Digestive systems

GROW
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Digestion

Digestion is:

- The breakdown of food into smaller nutrients for absorption and use by the body
- A similar process across all species

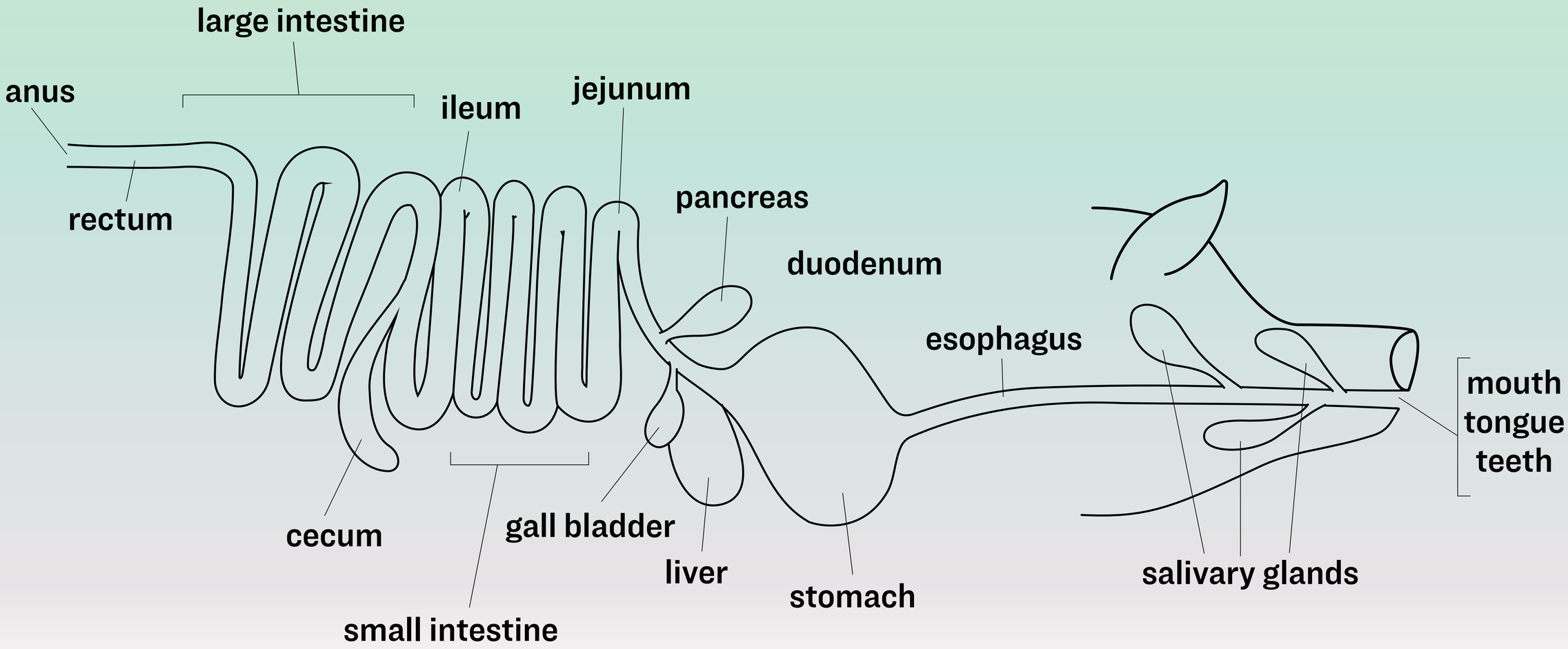
The four different types of digestive systems are:

- Monogastric (humans and many mammals)
- Avian (chickens and other birds)
- Ruminant (cows and goats)
- Pseudo-ruminant (horses and rabbits)

Monogastric digestive system

- Both carnivores and omnivores may have **monogastric digestive systems.** (e.g., humans, swine, dogs, and cats)
- Monogastric systems have a **simple stomach structure** (one compartment)

Digestive tract of the monogastric mammal



Monogastric parts and functions

Mouth

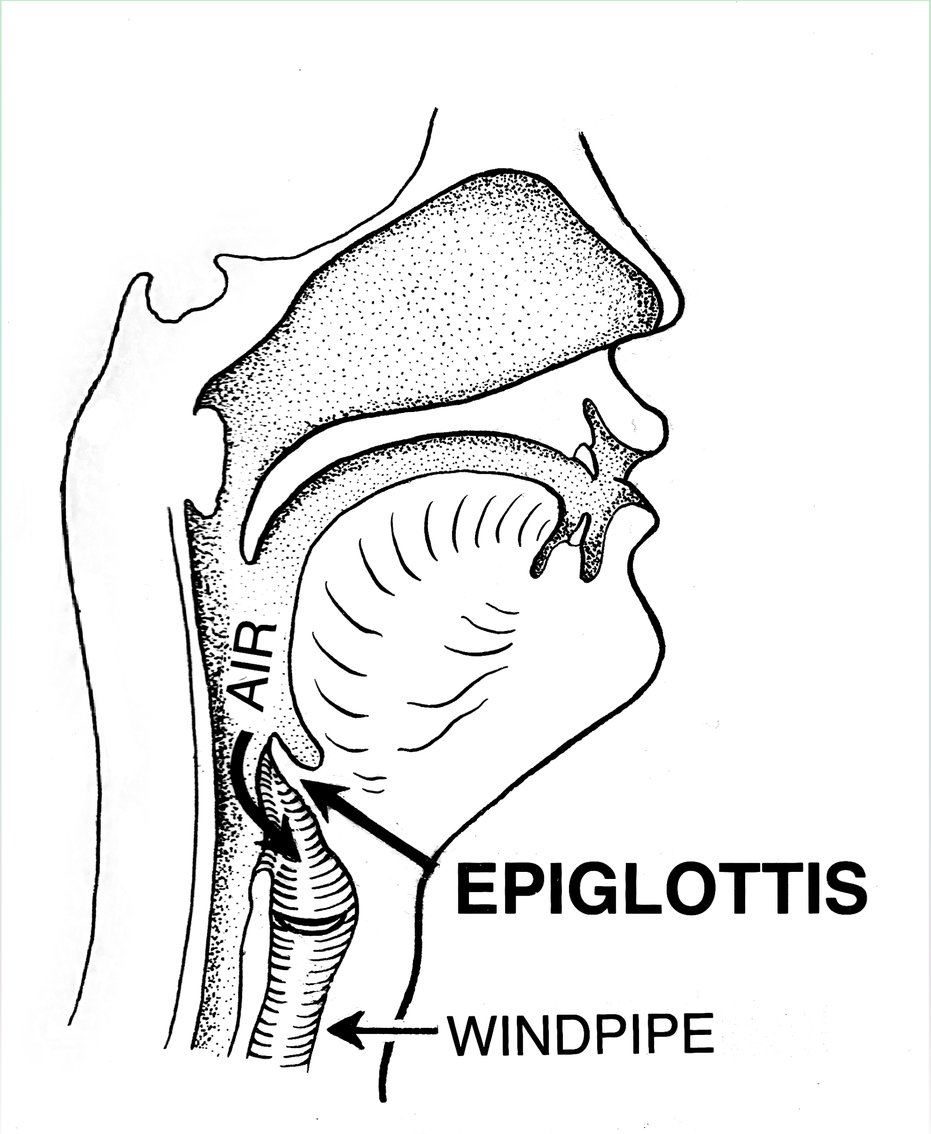
- Mastication occurs here—teeth grind food
- Addition of saliva from salivary glands
- Tongue helps move food and allows for taste and repares food for swallowing

Prehension: method in which animals “grasp” their food

Monogastric parts and functions

Epiglottis

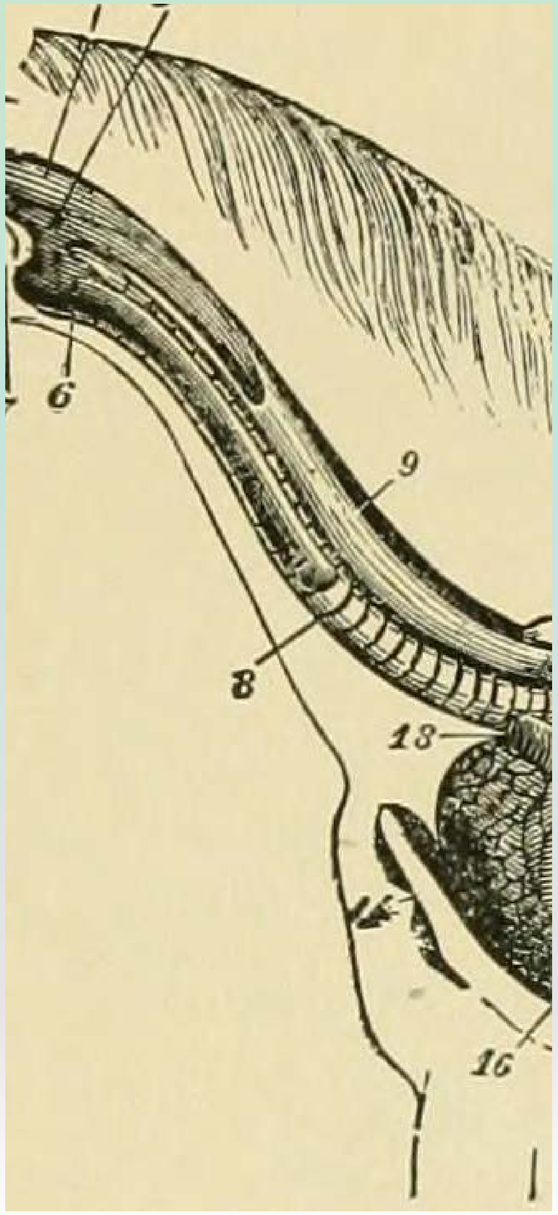
Flap or valve that closes windpipe (trachea) while swallowing



Monogastric parts and functions

Esophagus

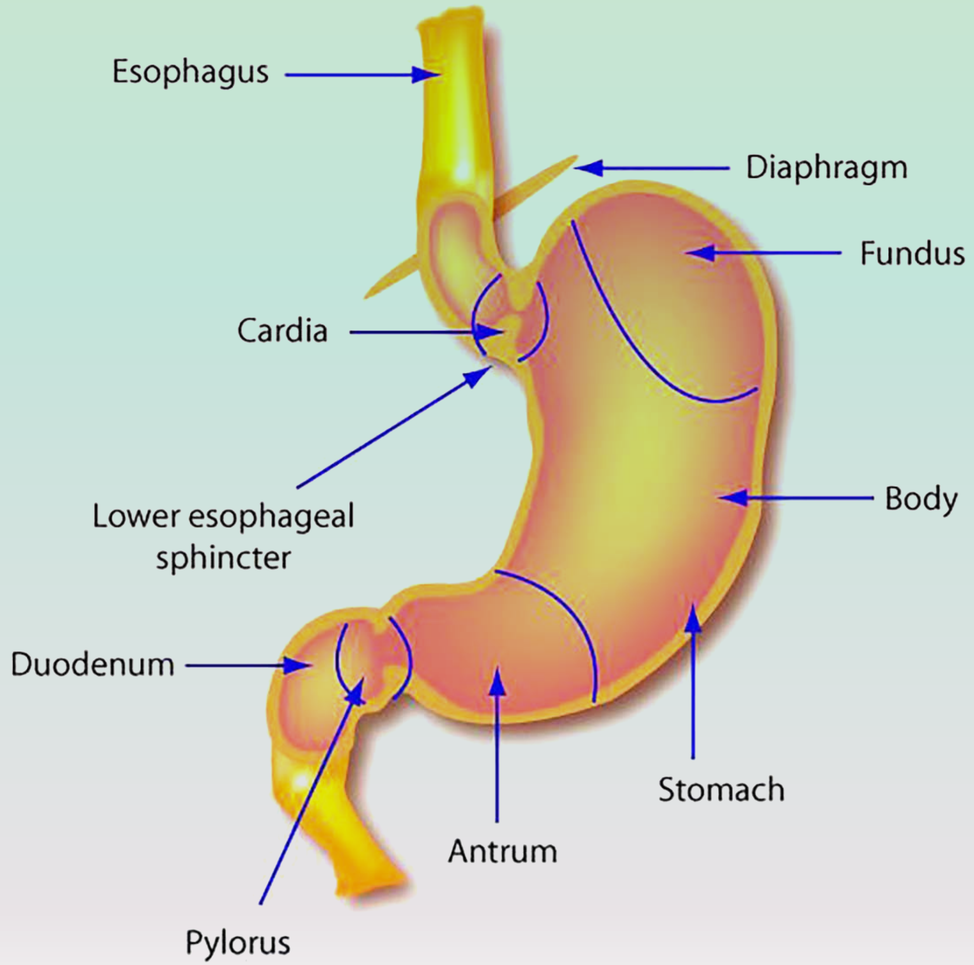
- Muscular tube for passage of food from the mouth to the stomach
- Smooth muscle lining
- Peristalsis carries food to the stomach



Monogastric parts and functions

Stomach

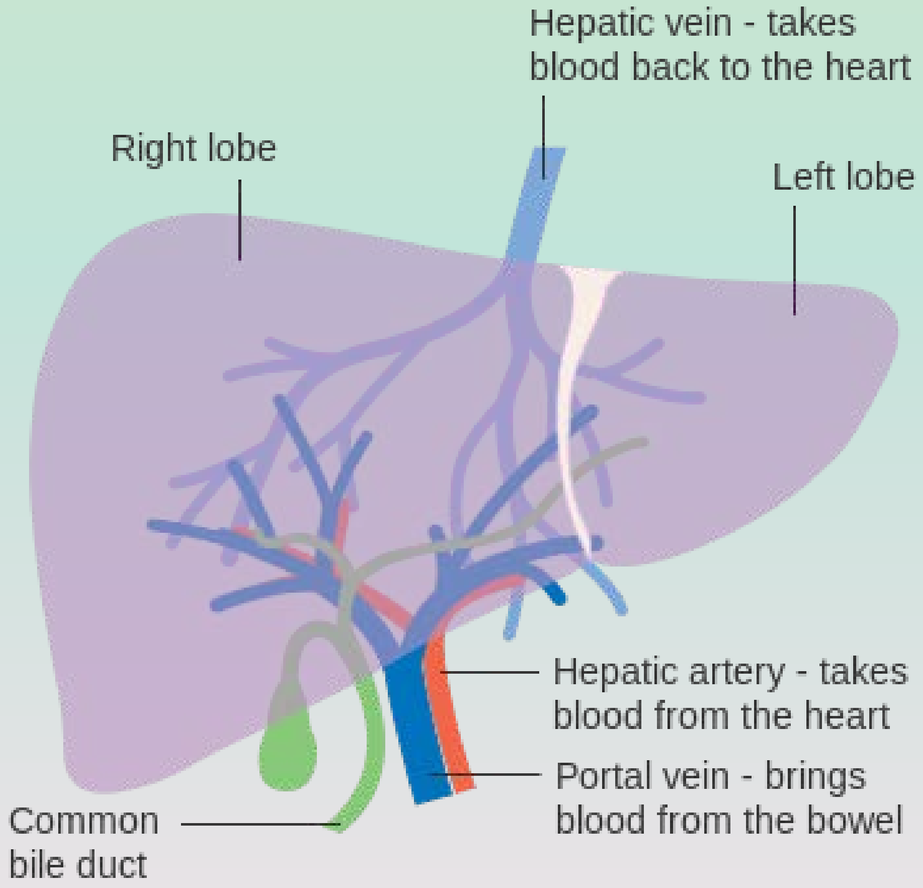
- Storage/additional breakdown of food
- Food digested by HCl (hydrochloric acid): pH between 3–4
- Secretes pepsin (enzyme that breaks down protein)
- Pyloric valve (smooth muscle sphincter): Ring of muscle surrounding and serving to guard or close an opening or tube



Monogastric parts and functions

Liver

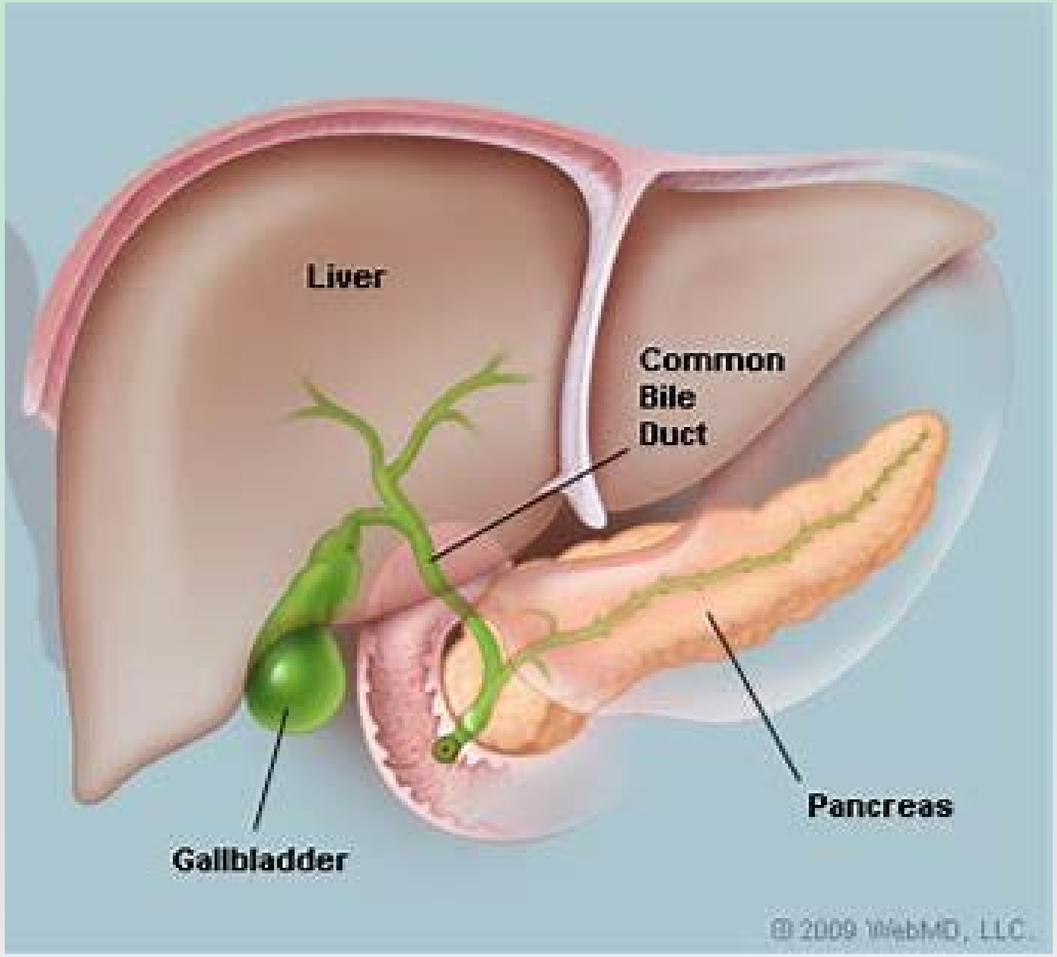
- Controls storage and concentration of nutrients such as proteins, fats, carbohydrates, vitamins, and minerals
- Make proteins
- Make clotting factors
- Produces bile, a digestive compound.



Monogastric parts and functions

Gall bladder

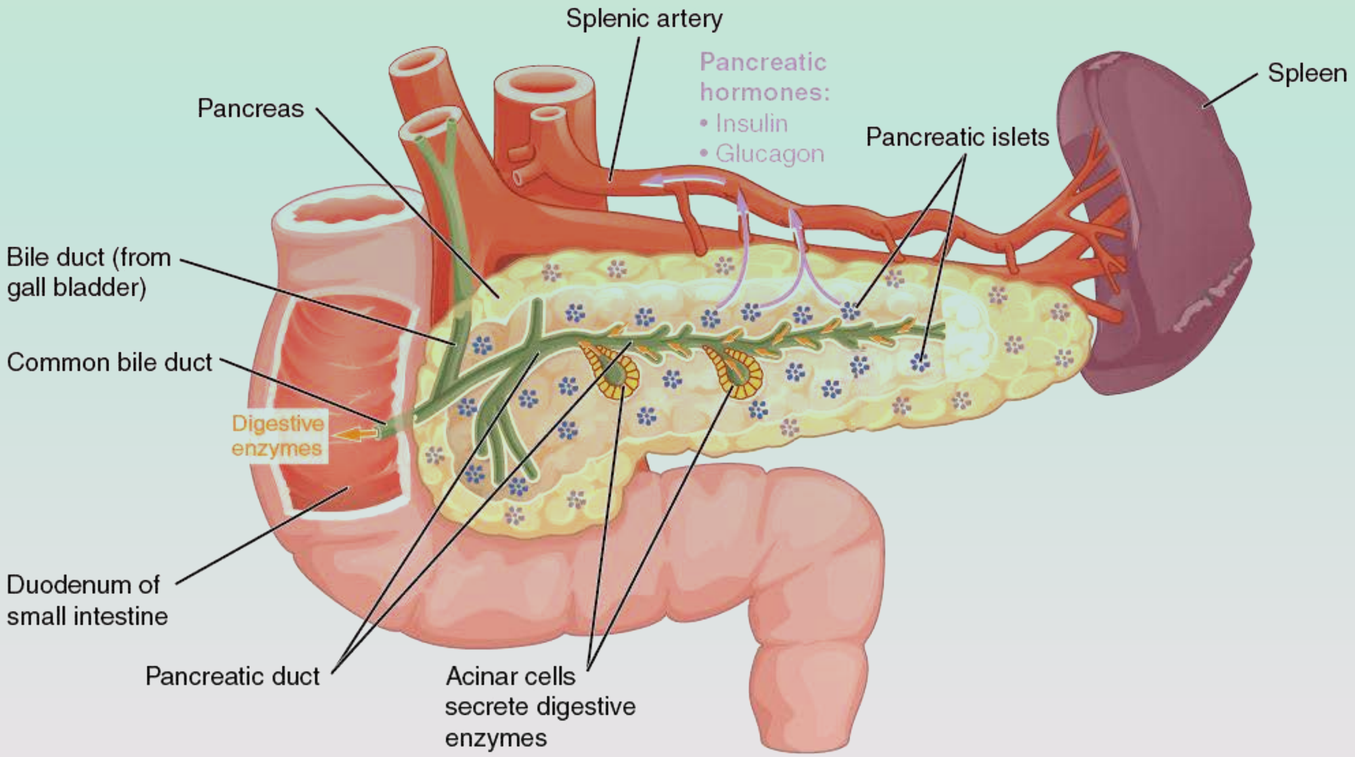
- Where bile is stored
- Bile can be concentrated here
- Released from here into the small intestine
- Structure and location around liver can vary greatly between species



Monogastric parts and functions

Pancreas

- Regulate blood sugar by producing insulin in endocrine system
- Also produces **pancreatic juice** in exocrine system
  - Enzyme that breaks down carbs, fats, and proteins
  - Secreted through the pancreatic duct



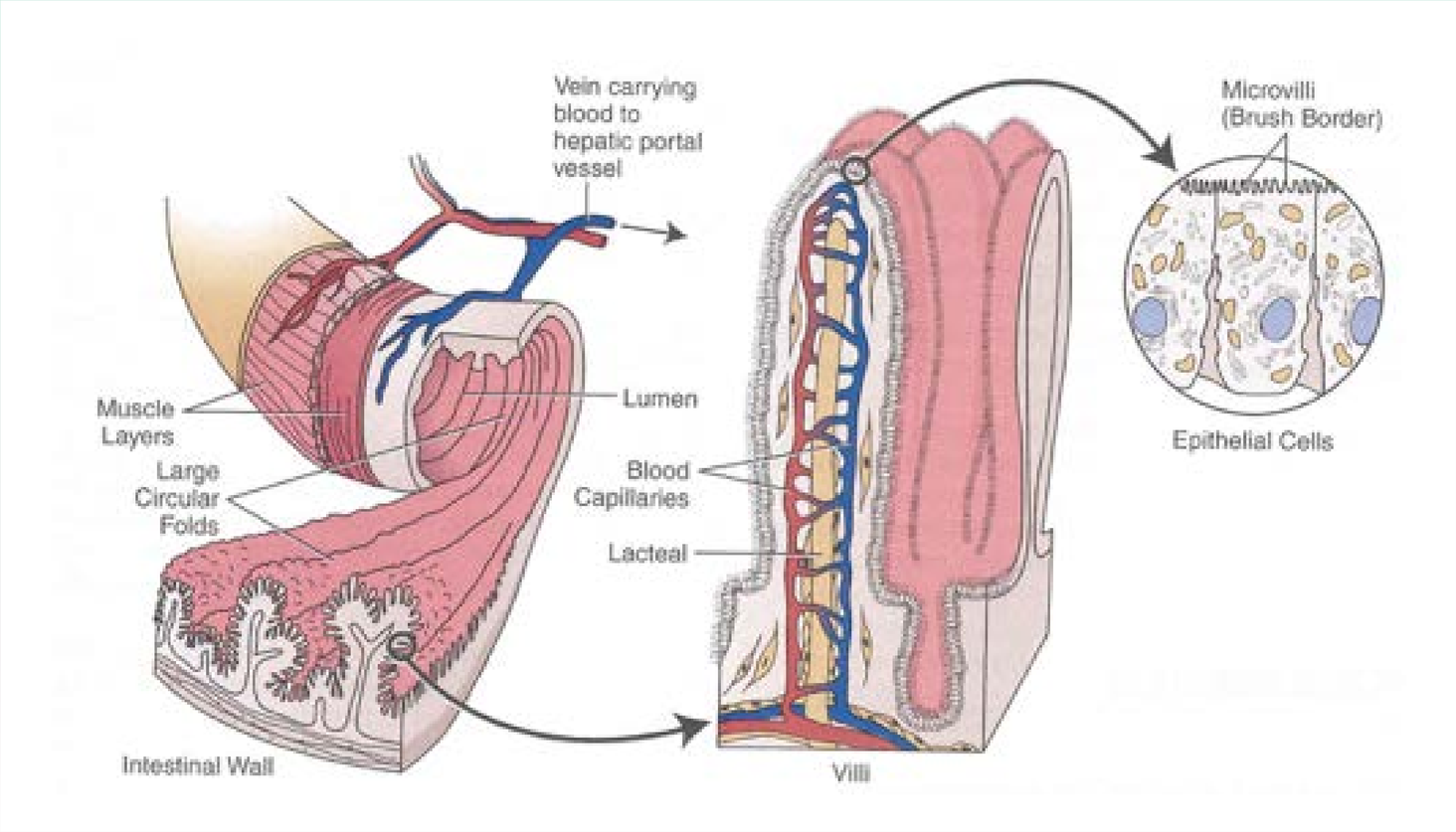
Monogastric parts and functions

Small intestine

- Enzymatic digestion and absorption
- Functions of the small intestine: digestion of proteins, carbohydrates, and fats; absorption of the end products of digestion
- Divided into three sections:
  - **Duodenum:** Most digestion occurs here
  - **Jejunum:** Some digestion and absorption occur
  - **Ileum:** Mostly absorption

Monogastric parts and functions

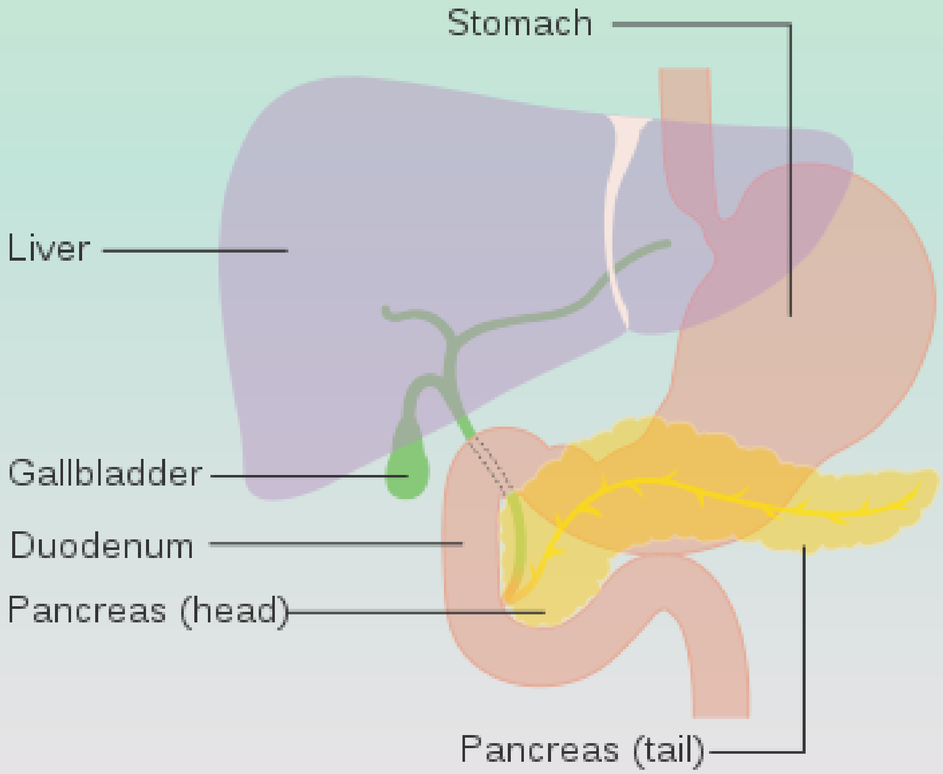
- **Villi:** Finger-like projections in lining of small intestine that contain blood vessels for nutrient transfer



Monogastric parts and functions

Duodenum

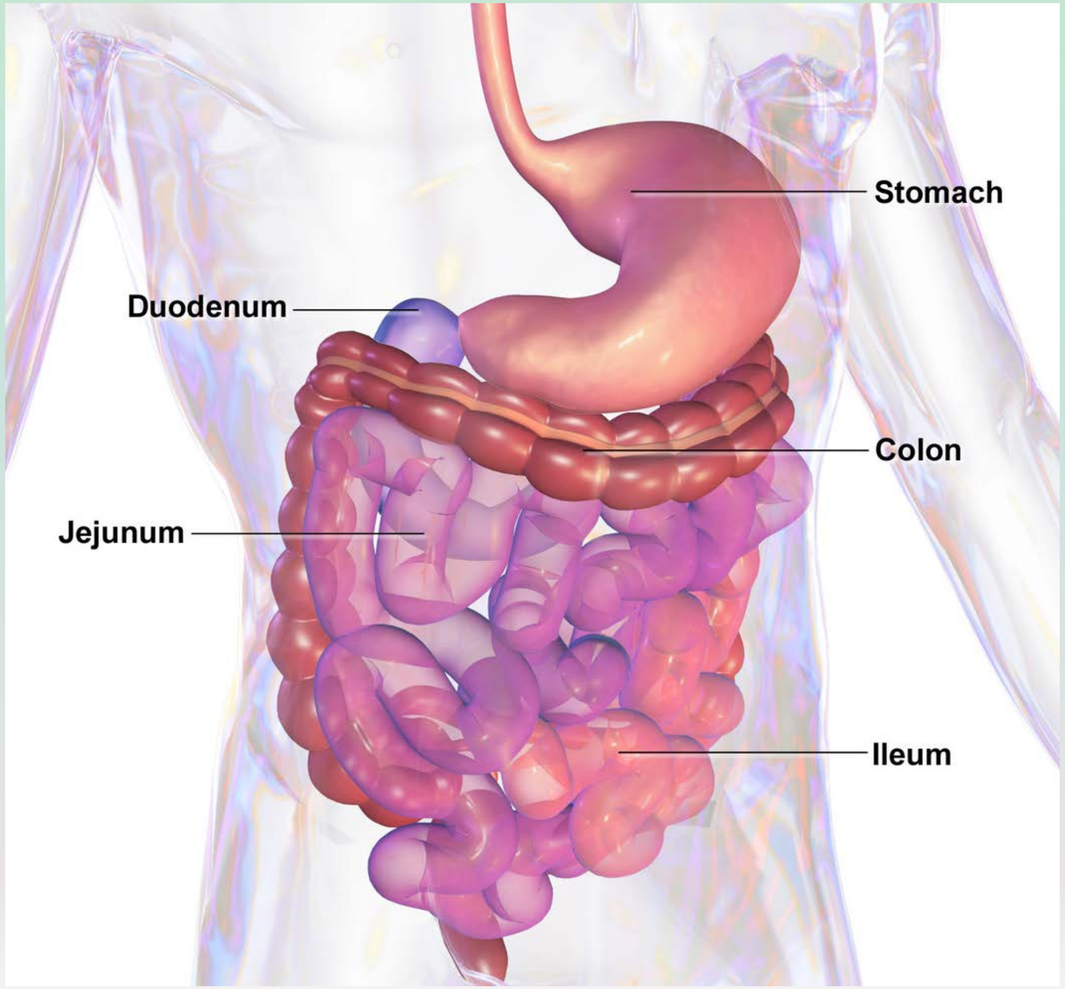
- First section of the small intestine
- Connects stomach to the small intestine
- Where bile and pancreatic juices are added



Monogastric parts and functions

Jejunum

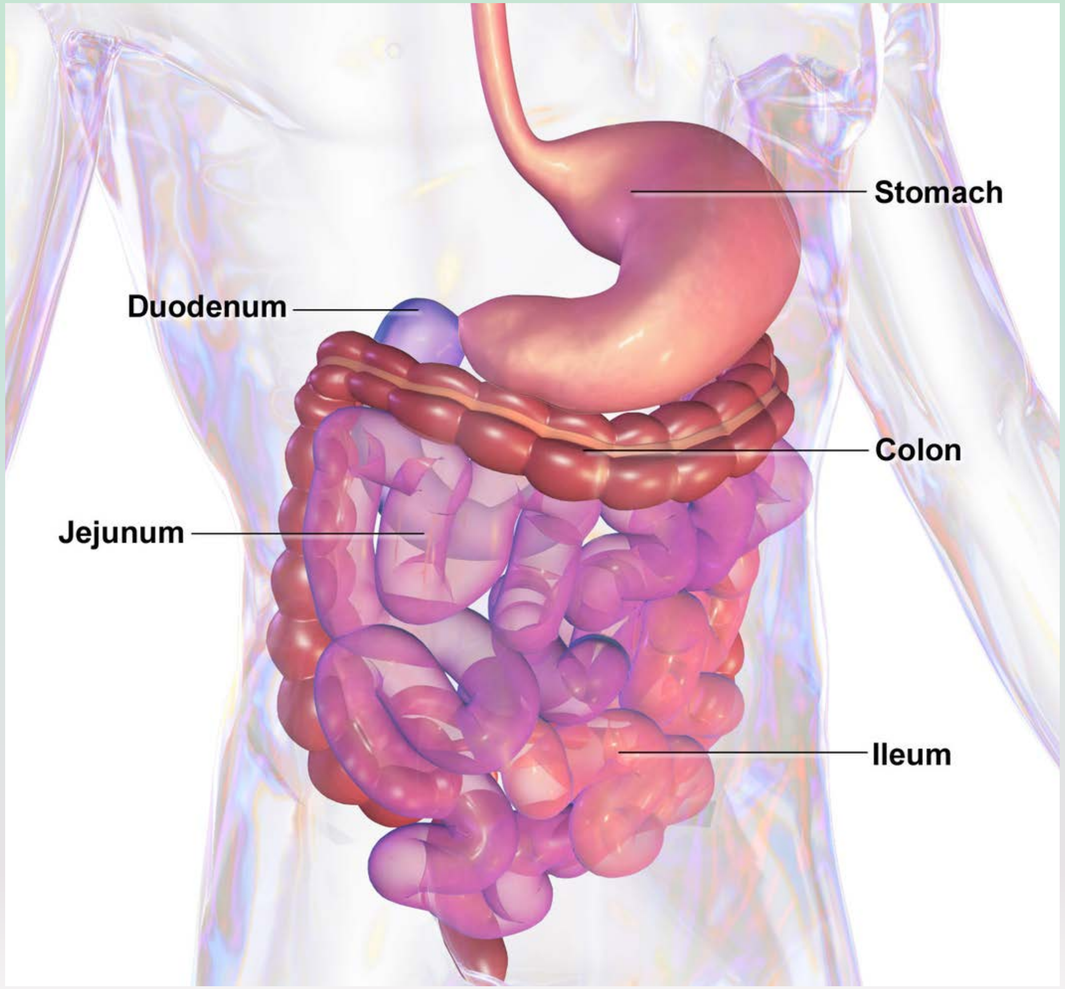
- Middle section
- Makes up about two-fifths of the small intestine
- Absorbs fully-digested carbohydrates, proteins, sugars, fatty acids, and amino acids
    - Nutrients enter the bloodstream, where they can then be distributed to the organs of the body



Monogastric parts and functions

Ileum

- Means “twisted intestine”
- Final section of small intestine
- Longest section
- Absorbs any nutrients that got past the jejunum, mainly vitamin B12 and bile acids
- Bile salts are reabsorbed by active transport in the ileum and returned by the blood to the liver



Monogastric parts and functions

Enzymes

- Proteins that help to break down nutrients within digestive systems
- Biochemically function to break down specific nutrients
- Different digestive systems have different enzymes and some systems use bacteria or other microbes to help break down specific food stuffs.

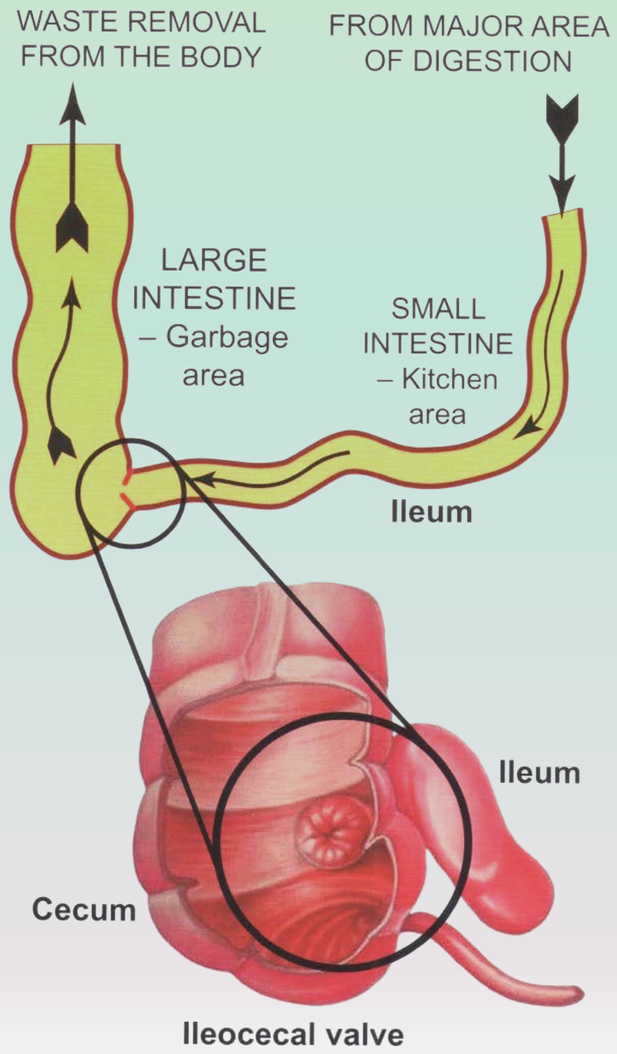
Enzymes in the small intestine

Enzyme	Function	Source
trypsin	digest proteins	secreted from pancreas
chymotrypsin		
carboxypeptides		
pancreatic amylase	digest carbohydrates	
lipases	digest lipids	
disaccharidase	digest carbohydrates	secreted from small intestine
dipeptidases	digest peptides	

Monogastric parts and functions

Ileocecal valve

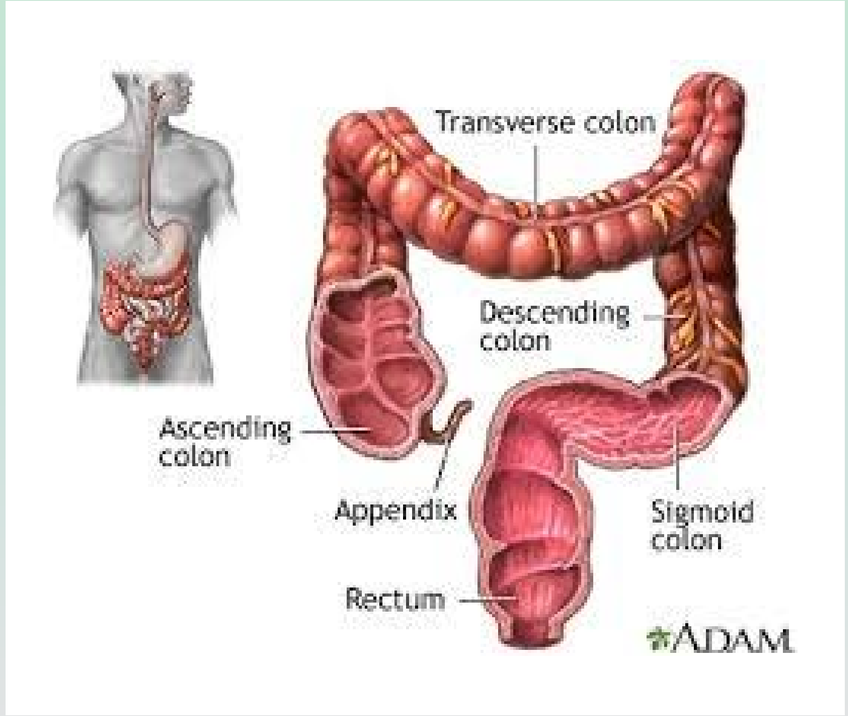
- Smooth muscle sphincter
- Where the ileum joins the large intestine



Monogastric parts and functions

Large intestine

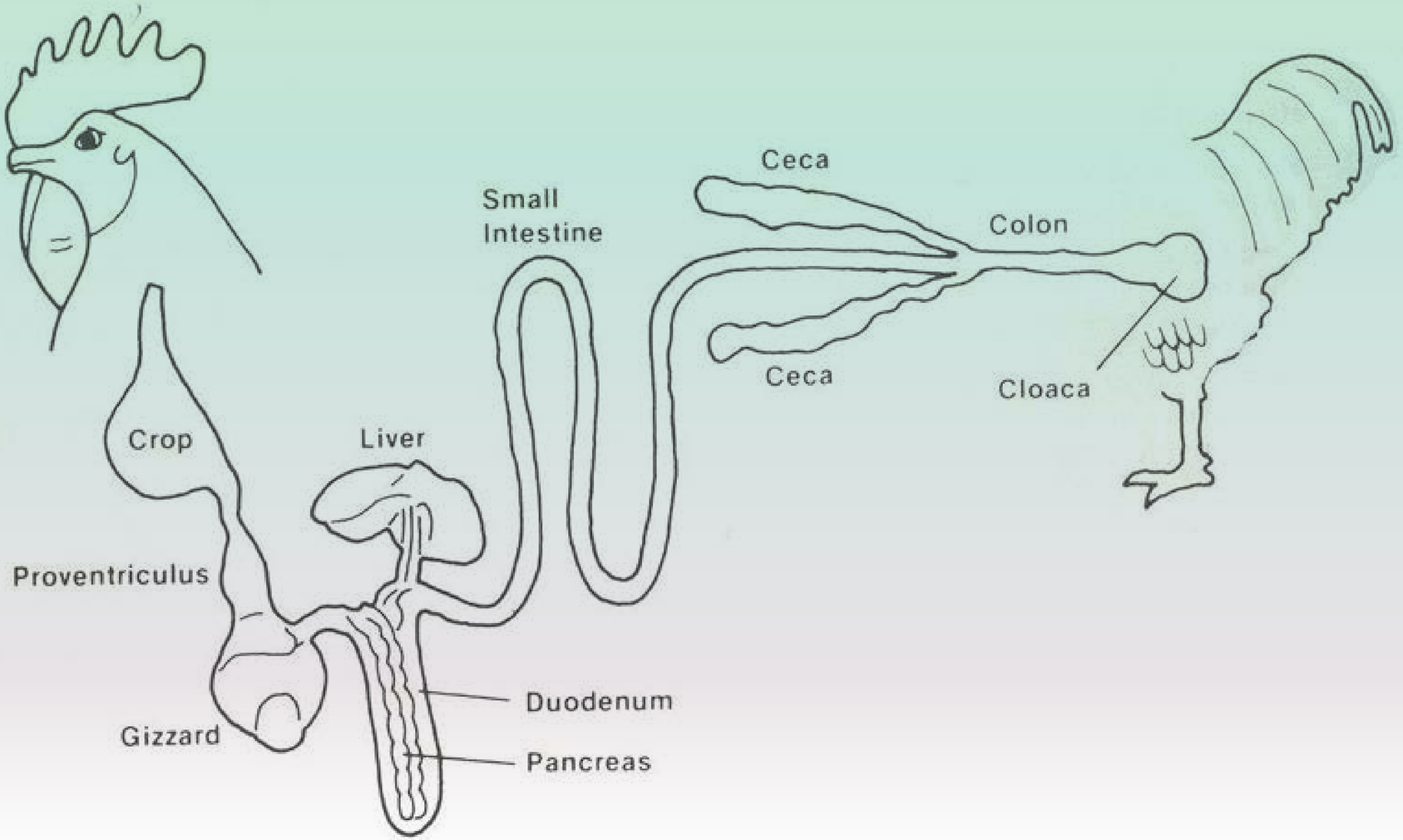
- Also referred to as the colon
- Much shorter than the small intestine in length, but larger in diameter
- Three main things happen here:
  - Bacterial activity: continuation of breakdown of the more indigestible food
  - Lots of water absorption, creating solid waste
  - Feces storage (until disposal from body)



Monogastric review

- What is “mastication?”
- What is “prehension?”
- What is “peristalsis?”
- What are the three parts of the small intestine?
- What does the liver do?
- What does the gall bladder do?
- What does the pancreas do?

Avian digestive system



Avian parts and functions

Beak

- No teeth
- Prehensile action: pecking food with their beak/bill
- Secretes saliva to soften food and aid in swallowing
- Houses the tongue which manipulates food and aids in swallowing food whole

Avian parts and functions

Esophagus

- Connects the mouth to the stomach
- Moves food from the mouth to the stomach using wave-like muscle contractions (peristalsis)
- Often deposits food in the crop of many types of birds before going to the stomach

Avian parts and functions

Crop (part of the esophagus)

- Temporary food storage pouch
- Located just outside the body cavity in the neck region
- An evolutionary adaptation that allows birds that need to eat in the open to consume large amounts of food for digestion later
- Swallowed feed and water are stored in the crop until they are passed to the rest of the digestive tract
- Very little digestion takes place here

Avian parts and functions

Stomach

- Divided into two parts
  - Proventriculus
    - Glandular part of the stomach where food is partially digested
    - Hydrochloric acid and digestive enzymes, such as pepsin are added
  - Ventriculus/gizzard
    - Part of the digestive tract of birds, reptiles, earthworms, and fish
    - Muscular portion of the stomach which grinds food, often with the help of ingested stones or grit (a supplement given to chickens that eat whole grains)

Avian parts and functions

Small intestine

- Made up of the duodenum, jejunum, and ileum
  - Duodenal Loop: surrounds pancreas
- Varies in length depending on diet
  - Longer in carnivorous (meat eater) birds
  - Shorter in herbivorous (plant eater) birds
- Remainder of digestion takes place here
- Main place of absorption of nutrients
  - Bile aids in absorption of fat-soluble vitamins (A, D, E, and K)

Avian parts and functions

Ceca

- Plural form of cecum
- Two pouches located where the small and large intestines meet
- Remaining water is absorbed here
- Fermentation of any remaining coarse materials

Avian parts and functions

Large intestine

- Also known as the colon
- Absorbs water, dries out indigestible items, and eliminates waste products
- Contains bacteria which allow birds to metabolize remaining nutrients
- Connects to the cloaca

Avian parts and functions

Intestinal microflora

- Both the small and large intestines contain beneficial organisms
- Microflora: ‘micro’ meaning “small” and ‘flora’ meaning “plants”
- Aid in digestion
- Born with sterile digestive tracts and need to consume the microflora
- Mother’s fecal material
- Probiotics in feed

Avian parts and functions

Cloaca/vent

- Location where digestive wastes mix with wastes from the urinary system
- Chickens usually void fecal material as digestive waste with uric acid crystals on the outer surface
    - Therefore, chickens do not urinate!
- Eggs come out of this chute

Avian review

- What does prehensile mean?
  a. To eat b. To seize or grasp c. To swallow
- What is the prehensile action in birds?
- Compare gizzards with teeth.
- What is the difference between the proventriculus and ventriculus or gizzard?
- The duodenal loop surrounds the _____.
- What is the function of the ceca?
- What is the function of microflora?
- What is the function of the cloaca or vent?

Ruminant digestive system

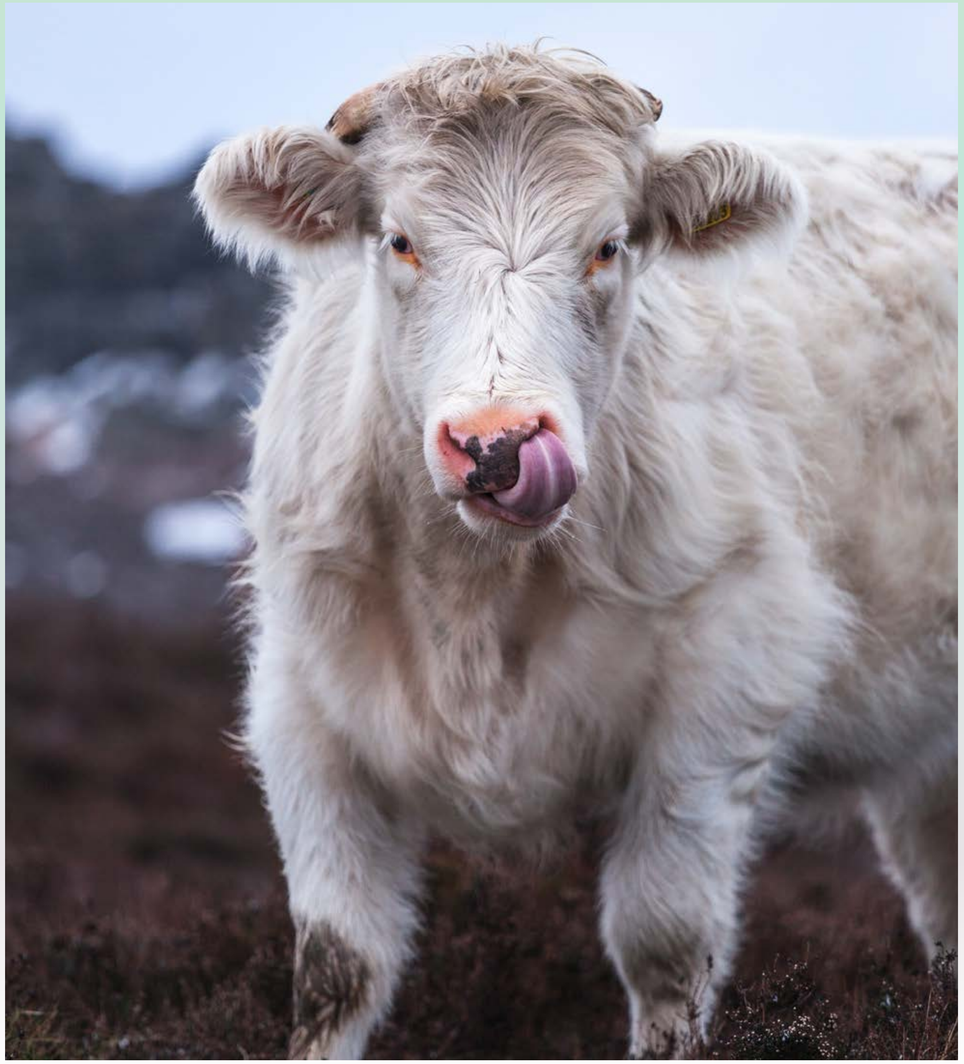
What is a ruminant?

Animals that acquire nutrients from plant-based food by fermenting it in a specialized stomach prior to digestion, principally through microbial actions.

Ruminant parts and functions

Mouth

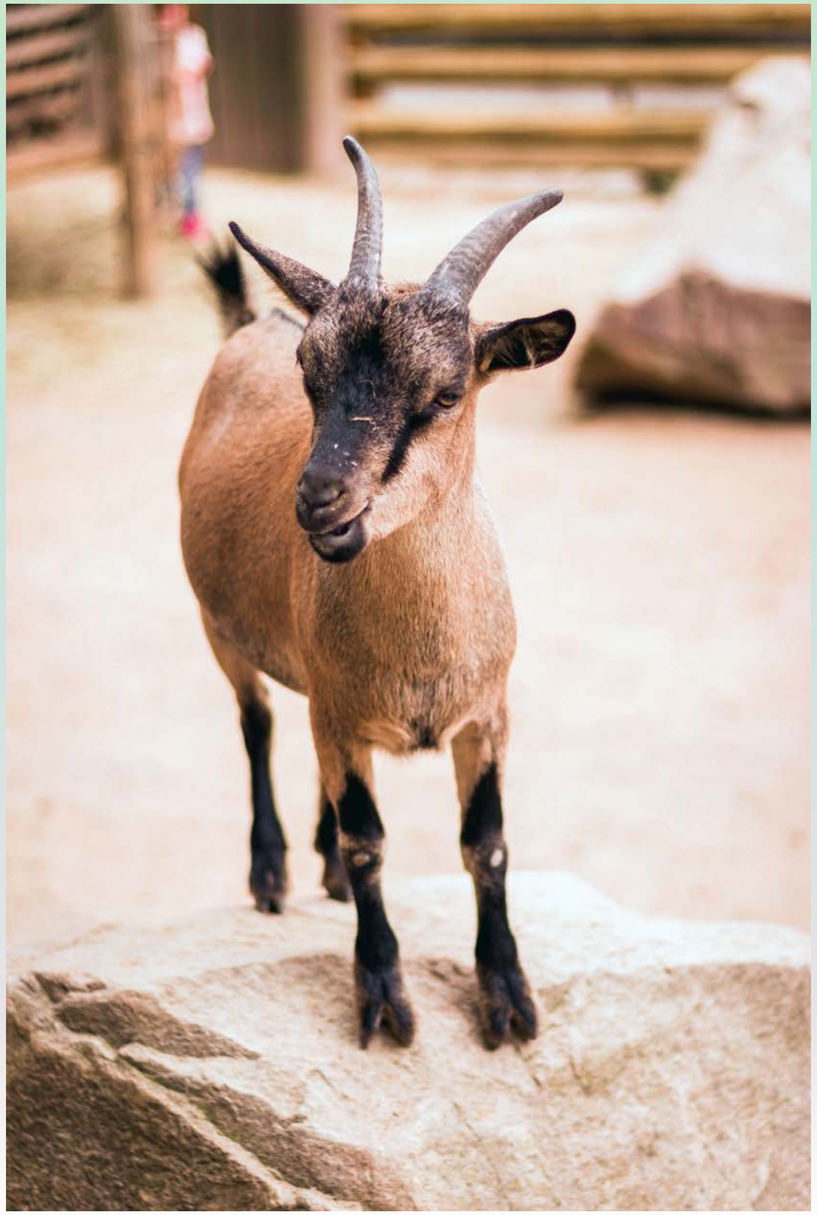
- Where food is moistened to aid in chewing by teeth
- Lips, tongue, teeth, and saliva start the digestion process
- Ruminants only have front teeth in the lower jaw, which cut grass against the dental pad
- Upper and lower molars used for grinding food



Ruminant parts and functions

The esophagus

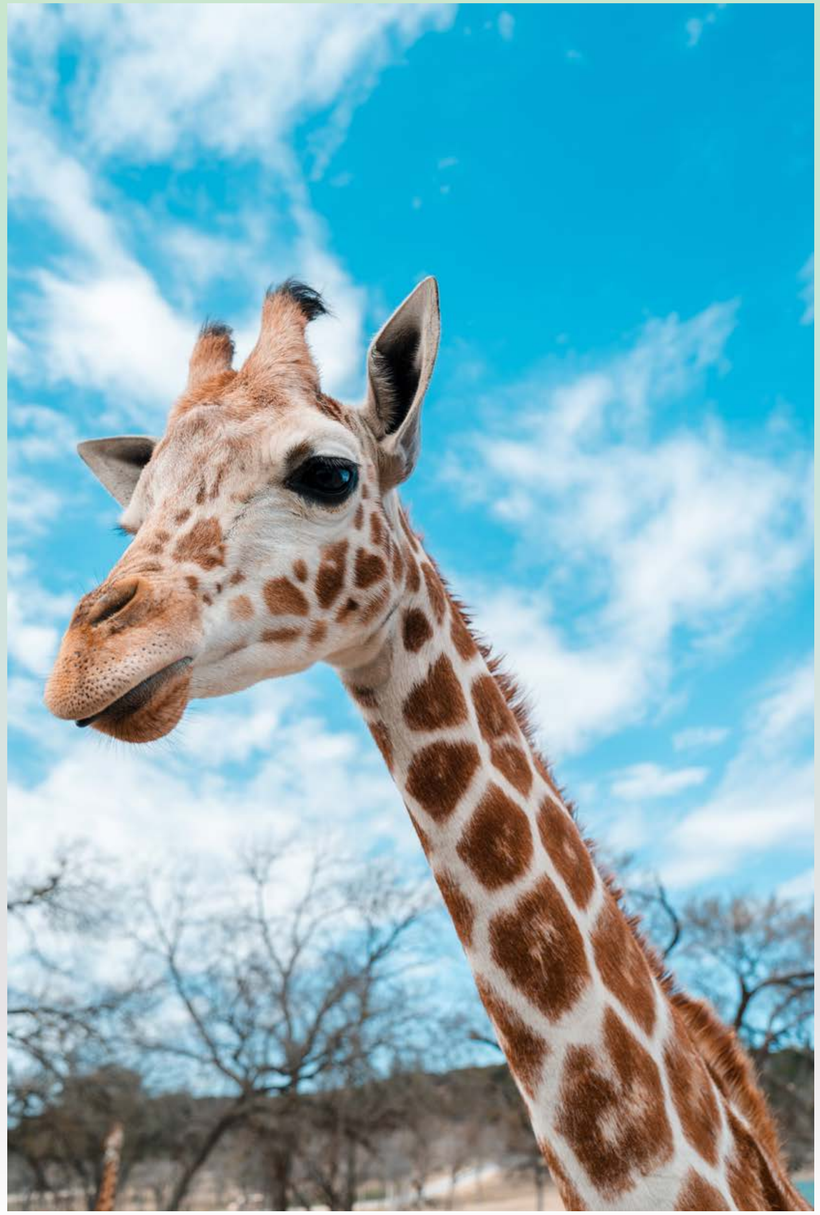
- Transports food to and from the mouth and stomach
- Food can make multiple trips
- Ruminants can regurgitate, re-masticate, and re-swallow their food (“chewing their cud”)
- May do this for up to 8 hours a day



Ruminant parts and functions

The stomach

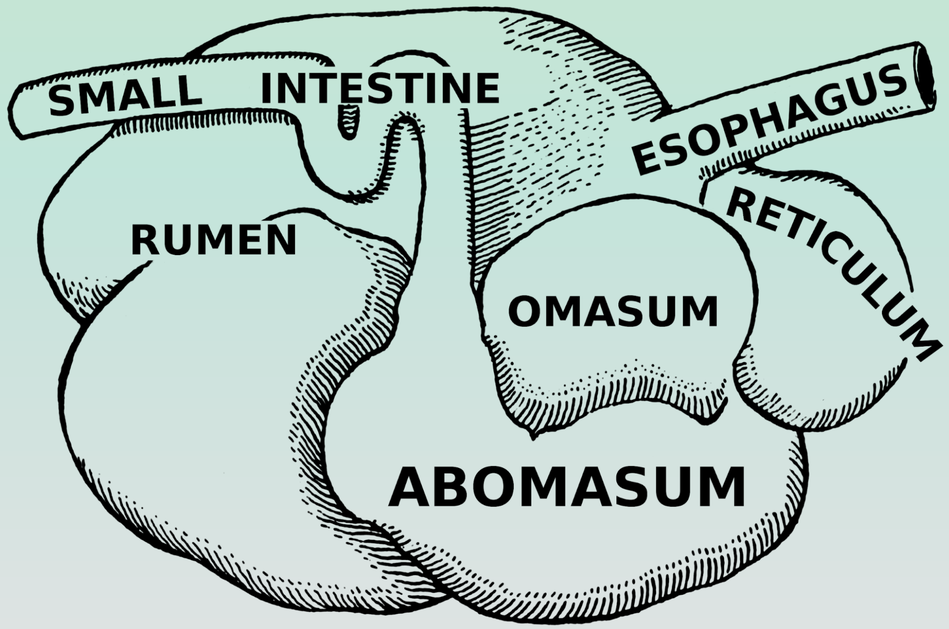
- One stomach; four parts
  - Each compartment has a specific function
  - The first and third are considered forestomachs
    - Aid digestion through microbial fermentation
    - Microbes help break down fibrous material



Ruminant parts and functions

The stomach

- Rumen a.k.a. “the paunch”
  - Largest compartment
    - Can hold up to 40 gallons in a cow
    - Makes up 80% of the stomach
    - Top third is gas, middle third is solid feedstuffs, and the bottom third is digested feedstuffs
    - Contains a large population of microorganisms
    - Help digest feed and provide energy for the animal
    - Produce the majority of amino acids



Ruminant parts and functions

The stomach

- Papille
  - Finger-like structures that texture the inner lining
  - Provides more surface area

Ruminant parts and functions

The stomach

- Reticulum a.k.a. honeycomb or “hardware” stomach
  - Relatively small
    - 2 gallons in a cow
    - Makes up 5% of the stomach
    - Contractions cause movement for the rumen to mix feed
    - Pumps food back up the esophagus for rumentation

Ruminant parts and functions

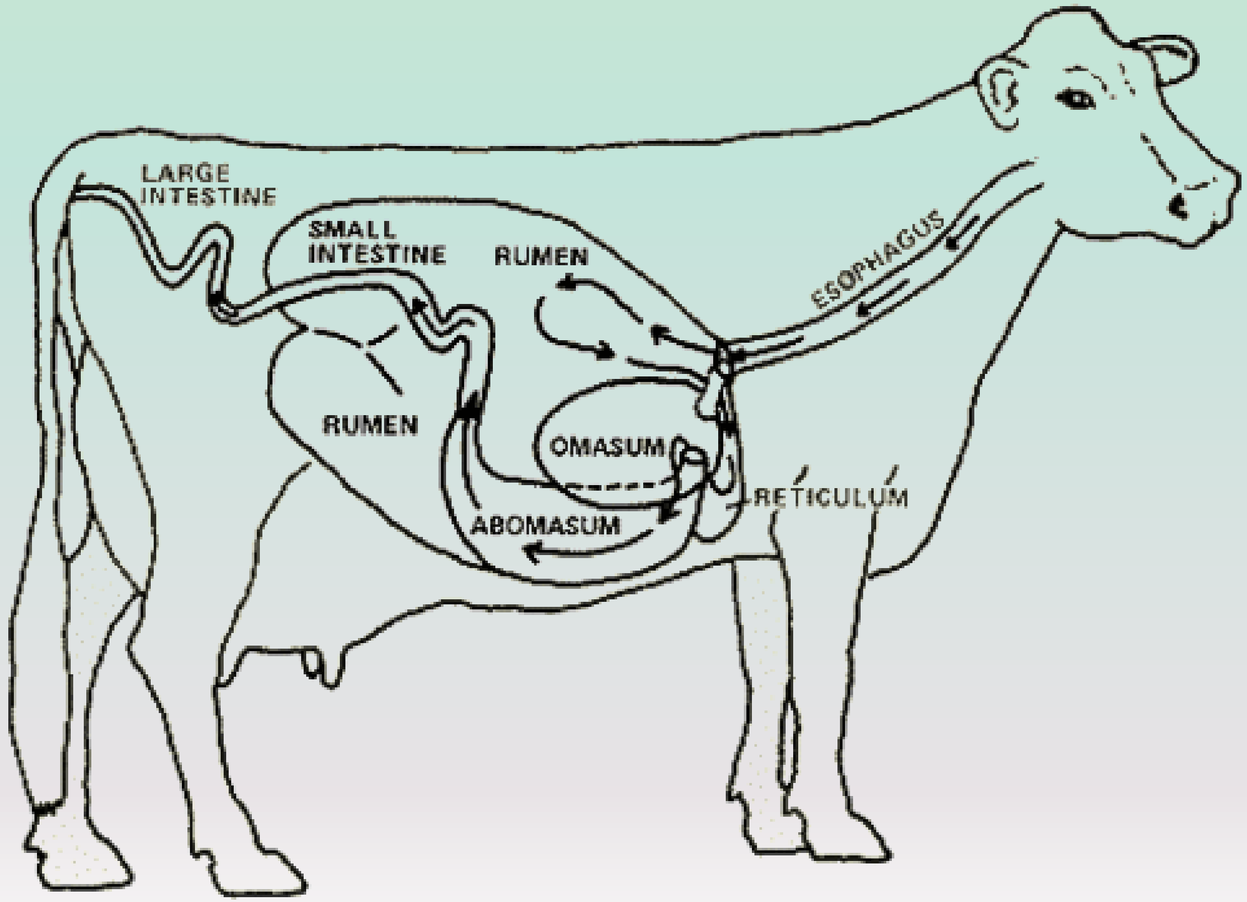
The stomach

- Omasum a.k.a. “the butcher’s Bible”
  - Round, muscular section
    has many folds to grind and squeeze the feed
    - Holds 4 gallons in a cow
    - Makes up 8% of the stomach
    - Many folds in the interior walls’ structure—looks like a book

Ruminant parts and functions

The stomach

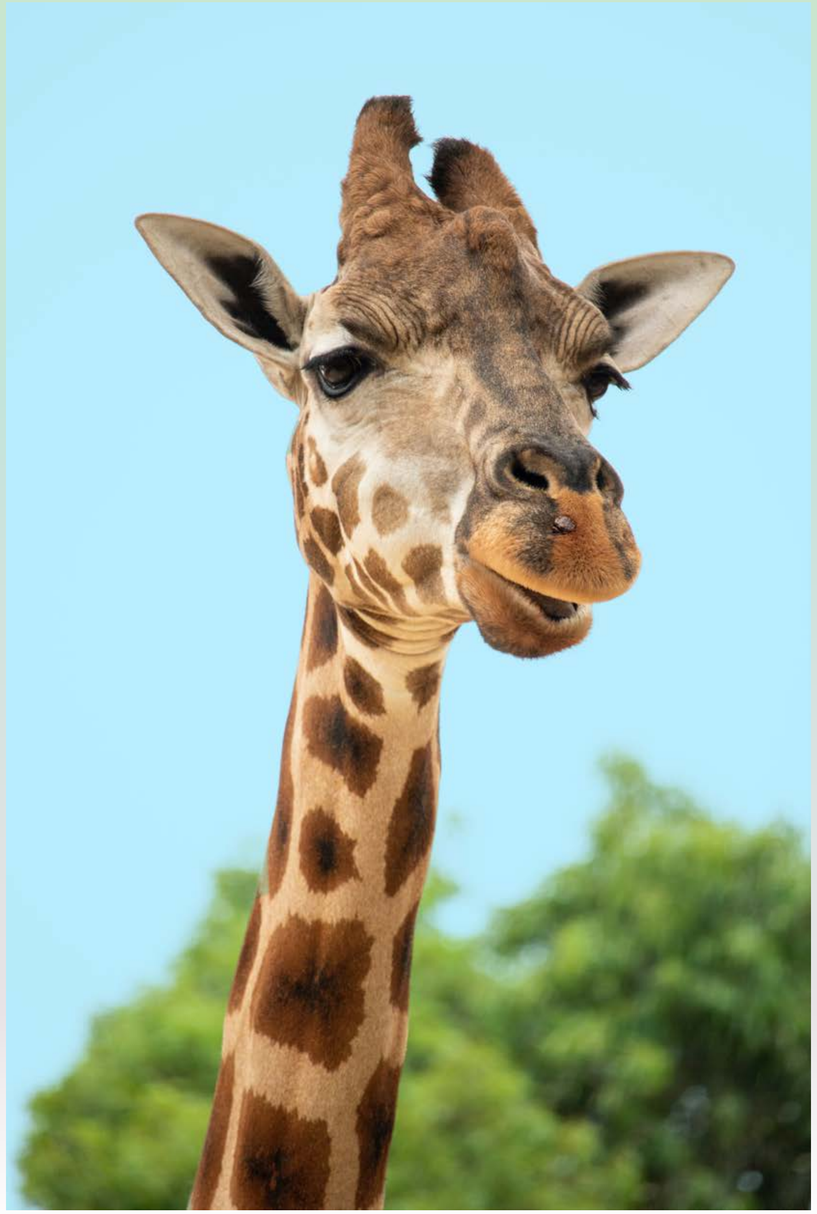
- Abomasum
  - The “true stomach”
    - Functions are similar to the monogastric stomach
    - Bile added to help the breakdown of proteins and lipids
    - Only compartment that produces enzymes and mucous



Ruminant parts and functions

Small intestine

- Where most nutrients are absorbed into the bloodstream
- Is about 20 times the length of the animal!
  - 6-foot long cow = 120 feet
- Three main parts:
  - Duodenum
  - Jejunum
  - Ileum



Ruminant parts and functions

Large intestine

- Unused food material is prepared for removal from the body
- Three main parts:
  - **Cecum:** minor role in further breakdown of roughages
  - **Colon:** absorbs water and forms undigested wastes into feces
  - **Rectum:** stores feces until it is passed out of the body

Anus

- Opening in which waste exits the body
  - Feeds that aren’t absorbed

Ruminant review

- How many parts does the stomach of a ruminant have?
- What is the name of the largest compartment of the stomach in ruminants?
- What does the esophagus in ruminants allow for?
- The first and third compartments of the stomach (forestomach) allow for what action(s)?
- The reticulum helps to _____ food and pump food back up through the _____.
- What is the function of the omasum?
- How is the abomasum similar to the stomach of other mammals?

Pseudo-ruminants

- An animal that eats large amounts of roughage
- Does not have a stomach with several compartments
- Digestive system performs some of the same functions as those of ruminants (i.e., in horses, the cecum ferments forages)
- Can digest large amounts of roughage because of a greatly enlarged cecum and large intestine (many areas for microbial digestion of fiber)
- Pseudo-ruminants often eat forages as well as grains and other concentrated feeds. (Examples include horses, rabbits, guinea pigs, and hamsters.)