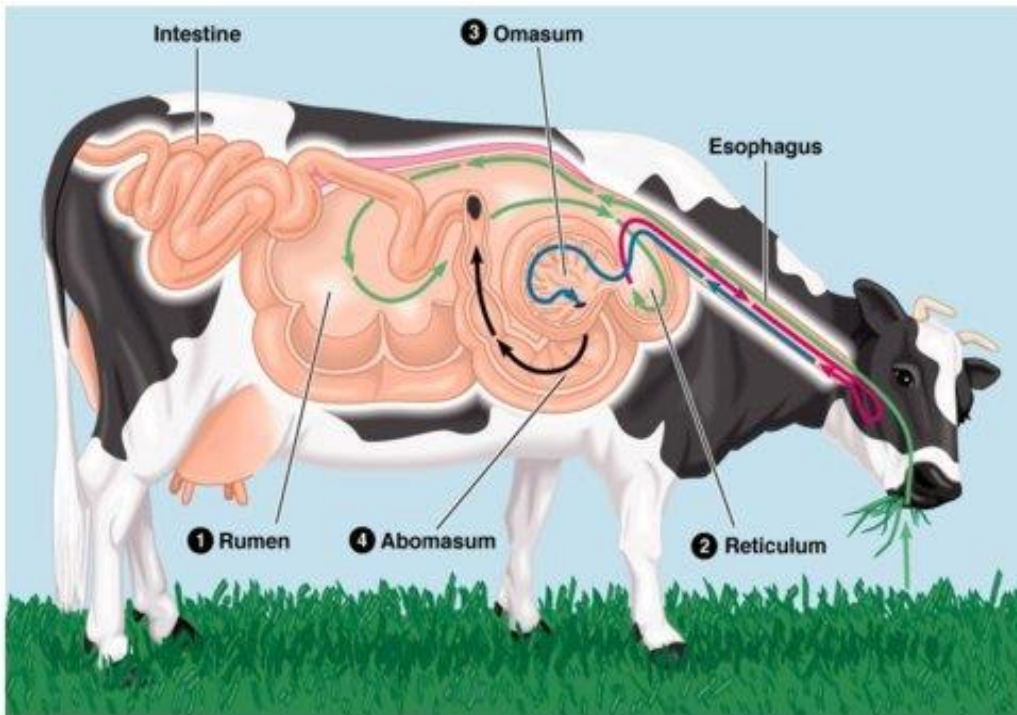


AF 1201

Digestive System





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Complex / Compound Stomach

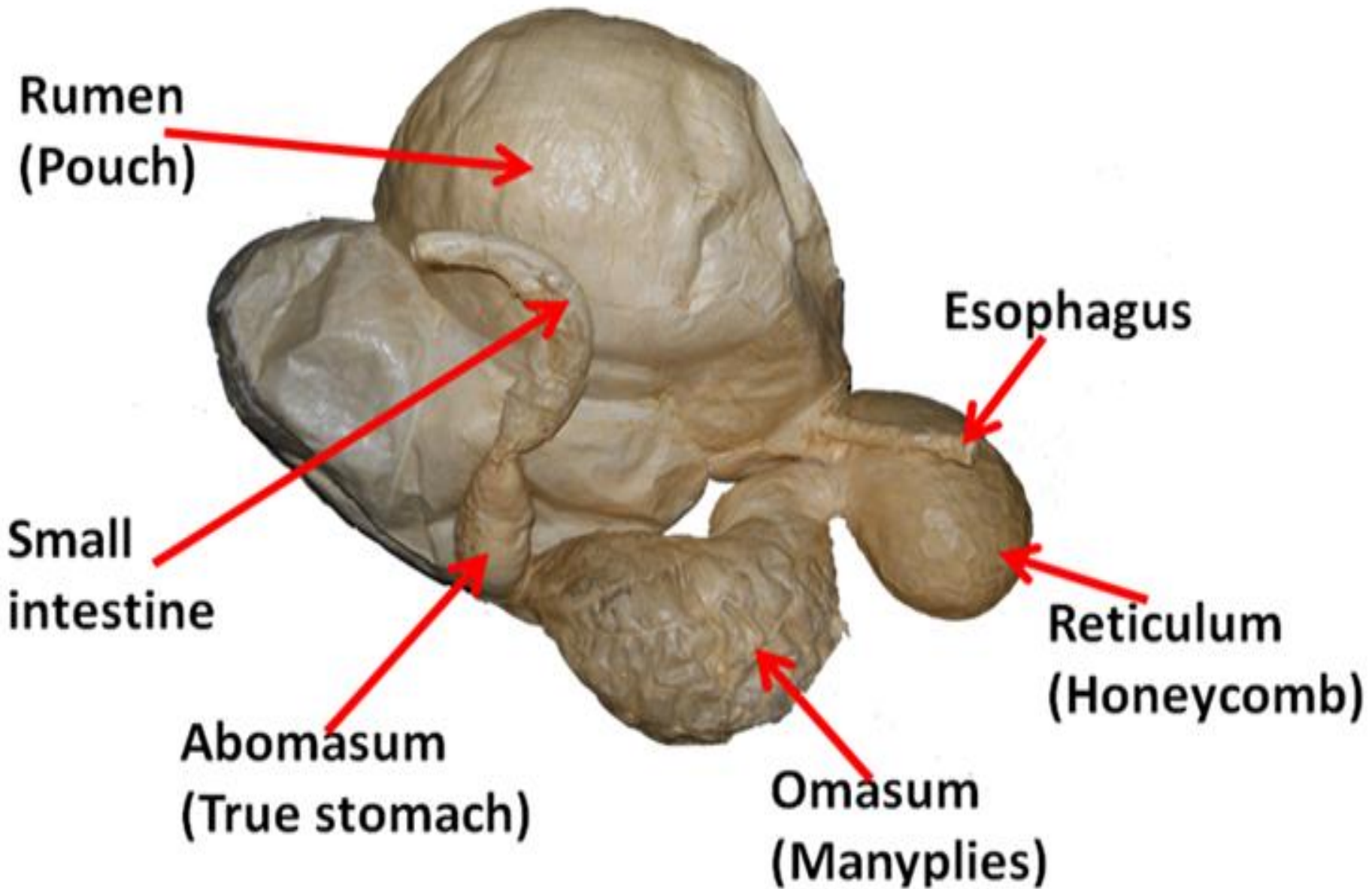
- Large structure, located on the left side

- 4 parts

Rumen, Reticulum, Omasum	Abomasum	
		
Fore stomach		True glandular

(Enlargement of esophageal region)

	Ru.	Re.	Om.	Ab.	Capacity
• Cattle	- 80%	5%	7%	8%	30-40 gallons
• Sheep/Goat	- 70%	8%	2%	20%	7-8 gallons



**Rumen
(Pouch)**

**Small
intestine**

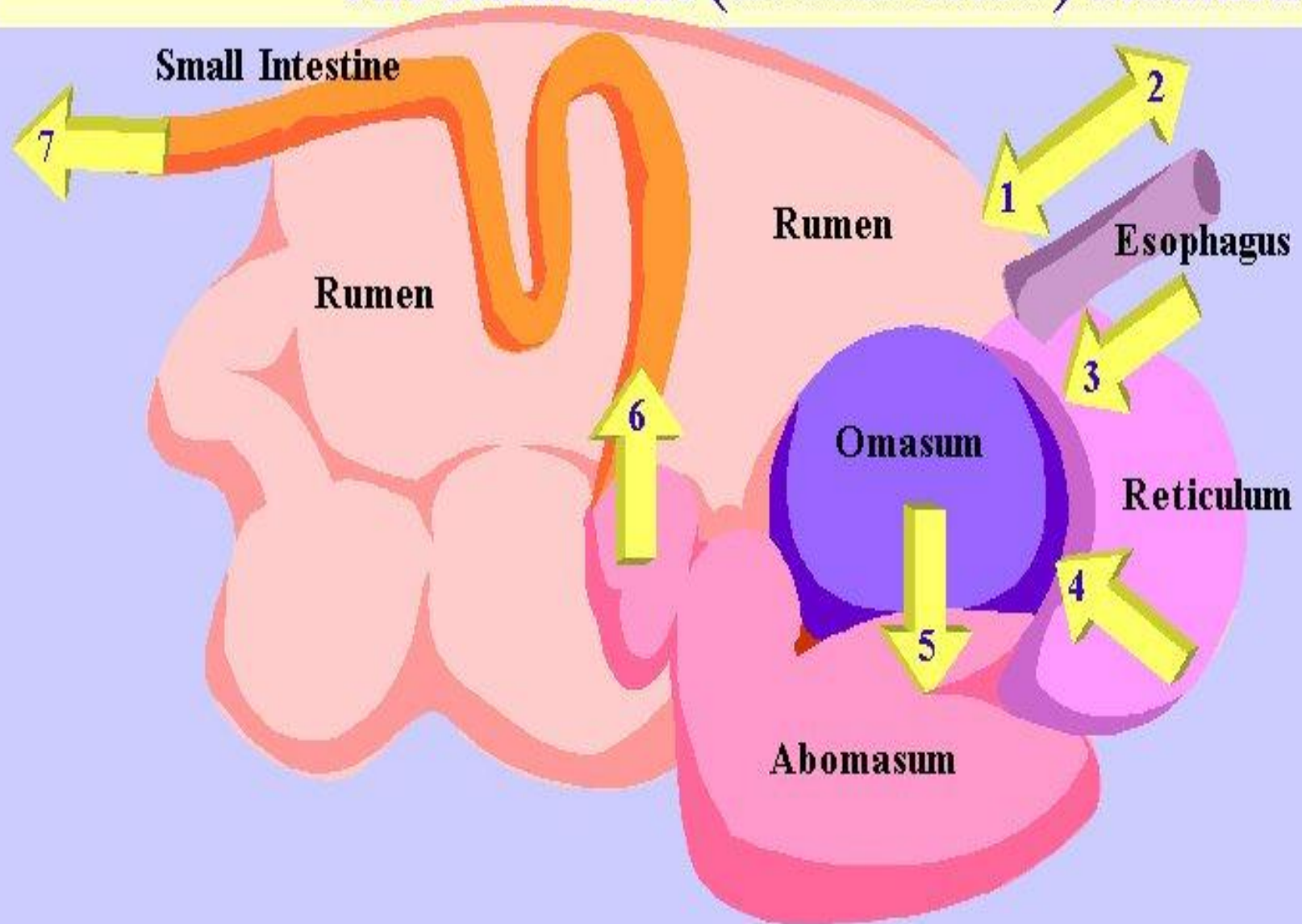
**Abomasum
(True stomach)**

**Omasum
(Manyplies)**

Esophagus

**Reticulum
(Honeycomb)**

The Ruminant (DIGASTRIC) Stomach



Rumination

- Rumination, also called cud-chewing, is the process by which the cow regurgitates previously consumed feed and masticates it a second time. The re-chewed feed with saliva is formed into a bolus and swallowed a second time.
- It is the floating, large particles on top of the rumen which are re-chewed.
- One purpose of rumination is to decrease particle size and increase surface area of the feed. This results in an increase in digestion rate of feed and a decrease in the lag time prior to fermentation.
- The fibrous particles stays in the rumen longer causing the rumen to feel more full if the cow is not ruminating enough. This reduces the total intake of the cow and negatively impact milk production.
- Another purpose of rumination is to make saliva (98 to 190 liters per day) to buffer the rumen and decrease rumen acidity.

Rumen (184 L)

- First compartment of the cattle's stomach where fermentation occurs
- Exterior – grooves
- **Towel like appearance/Papillae** - increase surface area
- Papillae development stimulated by VFA (Acetate, propionate, butyrate), roughage, formulated feed
- Largest compartment of the stomach
- Extends within the left side of the body cavity from the diaphragm to the pelvis
- Critical site for feed digestion in ruminants



- Has a complex environment
 - Composed of microbes
 - Large number of bacteria, protozoa and fungi
 - Basis of the fermentation
 - 70% of the energy requirements of the animal are supplied by microbial activity
 - Gases
 - Rumen fluid

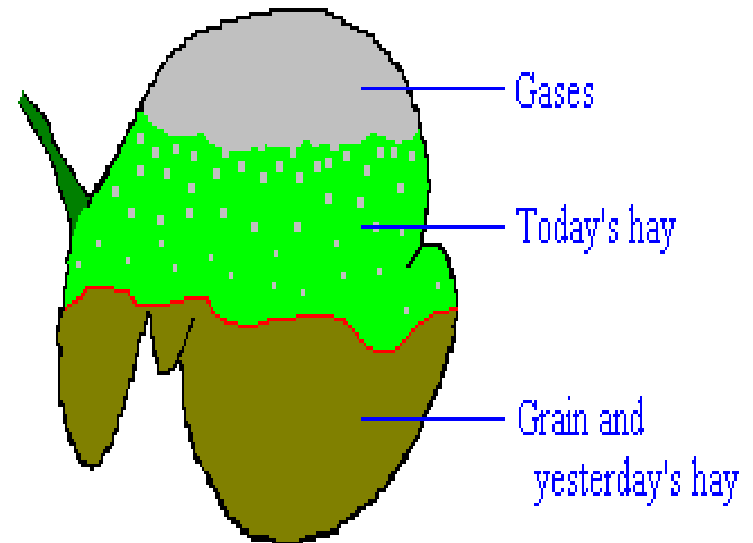
- Contents separate into 3 zones based on their density and particle size

- **Gas**

- Fermentation by-products
- Rises to the top

- **Small, dense particles**

- Grain, well digested forage
- Sink to the bottom

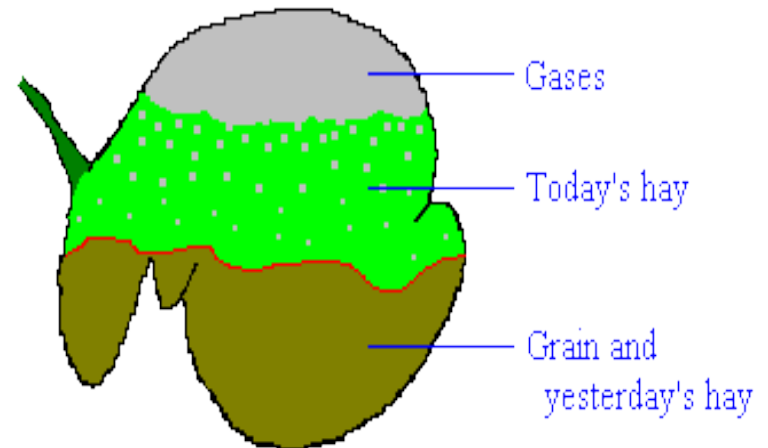


– **Lighter, longer particles**

- Recently eaten forage

- Form a middle layer on top of the rumen fluid

– Feed remains in the rumen until the particles are small enough to pass into the reticulum



Rumen function

- Depends on
 - Microbes
 - pH
 - Feed type and particle size
 - Motility

Functions of Rumen Microbes

- Digest cellulose and hemicellulose
- Produce a high quality protein
- Produce volatile fatty acids (VFA's)
 - Main by-products of fermentation
 - Absorbed through the rumen wall
 - Use as energy by the animal
- Produce B vitamins

- Break down the lipids
 - Into glycerol to produce VFA's and fatty acids
 - Fatty acids will not be absorbed by the rumen
- Detoxify toxic compounds
 - Unsaturated fatty acids are toxic to rumen bacteria
 - can be converted to non-toxic fatty acids
 - if too much fat is fed, the bacteria will be overwhelmed and reduce fiber digestibility

- Fermentation products

- **Volatile Fatty Acids (VFA)**

- Acetate, Propionate and Butyrate
 - Absorbed by the animal through the rumen wall
 - Carried through the blood system
 - To the liver for further processing and storage

- **Fermentation by-products**

- CH₄
 - CO₂
 - H₂

pH

- Normal environment of the rumen is neutral (5.5 - 7)
 - most rumen microbes can grow well
- T⁰C in the rumen = 38-42 (39 °C)
- Acidic by-products of fermentation must be removed from the rumen
 - Continuously absorption through the rumen wall
 - Frequently addition of saliva

- Digestive problems in ruminants
 - Occur when the mechanisms regulating the pH balance are disrupted
 - Increased fermentation rates can lead to a rapid decline in rumen pH
- Influence on the rumen pH
 - Diet
 - Microbe population

Rumen microbiology

- Three main groups
 - Bacteria – 200 spp. ($2-5 \times 10^{10}/\text{ml}$)
 - Protozoa – 20 spp. ($2-50 \times 10^4/\text{ml}$)
 - Fungi (10-1000/ml)
- Microbial population in equilibrium
- Diets change the MP
- Most tolerate anearobic condition

Functions of the rumen

- Storage
- Refinement of coarse pieces (rumination)
- Microbial fermentation
- Absorption of fermented products
- Vit. B synthesis
- Build up of complex protein

Reticulum (16 L)

- Acts as a holding area for feed after it passes down the esophagus
- Honeycomb structure to its wall
- Trap large feed particles
 - Make sure they don't enter the next section of the stomach before they are digested



- These particles
 - Then regurgitated
 - Re-chewed
 - Saliva added
 - Then re-swallowed (chewing their cud)
 - Allowed cattle to eat forage rapidly and then store later for digestion
 - Saliva is important to the rumen as it functions as a buffer



Omasum (8 L)

- Much smaller than the rumen
- Acts like a filter
- Grinds feed particles (digesta)
 - Reduce the particle size
 - Absorb excess moisture
- Many folds/leaves of the omasum
 - Squeeze out the water from the feed
 - Majority of the water doesn't 'escape' into the rest of the digestive tract and remains in the rumen



Abomasum (27 L)

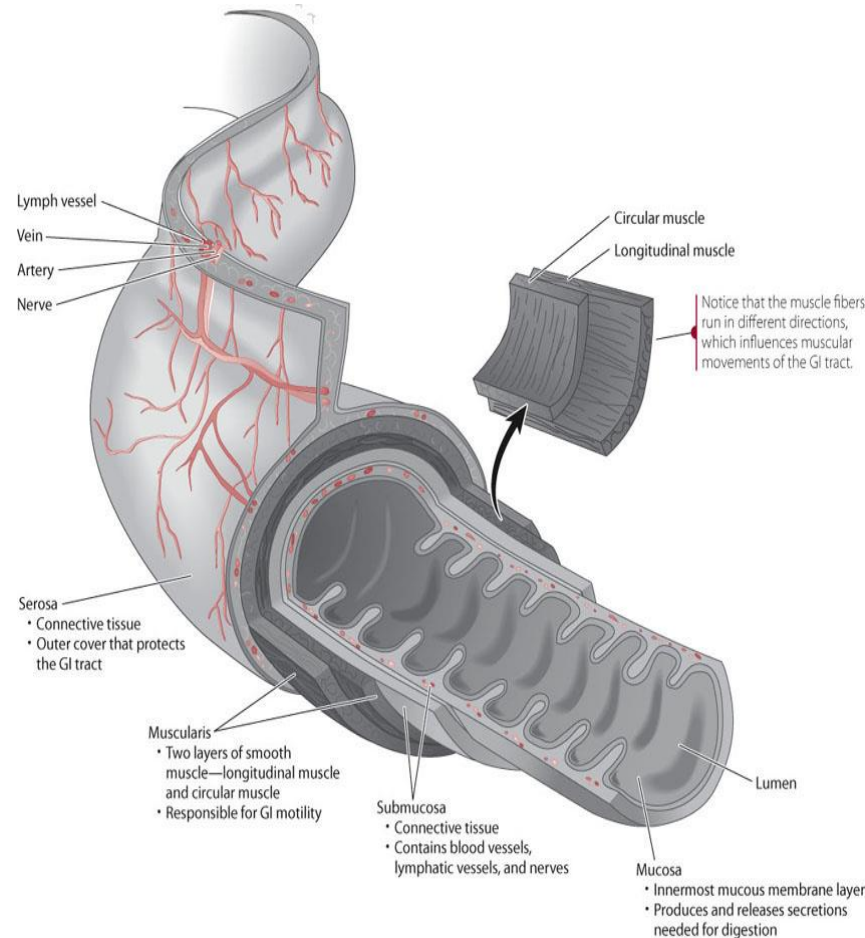
- Final compartment of the stomach - 'True' stomach
- Functions in a similar manner as the stomach of a monogastric
 - has a low pH and enzymes to digest the proteins in the feed



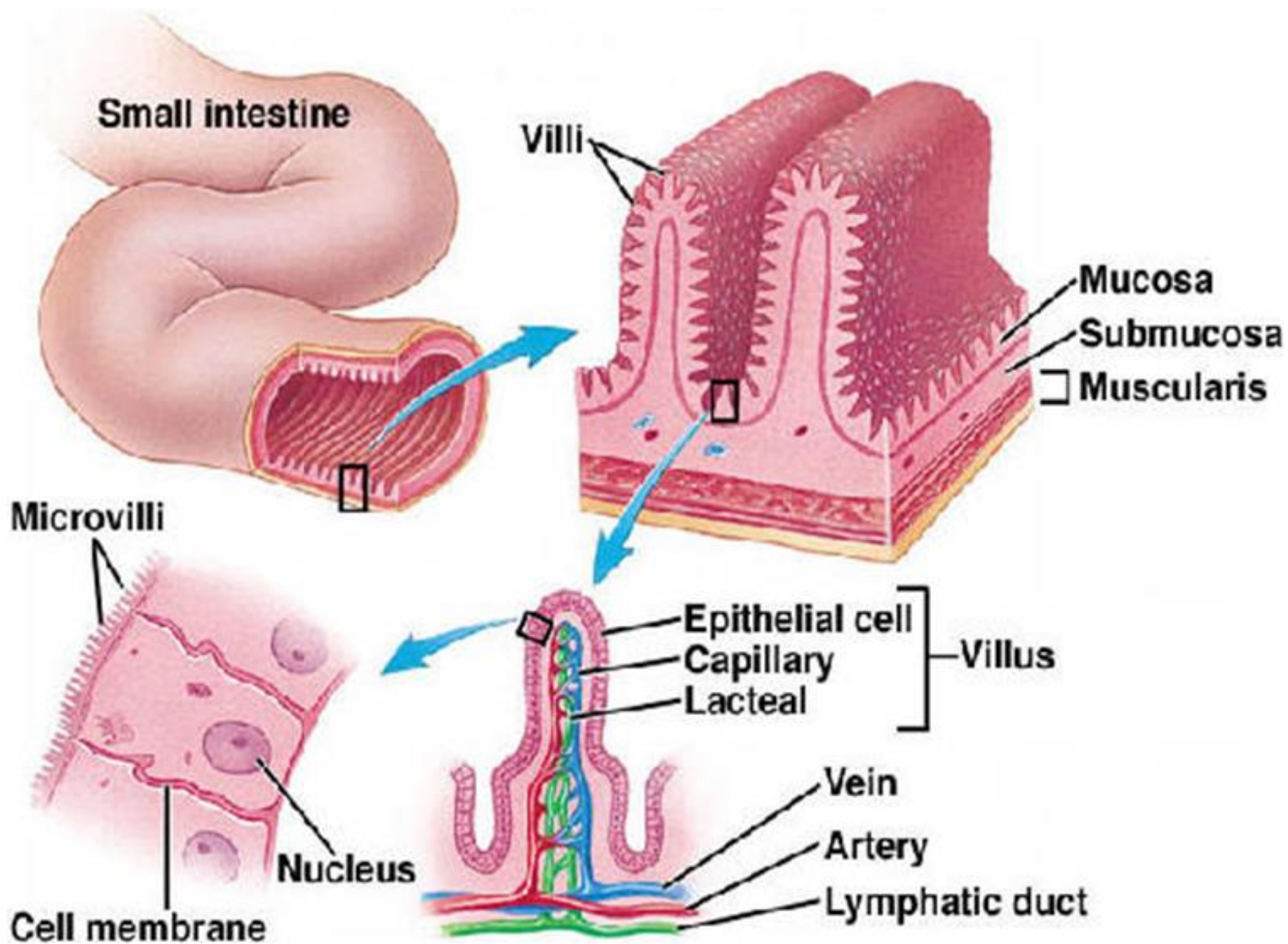
- <http://www.milkproduction.com/Library/Scientific-articles/Animal-health/The-stomach-of-the-dairy-cow/>

Intestines

- 2 parts - small & large
- **Small intestine**
 - A tube connecting the stomach to the ceacum
 - 3 parts
 - Duodenum
 - Jejunum
 - Ileum



- Small intestine plays a role in
 - Digestion
 - Absorption of nutrients
- Its surface area is increased by large circular folds
 - Villi
 - Microvilli



Duodenum

- U shape
- Receives secretions from liver & pancreas

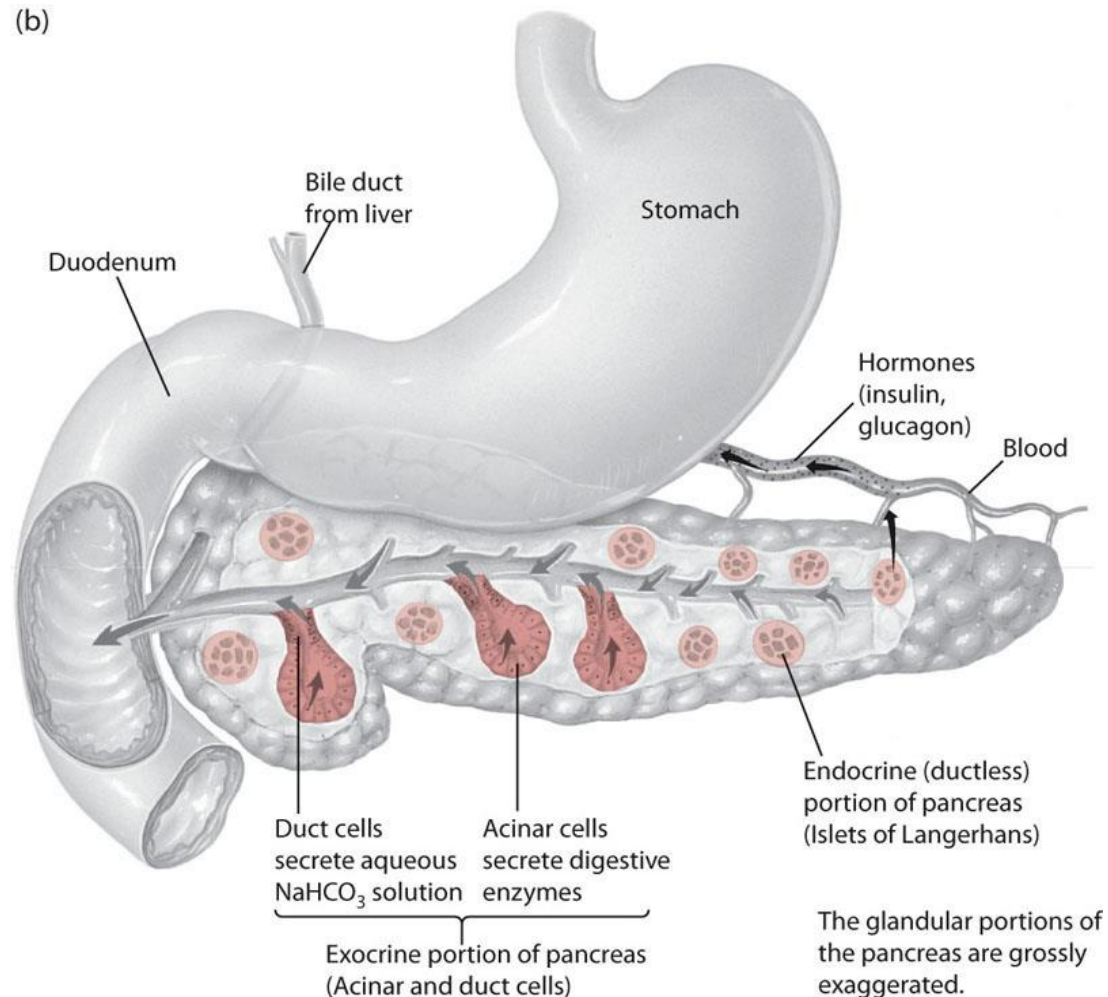
Pancreas

- **Endocrine function**

- β -cells - **Insulin**
- α -cells - **Glucagon**
- δ -cells - **Somatostatin**

- **Exocrine function**

- Acinar cells
 - Digestive enzymes
- Duct cells
 - Bicarbonate
 - Electrolytes



Pancreatic Juice

- Produced in pancreas and secreted into pancreatic duct
- Composition
 - Water
 - Bicarbonate - makes alkaline
 - Enzymes
 - Proteases
 - Pancreatic amylase
 - Lipases

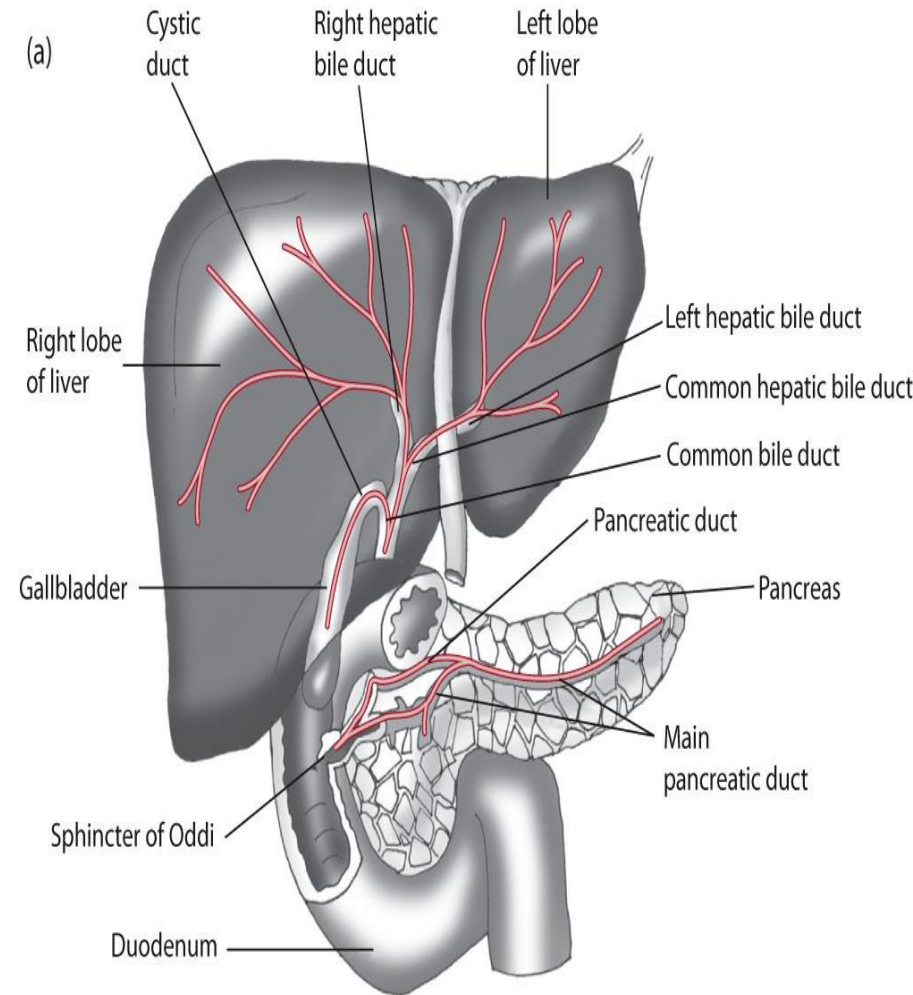
Liver and Gallbladder

- **Liver**

- Largest glandular organ in the body
- Nutrients are supplied to the liver from the portal vein and the hepatic artery

- **Gallbladder**

- Stores bile produced by the liver



Bile

- A yellow-green, slightly alkaline solution produced in liver and concentrated in gall bladder; containing:
 - Water
 - Bile acids produced in liver from precursor cholesterol
 - Bile pigments (bilirubin and biliverdin)
 - Cholesterol
 - Phospholipids
 - Bicarbonate ion

Jejunum

- 90% of the total length of SI
- No distinct demarcation from either the duodenum or the Ileum.

Ileum

- Last 4-5 % of length of SI

SI functions

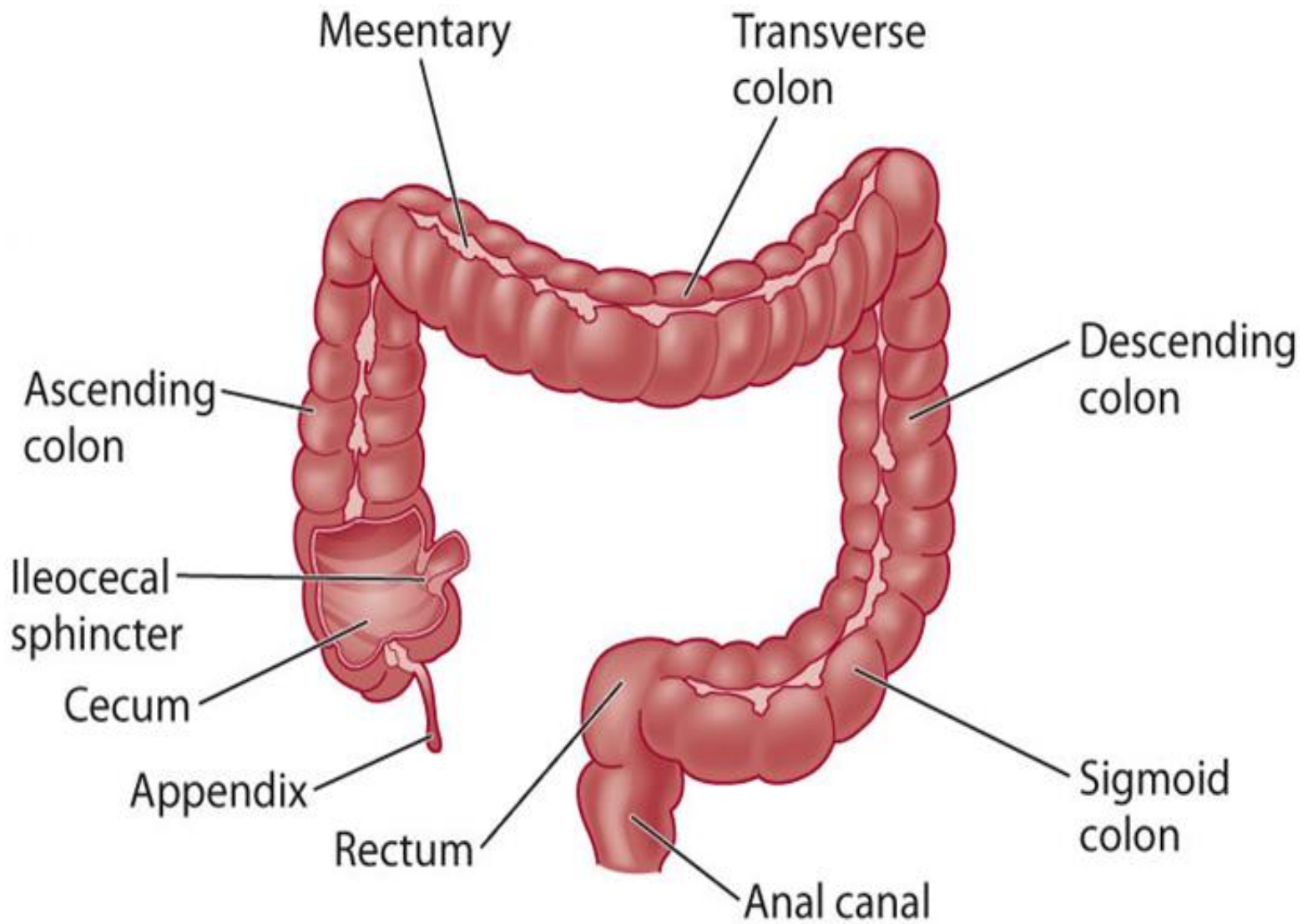
- Mechanical & chemical digestion of food
- Absorption of nutrients
- Propulsion of digesta

Cecum

- Connections b/w SI & LI, a blind sac
- A valve structure controls the passage of digesta into next compartment called ileo-cecal valve
- Hind gut fermenters (Rabbit) - extensively modified, has microbes,
- Food is circulated within cecum which allows time for microbial digestion
- Cecal fermentations depends on spp

Large Intestine

- Divided in to the large colon & small colon
- Large colon
 - consists of Ascending, Transverse & Descending
 - No enzymes secretion, villi, microvilli not found
 - Extended surface area in colon for absorption
 - Repulsion of undigested materials
 - Circular muscle layer breaks into small particles
 - Longitudinal muscle layer facilitates propulsion



- **Primary functions**

- Absorption of water and electrolytes
- Bacterial digestion, as by-products (CO_2 , CH_4 , H_2S)
- Vitamin synthesis (B and K)
- Expulsion of feces

Rectum & Anus

- Terminal portions, has a sphincter at the anal orifice
- Undigested materials released by rectum which is not glandular, but epithelium is keratinized

- **Rectum**

- an organ of storage where fecal products are retained until such time as sufficient quantity has been accumulated to result in nervous stimulation & defecation

- **Anus**

- Caudal terminations of DT
- Consists of two sphincter muscle & a retractor muscle which are contracted except during defecation