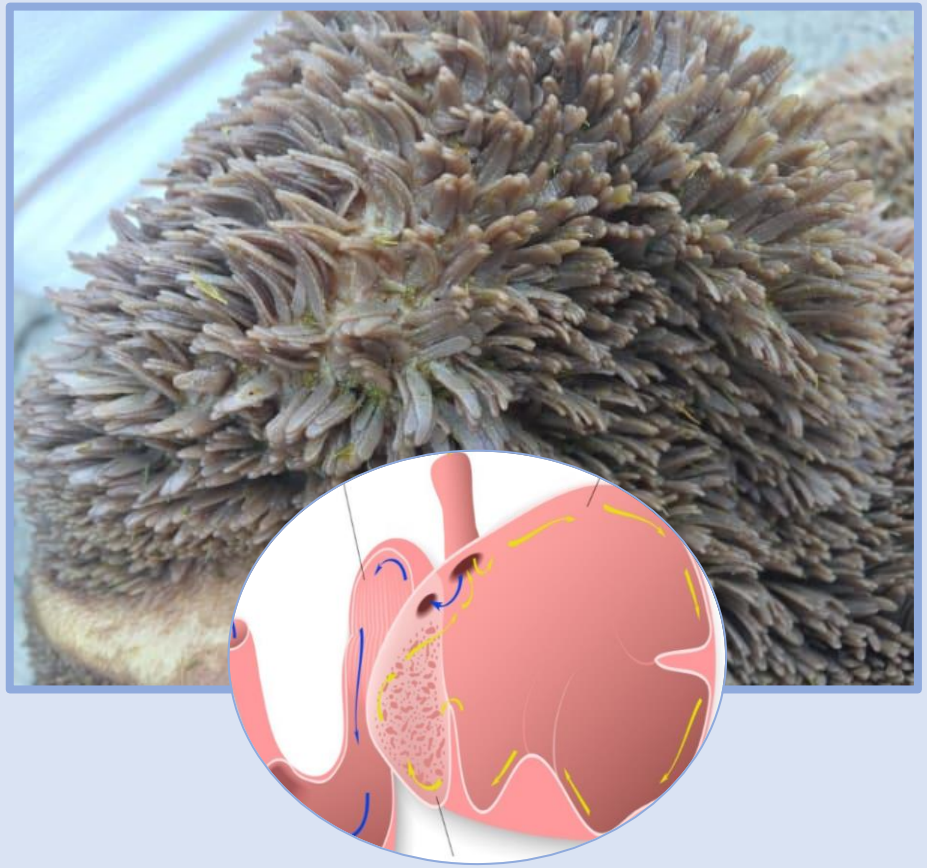
Theme 3: Animal Nutrition and Feeding

RUMEN FERMENTATION

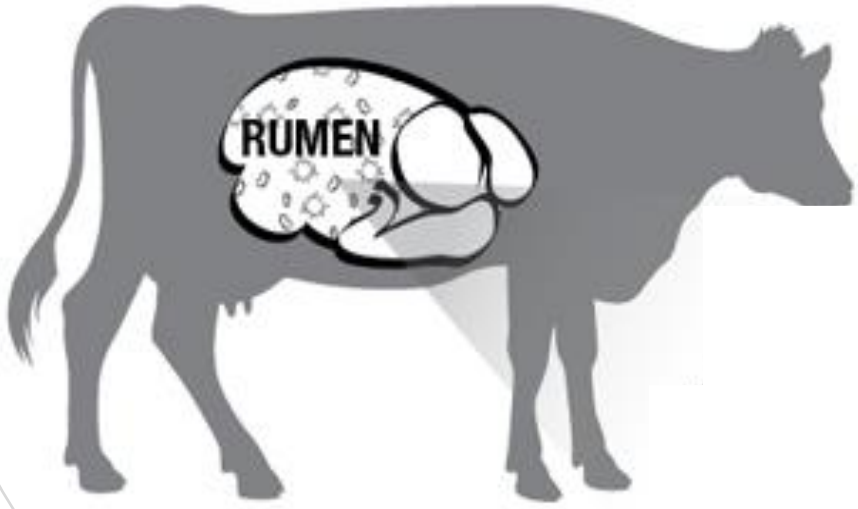
(Level 2)

Topic	Training & information Content
3.1	Estimating feeding value of fodder & feed on dairy farms
3.2	Sampling feeds & forages/analysis interpretation
3.3	Estimating Dry Matter intake for various breeds/age categories of dairy cattle in the tropics
3.4	Reviewing feed intake, rumen fill, Body Condition Scoring (BCS)
3.5	Life weight estimation of cows
3.6	Rumen fermentation
3.7	Mineral & vitamin requirement, guidelines
3.8	Manure scoring and evaluation
3.9	Guidelines for ration calculations for various breeds, heifers, lactation stage (Rumen8)
3.10	Use of Rumen8 software for ration calculation
3.11	Optimization of ration with Rumen8
3.12	Feeding management guidelines
3.13	Feeding management of dry cows/close-up
3.14	Feeding systems
3.15	Metabolic disorders
3.16	Scoring locomotion and hoof condition
3.17	Mycotoxin in dairy cattle nutrition
3.18	Heat stress in dairy cattle nutrition
3.19	Monitoring feeding management, using KPIs (based on Rumen8)



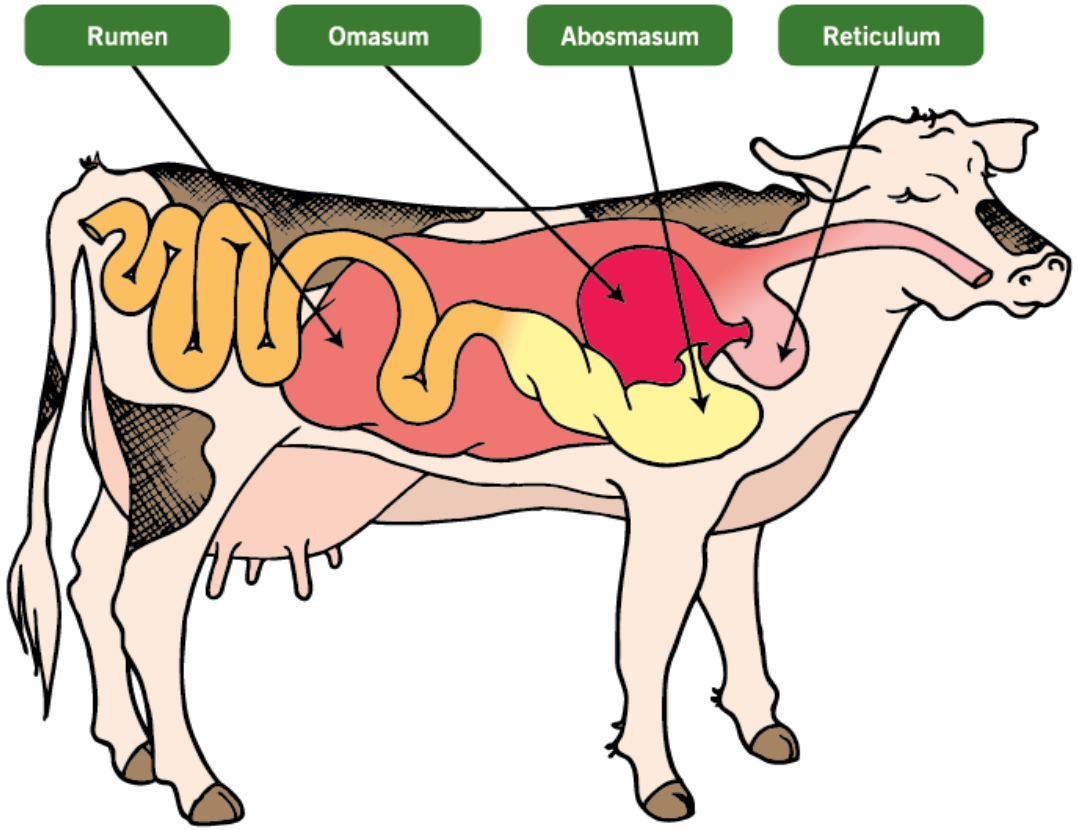
1. You will learn about (learning objectives):

- ❑ The rumen as one of the most important parts of the cow's digestive system.
- ❑ How the rumen functions and its ecosystem; rumen microorganisms.
- ❑ Fermentation processes in the rumen and factors affecting it.



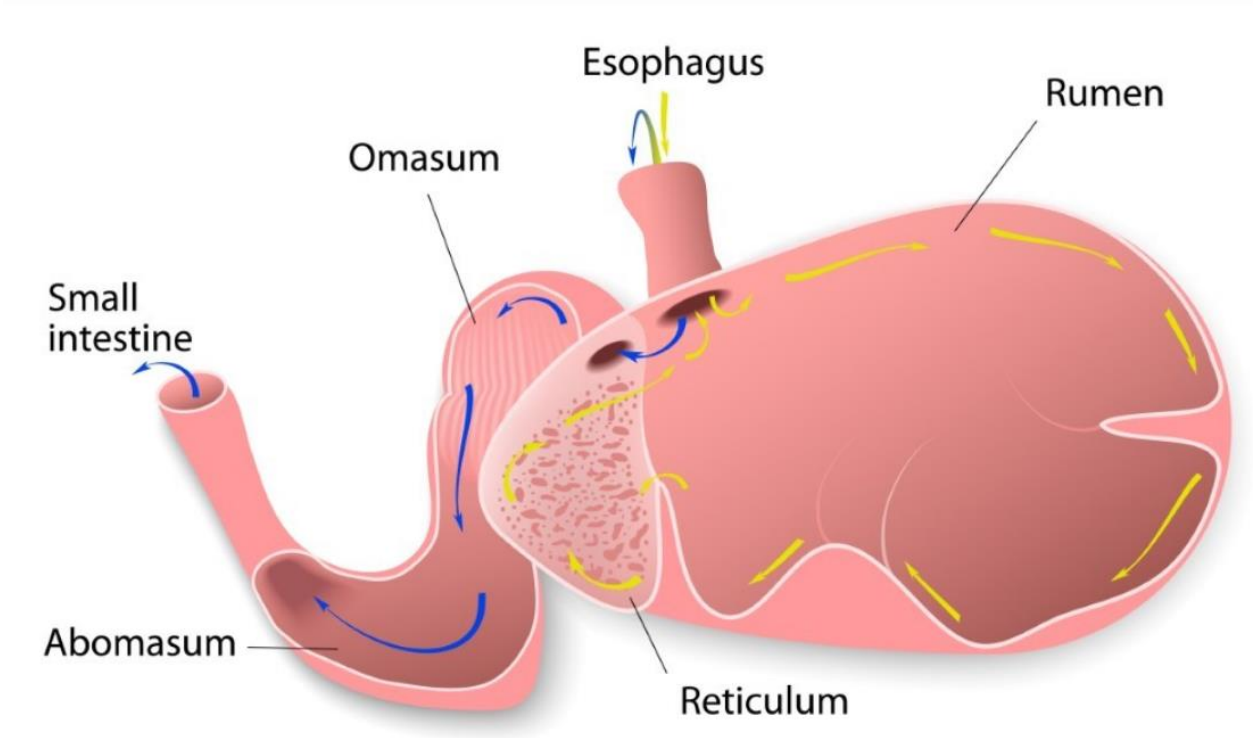
2. Introduction

- A cow’s digestive system consists the reticulum, omasum, abomasum, rumen and intestines.
- Major fermentation processes starts and occur in the rumen.
- Rumen fermentation is a process that converts ingested feed into nutrients e.g. energy.



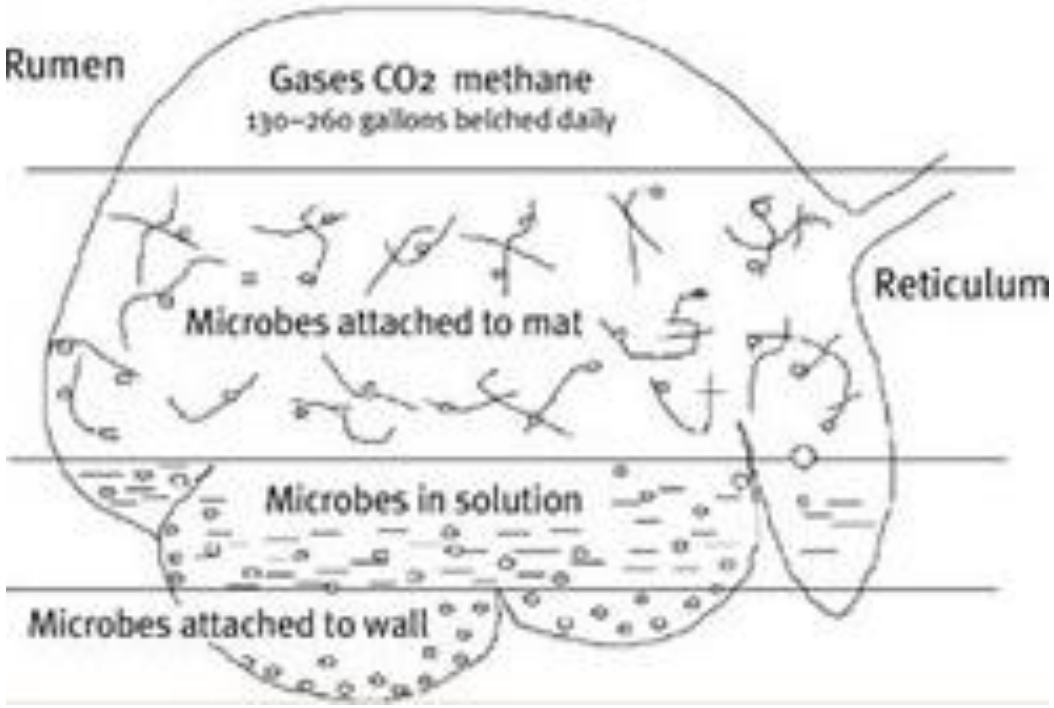
2.1 Introduction Cont'd…

- The rumen depends on microorganisms for fermentation/digestion of feeds i.e., bacteria, protozoa, and fungi that coexist with the cow.
- By-pass nutrients are digested in the abomasum and small intestines.



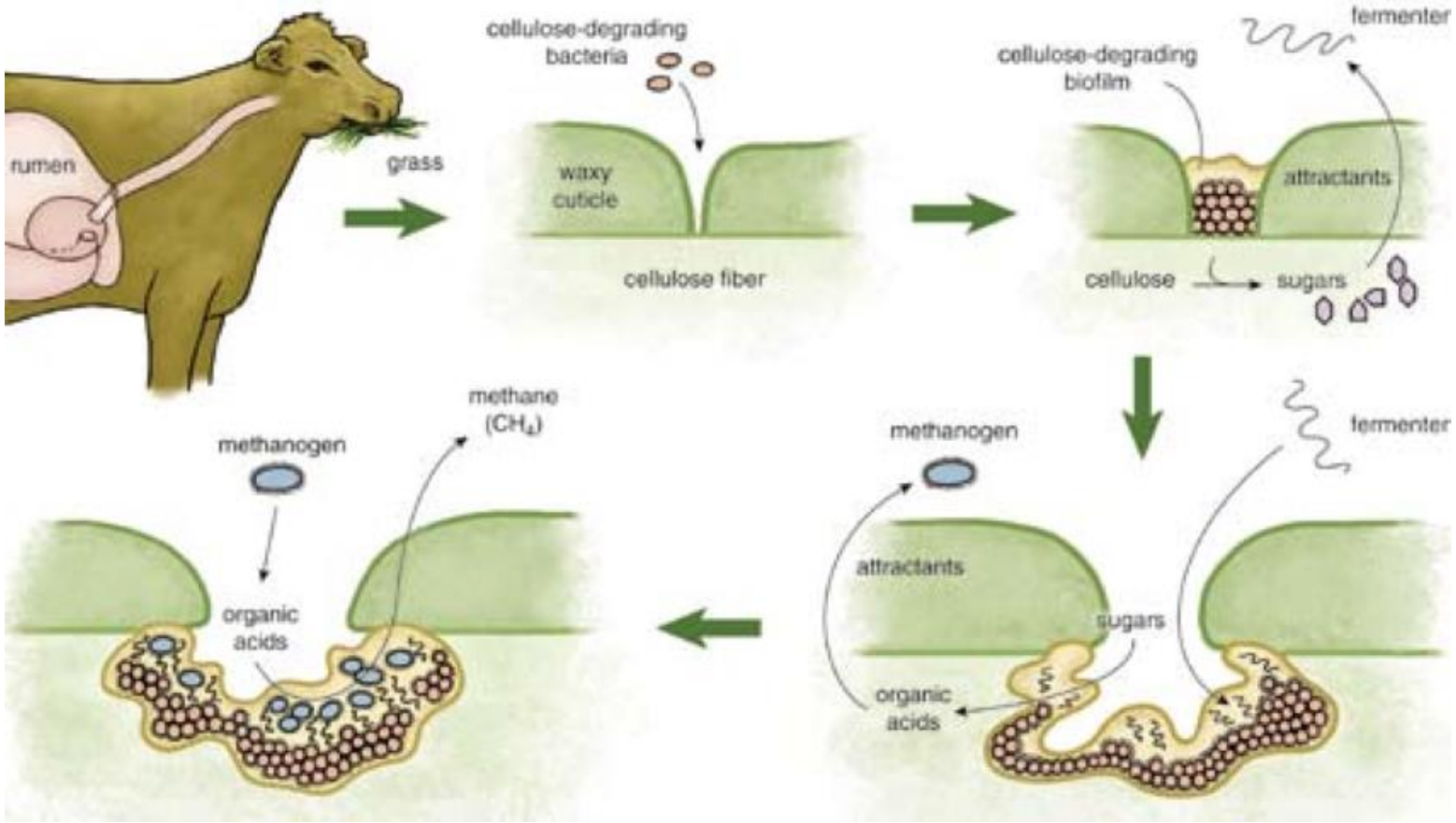
3. The rumen microorganisms

- These are grouped into two:
  - The slow-working fiber-digesters located on the fiber mat in the rumen,
  - The fast-working microorganisms that float around in the rumen fluid, looking for easily-digested nutrients like sugars and starches.



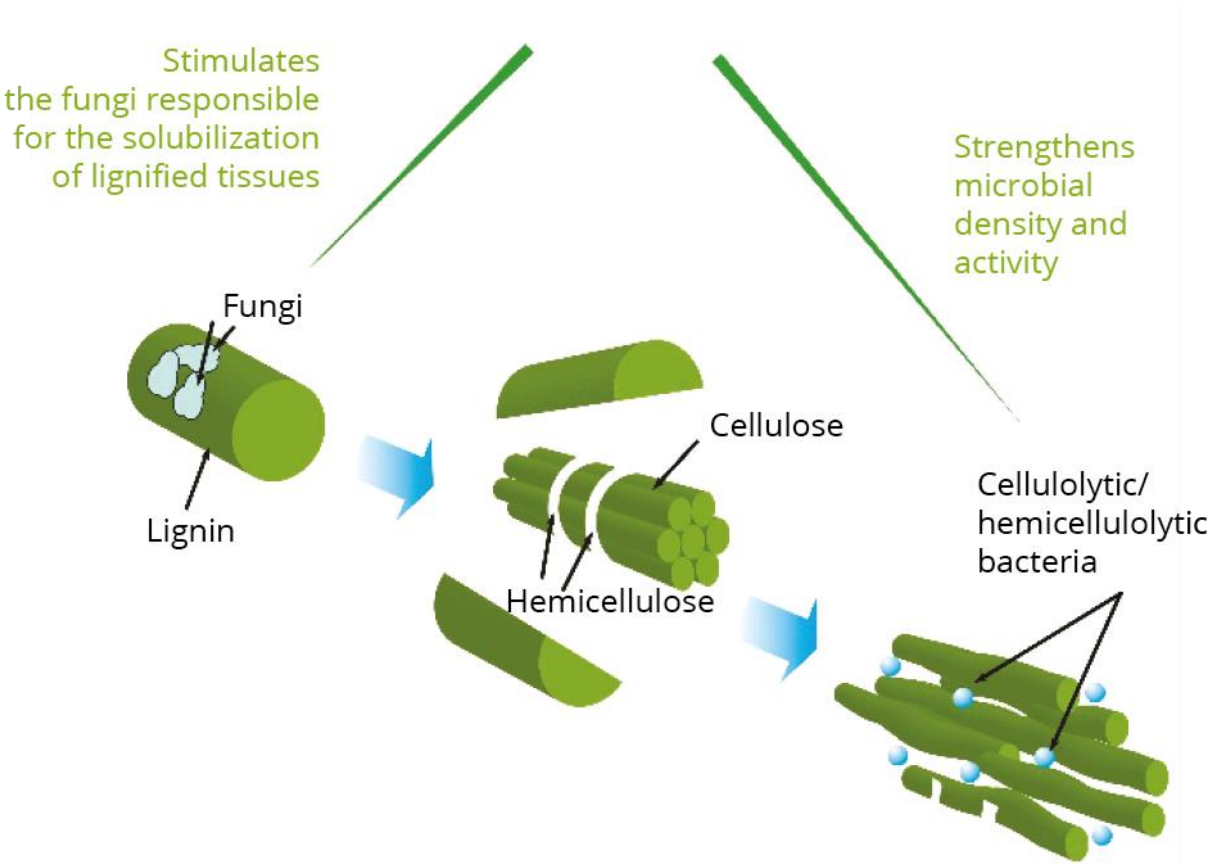
4. Rumen microorganisms: Bacteria

- The rumen bacteria have different functions depending on what they act on.



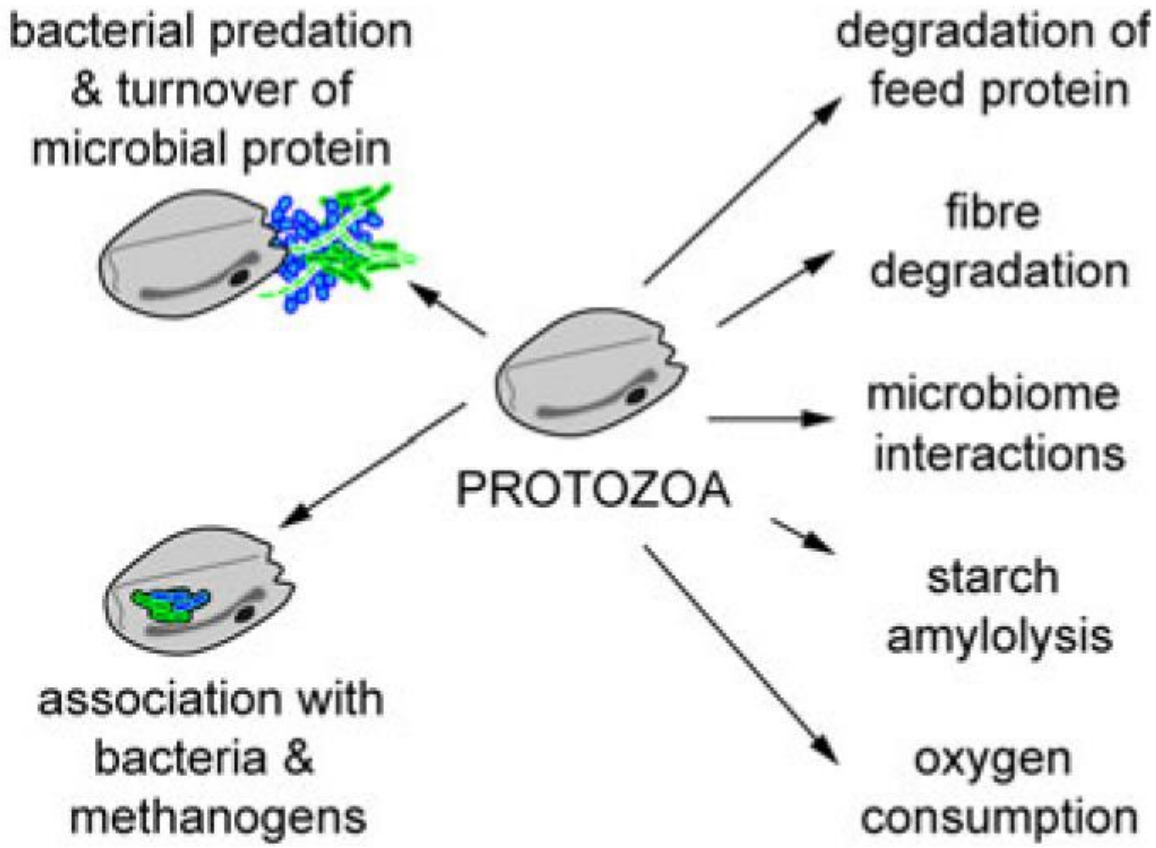
5. Rumen microorganisms: Fungi

- Fungi represent a small proportion, approx. 8% of the biomass in the rumen ecosystem.
- Rumen fungal populations are favored by the consumption of highly lignified fibrous forage.
- The fungi quickly flourish once the feed concentration is increased.



6. Rumen microorganisms: Protozoa

- Protozoa digest and ferments cellulose, carbohydrates and protein.
- Protozoa also ingest bacteria and feeds particles.
- In the rumen environment, soluble proteins are mostly degraded by bacteria and protozoa.

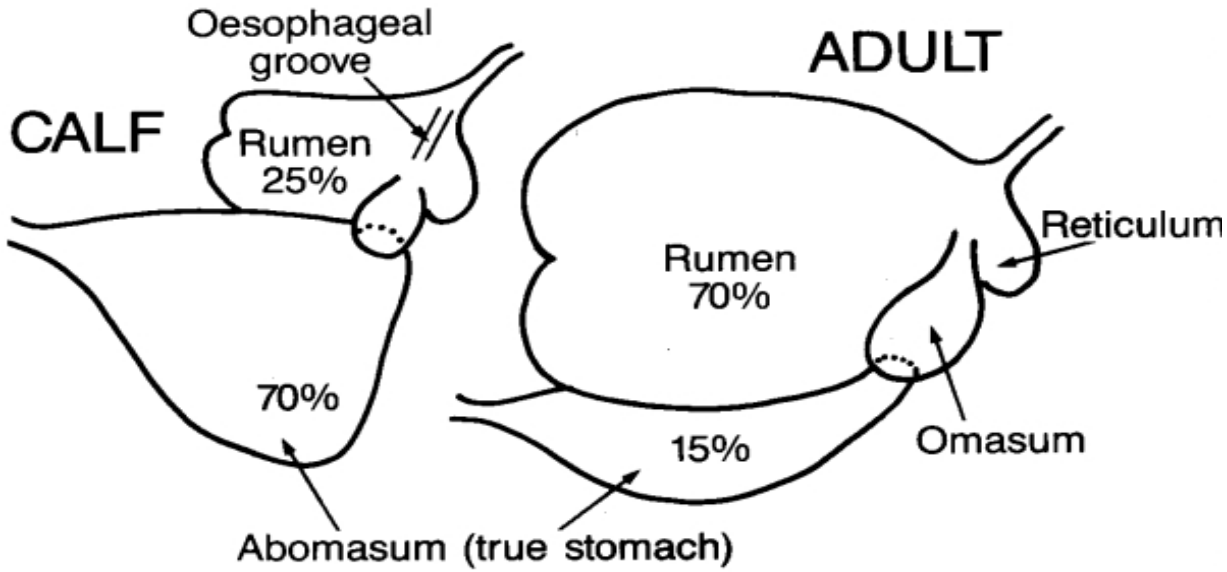


7. Features of the Rumen

- The interior surface of the rumen forms numerous papillae that vary in shape and size.
- Rumen is the largest chamber and has regular contractions to move food around for digestion, eliminating gases.
- It also send foods particles back to the mouth for remastication (chewing cud).

8. Rumen function in young stock

- The very young calf is described as "monogastric," i.e. it has a single stomach (abomasum).
- Rumen development in calf starts from 3 weeks of age and continues into the 4th month.
- After the 3rd month the rumen should be fully functioning and take over, including fibrous feeds.



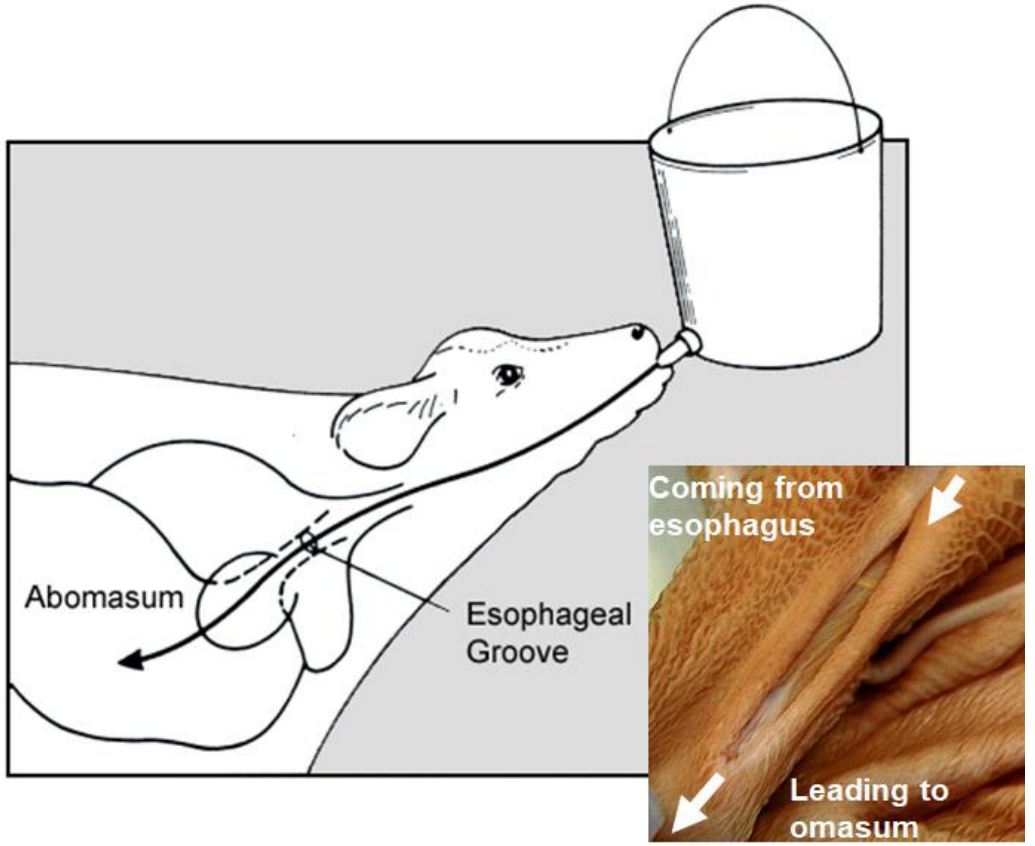
Undeveloped rumen (Day 0)

Developing rumen (Week 18)

Developed rumen (24 months)

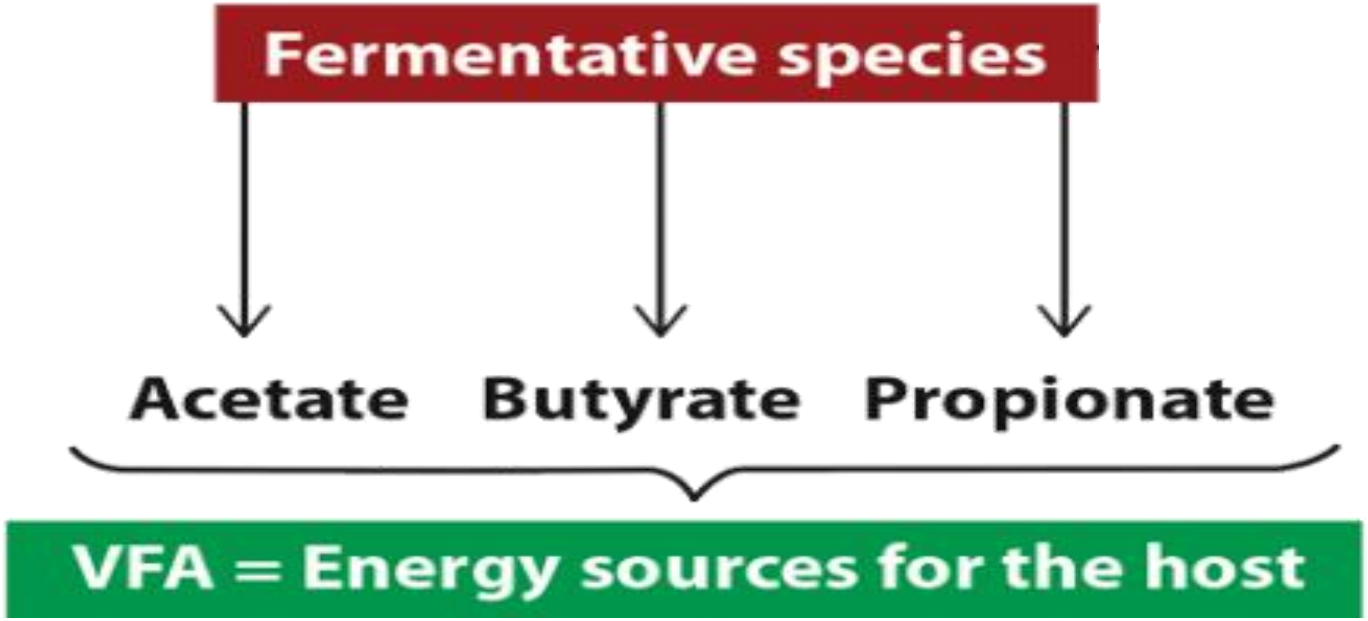
8.2 Rumen function in young stock Cont'd…

- To aid rumen and rumen flora development, introduce fibrous feeds and concentrates to the calf in the second week after birth.
- At early age the rumen is not functional but the calf still needs feeds. The calf is using abomasum and intestines to digest feeds.
- The esophageal grooves allows milk to bypass the rumen and directly enter the abomasum.



9. Rumen fermentation process

- The rumen microorganisms produce enzymes necessary for fermentation processes.
- This allows ruminants to efficiently obtain energy contained in forages.
- Their digestive system allows them to use cellulose as an energy source. However, it’s not completely efficient. Some other final products are methane gas and excess ammonia.



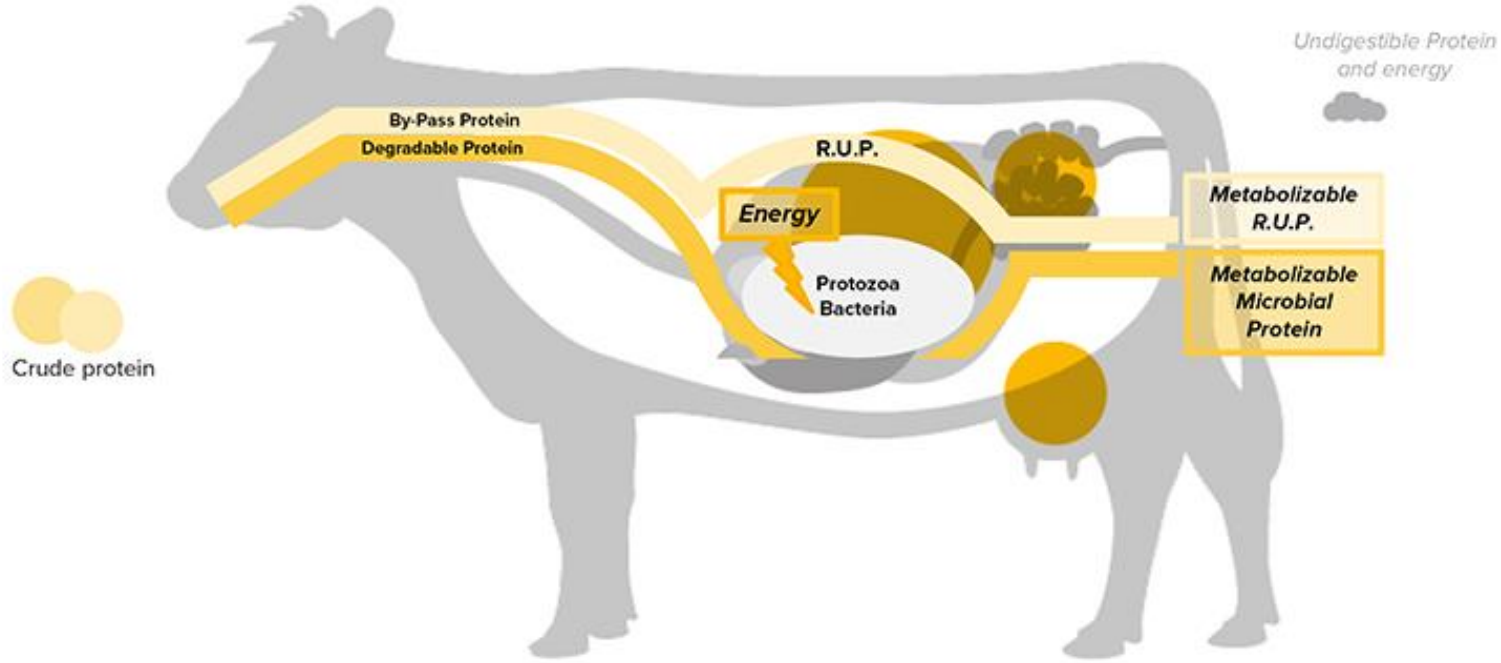
10. Rumen Degradable Protein (RDP)

- Cows get their protein from a variety of sources, and digestion occurs primarily in two ways.
- Rumen-degradable proteins are digested in the rumen by microorganisms and converted to ammonia.
- The microorganisms then use the nitrogen present in ammonia to synthesize microbial proteins.
- The rumen microorganisms are also digested and absorbed in the small intestine as microbial protein.

Protein rich
forage - Lucerne

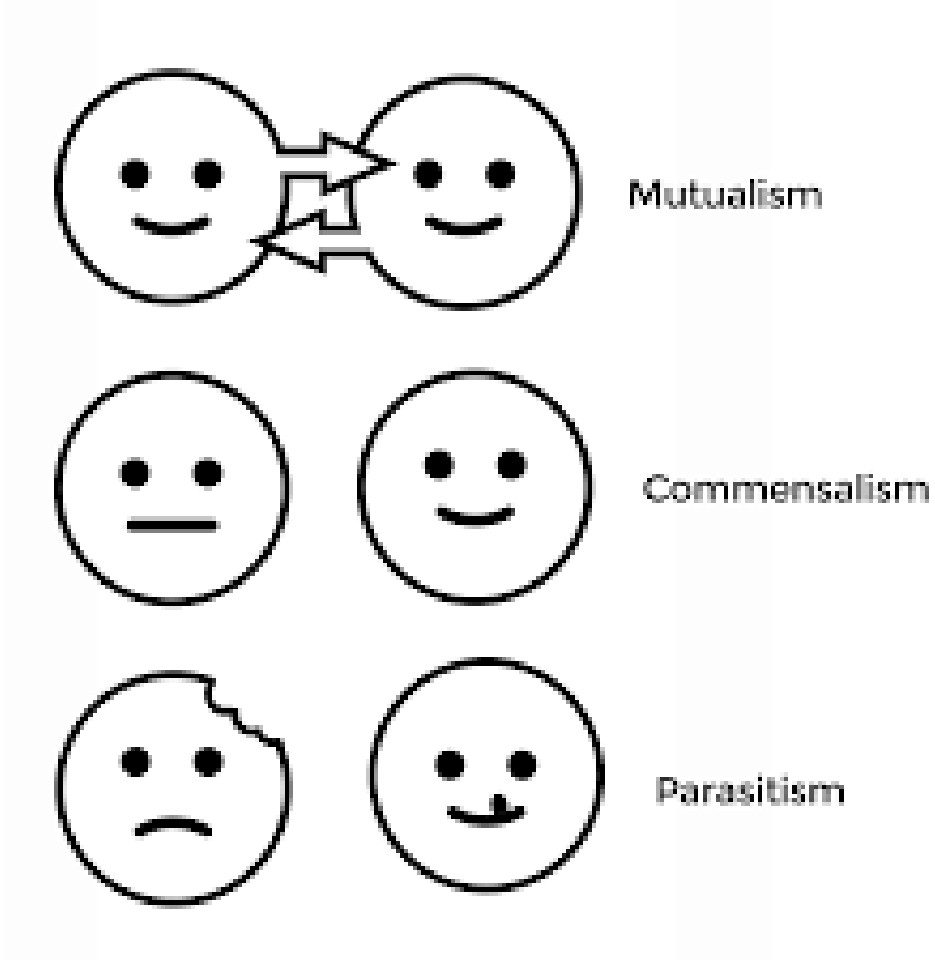
11. Rumen Un-degradable Protein (RUP)

- RUP are not fermented in the rumen, hence also known as bypass proteins.
- The RUP passes the rumen undigested directly into the abomasum and intestines. They are broken down to amino acids and absorbed in the intestines.



12. The symbiotic relationship

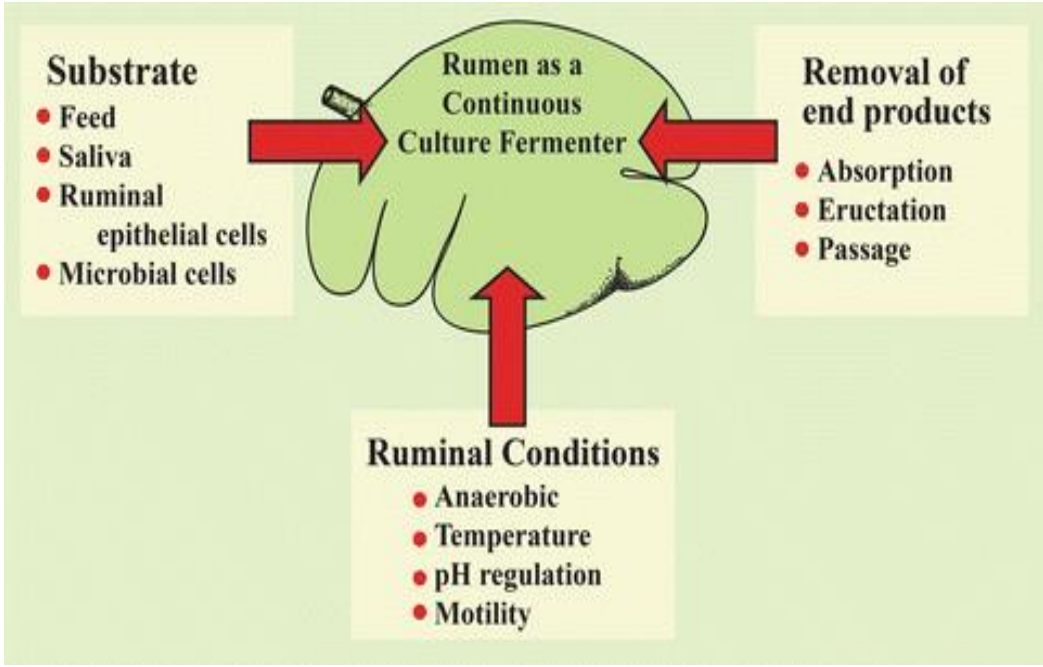
- Interaction between microorganisms and the host animal results in a symbiotic/mutual relationship.
- In the rumen the host and microorganisms relates in such a way that the host feeds on plant fibers.
- This plant fiber can only be degraded by the rumen microorganisms.



13. Microorganisms coexisting conditions

The microorganisms co-exist under the following conditions:

i. The chewing of cuds and saliva.
ii. The quality, nutrients and consistency of feeds.
iii. The rumen temperature.
iv. The rumen pH levels and regulation.
v. The anaerobic conditions (no oxygen in the rumen).

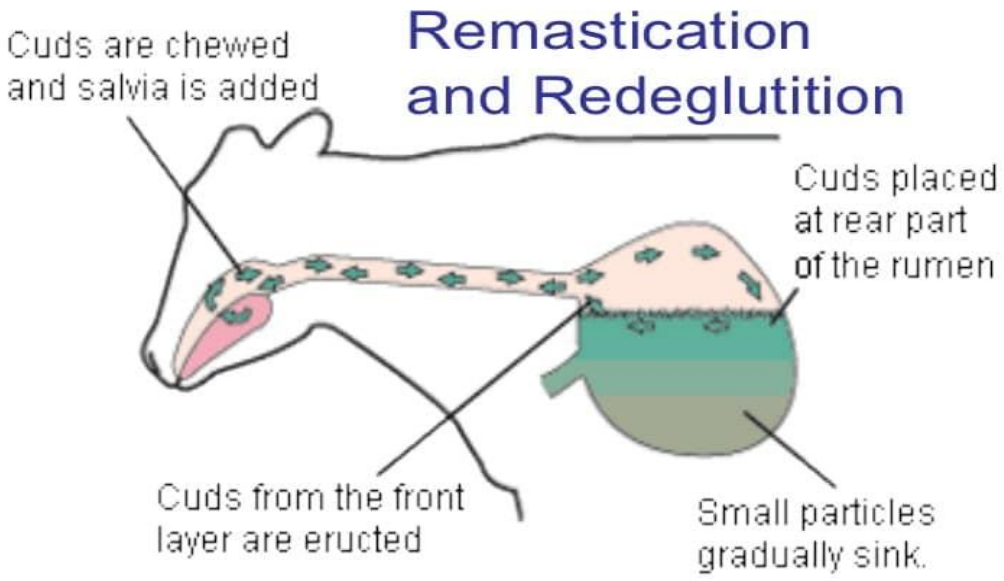


*Motility = Movement, contraction
*Eructation = Belching

14. Rumination/chewing of cud

- Food stored in the rumen is sent back up to the mouth through the esophagus to be re-chewed.
- This further reduces feed particle size, enhancing microbial function and feed passage.
- The produced saliva buffers the rumen to enhance microbial growth and development.

Remastication = Repeated chewing of the cud
Redeglutition = Swallowing food



15. Effective fiber content in feeds

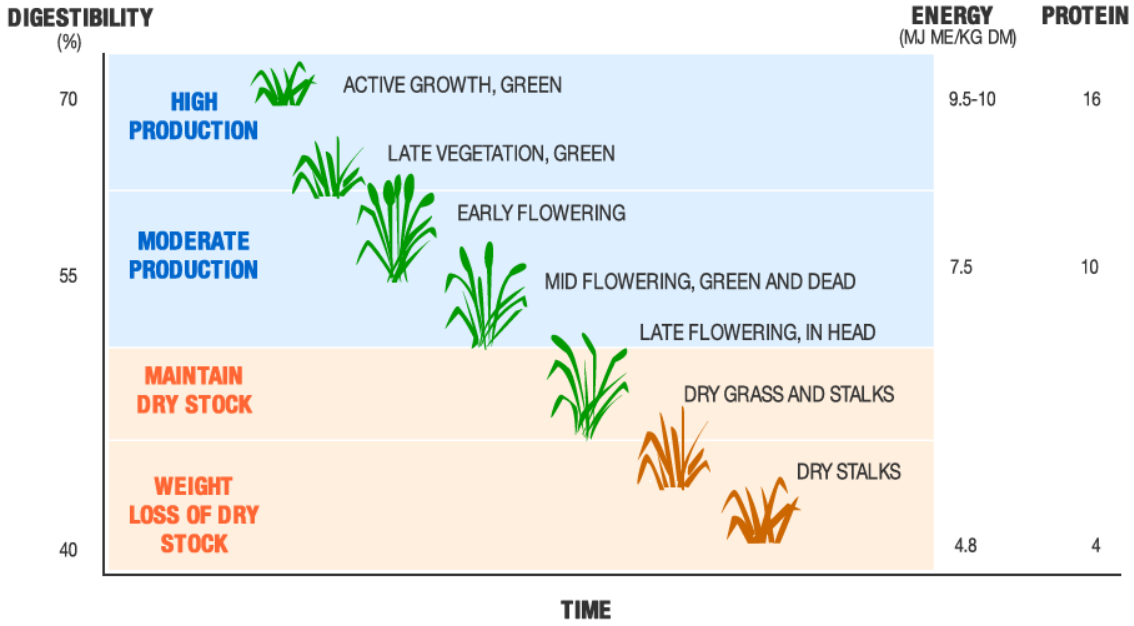
- Effective fiber, which forms the rumen material is required for optimal microbe production.
- These effective fiber stimulates cud chewing and production of saliva for buffering the rumen pH.
- Effective fiber therefore stimulates the speed of digestion and contraction of rumen muscles wall.
- Effective fiber affects the total intake of dry matter and nutrients.

Lucerne hay

Boma Rhodes grass hay

16. Fibre digestibility

- Feeds such as concentrates and lush forage (young vegetative stage) contain lower amounts of fiber.
- The easily digestible fiber builds up the quick working ´floating´ microorganisms population.
- It also causes feed to move more quickly through the rumen and digestive system, which triggers intake of more feed.



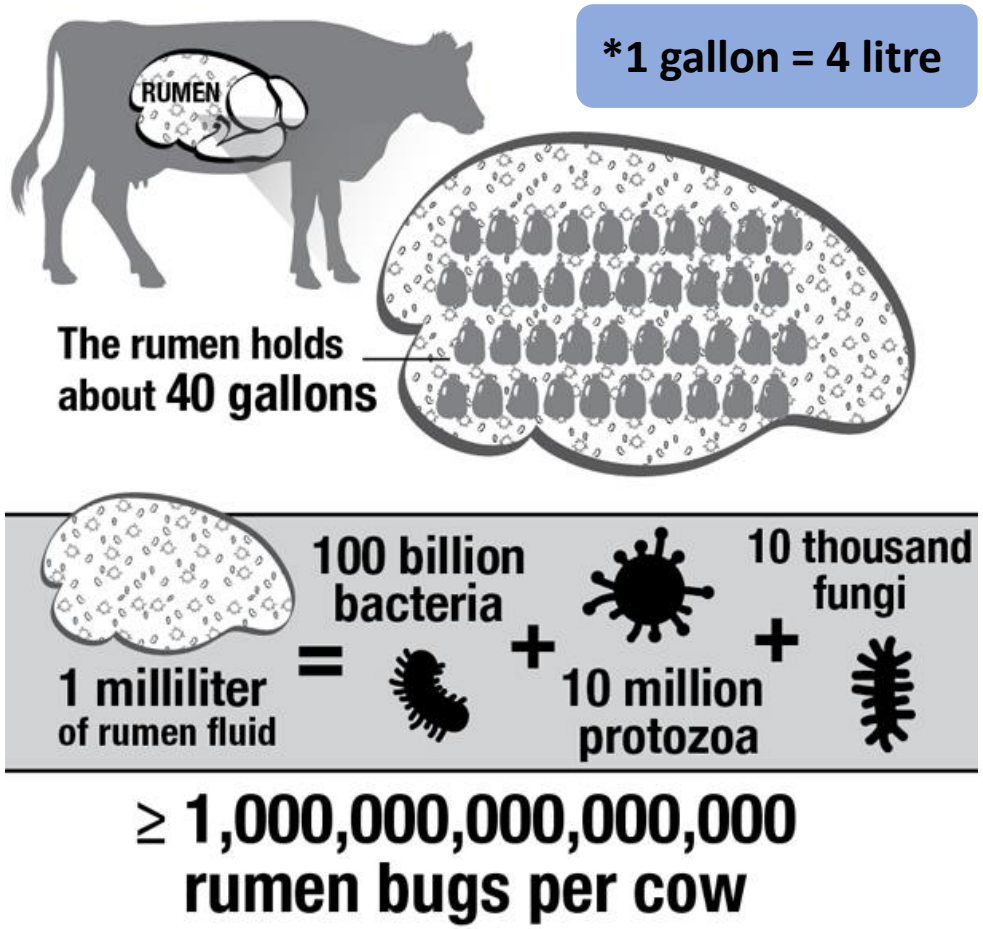
Lush forage

16.1 Fibre digestibility Cont'd…

- The mature forages have a higher fiber content and lower soluble carbohydrates (sugar and starch) content.
- This builds up the slow-working, fiber-digesting microorganisms hence causes feed to move more slowly through the digestive system.

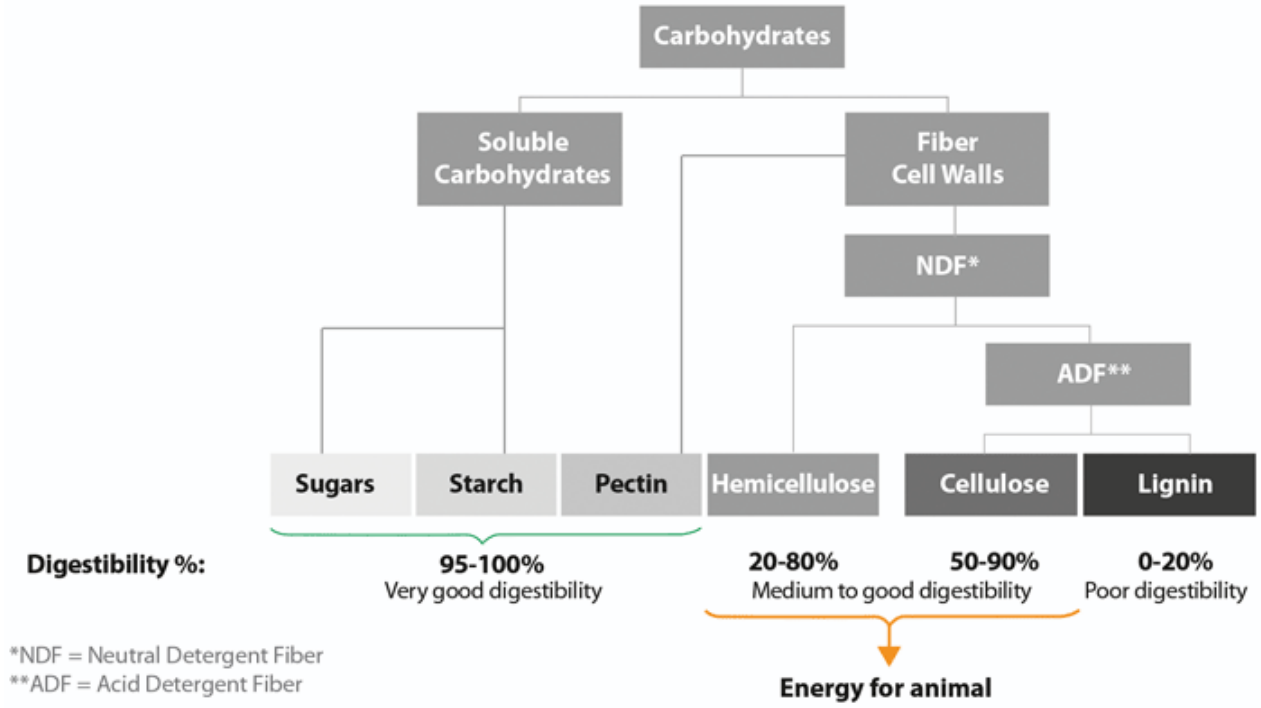
17. Importance of ration consistence

- When feed is changed suddenly, the microbe population in the rumen changes and a new balance between the different types of bacteria will be established. This however takes some time (1-2 weeks).
- Forage fiber-digesting microorganisms may take 4-6 weeks to populate.
- Starch-digesting (grain or grain by products) microorganisms take 4-5 days to populate.
- Therefore regular diet change is not optimal.



18. Energy as an essential nutrient for microorganisms

- Most of the energy needed for microorganisms to grow and multiply is sourced from:
  - Sugars (e.g. lush forages, molasses and citrus pulp)
  - Starch (e.g. cereal grains and agro-industrial by products)
  - Digestible fiber (e.g. forages, cottonseed hulls, palm kernel extract and brewer´s grain).



19. Protein as an essential nutrient for microorganisms

- Microorganisms use both true protein (e.g. protein meal & pastures) and non-protein nitrogen (e.g. urea).
- Feeding excessive amounts of protein to cows is not good for their health (and not cost effective).
- Excess protein is converted to urea, which can have hazardous effects on and could compromise cow fertility.

Lucerne pellets

20. Minerals as essential nutrients for microorganisms

- Calcium, phosphorus, sulphur and magnesium are essential for microorganisms to grow and multiply.
- Young stock should be introduced to minerals and salts as early as the first week.
- These minerals are important for a healthy rumen development in young stock.

21. Water for microorganisms function

- Cows can drink depending on their milk production level so should always have free access to water 24hours.
- Cows are particularly thirsty after milking. Water at the exit and entry points is necessary.

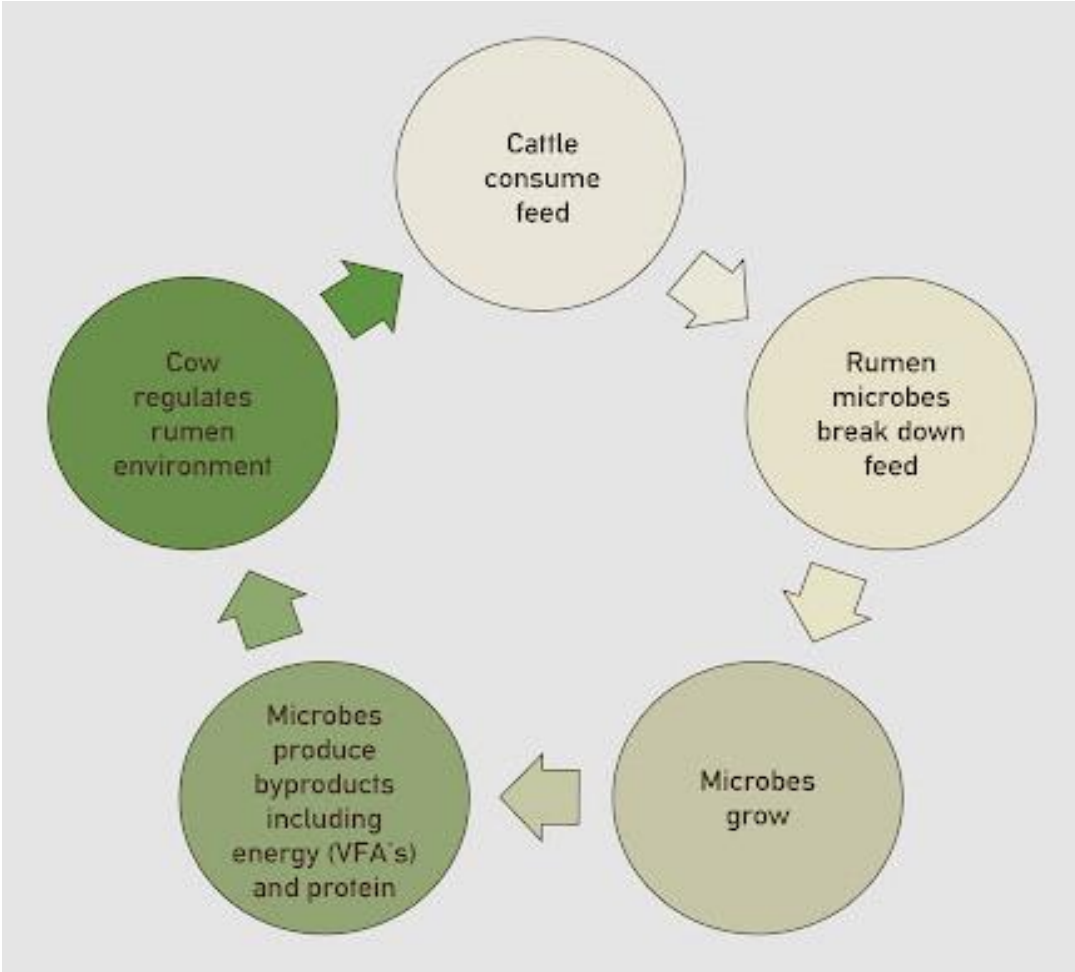
Further reference: Module on water supply and demand.

22. Indicators of poor rumen health

- Low milk production, milk fat & protein ratio reduction.
- Increase in liquid/thin manure.
- Drop in both weight and body condition of cows.
- General cow performance drops such as reproductive performance.

23. Take home message/Summary

- Rumen fermentation is a result of metabolism of microorganisms present in the rumen environment.
- Achieving the end products of rumen fermentation is necessary for ruminant nutrition.



Summary of basic functioning of the rumen

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