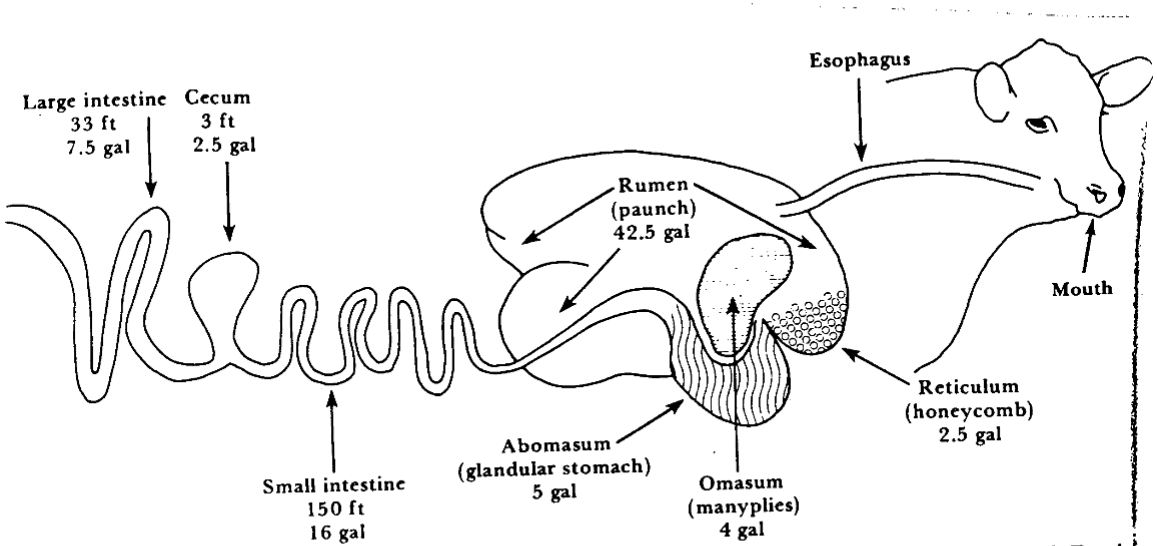
Ruminant Characteristics

- Complex structure with four compartments



Complex digestive tract—20 X body length. Chews after fermentation (ruminates). Stomach capacity 54 gal. Total capacity 80 gal. 32 teeth.

FIGURE 1–9. Digestive system of the ruminant (cow).

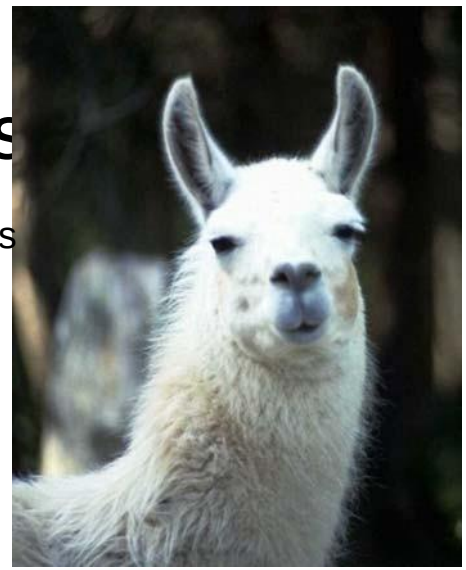
Ruminant Characteristics

Primarily herbivores

- Cattle, sheep, goats, deer, elk
- Camelids are “pseodu” ruminant

S

- 60-75% of ingesta fermented by microbes before exposed to gastric juices



Esophagus

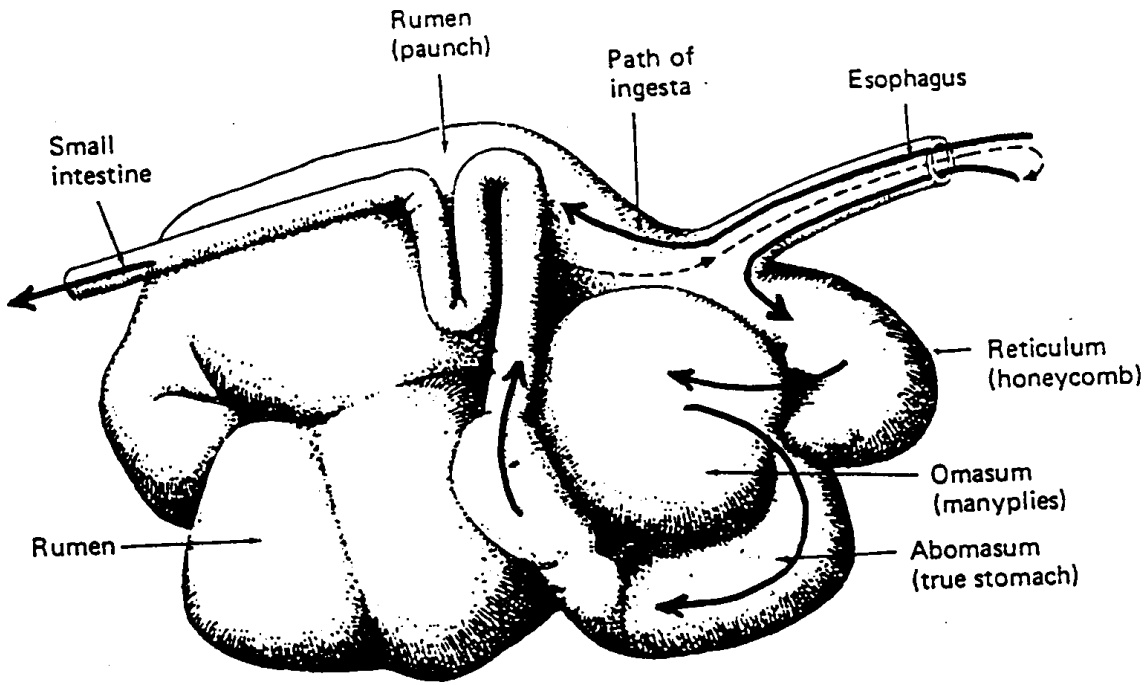
- Tongue
  - Used more by cattle and goats (also use lips)
- Teeth
  - No upper incisors
  - Used more by sheep (use lips to “sort” feed)
- Saliva
  - Continual production
  - Cattle: 12 gal/d vs Sheep: 2 gal/d
  - No enzymes; High pH.

No sphincter valve

- Opens into reticulum and rumen
- Muscle contractions move in bothdirections

Stomach compartments

- Reticulum
- Rumen
- Omasum
- Abomasum



A higher proportion of a ruminant's digestive system is stomach

Rumen Characteristics

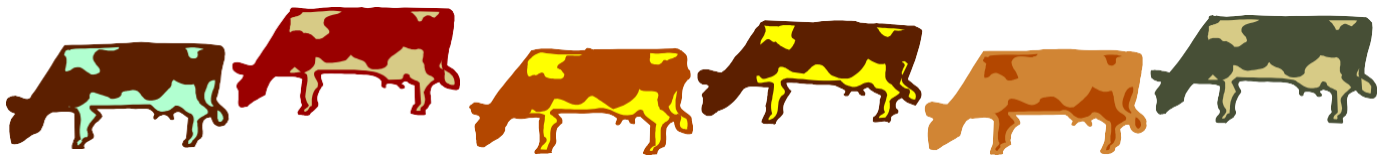
- Located next to heart
- Honeycomb appearance
  - Catches metal and hardware
- Pathways
  - Esophagus
  - Rumen
  - Omasum
- No enzymes secreted
- Left side of abdomen
- Papillae lining
- Muscular pillars
- Fermentation vat
  - Primarily anaerobic
  - Some aerobic microbes
- Not functional at birth

Small and Large Intestine

- Storage
- Soaking
- Physical mixing and breakdown
- Fermentation
  - Synthesizes some vitamins
  - Synthesizes AA and protein
  - Breaks down fibrous feeds into VFAs

- Acetic Acid
- Butyric Acid
- Propionic Acid

Small and Large Intestine



- "Manyplies"
  - No enzymes from walls
  - Function
    - Reduce particle size
    - Absorb some water
  - "True stomach" that secretes enzymesfrom walls
  - Glandular stomach like a Monogastric fundic region
    HCL, Mucin
    - Pepsinogen, Rennin and Lipase
  - Same SI sections
    - Duodenum, Jejunum and Ilium
  - Same LI sections

Small and Large Intestine

- Cecum, Colon and Rectum

Ruminant Differences con't

- Esophageal Groove
  - By passes reticulum and rumen in younganimals
- Rumination
  - Chew their cud (food bolus)
  - Up to 8 hours/day
    - Decrease particle size for microbes
    - Increases saliva production to buffer rumen
  - About 30 times/day
    - Eructation (belching)
    - CO_2 and Methane
  - Produced by microbial population in rumen
  - Rumen contracts and forces gas out
  - Bloat can result if ruminant doesn't belch

Bloat

Gas can’t escape

Animal dies from suffocation because of distended rumen

Digestive Fluids con't

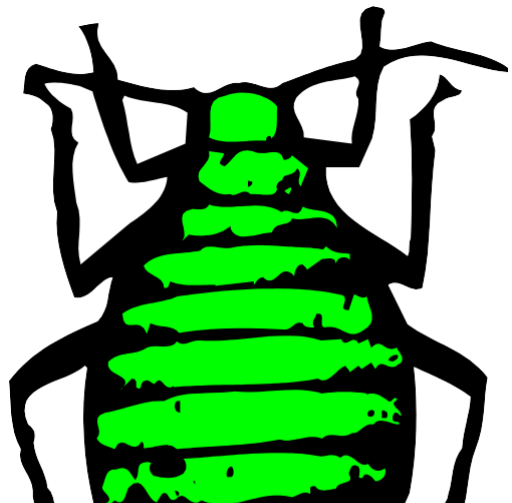
- Saliva
- Gastric juices from stomach
  - Pepsinogen
  - Rennin
  - Lipase
  - HCL
- Pancreatic secretions
  - Trypsin, Chymotripsin, Carboxypeptidase
  - Amylase
  - Lipase
  - Buffers
- Liver Secretions

Digestive Fluids con’t

- Bile salts; No enzymes

Microbial Fermentation

- Intestinal enzymes
  - Aminopeptidase, Dipeptidase, Nucleases
    - Denaturing proteins
  - Maltase
  - Lactase
  - Sucrase
- Short Life cycle
- Synergistic relationship
- Types of microbes
  - Starch fermenters
  - Amylotic microbes
  - Cellulose/roughage fermenters
    - Cellulolytic microbes

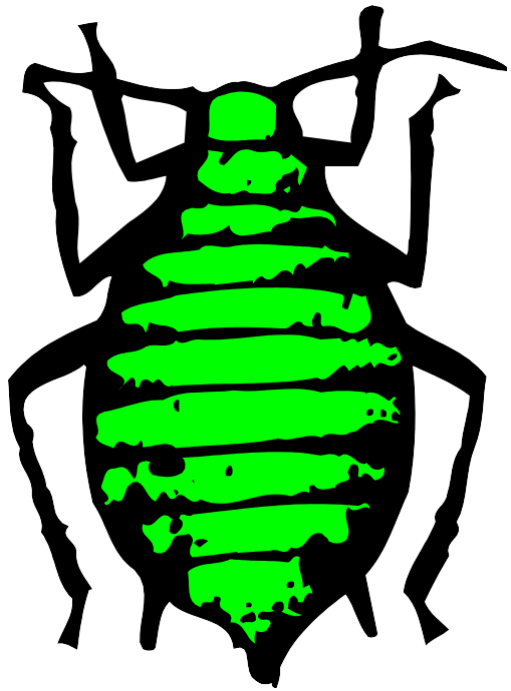


Microbial Fermentation

- Adjust according to diet

Microbial Fermentation con't

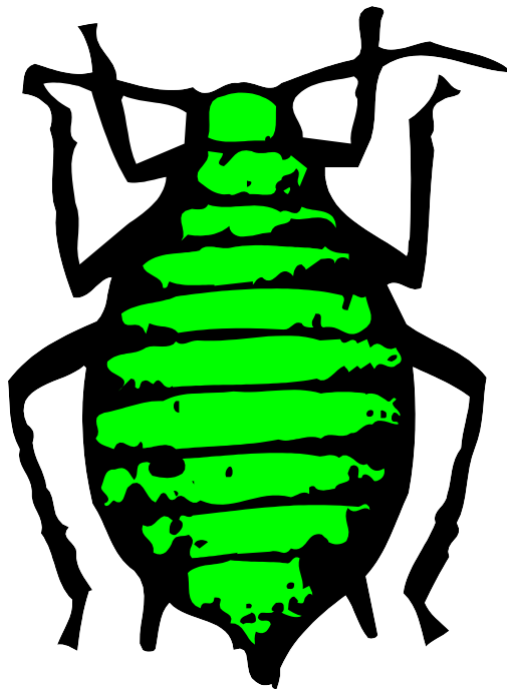
- Categories of microbes
  - Bacteria
  - Protozoa
  - Fungi
  - Bacterial viruses



Note: Type present depends on diet being fed

Microbial Fermentation

- Regulation of microbes
  - Bacteria vs Protozoa
- Competition
- Acidic environment
- Shifts with diet
- Shifts with consumption



Rumen Activities

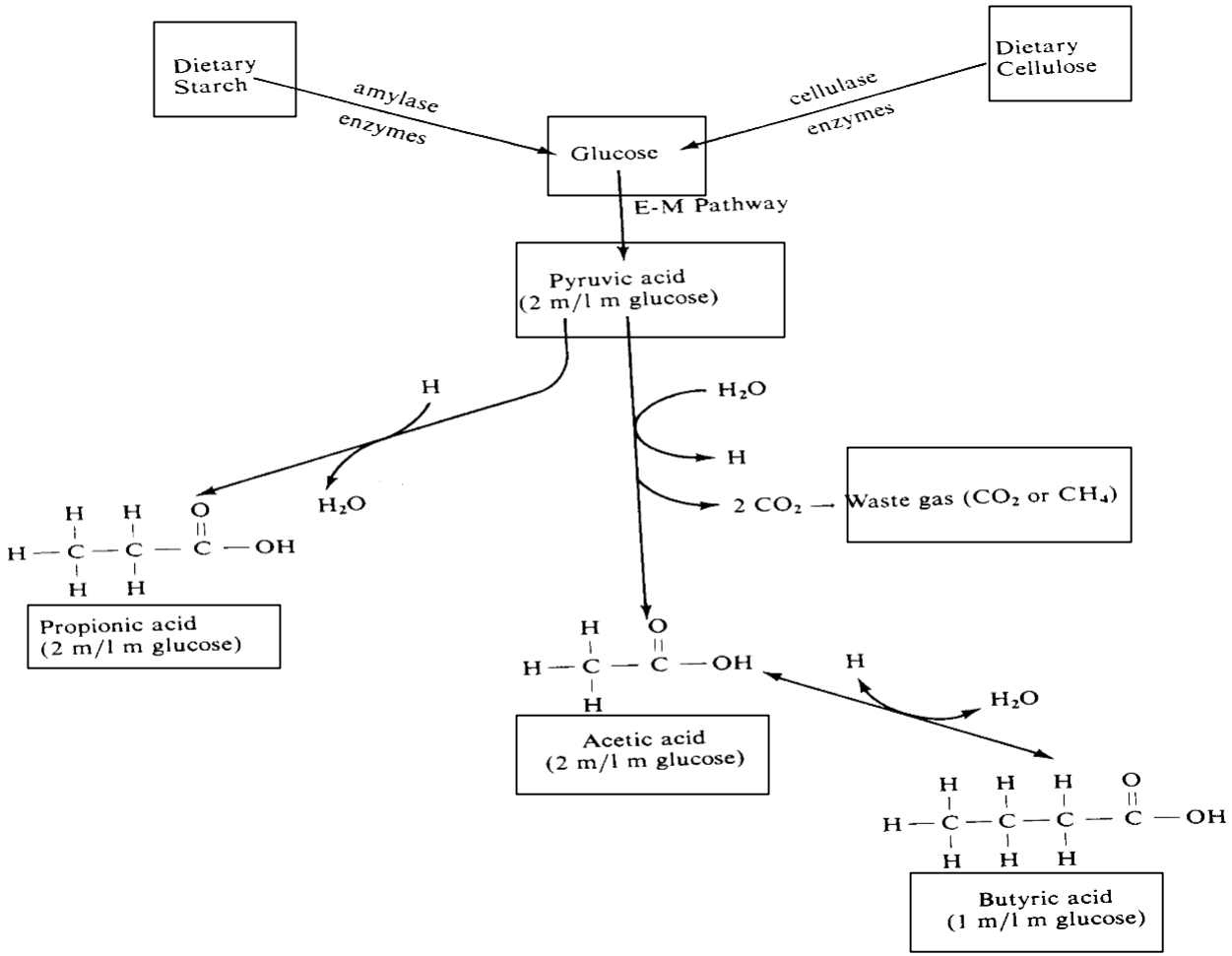


FIGURE 1–3. Volatile fatty acid formation in the rumen.

Volatile Fatty Acids (VFAs)

- Acetic Acid (Acetate)
  - Most comes from cellulose
  - Important to milk fat in dairy cows
- Propionic Acid (Propionate)
  - Most comes from starch
- Butyric Acid (Butyrate)
  - Derived from Acetic acid

Notes on VFAs

- Pyruvic Acid → Acetic Acid
  - CO_2 and CH_4 given off
- Ionophore Feed additives
  - Increases production of propionic acid
  - ~~Decreases production of acetic acid~~

Normal Process

- Propionic
- Lactic Acid
- Normal microbial process
- Lactic acid lower pH
- Lactic Acid
- Pyruvate
- Lactic Acid fermenters required
- Pyruvate is converted to glucose in liver
- Conversion of lactic acid restores pH balance

Quick Diet Changes

- Propionic — Lactic Acid
  - Lactic acid lowers pH
- Lactic Acid — Pyruvate
  - Lactic Acid fermenters are slow growing
  - Can’t keep up so pH is not restored
  - Low pH kills microbes
  - Animal often dies of lactic acidosis

Questions to ponder….

Causes of Lactic acidosis:

- Quick diet changes to high concentrates
- Removal from feed
- Restriction of feed intake during stress
- Voluntary feed aversion
  - Palatability
  - Character
- All of these cause microbial imbalance

- Review what happens when you suddenlyswitch from high roughage to high grain…..
- What happens to an animal if you suddenly switch from a high grain to ahigh roughage diet?

Importance of pH in Digestion

- VFAs
  - Main energy source for cows
- CO_2
- CH_4 (Methane)
- NH_3 (Ammonia)
- Microbes

- Optimum is 6.8
- Factors affecting pH
  - Diet
    - Hay versus Grain
  - Level of intake
  - Frequency of intake
- Regulating pH

- Starch Fermenters
- Cellulose/roughage Fermenters
- Understanding consequences of quick

Rumen Development

- 48 -100 liters of liquid
  - Larger in cows on a forage diet
  - Forage-fed calves have larger rumens
- 15-21% of mature cow weight is rumen contents

Rate of Passage

- Definition
  - How fast food passes through the rumen
  - General trends with various feedstuffs
  - Ground vs Stem Hay
  - Concentrates

- Why important?

Last tidbits on Microbes

- Microbe development in young ruminants
- Probiotics
  - Definition- Feed additive for steers
  - Purpose
- Antibiotics
  - Effects on microbes