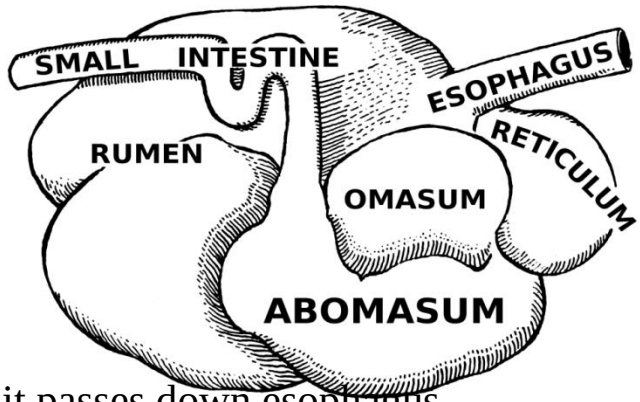
Metabolism in Ruminants

Ruminant stomach consist of four compartments or chambers

1) Reticulum
2) Rumen
3) Omasum
4) Abomasum



Reticulum

1- Holding area for feed after it passes down esophagus.
2- Provides additional area for fermentation.
3- Contains microorganisms, like rumen
4- Collection compartment for foreign objects.
5- Helps open and close rumen.
6- Can contract to a fraction of its resting size

Rumen

1- Largest of the four components.
2- On the left side of the animal.
3- Storage site and fermentation vat.
4- Houses millions of microorganisms.
5- Lined with millions of finger-like projections (papillae) that are needed for absorption

Rumination: consist of four processes

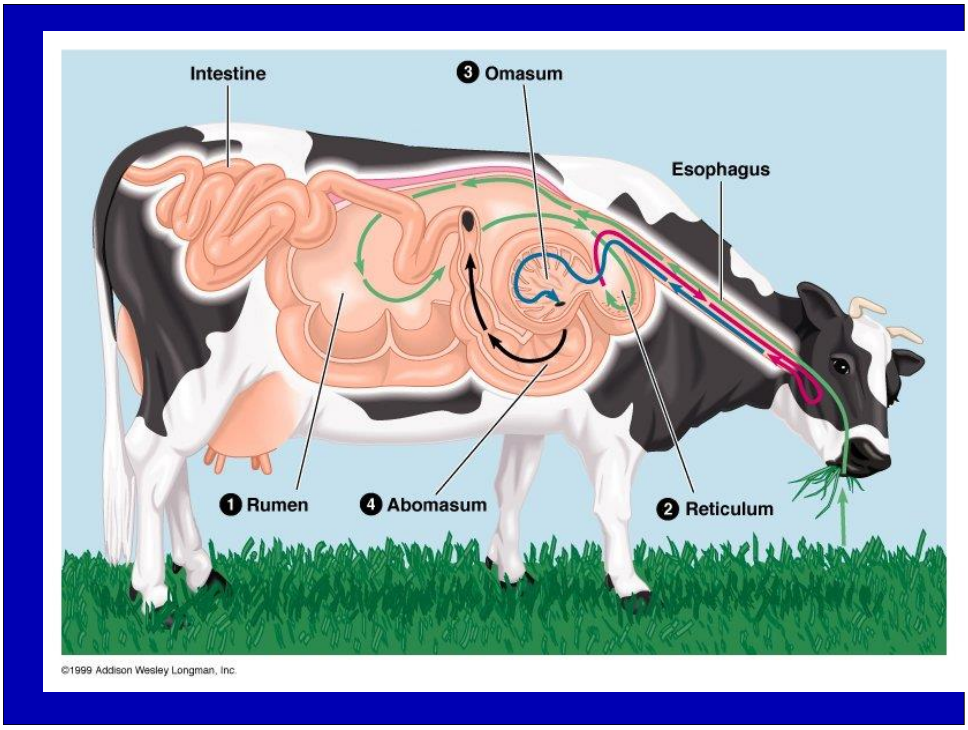
1) Regurgitation

2) Re-chewing

3) Adding saliva

4) Re-swallowing

Rumination lead to reduces feed particle size and increases rumen volume, which allows animal to consume more feed



Omasum

1- A heavy, hard organ that has many folds or leaves.

2- Little, if any digestive activity.

3- Grinds feed particles.

4- Removes moisture

Abomasum

1- True, glandular stomach

2- Functions similarly to monogastric stomach

3- Secretes gastric juices which aid in digestion

Digestive system comparisons

Function	Ruminants	Hind Gut Fermentors	Monogastric
Digest and extract energy from cellulose	Yes (rumen/reticulum)	Yes (large intestine)	Very limited (large intestine)
Utilize dietary sugar sources directly	No (fermented to VFA's)	Yes (absorbed as glucose)	Yes (absorbed as glucose)
Utilize protein from feeds directly	Limited (most converted to microbial protein)	Yes	Yes
Utilize fat from feeds directly	Some (most fermented to VFA's)	Yes	Yes
Utilize microbial protein	Yes (60-80% of AA from microbes)	No	No

Sources of fat in ruminant

1-Feed (seeds{ Triglycerides} and forages{ Glycolipids})

2- Diet supplementation (palm oil, fish oil)

3-De novo synthesis

Lipid Metabolism In Ruminants

Herbivores diets are normally quiet low in lipid because of the small quantity (2-5%) contained in most plant food sources. These dietary

characteristics have required both metabolic adaptations and methods for conserving essential fatty acids (EFA).

Plant lipids are altered extensively by the rumen fermentation, and the lipid actually received and absorbed by the animal differs from that ingested

The rumen is intolerant to high levels of fat, which may upset the fermentation. This situation in functioning ruminant contrast with that in the newborn ruminant.

In most metabolic systems FA's are derived from glucose. Dietary derived glucose is scarce in ruminant metabolism, however and ruminants have evolved mechanisms for its conservation, the most important of which is the lack of pathways for converting glucose into FA's

About 90% of fat synthesis in ruminants occurs in the adipose tissue.

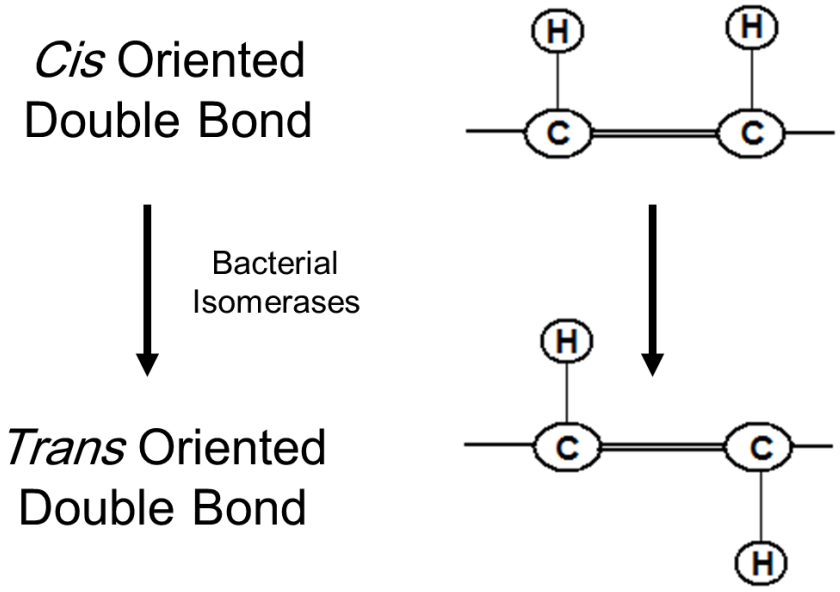
The liver, which is the major lipogenesis site in many non-ruminants species, accounts for only 5% in ruminants.

Lipolysis in ruminants

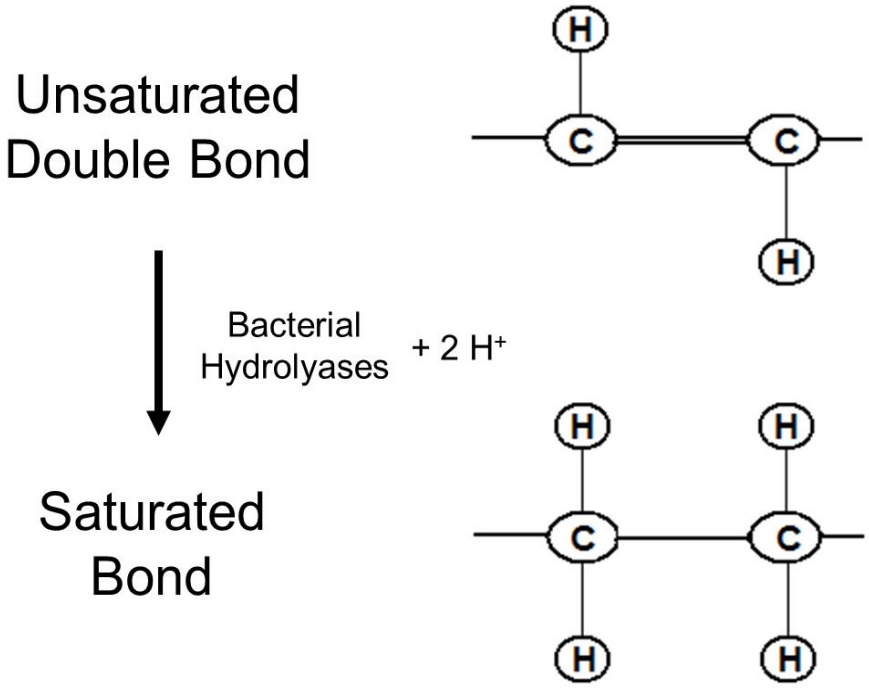
Shortly after esterified plant lipids are consumed, they are hydrolyzed extensively by microbial lipases, causing the release of constituent FA's.

The lipase hydrolyzes acylglycerols completely to FFA, glycerol and galactose with little accumulation of mono or diglycerides. Glycerol and galactose are fermented rapidly, yielding propionic and butyrate acid (VFAs) as a major end product.

1- **Isomerization**



2-Biohydrogenation



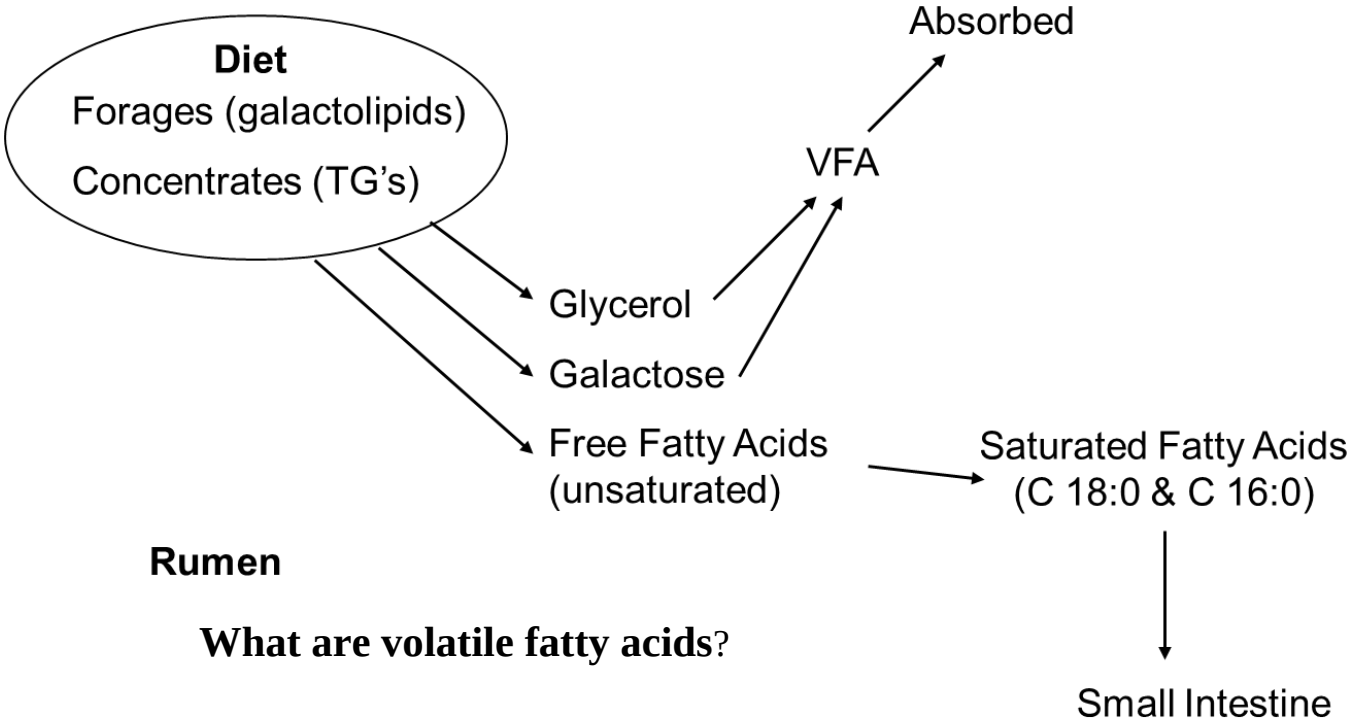
Importance of Biohydrogenation

1- Aids in relieving the rumen of excess hydrogen ions caused by constant acid production through normal fermentation.

2- Also, PUFA are highly toxic to rumen bacteria.

Rumen microbial environment: consist of Fungi, Protozoa and Bacteria. They Need protein source to function and established early in life (as early as 6 weeks)

Rumen Lipid Metabolism



What are volatile fatty acids?

VFAs are ruminant energy source. Produced in large amounts through ruminal fermentation and are of paramount importance providing greater than 70% of the ruminant's energy supply.

1-Acetic

2-Propionate

3-Butyric

VFA's are absorbed through the epithelium, down a concentration gradient and carried by ruminal veins to the

portal vein and then the liver. Continuous removal of VFA's is crucial for rumen pH. Different VFA undergo different degrees of metabolism as following

• Acetate and propionate pass through the epithelium largely unchanged

• Butyric acid is metabolized in the epithelium to beta-hydroxybutyric acid, a type of ketone body.