digested and supplies the necessary amino acids, particularly methionine and lysine, for tissue growth. Milk either as fresh milk or quality milk replacers is the only protein source recommended for young calves.

Use of other animal proteins, while containing more of the essential amino acids for young calves and may be more digestible than vegetable proteins, is not permitted because of health concerns for spread of diseases such as foot and mouth and BSE (bovine spongiform encephalitis). Feeding of protein meals of animal origin such as meat meal, blood meal or fish meal to ruminants is banned in Australia.

Vegetable protein sources in protein meals, concentrates and forage offer lower levels of essential amino acids and are useful supplements but cannot replace casein for young calves. These proteins are suitable for older animals and can begin to replace milk protein for older functional ruminant calves (6 to 8 weeks) who can convert it to rumen microbial protein which provides an optimum amino acid balance.

Urea is unable to be used by a calf until it is eating large amounts of solid feed and the rumen is well developed. Urea is toxic to the young pre-ruminant (monogastric) calf.

In older animals most of the protein required is provided as microbial protein, the result of feed being first broken down and resynthesised by bacteria in the rumen, with some undigested feed protein reaching the hind gut.

### Metabolisable energy

Feeds supplying metabolisable energy are needed for growth, to maintain health, and normal body functions, for example breathing, eating and walking. A lack of energy will result in slow growth and late maturity.

Feeds which contain carbohydrates and fats are good suppliers of energy.

The newborn pre-ruminant calf cannot digest complex carbohydrates (fibre) and derives its energy from digestion of fats, simple 6-carbon sugars (lactose) and protein.

As the rumen develops it can make more use of more complex carbohydrate - starch, hemicellulose and cellulose from grain and forages through microbial fermentation. High digestibility solid feeds (carbohydrate sources and rumen degradable protein) are essential for rumen development. Fibre stretches and enlarges the rumen, digestible carbohydrate supports and stimulates the growth of cells and rumen papillae, (the walls of the rumen) for absorption of the end products of rumen microbial fermentation.

### Vitamins

At birth the calf has no reserves of vitamins A, D and E. They are supplied in the mother's colostrum and fresh milk. All vitamins except vitamin C are needed in the young calf's diet until the rumen is fully developed. Once the rumen is developed (2 to 3 months of age), the calf can produce all vitamins except vitamins A and E in its body or rumen; these must be supplied by the feed. Essential vitamins must be added in milk replacers, and in concentrate premixes if animals are not offered green feed.

Vitamin D is involved in calcium deposition and skeletal growth. Sunlight stimulates its production by skin tissues. Deficiency (rickets) could occur if calves are housed for long periods but is unlikely under normal paddock rearing conditions.

Vitamin A is obtained from green forage. Signs of vitamin A deficiency in calves include elevation of cerebrospinal fluid pressure, staggering gait and convulsive seizures. Rapidly growing animals on high concentrate diets and conserved roughage without access to green pasture may exhibit poor vision in dim light and blindness. Deficiency can occur in pregnant cows fed high concentrate diets or maize silage. This deficiency can result in shortened gestation, retained placenta, poor vision, and birth of dead, uncoordinated or blind calves.

Vitamin E is involved in metabolism as a biological antioxidant. Deficiency symptoms are similar to white muscle disease (selenium deficiency). Vitamin E is obtained in grains and natural feedstuffs but is reduced in stored feed and can be low in powdered milk or polyunsaturated oils.

### Minerals

The most important macro-minerals for calves are calcium and phosphorus, required for skeletal development. They are supplied in milk to the young calf and later, by good quality hay and pasture (particularly legumes), grain and protein meals. Levels in feed may not be adequate for the growing heifer and it is wise to supply additional calcium and phosphorus supplements such as dicalcium phosphate (DCP) or commercial mineral premixes from weaning. Most phosphate-type fertilisers are not suitable as mineral supplements for animal feeding as they contain excess levels of fluorine (super-phosphate, rock phosphate) or cadmium (MAP).

Magnesium is important in skeletal development, neuromuscular function and enzyme systems. Calves can mobilise skeletal magnesium for other functions but deficiency can occur if fed solely on milk for long periods, as reserves are depleted. Deficiency is also possible with lush green pasture (e.g. kikuyu), heavily fertilised with nitrogen and potassium (or manure). The growing calf should obtain sufficient magnesium from a combination of grain, hay or forage and milk.

Sodium, potassium and chlorine maintain body fluid balance and are involved in nutrient uptake and transport. They are controlling factors in nerve transmission. Salt (sodium chloride) supplements are beneficial for cattle in low salinity regions - usually high rainfall areas with red basaltic soils, often with kikuyu pastures. Where farms have saline soils or water, salt supplementation is generally not needed and excess in feed can be an environmental contaminant. Salt can improve response by heifers to molasses, possibly by balancing higher potassium intakes from this supplement.

Sulphur is closely associated with nitrogen metabolism and is an essential component of protein, amino acids and B-vitamins. It has an important role for rumen microbial function. Deficiency can occur with diets high in carbohydrate - especially maize silage and low protein; or high in non-protein nitrogen (NPN).

### Trace minerals

Other minerals essential for growth and health include - iron, copper, manganese, molybdenum, cobalt, zinc, iodine and selenium. Requirement for these minor minerals is dependent on their availability in feed and deficiency or excess in the local environment. In excess some minerals (e.g. manganese, selenium) can be toxic and have negative impacts on both animal performance and the environment.

### Water

A lack of water will cause the death of a calf sooner than the lack of any other nutrient. Calves 1 to 2 weeks old will begin to drink water between their milk feeds, and by 6 weeks may drink 4 or 5 litres daily. How much calves drink depends on the weather, availability of shade and the amount of milk fed.

Milk feeding once or twice per day does not supply sufficient water for the calf. Fresh, clean water should be available at all times. Water is especially important when calves have access to meals or hay and/or milk feeding has ceased temporarily, for example, when scours occur. A scouring calf will dehydrate very quickly. Electrolyte replacer solutions will aid in rehydrating the calf to overcome a scour problem.

## *Feeding*

High-quality digestible feeds are necessary to achieve normal development and target growth rates by replacement heifers. The calf's requirements will be met by a balanced combination of feeds and choice

from the following classes with actual feeds and levels determined by calf age, health and growth desired as well as availability and costs:

- milk - whole milk, commercial high-quality milk replacers
- solid feeds - forage (pasture, hay, silage, straw) - concentrate (grain, protein meals, molasses, by-products) required for growth and rumen development
- fresh water - essential for health and growth
- minerals - calcium, phosphorus supplements, possibly salt, other minerals, trace elements premix depending on diet and environmental levels.

*Source: Queensland Department of Agriculture, Fisheries and Forestry; 2009*