VET-114
Animal Anatomy and Physiology 2

Webinar – Chapter 11

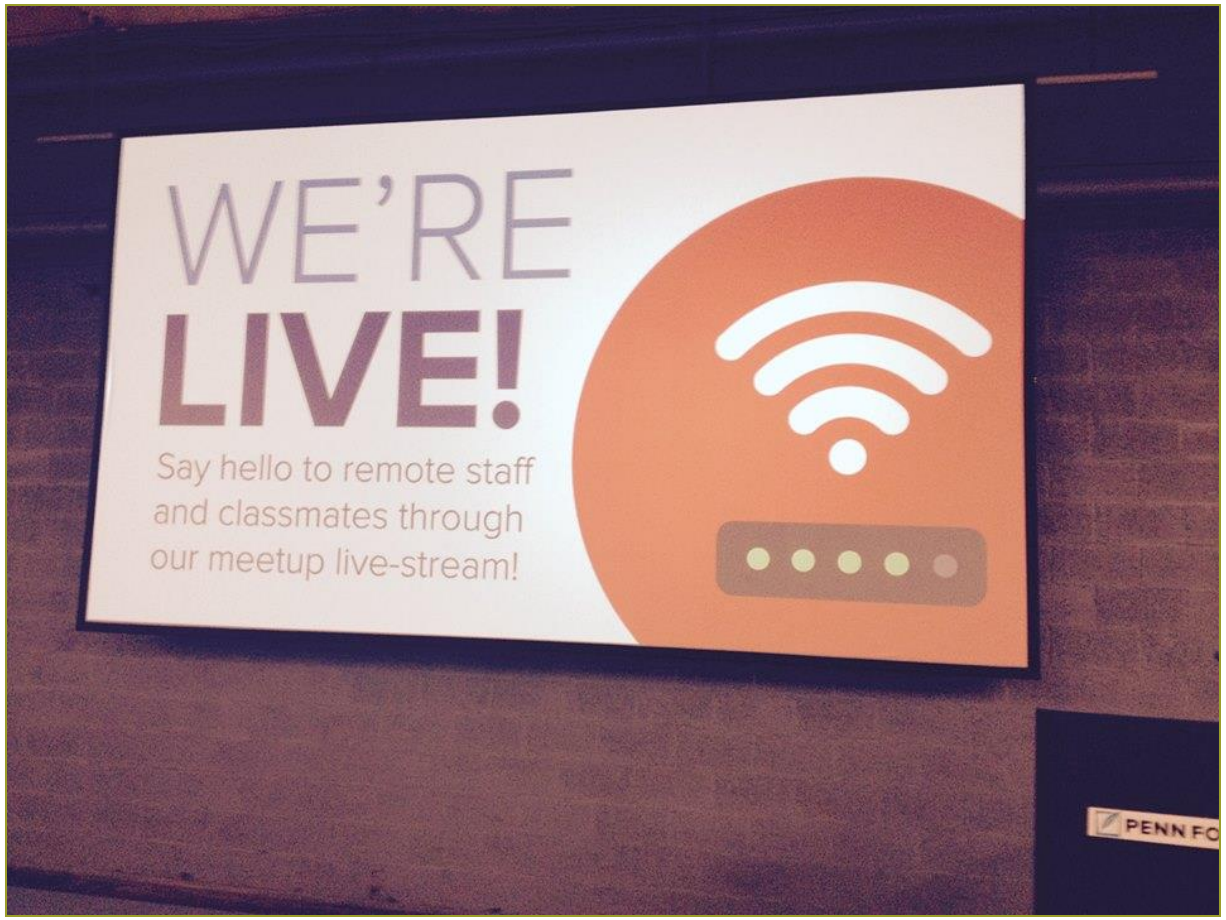
Digestive System

A Warm Welcome from My Faculty TEAM and Me!!! ☺

The Pledge of Allegiance

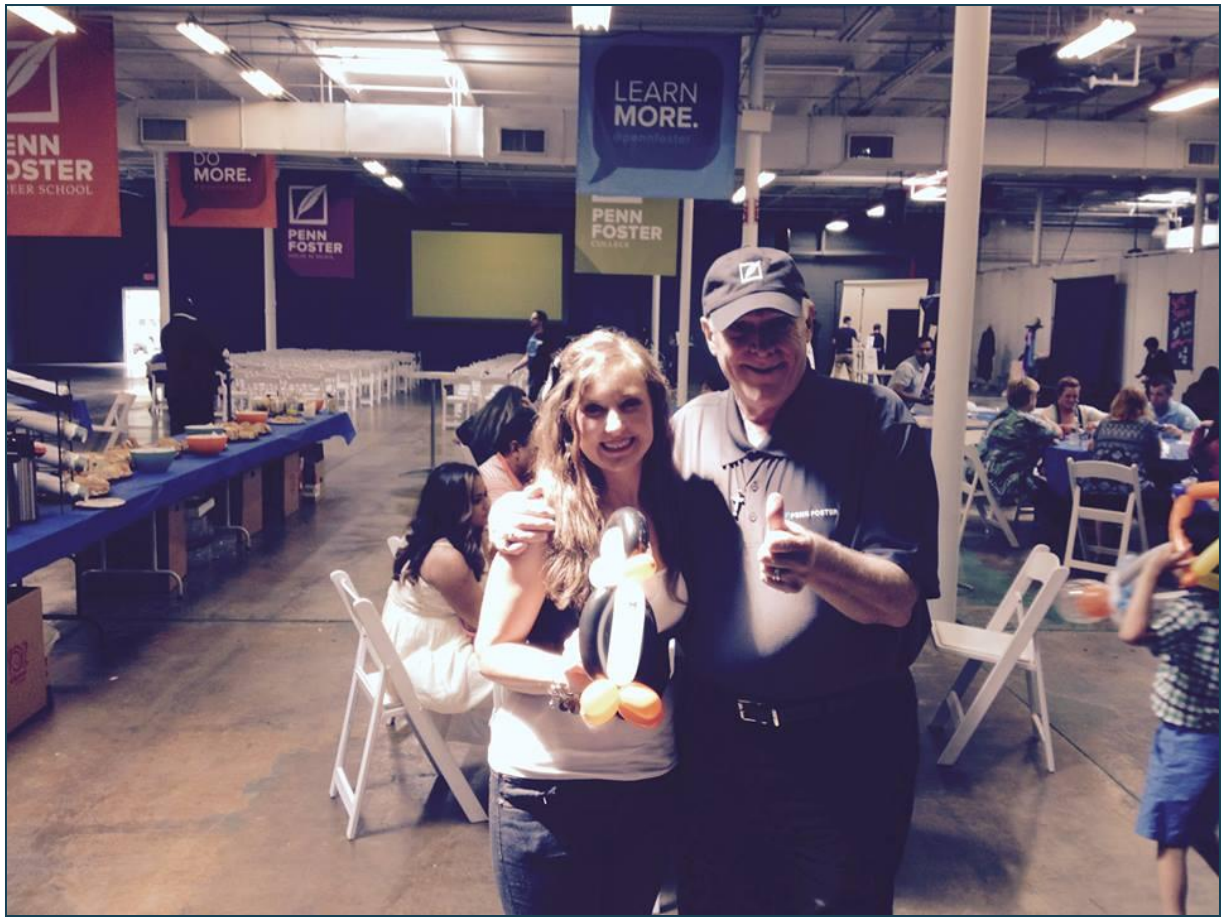
Tribute to Our Military Students and Their Spouses!

Scranton Meet-Up! Streaming Live!



The “Jersey Girls”! ☺

Megan Andrews CVT

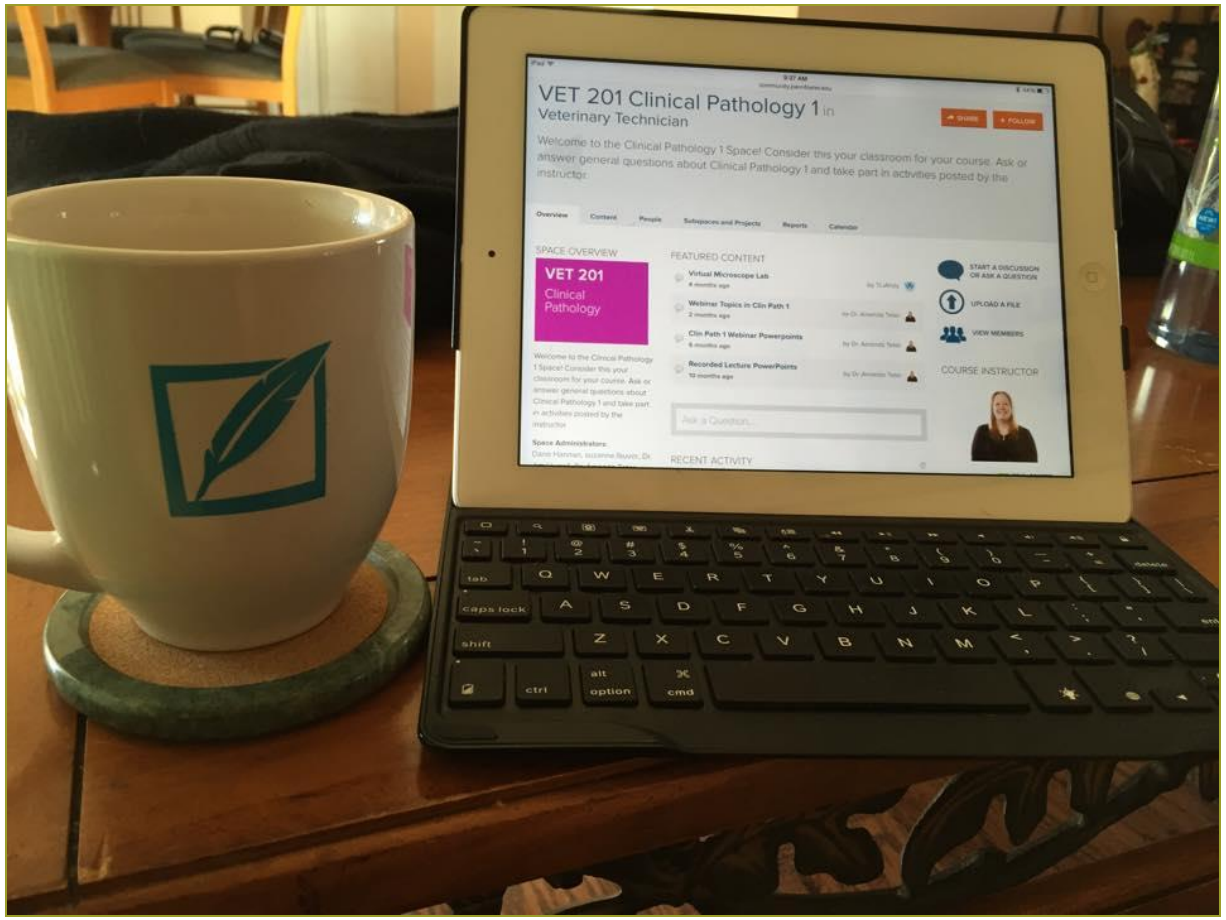


Lisa Hughes Graduating!!!

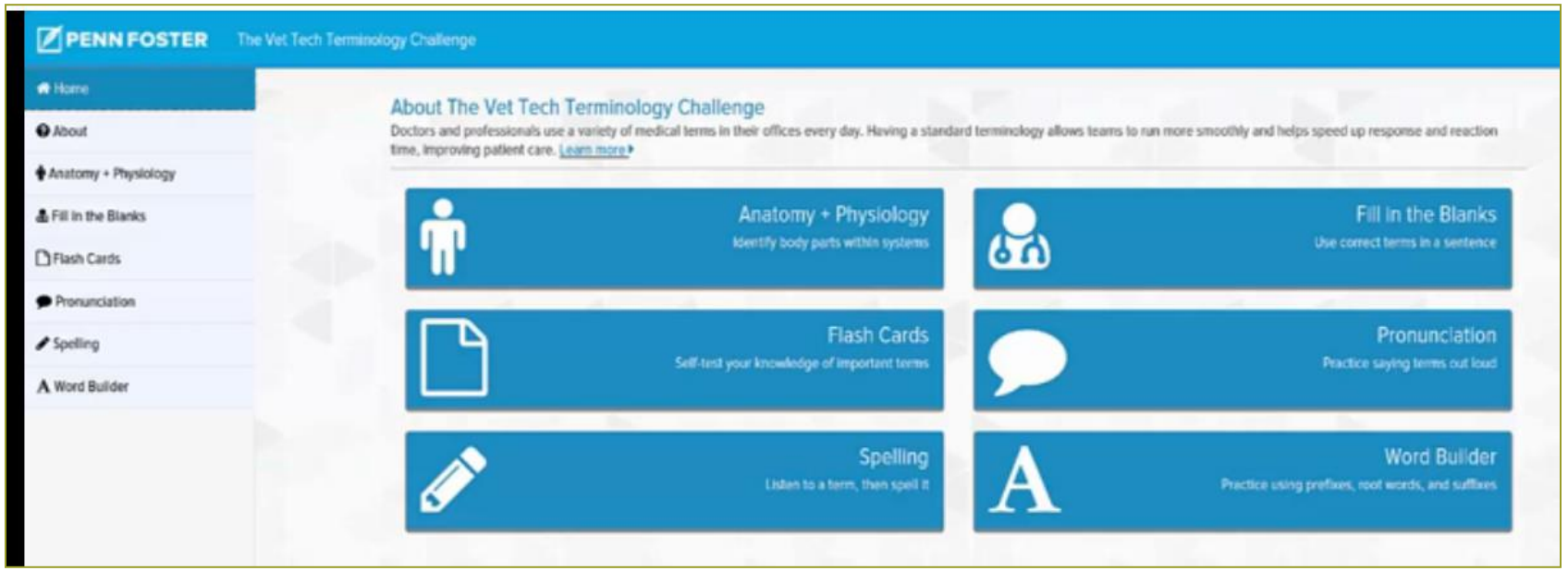
Heather Geyer – National Award!

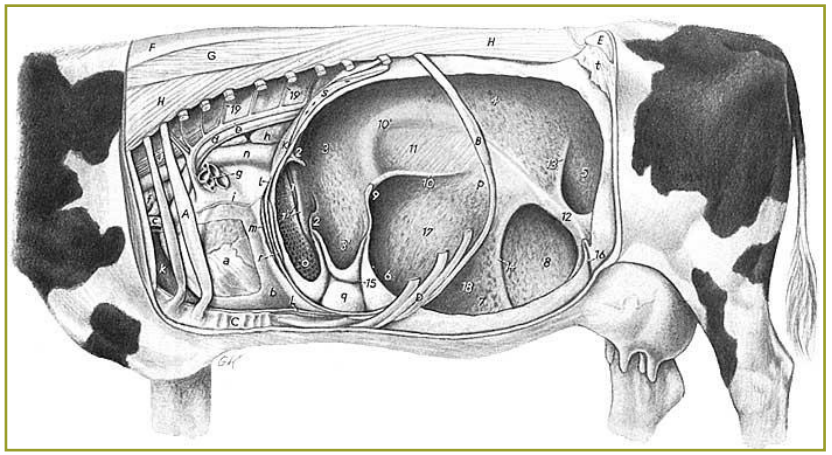

22
Heather Geyer
DEAC Graduate of the Year,
Veterinary Technician Associate Degree
PENN FOSTER

Are You Using the Course Spaces?

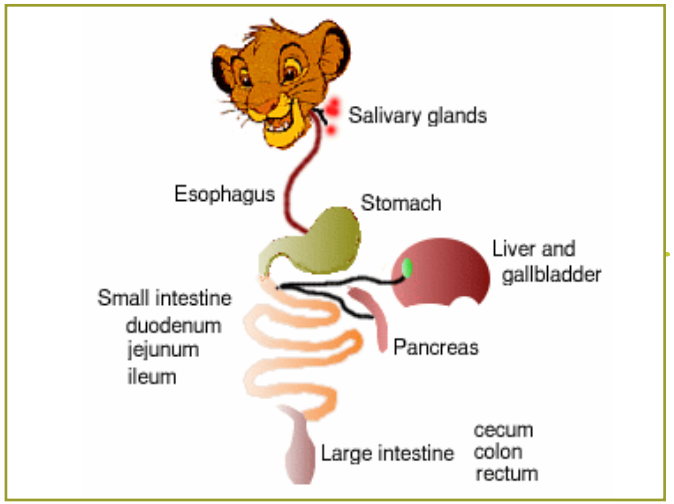


New “Medical Terminology Game”!





The Digestive System
Chapter 11



Pages 264-282

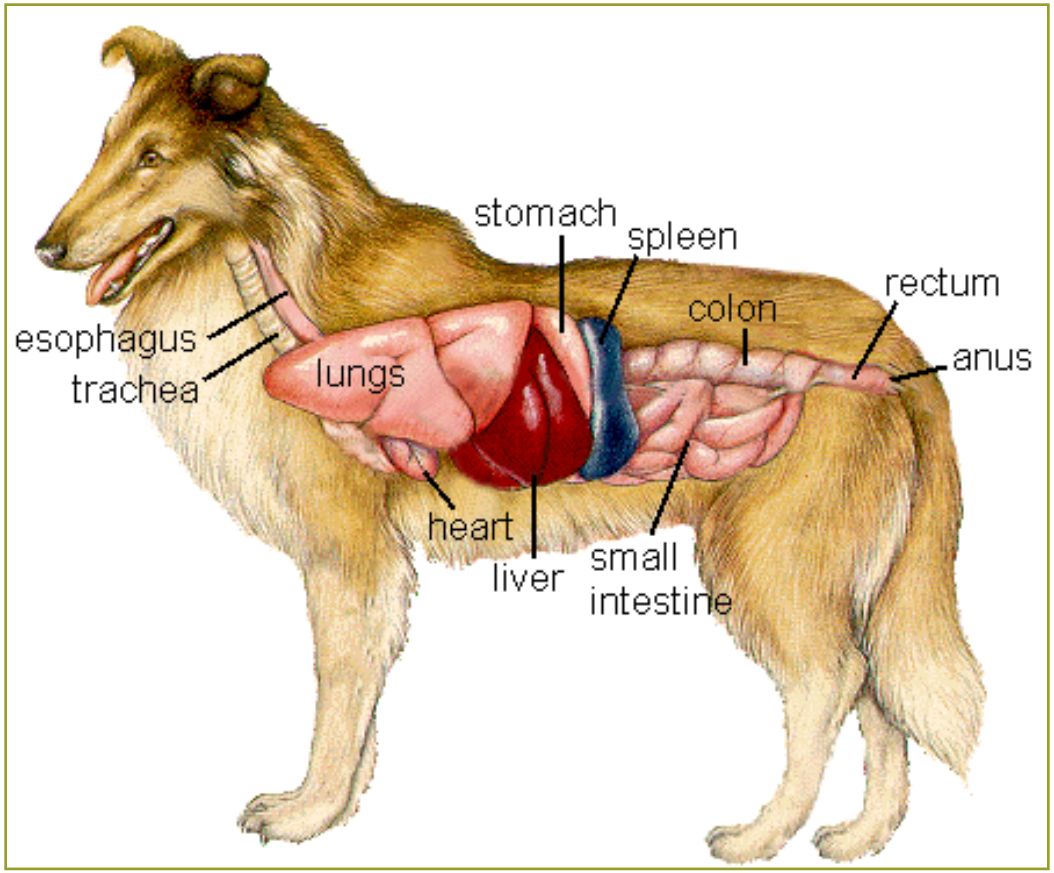
Textbook Learning Objectives

Chapter 11 – Page 264

- List the functions of the digestive system.
- Describe the epithelial and muscle layers of the gastrointestinal tract.
- Explain the process of peristalsis.
- List the structures of the oral cavity.
- List and give the locations of the salivary glands.
- Name the types of teeth found in carnivores and herbivores and describe the structure of teeth.
- Differentiate between mechanical and chemical digestion.
- List the structures that make up the monogastric stomach and describe the function of each area.
- Explain the effect(s) on the gastrointestinal system of amylase, lipase, gastrin, pepsin, pepsinogen, prostaglandins, mucin, bicarbonate, secretin, cholecystokinin, proteases, and hydrogen and chloride ions.
- Describe the structure and functions of the rumen, reticulum, omasum, and abomasum.
- Differentiate between fermentative and nonfermentative digestion.
- List the segments of the small and large intestine and describe the general functions of each segment.

The Digestive System

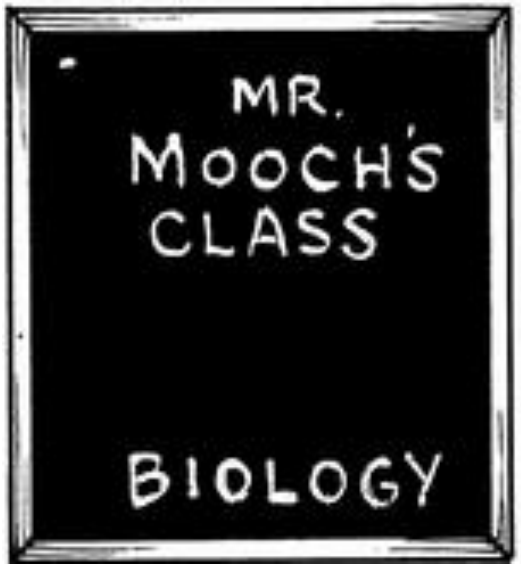
- Gastrointestinal tract (GIT)
- Alimentary canal



Putting Things in Perspective! ☺

VERY important system clinically!

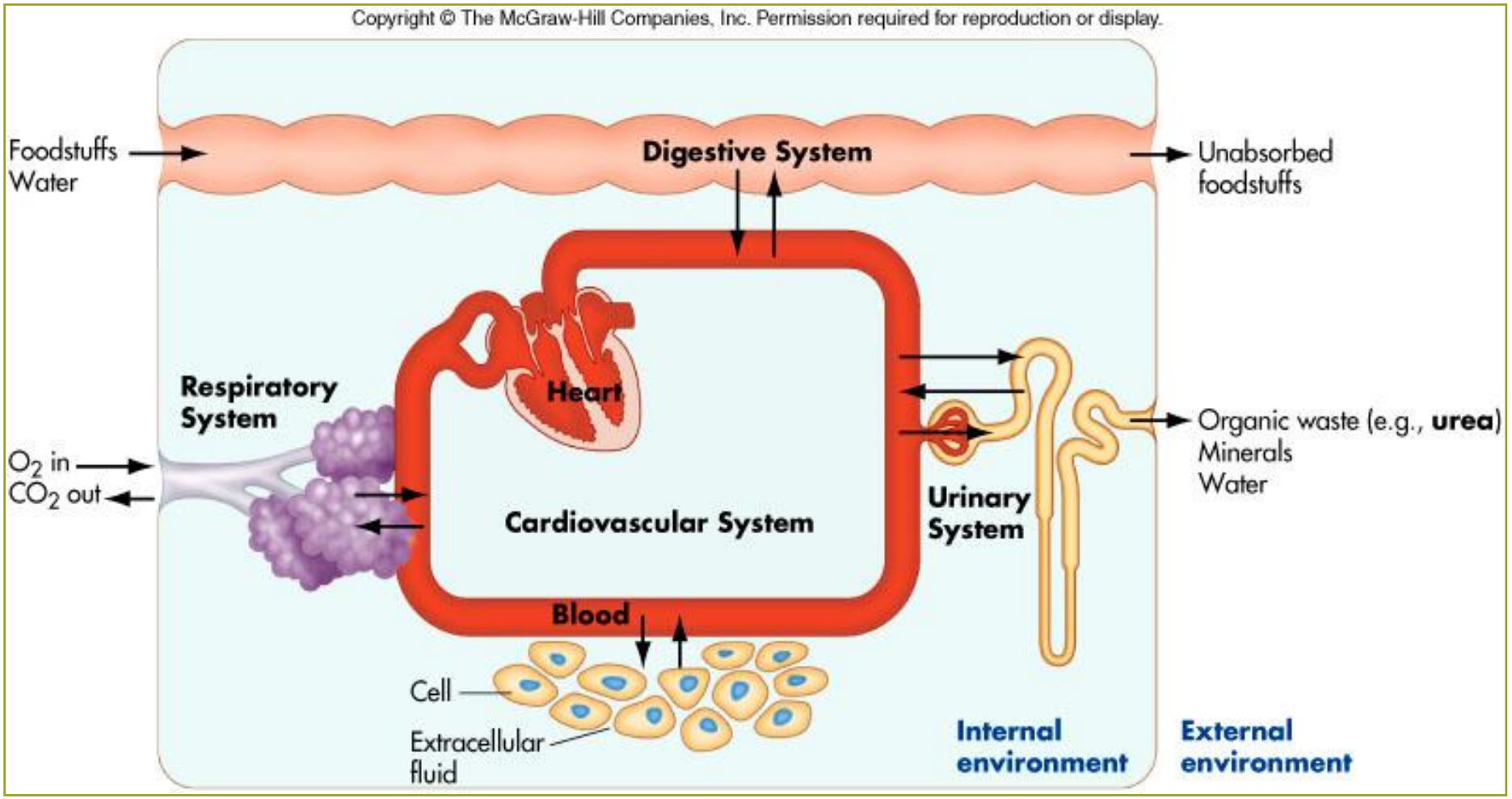

HERE, MOOCHIE, I THOUGHT YOU MIGHT LIKE THIS.
muttscomics.com
4/10
HA! HA! HA! HA! HA!


MR. MOOCH'S CLASS
BIOLOGY


'CANIS BAD BREATHUS'
ABCDE
muttscomics.com
9-18

"I'm afraid Sidney has foot and mouth disease,
Mrs Snoddy - and for a gastropod
that's about as bad as it gets

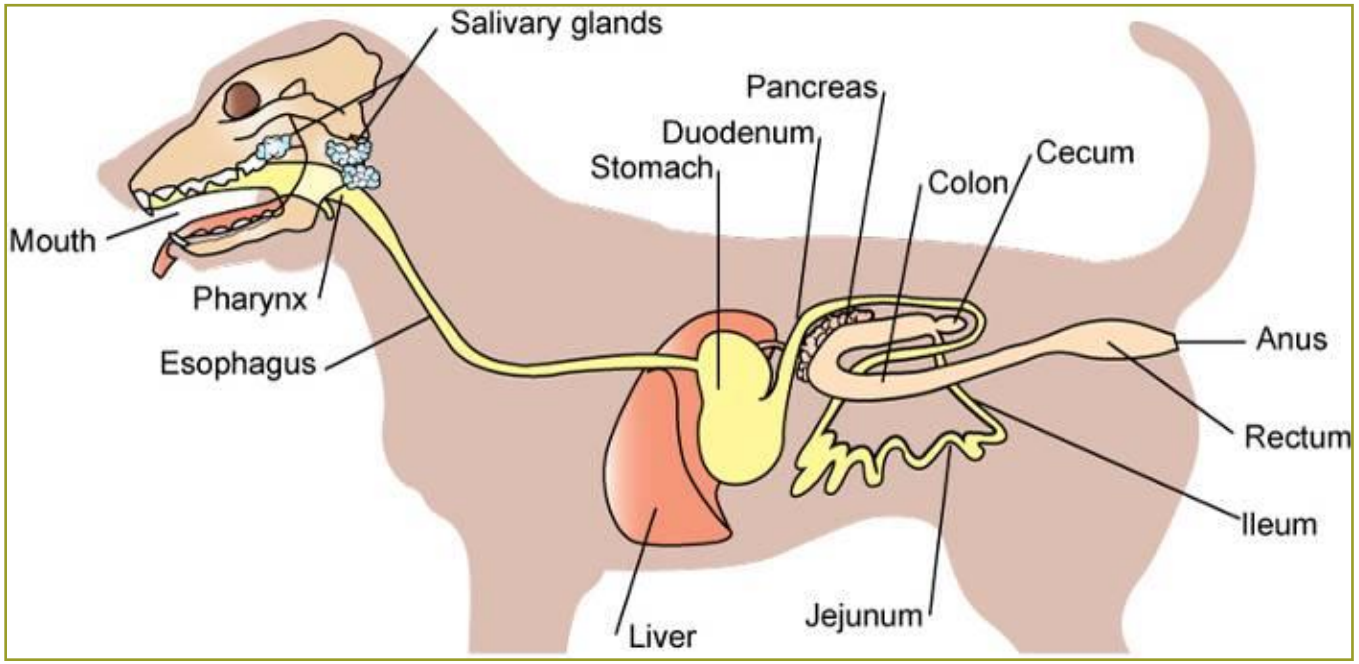
The “Tracts” of Internal Medicine

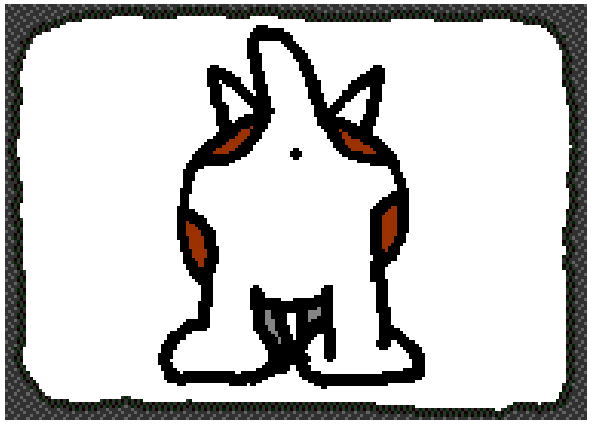


The Digestive System (GIT)

Figure 11-1, Page 265

- Digestive tract, gastrointestinal (GI) tract, alimentary canal, gut
- Tube that runs from the mouth to the anus; accessory digestive organs





Basic Functions of GIT

Digestion of Macronutrients

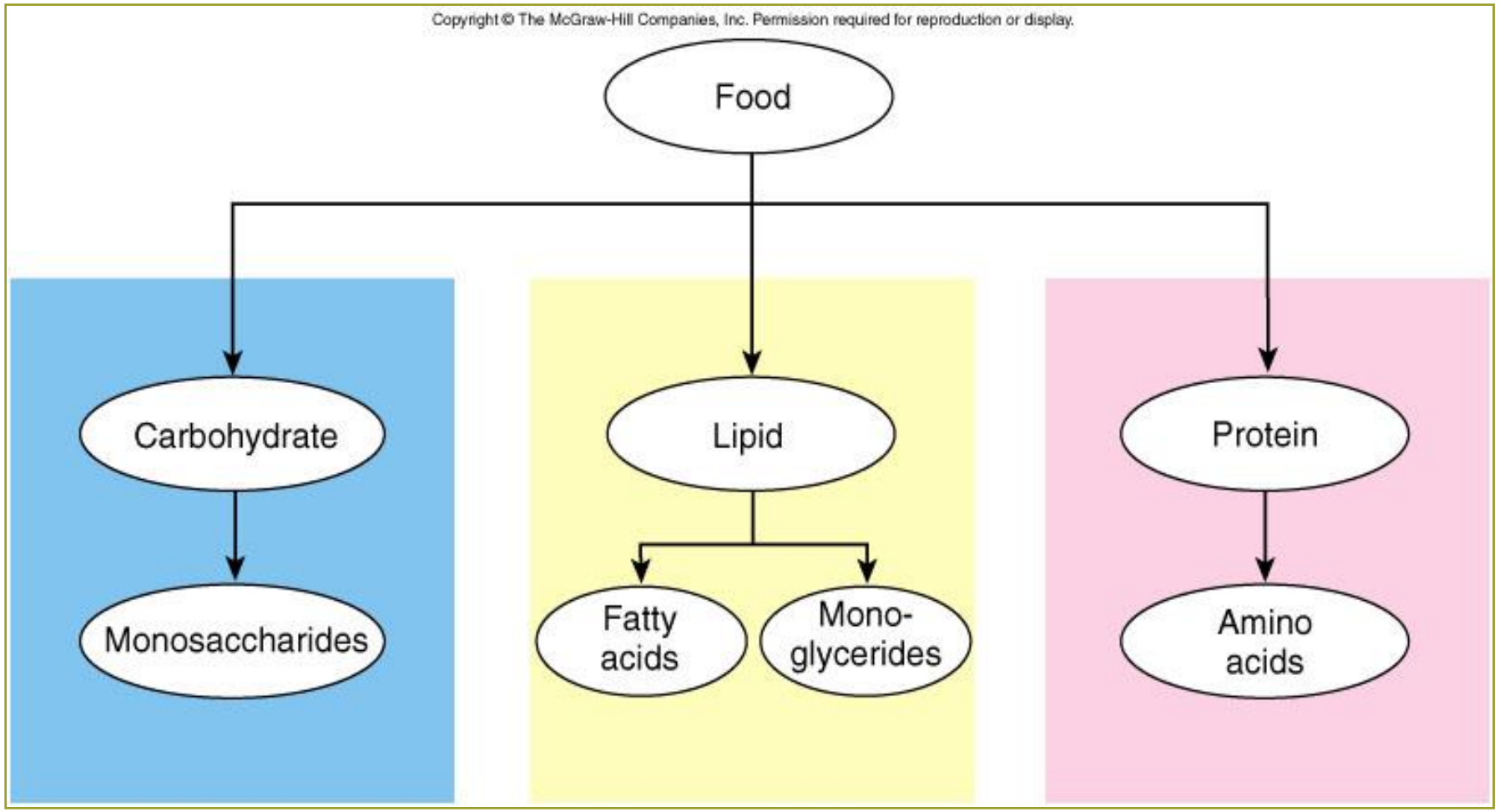
Absorption of All Nutrients

Elimination of Wastes

Digestion of Macronutrients

- Definition – large nutrient molecules that require breakdown into smaller molecules before being absorbed
  - "Energy" nutrients (Calories)
  - **Carbohydrates**
  - **Fats**
  - **Proteins**

Digestion of Macronutrients



Absorption of All Nutrients

- Macronutrients
- Micronutrients – nutrient molecules so small that no digestion is required before being absorbed
  - Vitamins
  - Minerals
  - Water

Elimination of Wastes

- **Food** –
- **Chyme** –
- **Feces** – waste product from animal's digestive tract expelled through the anus during **defecation**
  - Water (75%)
  - Bacteria
  - Fiber
  - Undigested/unabsorbed nutrients
  - Waste products

Comparative A&P

Herbivores

Carnivores

Omnivores

Species Variation

- Requirements for digestion and absorption of foodstuffs vary depending on diet of animal
  - Herbivores – plant-eating animals (cattle, sheep, goats)
  - Carnivores – meat-eating animals (cats)
  - Omnivores – animals that eat plant material and meat
- Monogastric animals – simple, single stomachs
- Ruminants – multiple mixing and fermentation compartments in addition to stomach

Herbivores

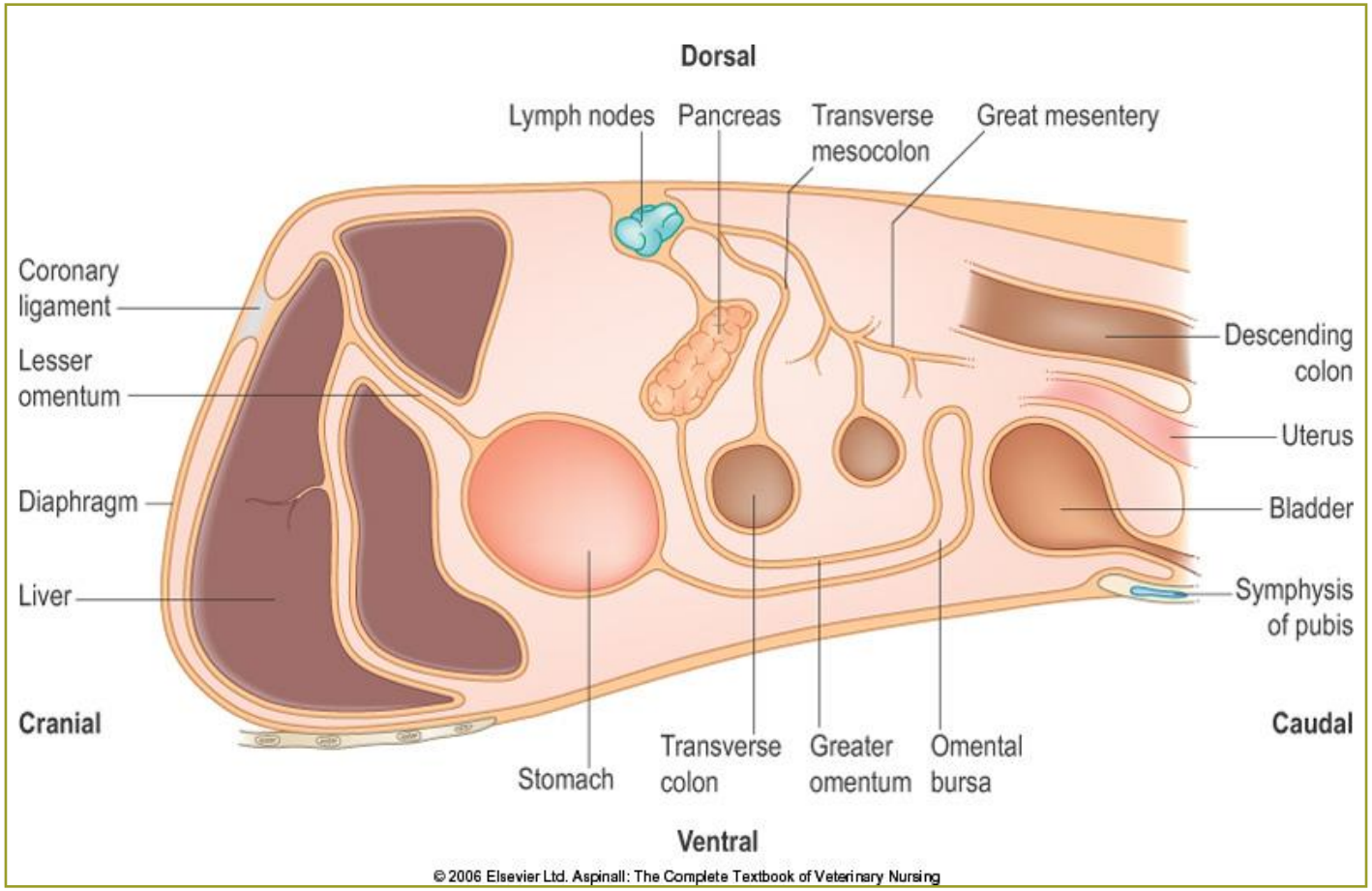
Carnivores

Omnivores

Anatomy of GIT

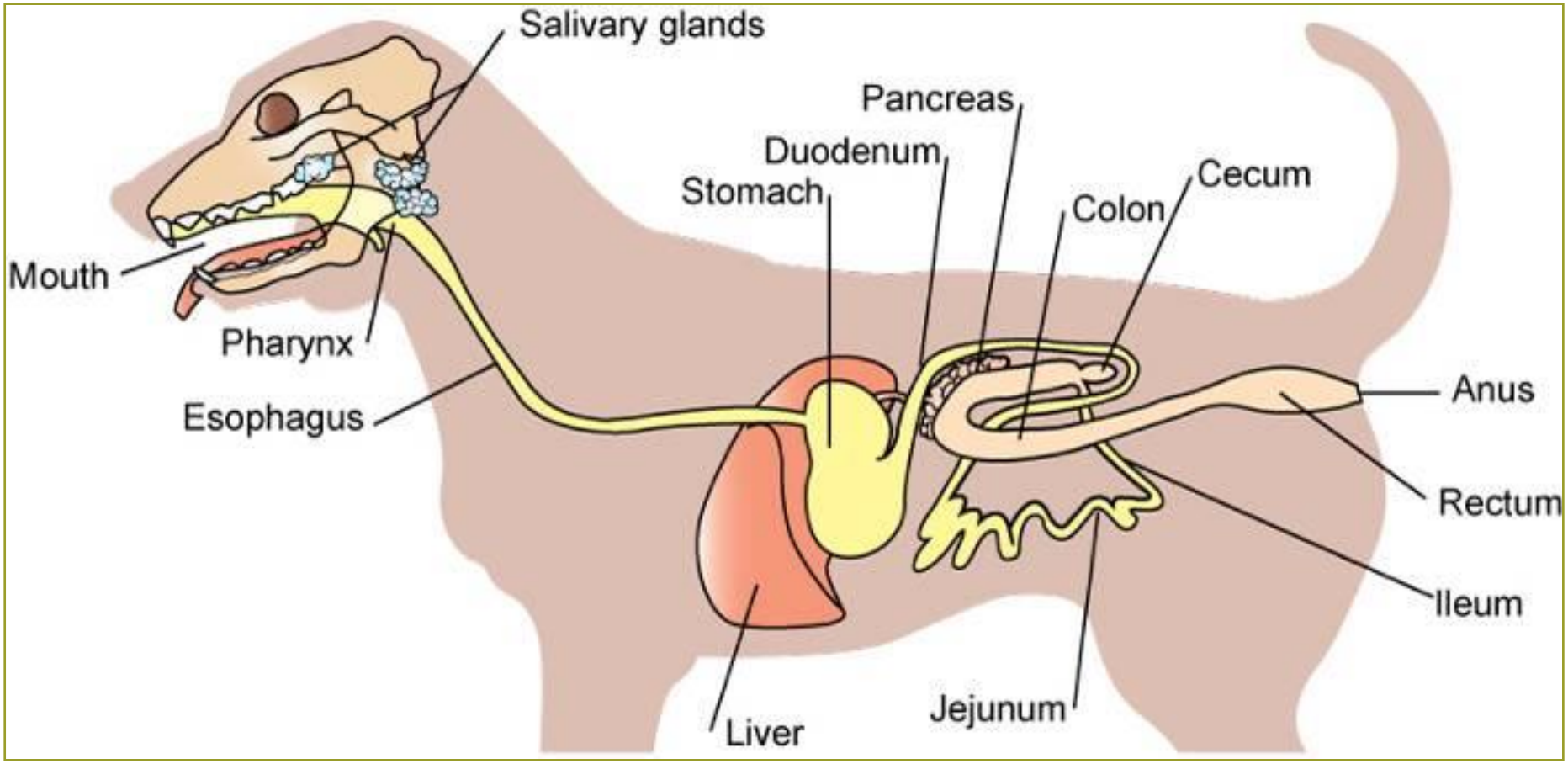
Trace a Bolus of Food from the Oral Cavity to the Anus

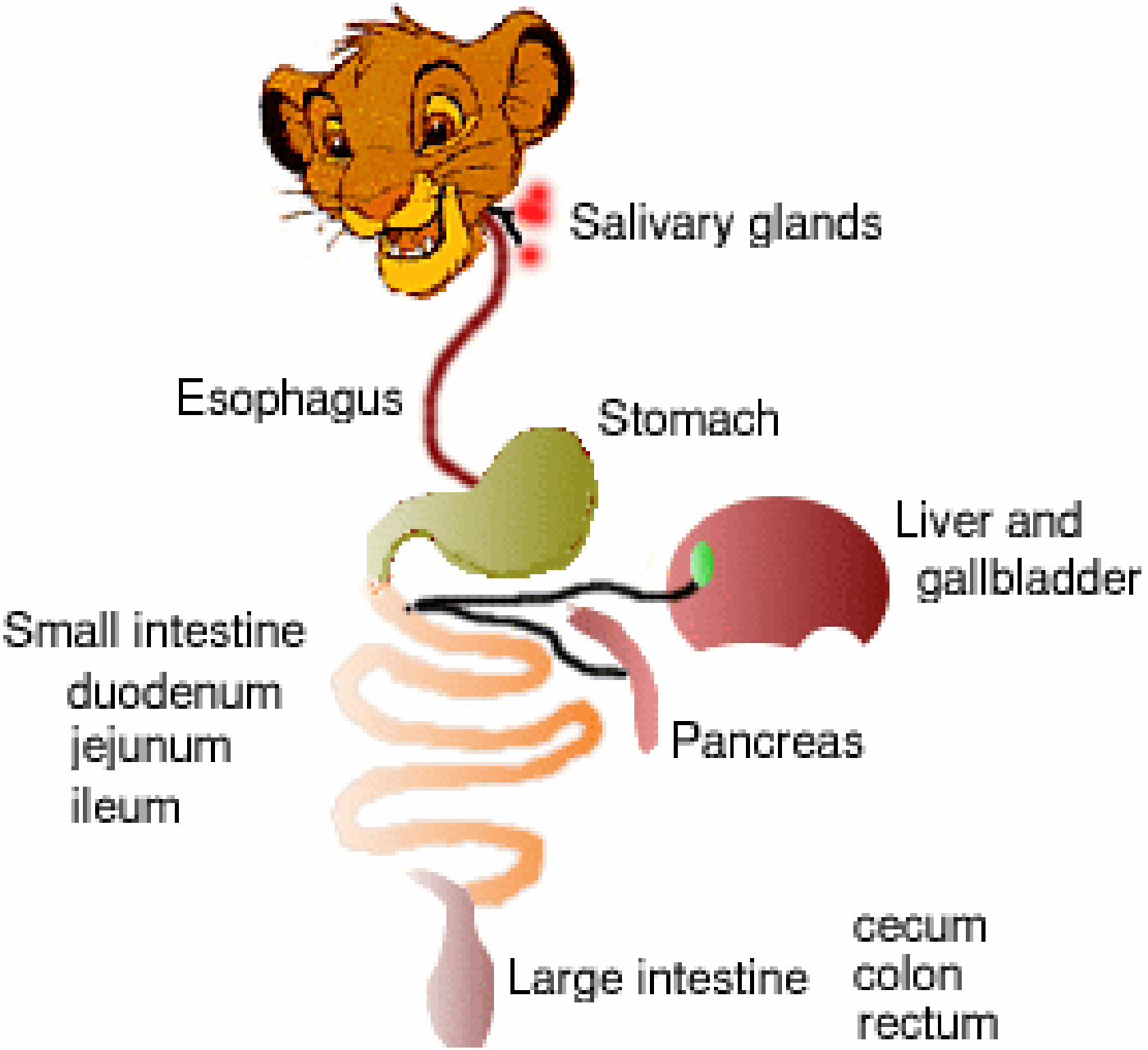
3 Tracts Exiting Body

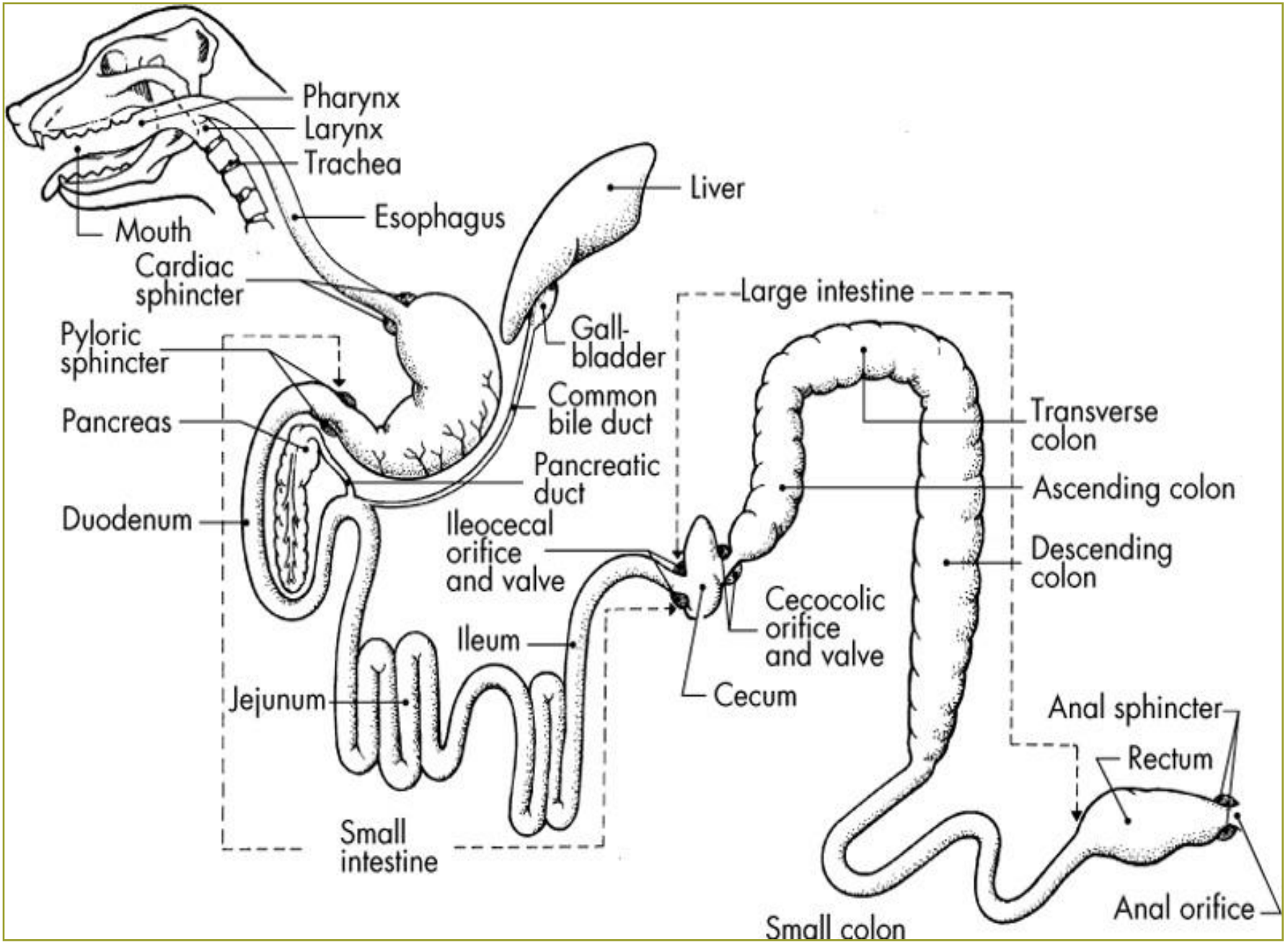


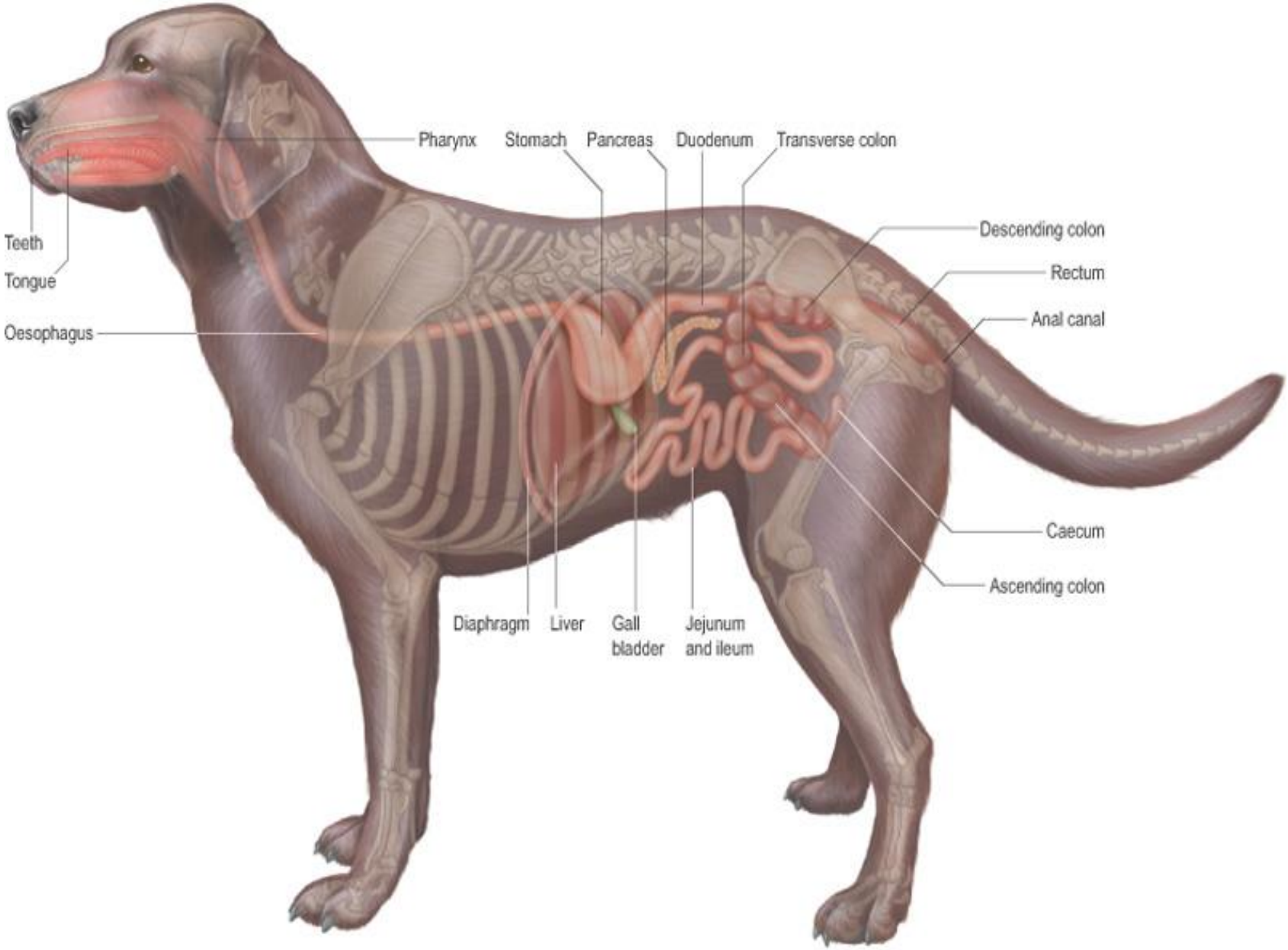
Trace a Bolus of Food

Figure 11-1, Page 265




Salivary glands
Esophagus
Stomach
Liver and
gallbladder
Small intestine
duodenum
jejunum
ileum
Pancreas
Large intestine
cecum
colon
rectum

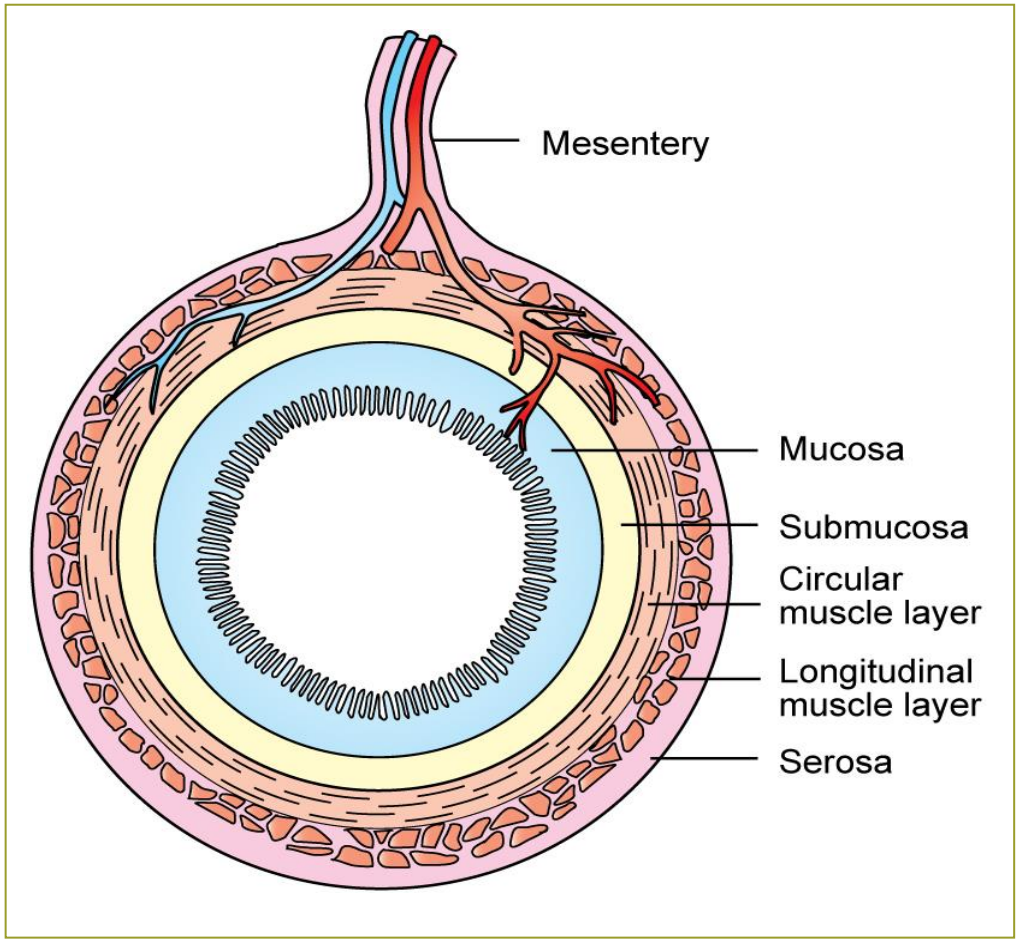

Pharynx
Larynx
Trachea
Esophagus
Liver
Mouth
Cardiac sphincter
Large intestine
Pyloric sphincter
Gall-bladder
Common bile duct
Transverse colon
Pancreas
Pancreatic duct
Ascending colon
Duodenum
Ileocecal orifice and valve
Descending colon
Cecocolic orifice and valve
Ileum
Cecum
Jejunum
Anal sphincter
Rectum
Small intestine
Small colon
Anal orifice



Digestive Tract Structure

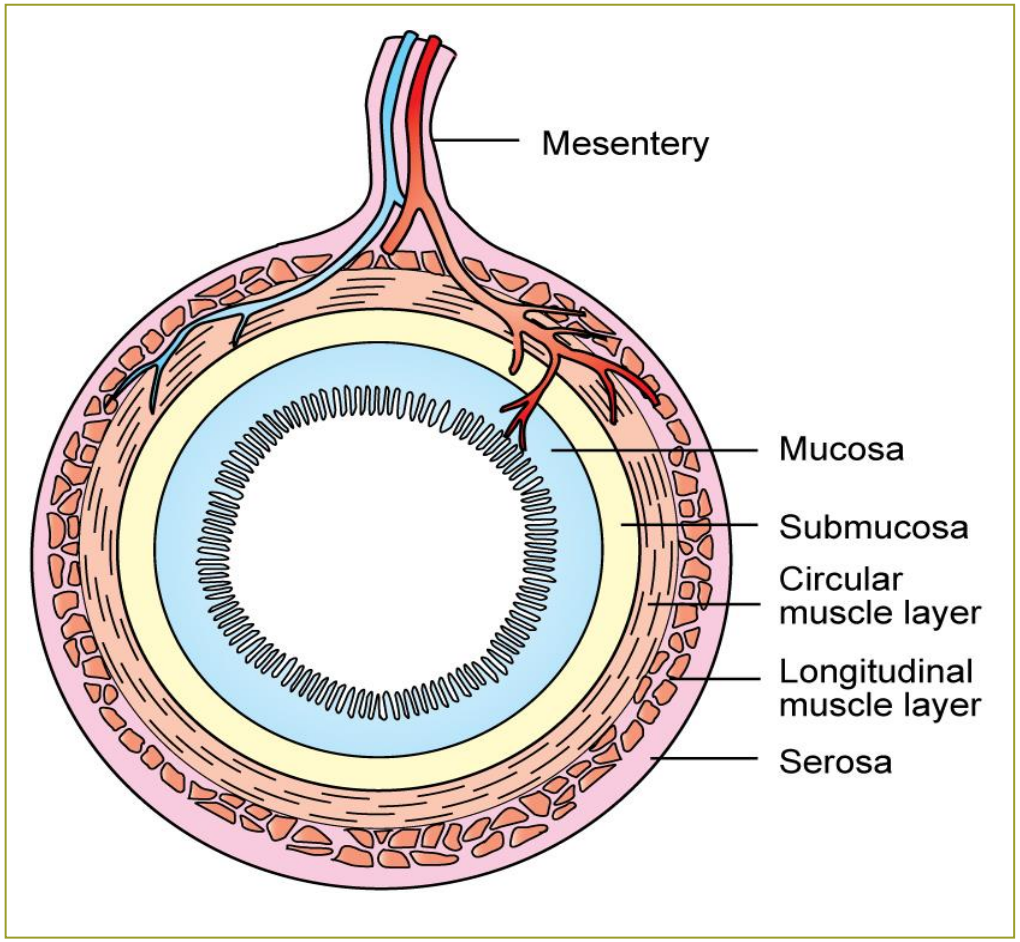
Figure 11-2, Page 266

- Mucosa – lining of GI tract; epithelium and loose connective tissue
- Submucosa – dense connective tissue; may contain glands
- Muscle layer – outside the submucosa
- Serosa – outermost layer; thin, tough connective tissue.



Mesentery

- Sheets of connective tissue
- Suspend digestive tube in abdomen from dorsal body wall
- Contains blood and lymph vessels and nerves that supply GI tract



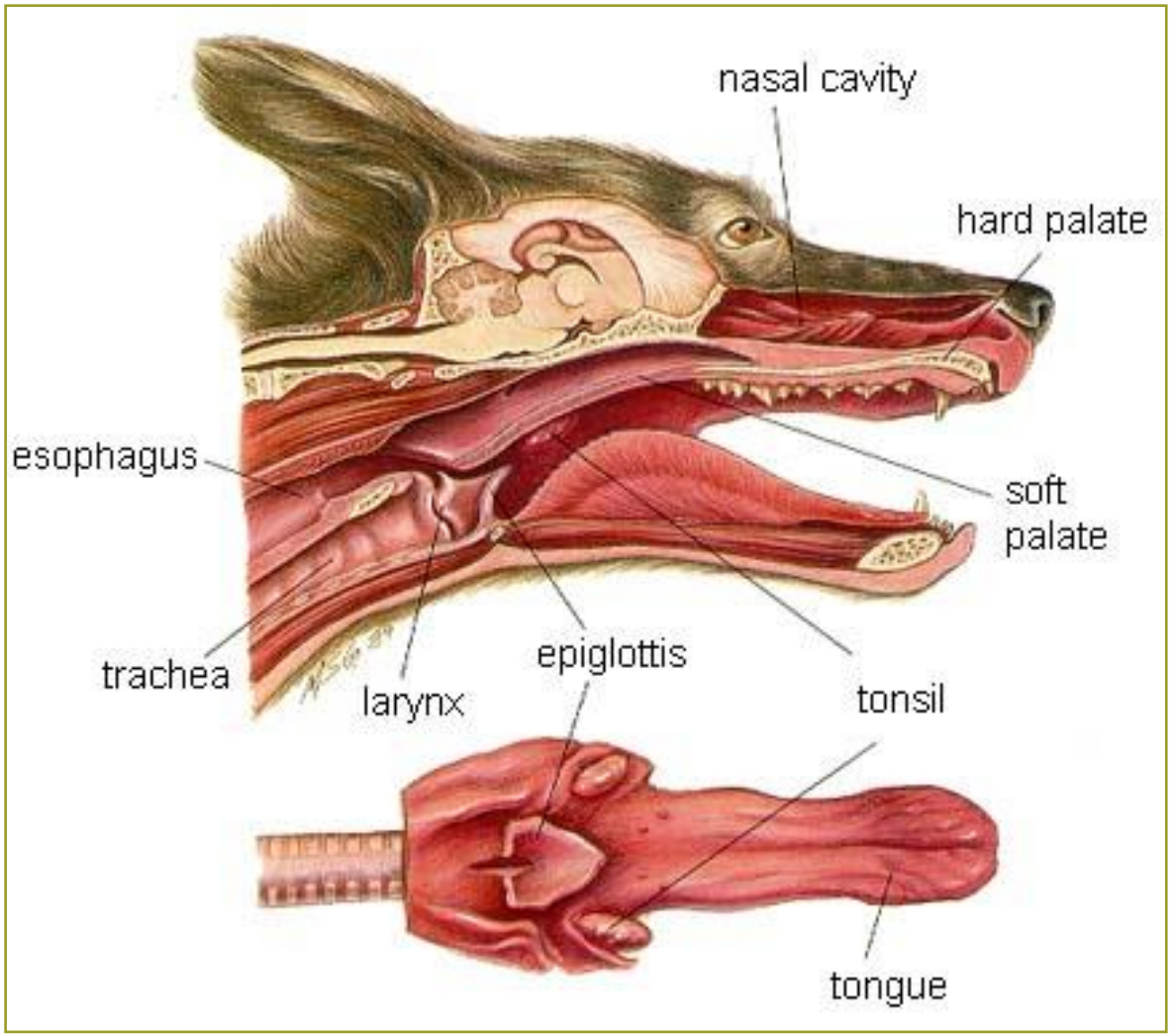
Mouth

Oral cavity

Buccal cavity

Mouth (Oral Cavity)

- Lips
- Salivary glands
- Tongue
- Teeth
- Hard palate
- Soft palate



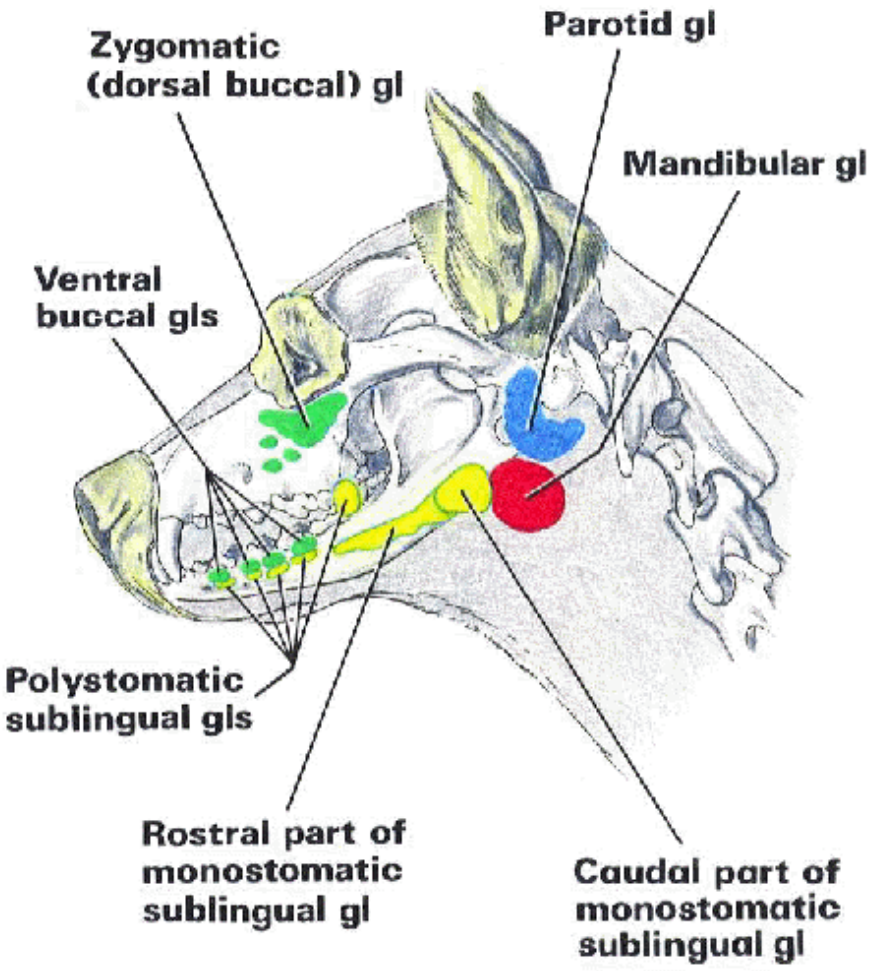
Salivary Glands

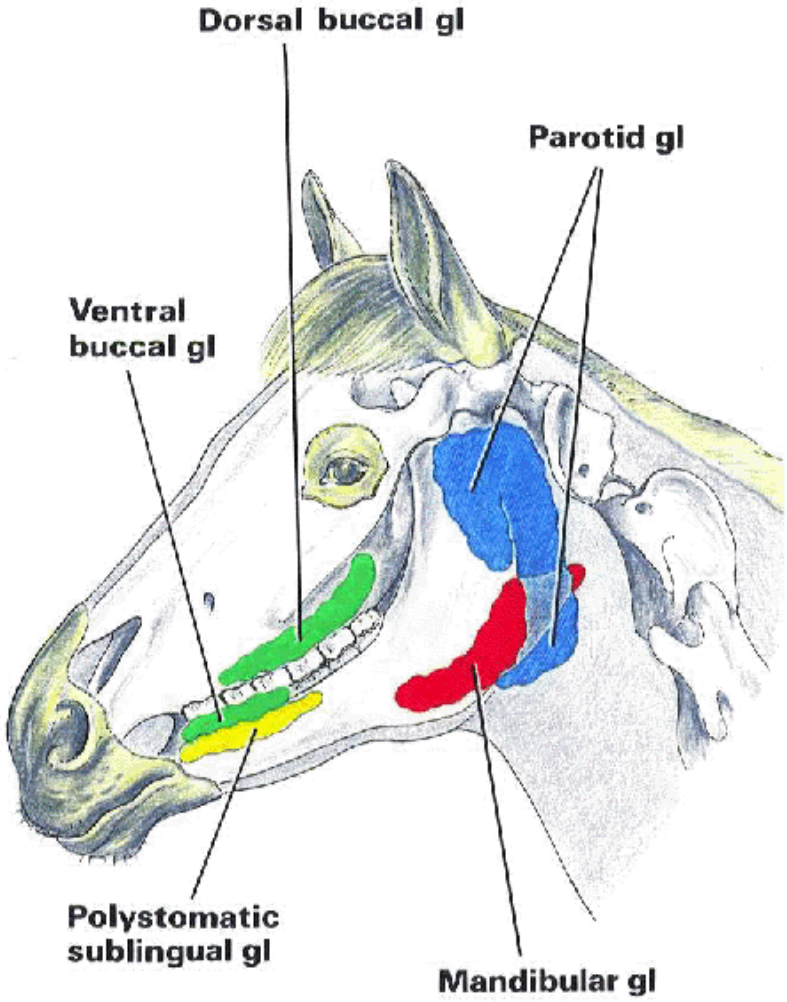
- Exocrine glands
- Produce saliva; usually three pairs with ducts that carry the saliva to the oral cavity
  - Parotid salivary glands – ventral to the ear canals
  - Mandibular salivary glands – ventral to the parotid glands at the caudal angle of the mandible
  - Sublingual salivary glands – medial to the shafts of the mandible just under the base of the tongue

Oral Cavity Functions

- Lips may play role in **prehension**
- Initiate **mastication** (mechanical digestion)
  - Breaks food into smaller particles that increase the surface area available for exposure to the enzymes involved in chemical digestion
- Initiate chemical digestion
  - **Saliva** – added to food as it is chewed; moistens, softens, and shapes food into a form that is more readily swallowed
  - **Salivary amylase**

Comparative Anatomy

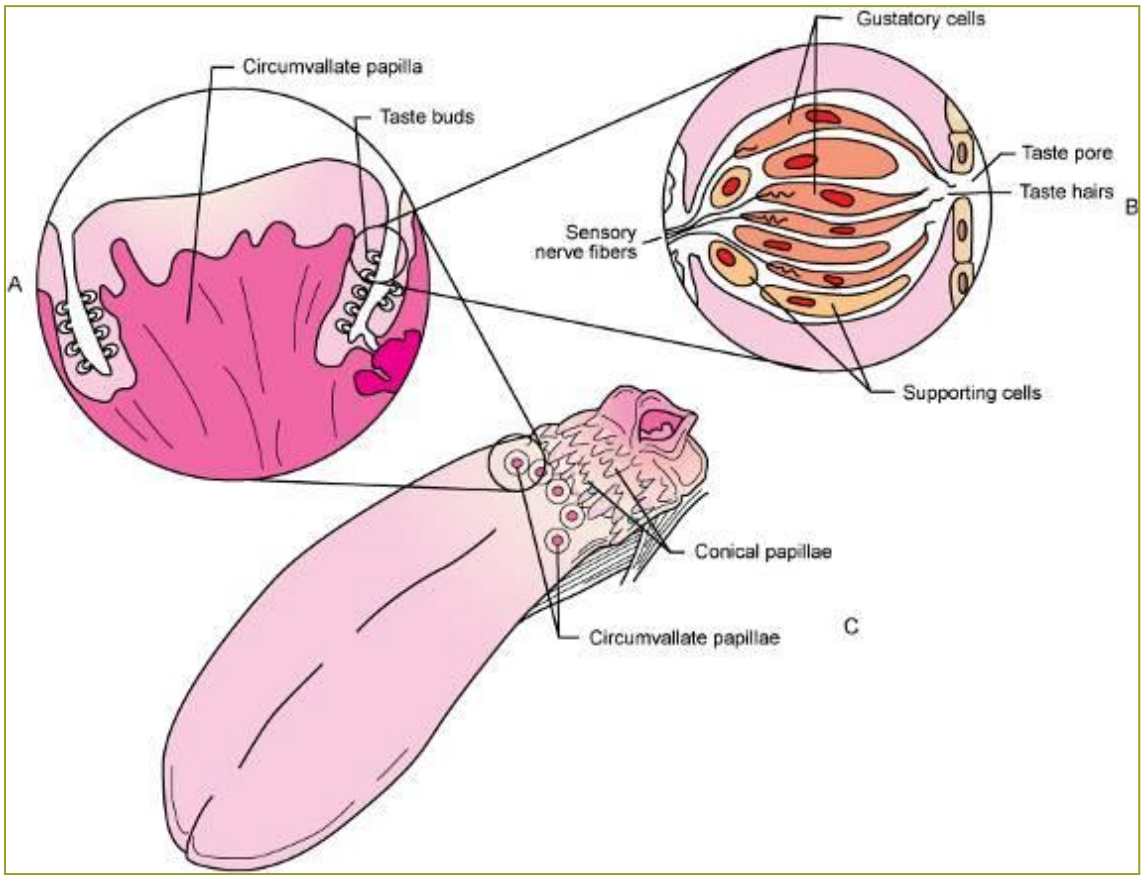


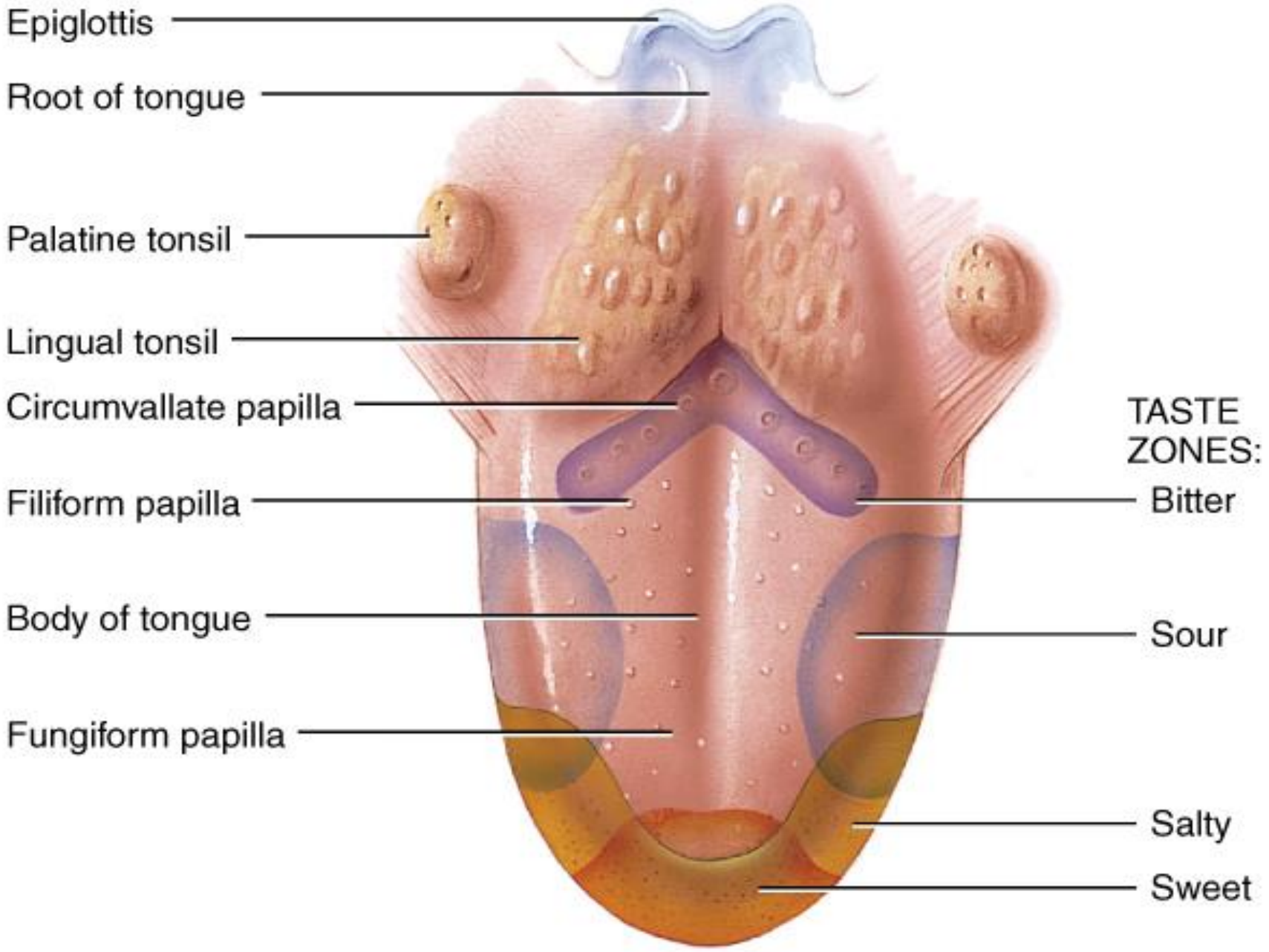


Tongue

Figure 14-2, Page 343

- Tongue has 4 types of taste buds




Epiglottis
Root of tongue
Palatine tonsil
Lingual tonsil
Circumvallate papilla
Filiform papilla
Body of tongue
Fungiform papilla
TASTE ZONES:
Bitter
Sour
Salty
Sweet

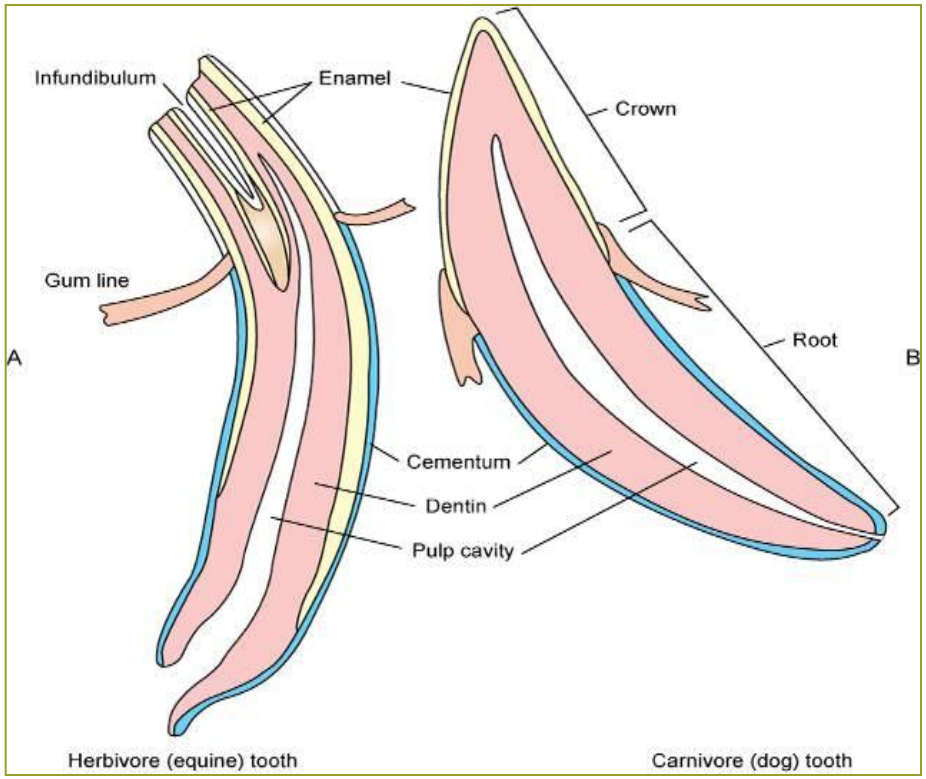
Teeth

- Mastication – chewing; physically break down food into smaller pieces
- Upper arcade – contained in maxilla and incisive bones
- Lower arcade – contained in mandible

Teeth Shape

Figure 11-4, Page 268

- Carnivore teeth – more pointed on their occlusal surface; slightly curved toward back of mouth
  - Good for holding prey, tearing, cutting, shredding
- Herbivore teeth have flat occlusal surfaces
  - Good for grinding plant and grain material



Types of Teeth

Incisors

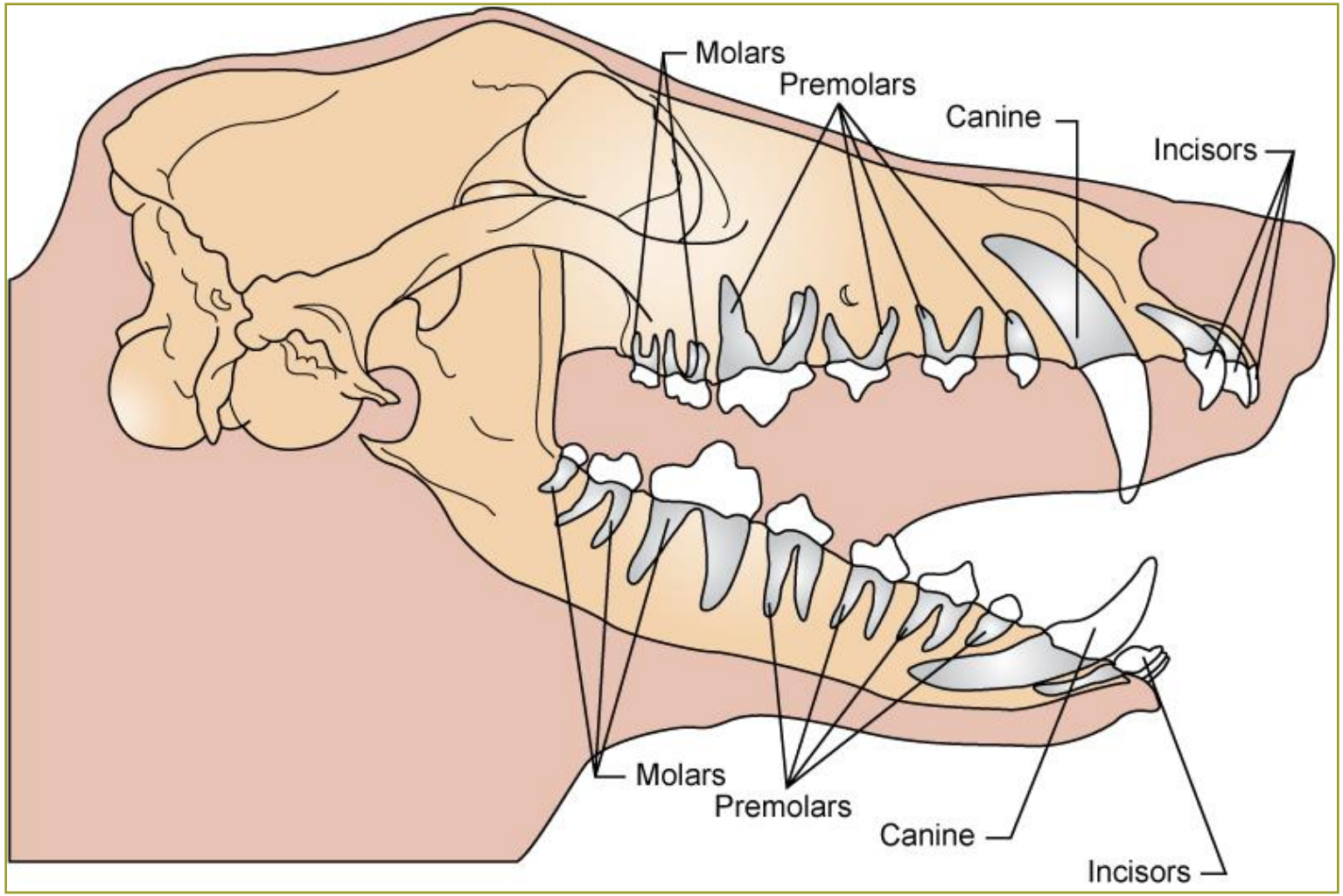
Canines

Premolars

Molars

Types of Teeth

Figure 11-5, Page 268



Tooth Terminology

- Lingual – inner surface of the lower arcade of teeth
- Palatal – inner surface of the upper arcade
- Labial – outer surface of the upper and lower arcade at the front the mouth
- Buccal – outer surface of the teeth more caudal in the mouth

Maxilla & Mandible

- Tooth Surfaces
  - Lingual
  - Palatal
  - Labial
  - Buccal

Dental Formula

- Represents the typical number of each type of tooth found in the upper and lower arcade
- Tooth type designated ***I*** for incisor, ***C*** for canine, ***P*** for premolar, and ***M*** for molar
  - Upper case for adult teeth
  - Lower case for deciduous teeth

Dental Formula

- Tooth type followed by two numbers separated by a slash mark or expressed as a fraction of one number over the other
  - First number – number of teeth in *half* of the upper arcade
  - Second number – number of teeth in *half* of the lower arcade
- Total number determined by summing all the numbers and multiplying by 2

Dental Formulas

Table 11-1, Page 269
Bassert Lab Manual – Page 274

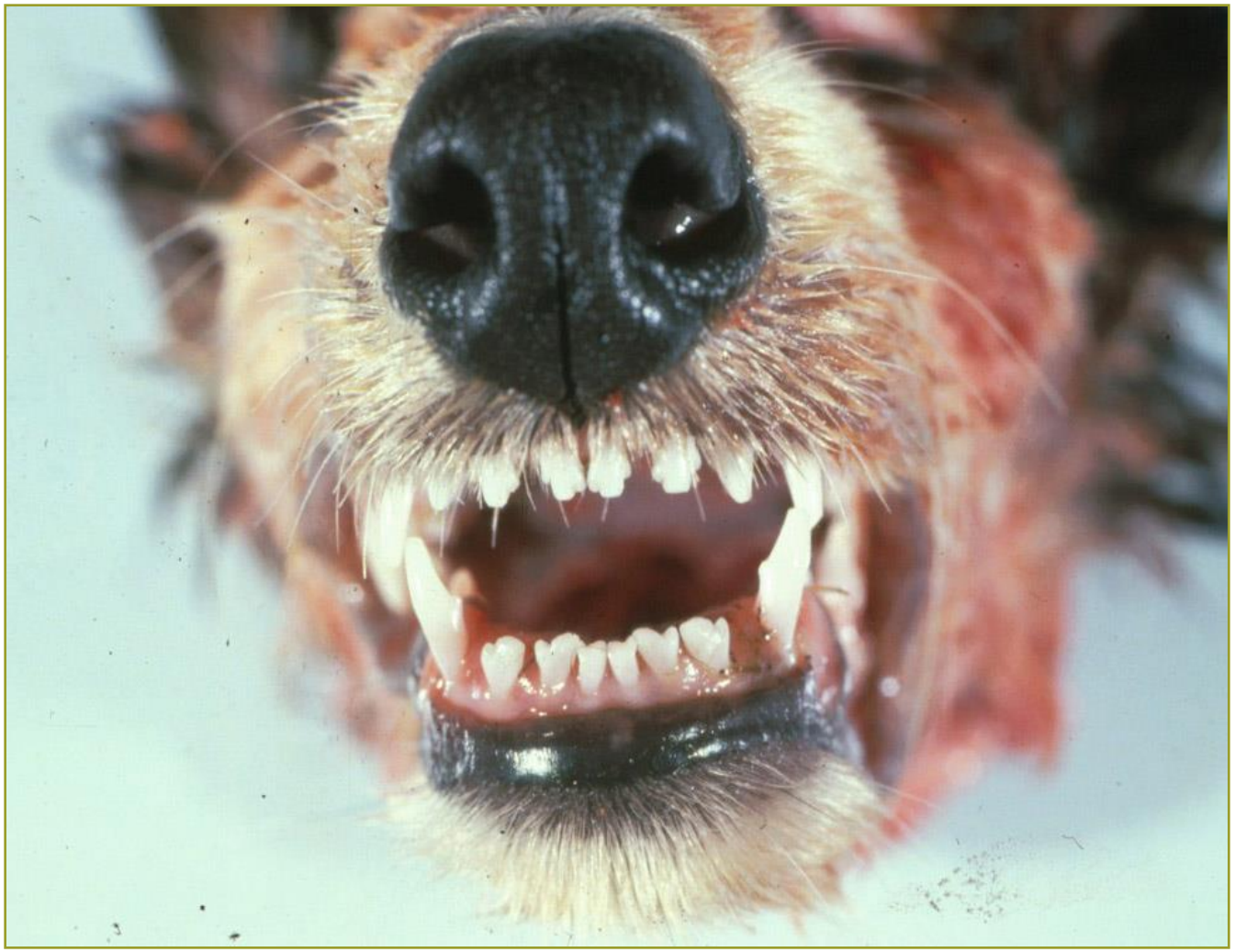
Example: Adult Dog

- The dental formula is $I\frac{3}{3}\ C\frac{1}{1}\ P\frac{4}{4}\ M\frac{2}{3}$ or $\frac{3142}{3143}$. The slash mark separates the upper arcade number from the lower arcade number.
- Add the numbers together:
  - 3 + 3 + 1 + 1 + 4 + 4 + 2 + 3 = 21 teeth, representing half of the total number.
- Multiply the number by 2:
  - 21 × 2 = 42 total teeth in the adult dog's mouth.

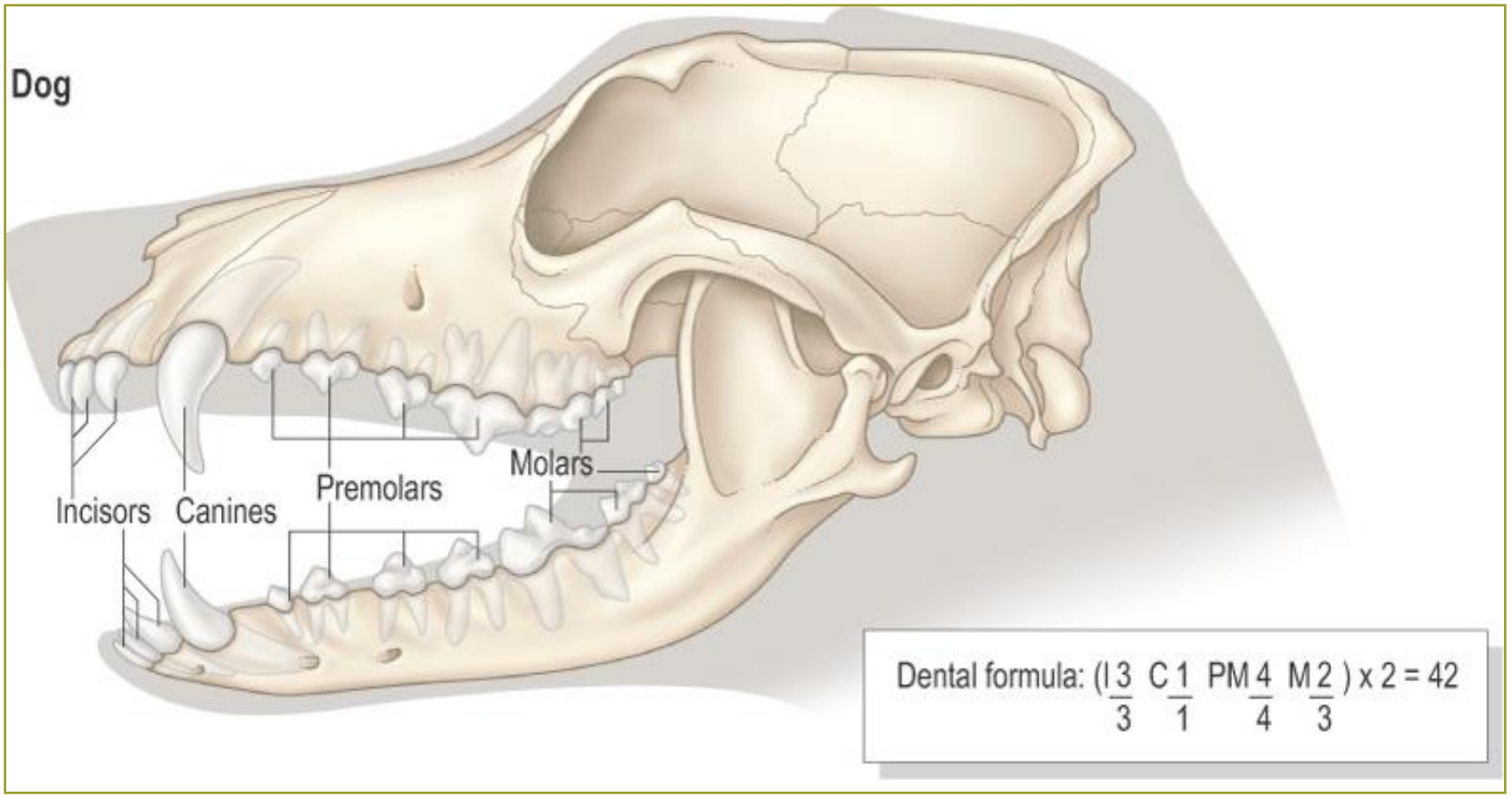
Dental Formulas for Several Domestic Species

Species	Dental Formula
Canine—puppy	$i\frac{3}{3}\ c\frac{1}{1}\ p\frac{3}{328}$
Canine—adult	$I\frac{3}{3}\ C\frac{1}{1}\ P\frac{4}{4}\ M\frac{2}{3}$
Feline—kitten	$i\frac{3}{3}\ c\frac{1}{1}\ p\frac{3}{2}$
Feline—adult	$I\frac{3}{3}\ C\frac{1}{1}\ P\frac{3}{2}\ M\frac{1}{1}$
Equine—adult	$I\frac{3}{3}\ C\frac{1}{1}\ P\frac{3-4}{3}\ M\frac{3}{3}$
Porcine—adult	$I\frac{3}{3}\ C\frac{1}{1}\ P\frac{4}{4}\ M\frac{3}{3}$
Bovine—adult	$I\frac{0}{3}\ C\frac{0}{1}\ P\frac{3}{3}\ M\frac{3}{3}$

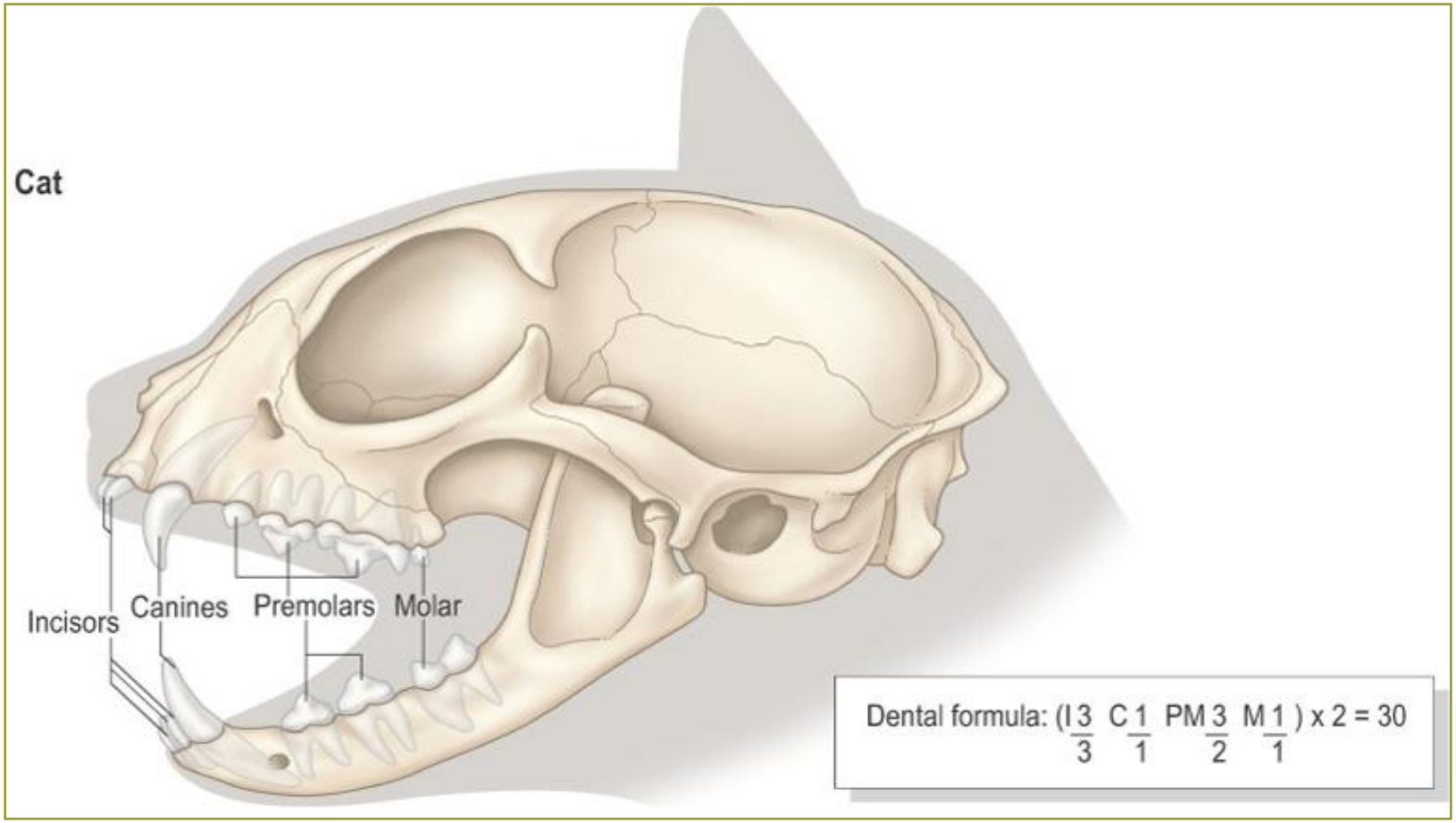
Canine Mouth



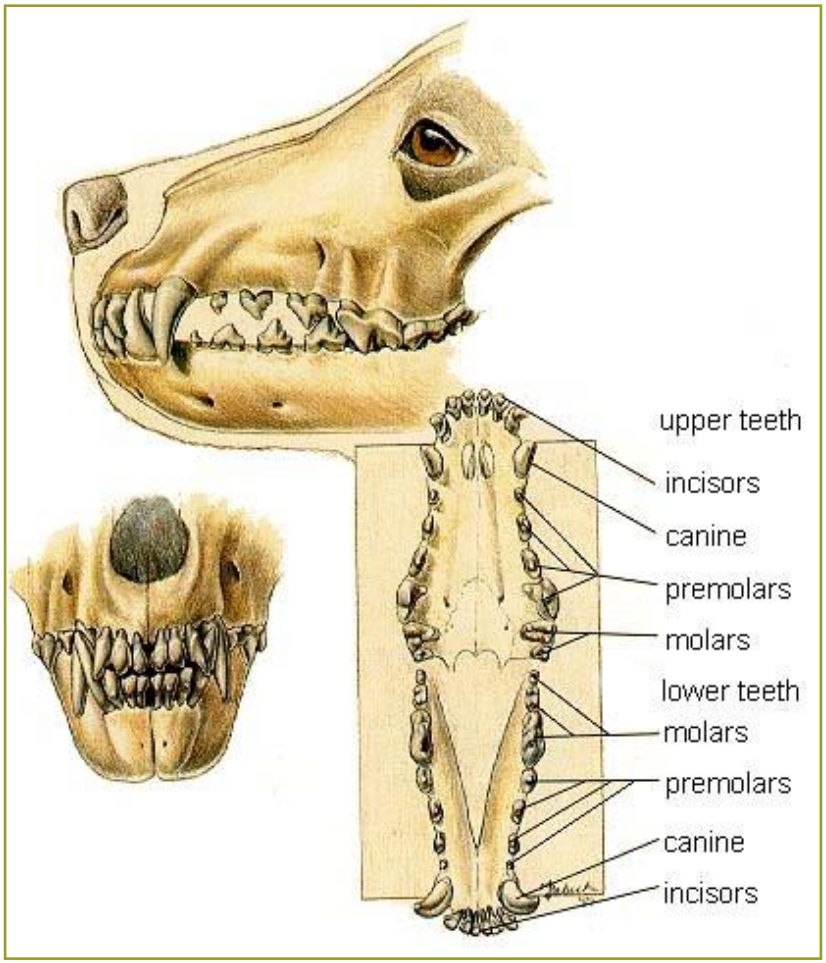
Canine Dental Formula

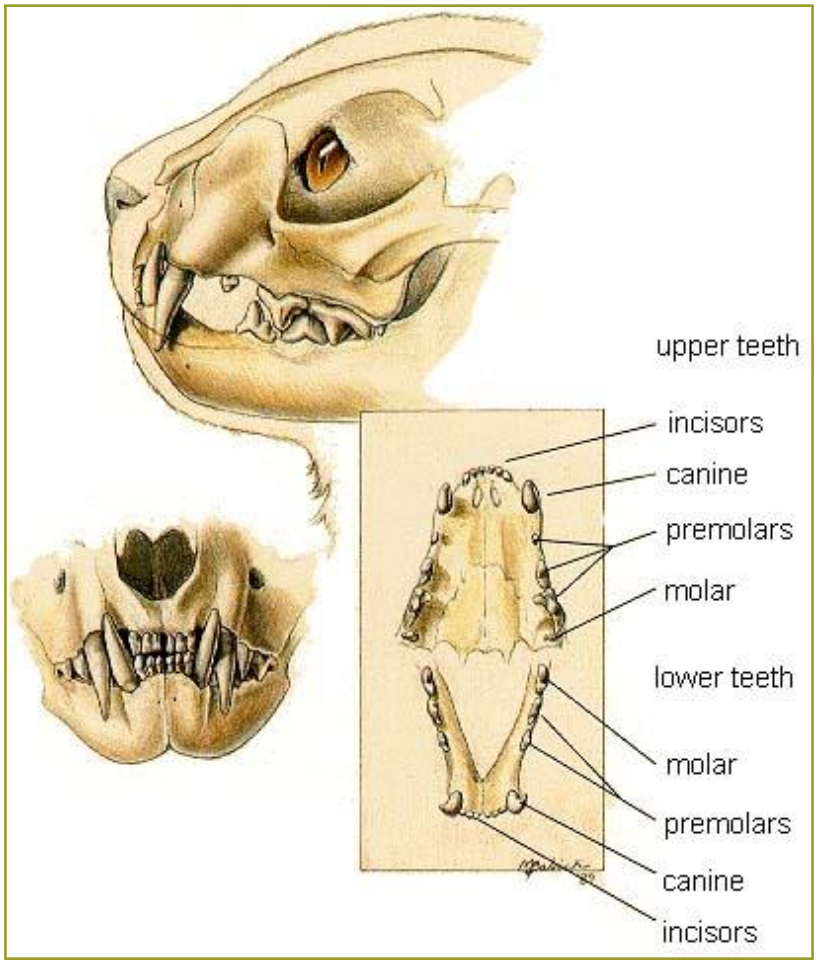


Feline Dental Formula



Comparative Anatomy
Dog & Cat

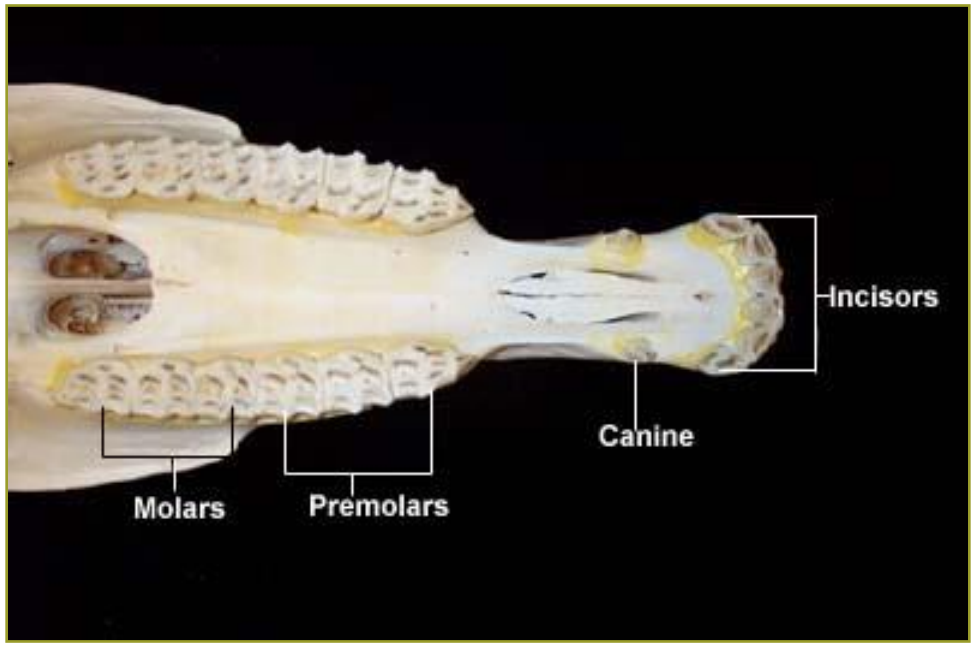




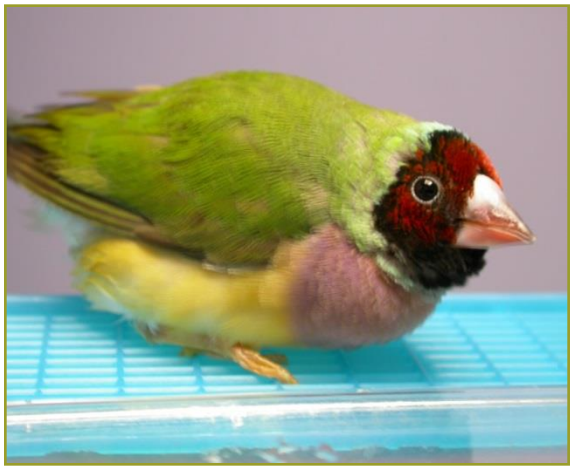
Comparative Anatomy – Ruminants

- **Ruminants** have no upper incisors or upper canine teeth
  - Dental pad – flat thick connective-tissue structure on the maxilla opposite the lower incisors and canine teeth

Horse Teeth



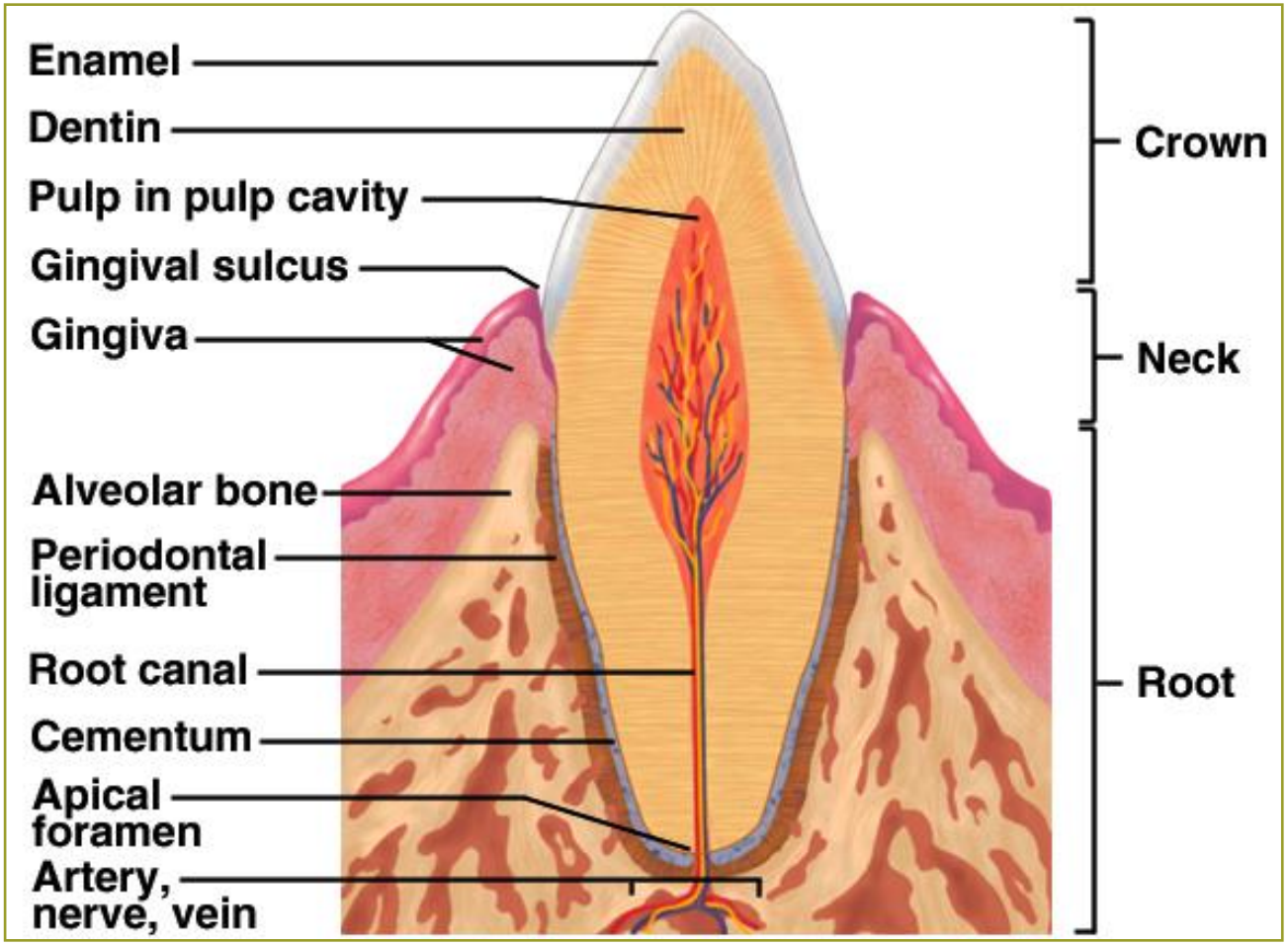
Comparative Anatomy
Bird Beak

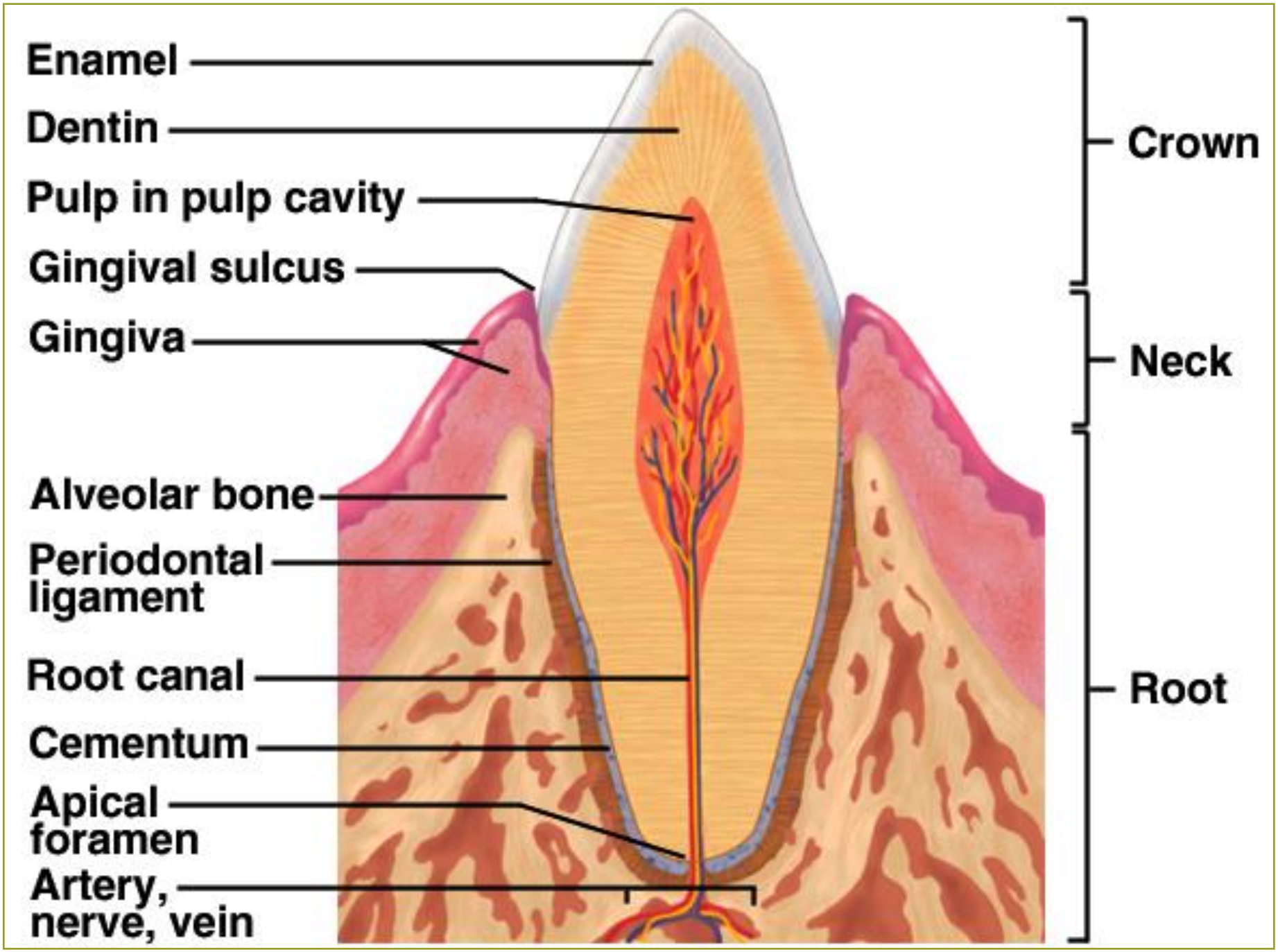


Structure of Teeth

Figure 11-6, Page 269

- Crown
  - Enamel
  - Dentin
  - Pulp
- Gingiva
- Root
  - Dentin
  - Pulp
  - Cementum
  - Periodontal ligament



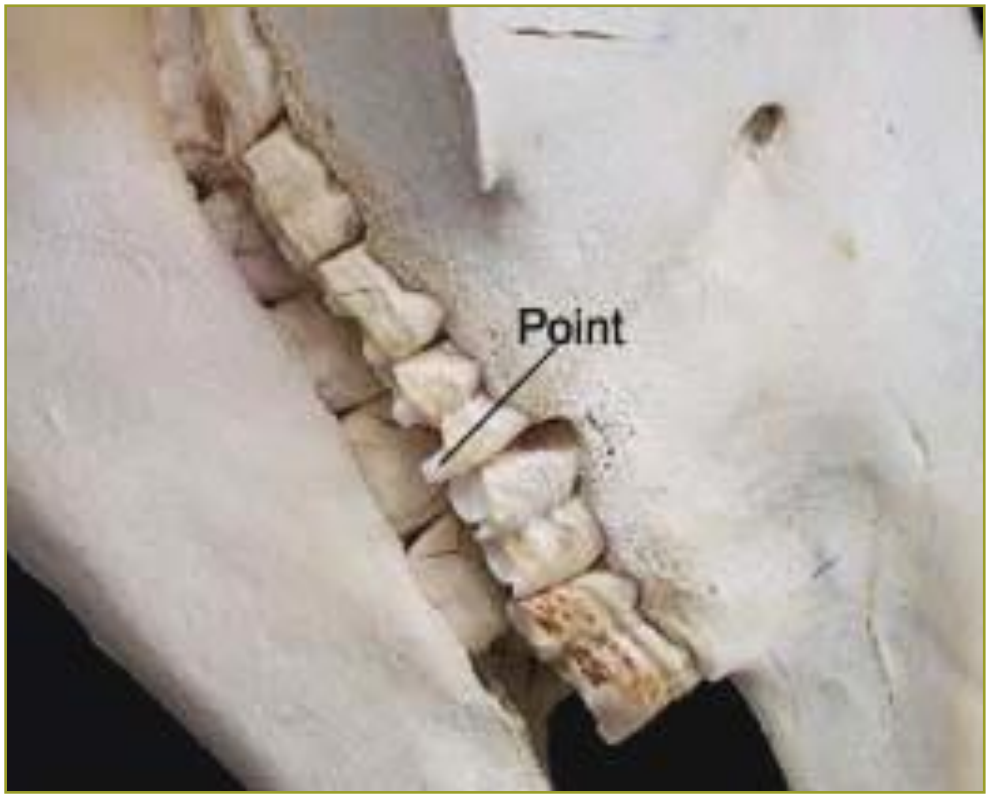

Enamel
Dentin
Pulp in pulp cavity
Gingival sulcus
Gingiva
Alveolar bone
Periodontal ligament
Root canal
Cementum
Apical foramen
Artery, nerve, vein
Crown
Neck
Root

Dental Care

- Clinical Application –
  - Page 270

Needs a Dentist?

Dental Pathology
Equine; Canine



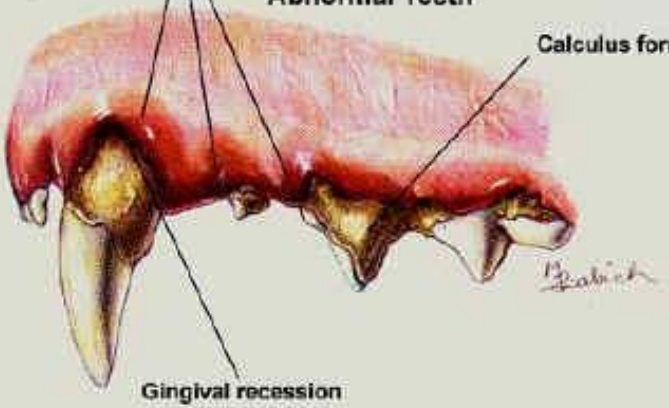
Normal Appearing Teeth

The brown substance (calculus) is laden with bacteria which cause permanent damage to the gums.

Chronic gingivitis

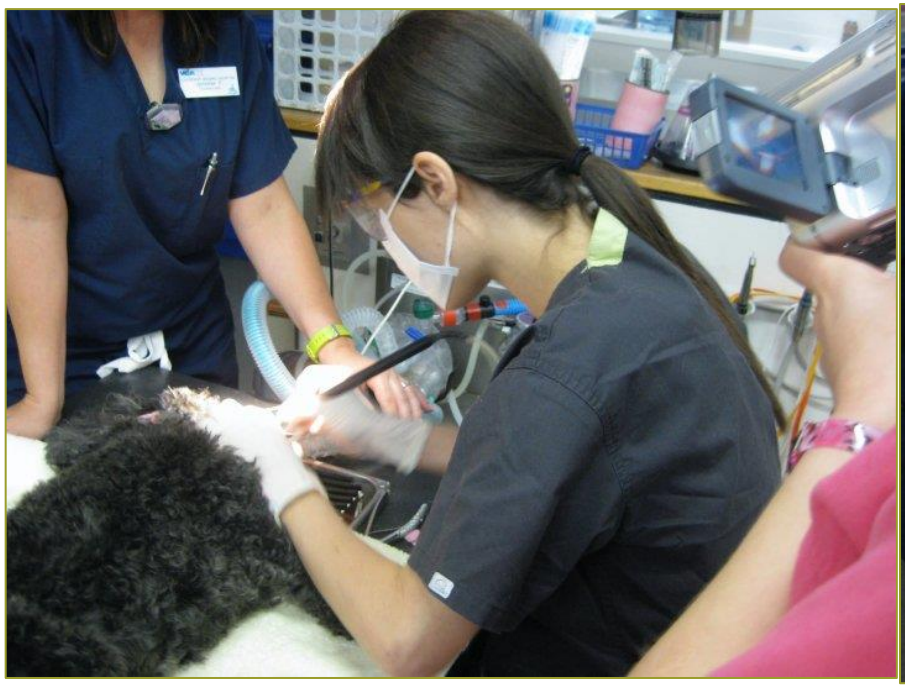
Abnormal Teeth

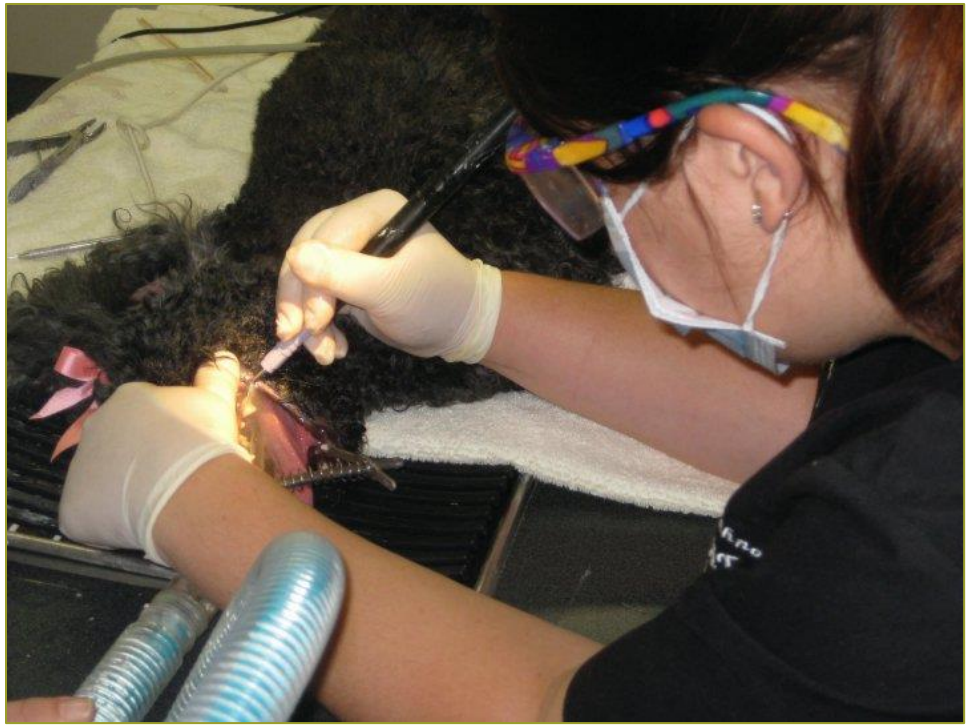
Calculus formation

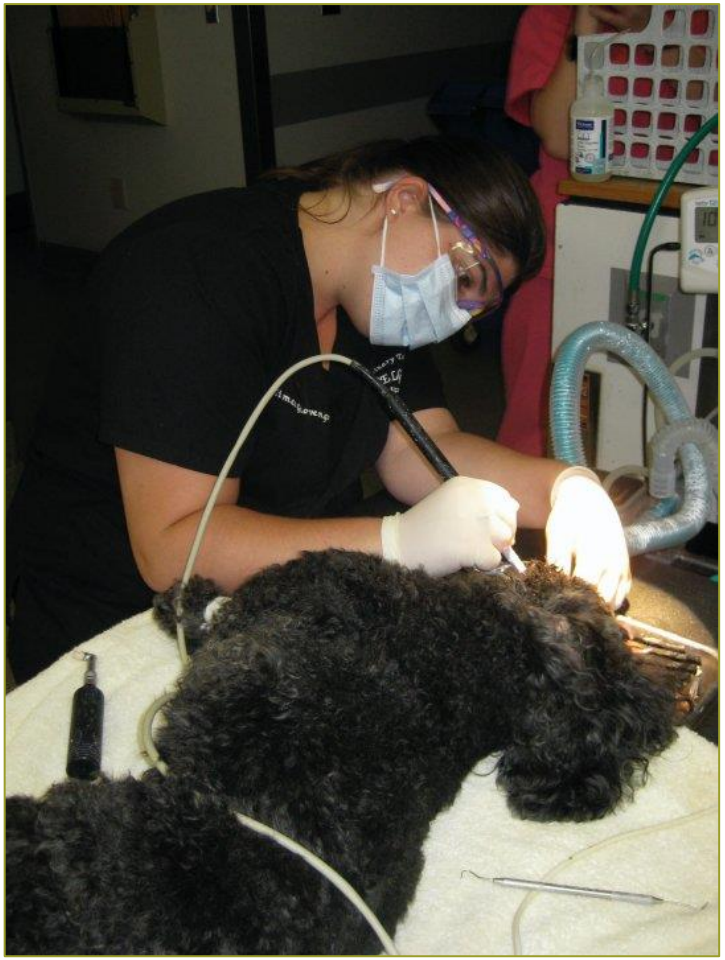


Gingival recession with root exposure

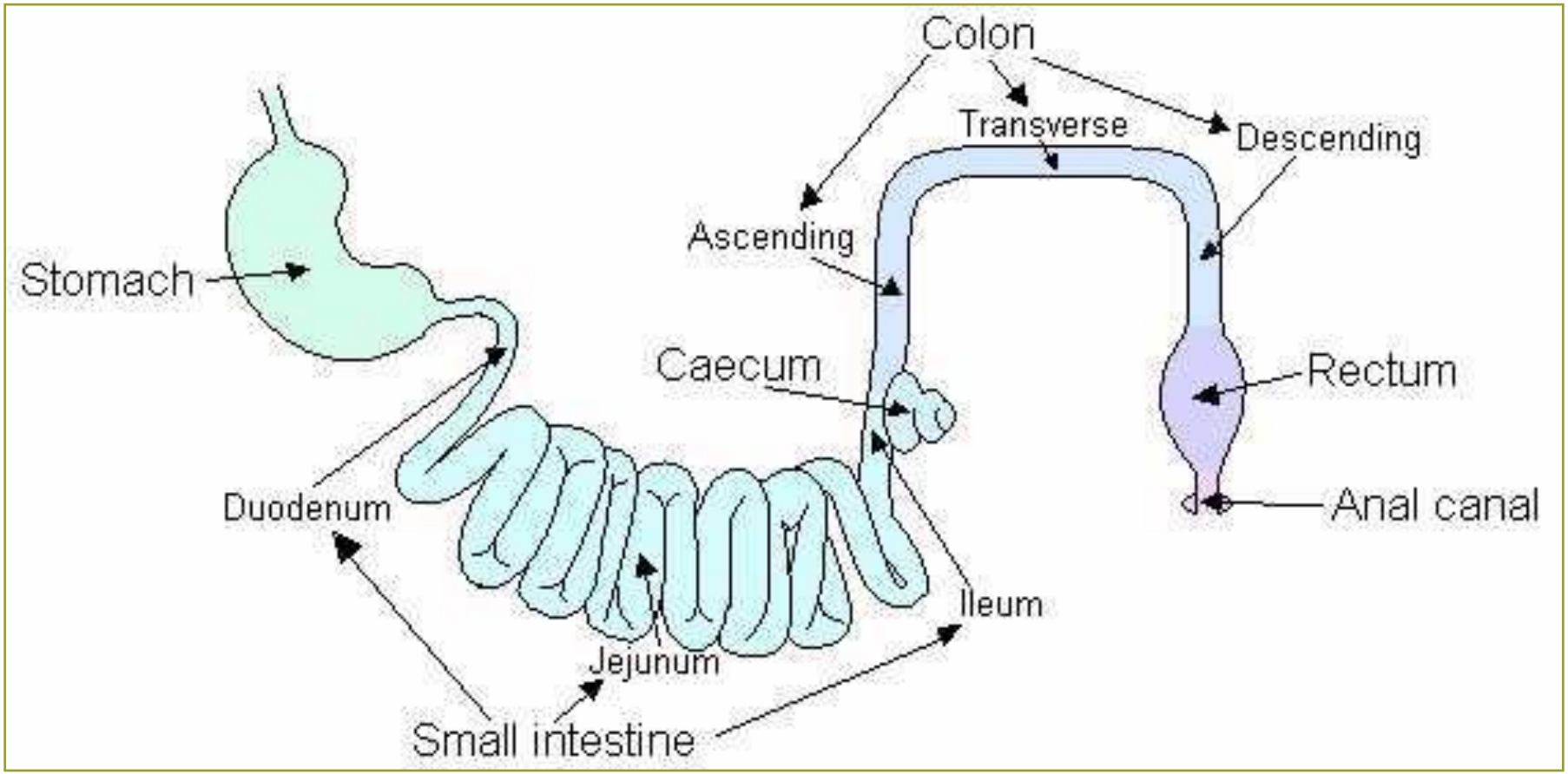
Dental Procedure

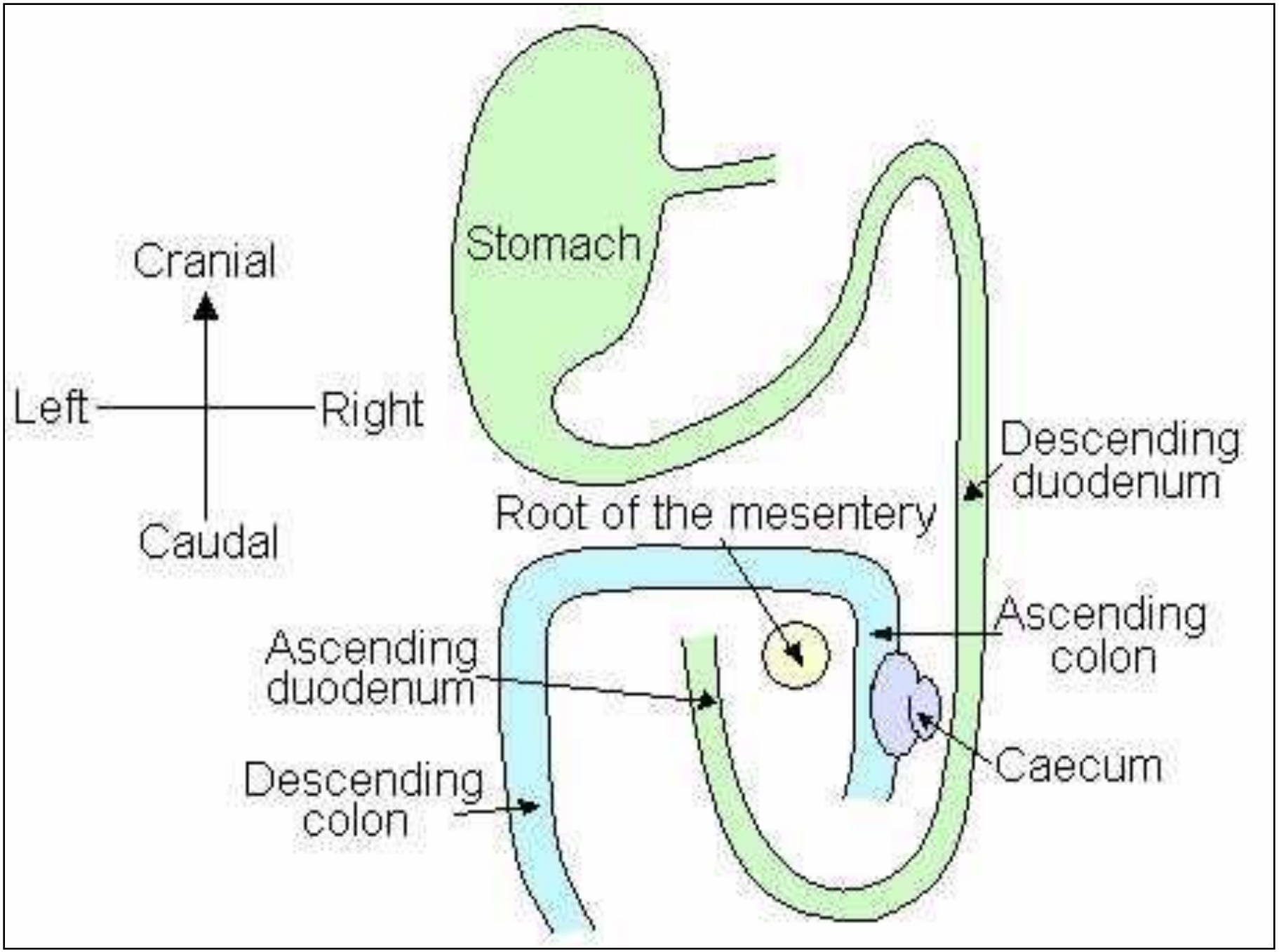


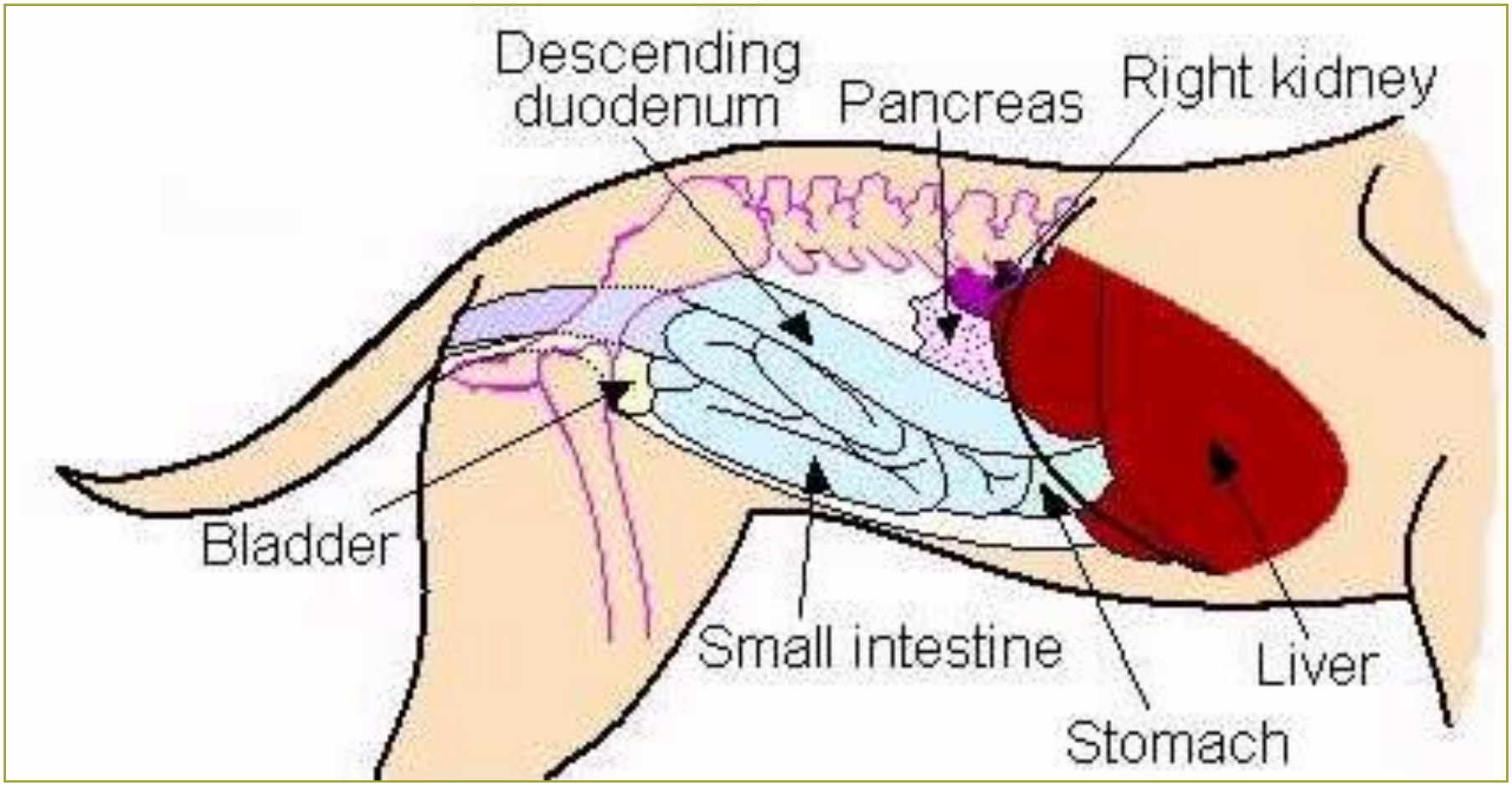


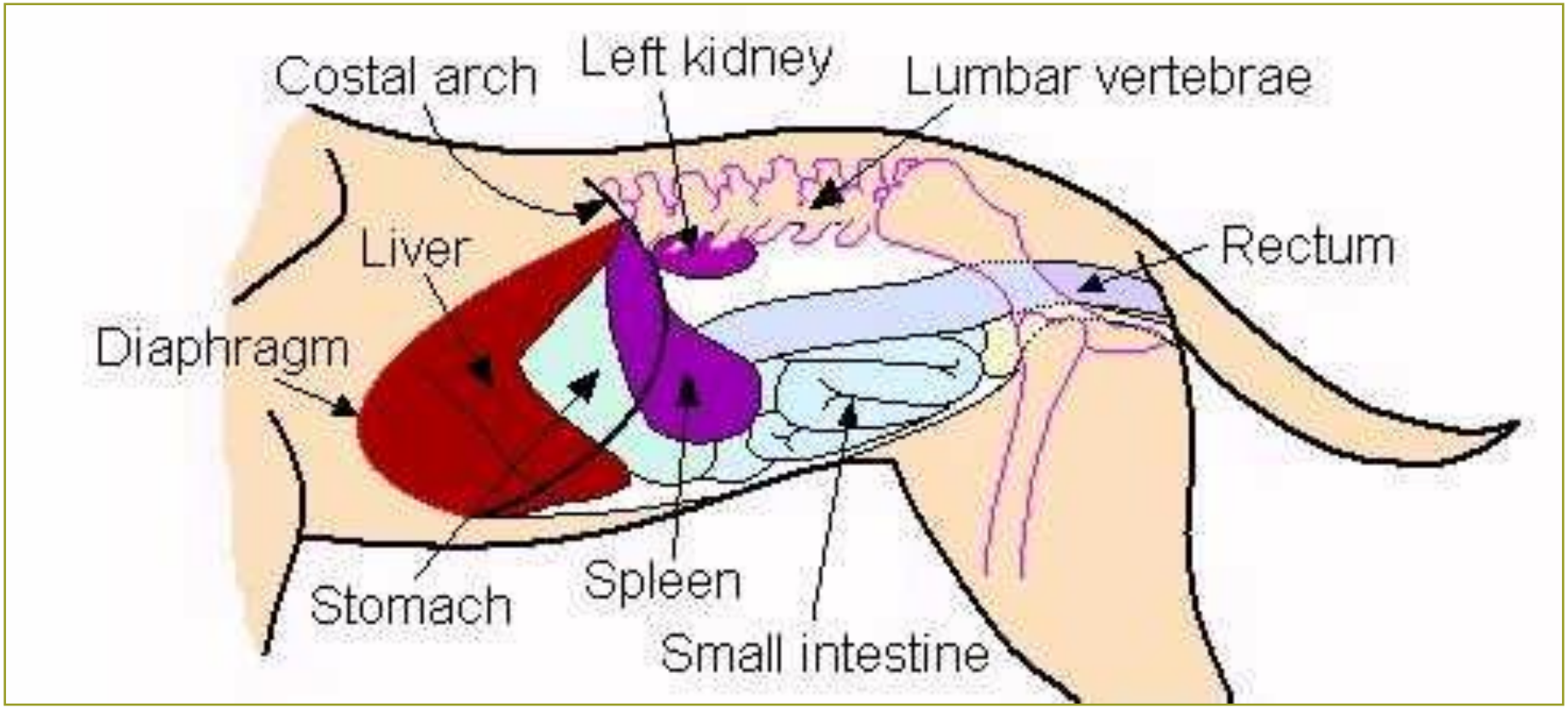


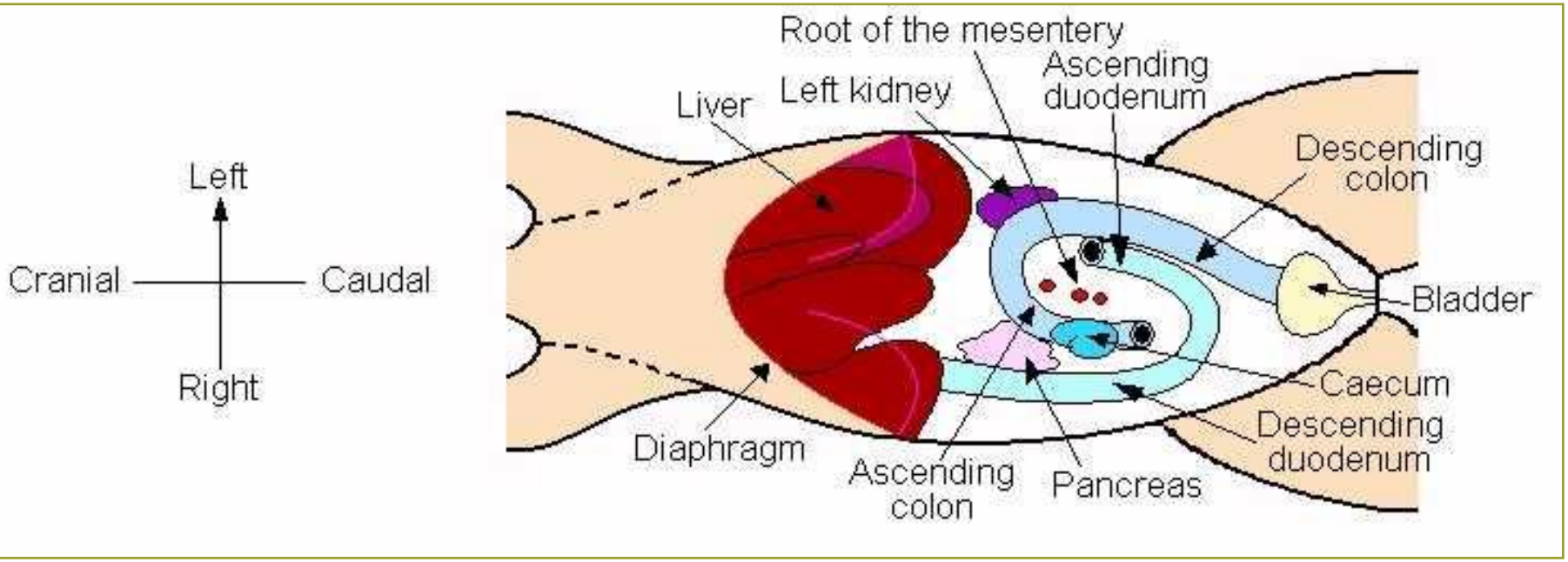
Into the Abdomen

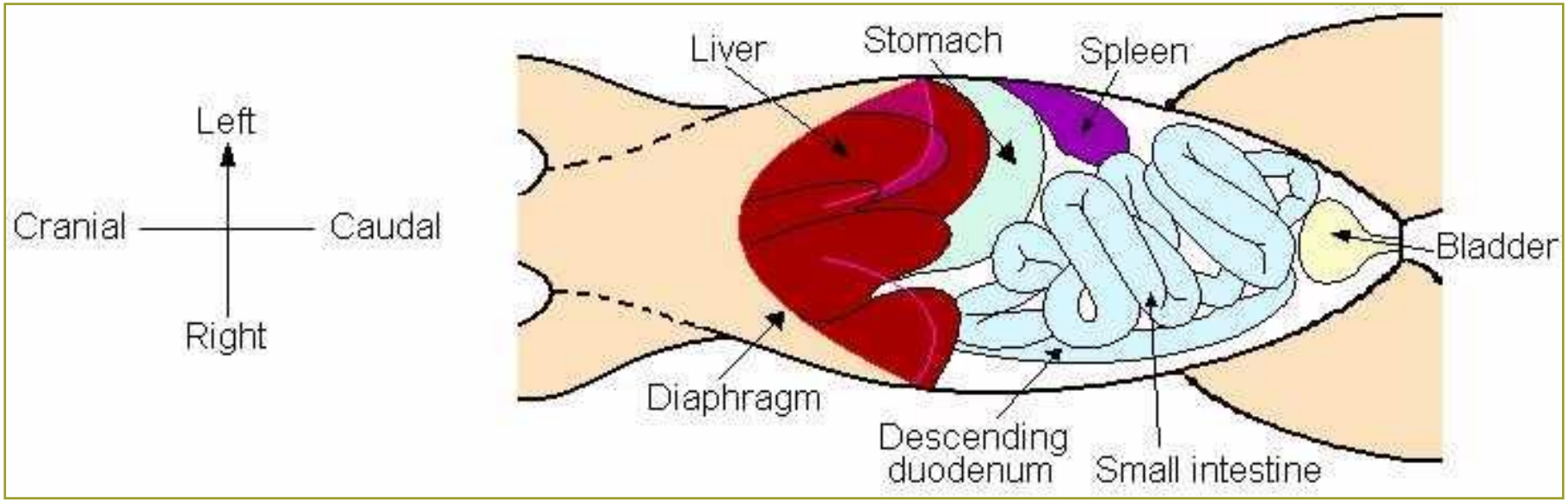



Cranial
Left
Right
Caudal
Stomach
Descending duodenum
Root of the mesentery
Ascending colon
Ascending duodenum
Caecum
Descending colon

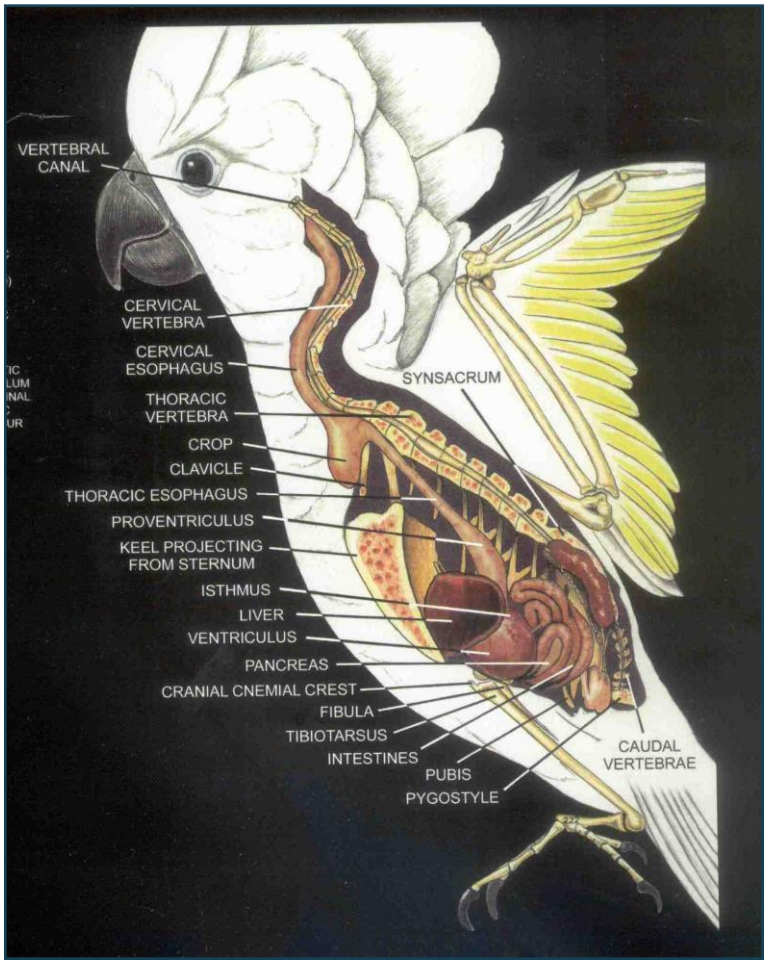

Descending duodenum
Pancreas
Right kidney
Bladder
Small intestine
Liver
Stomach

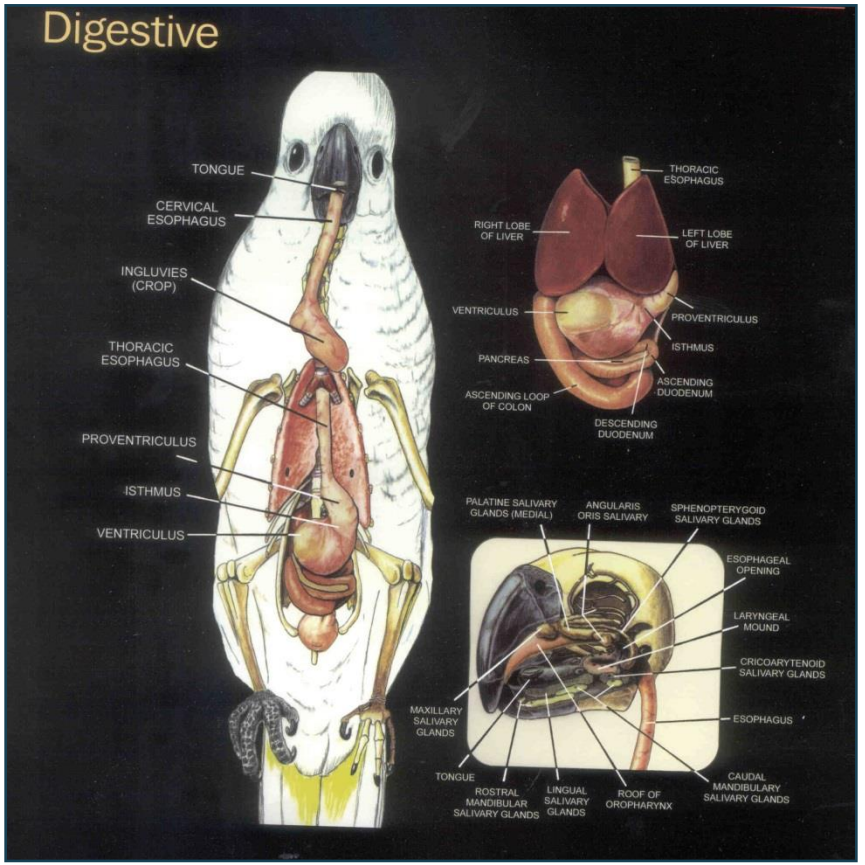

Costal arch
Left kidney
Lumbar vertebrae
Liver
Rectum
Diaphragm
Stomach
Spleen
Small intestine


Left
Cranial
Caudal
Right
Root of the mesentery
Liver
Left kidney
Ascending duodenum
Descending colon
Bladder
Caecum
Descending duodenum
Diaphragm
Ascending colon
Pancreas


Left
Cranial
Caudal
Right
Liver
Stomach
Spleen
Bladder
Diaphragm
Descending duodenum
Small intestine

Fun Comparative Anatomy! ☺





Esophagus & Stomach

Food Becomes Chyme

Esophagus

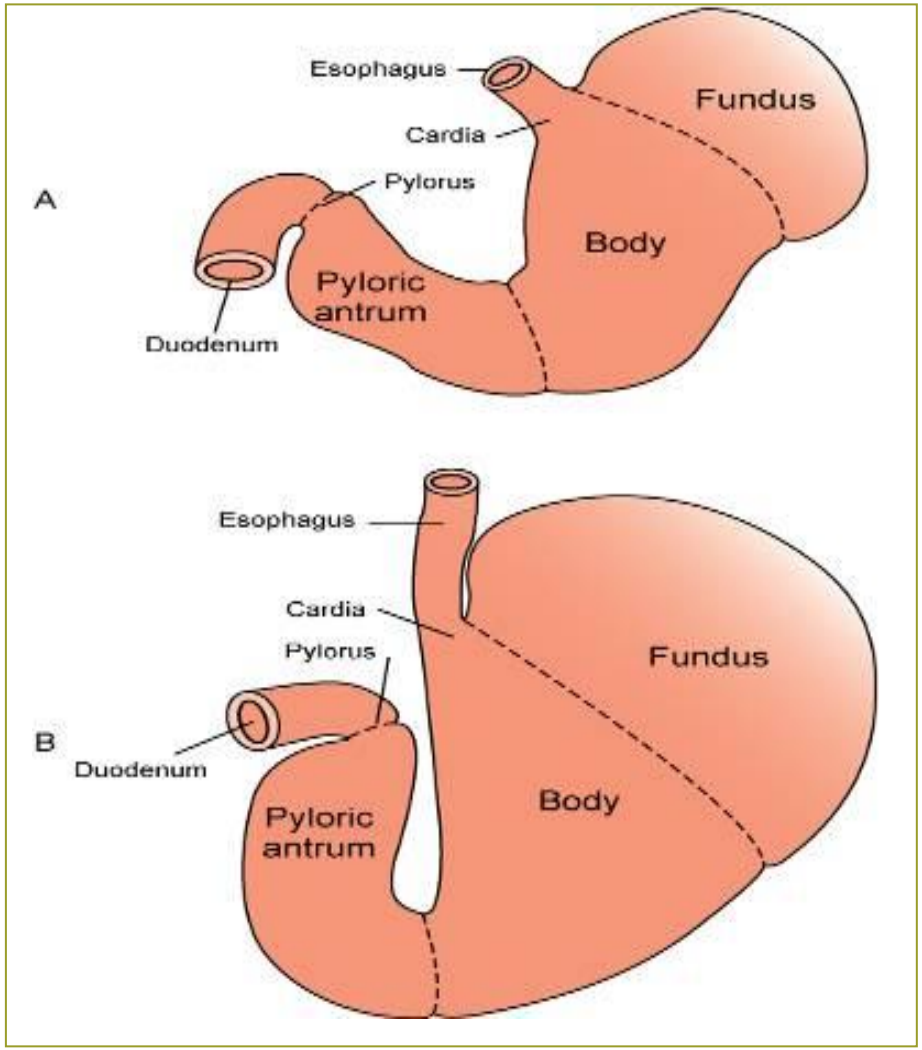
- Transports swallowed material from pharynx to stomach
- Enters the stomach at an angle in cardia region
  - Surrounded by cardiac sphincter muscle
- As stomach expands, fold of the stomach against esophagus closes the lower end of esophagus
  - Reduces the risk for reflux
  - In some species, the closure is strong enough to prevent reflux or vomiting (horse, rabbit)

Monogastric Stomach

Figure 11-7, Page 271

- Five different areas

1. Cardia
2. Fundus
3. Body
4. Pyloric antrum
5. Pyloris



Monogastric Stomach

- Cardia – opening from the esophagus
- Fundus – distensible blind pouch; expands as more food is swallowed
- Body – distensible middle section
  - Fundus and body contain numerous glands
  - Gastric glands contain:
    - Parietal cells – produce hydrochloric acid
    - Chief cells – produce the enzyme pepsinogen
    - Mucous cells – produce the protective mucus

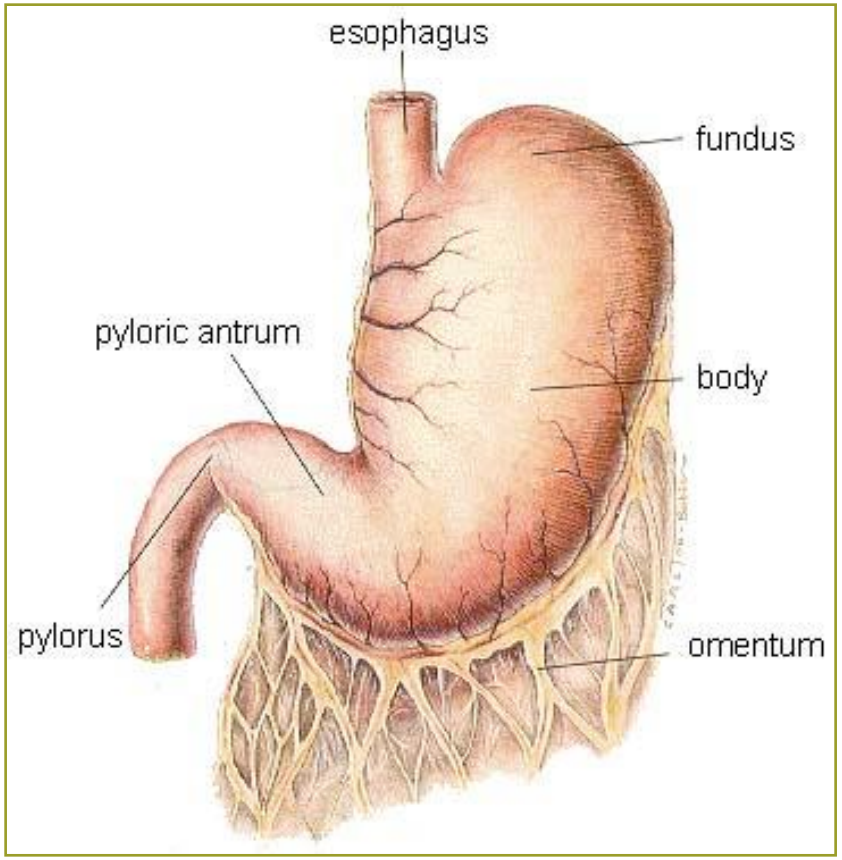
Monogastric Stomach

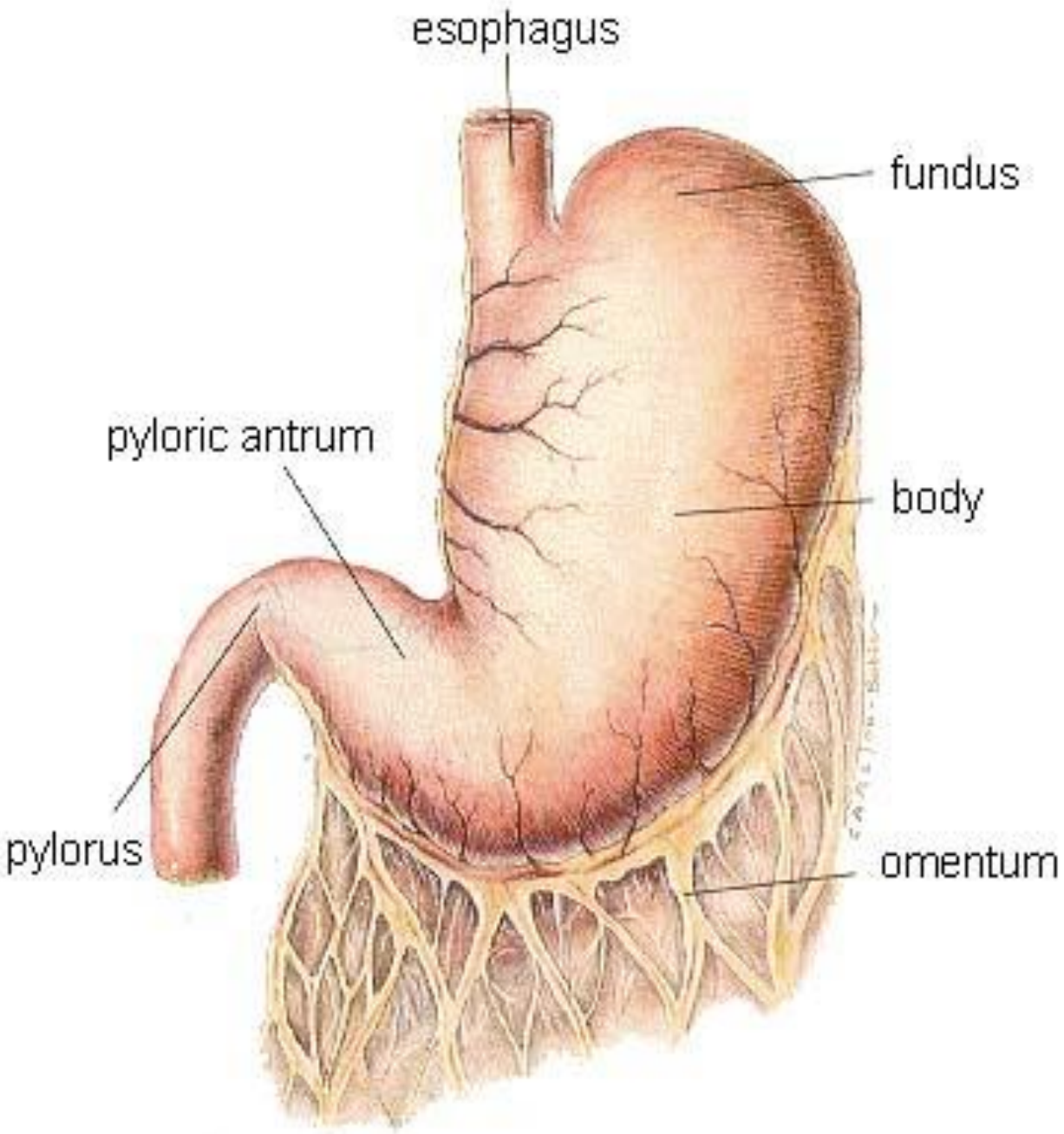
- **Pyloric antrum** – grinds up swallowed food; regulates hydrochloric acid
  - Glands contain G cells - secrete gastrin
- **Pylorus** – muscular sphincter; regulates the movement of **chyme** from the stomach into the duodenum
  - Prevents backflow of duodenal contents into the stomach

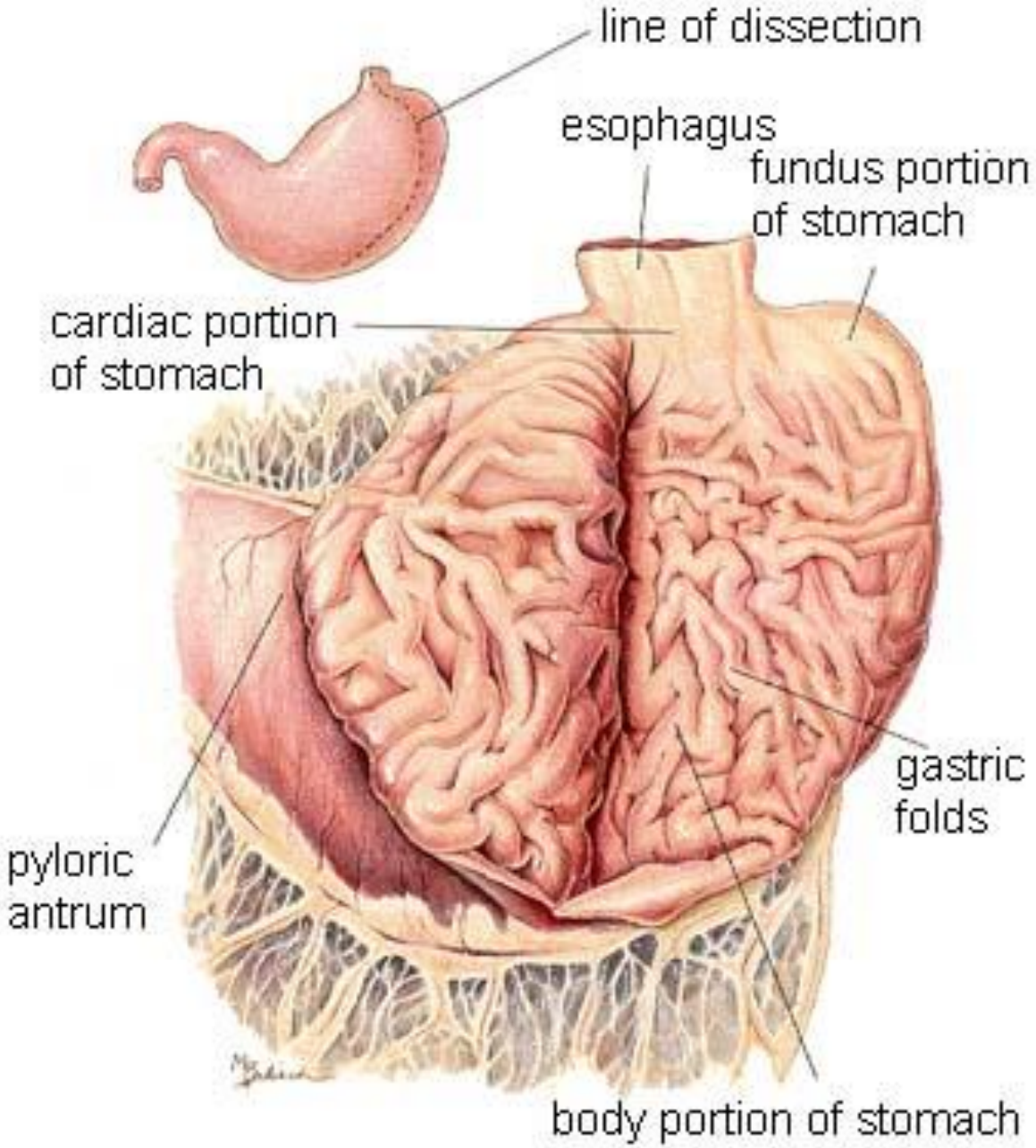
Esophagus & Stomach

Figure 11-7, Page 271

- Esophagus
  - Food bolus
  - Peristalsis
- Stomach
  - Mucosal lining (Rugae)
  - Mechanical digestion
  - Chemical digestion
    - HCl
    - Protease (pepsin)
- Pylorus (pyloric valve)

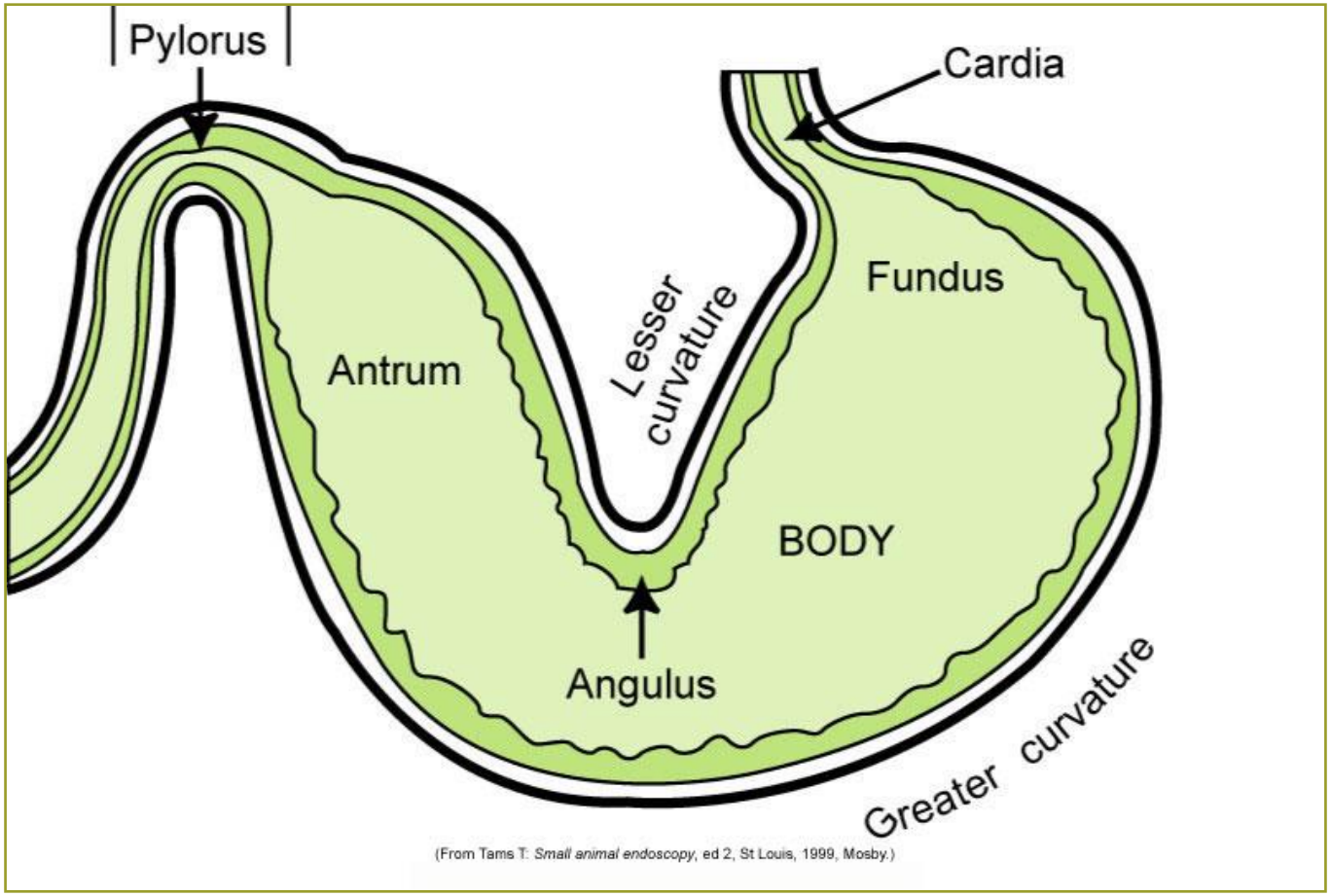



esophagus
fundus
pyloric antrum
body
pylorus
omentum


line of dissection
esophagus
fundus portion
of stomach
cardiac portion
of stomach
pyloric
antrum
gastric
folds
body portion of stomach

Rugae Have Ridges! ☺

Stomach Anatomy



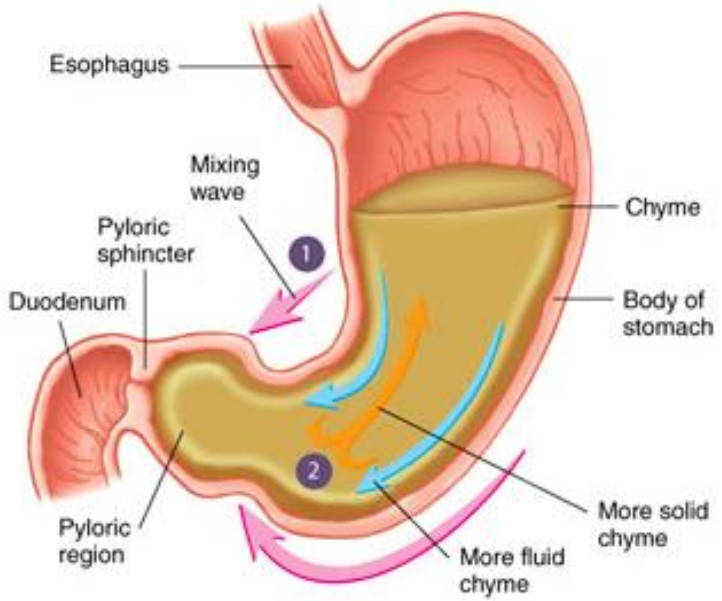
1. A mixing wave initiated in the body of the stomach progresses toward the pyloric sphincter (*pink arrows directed inward*).

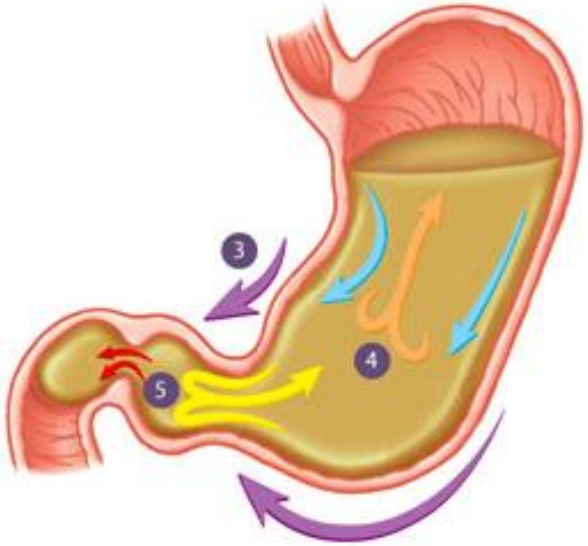
2. The more fluid part of the chyme is pushed toward the pyloric sphincter (*blue arrows*), whereas the more solid center of the chyme squeezes past the peristaltic constriction back toward the body of the stomach (*orange arrow*).

3. Peristaltic waves (*purple arrows*) move in the same direction and in the same way as the mixing waves but are stronger.

4. Again, the more fluid part of the chyme is pushed toward the pyloric region (*blue arrows*), whereas the more solid center of the chyme squeezes past the peristaltic constriction back toward the body of the stomach (*orange arrow*).

5. Peristaltic contractions force a few milliliters of the most fluid chyme through the pyloric opening into the duodenum (*small red arrows*). Most of the chyme, including the more solid portion, is forced back toward the body of the stomach for further mixing (*yellow arrow*).





Gastric Motility

- Each area of the stomach has different motor functions.
  - Fundus and body relax with swallowing of food
  - Body of the stomach contracts to help mix food
  - Pyloric antrum increases contractions in response to swallowing; stimulates mixing, grinding, and propulsive contractions that move food toward the pylorus
- Peristalsis also occurs in stomach and intestines

Gastric Secretions

- **Pepsinogen** - secreted by chief cells; precursor for the enzyme pepsin
  - Breaks proteins into chains of amino acids
- **Hydrochloric acid (HCl)**
  - Hydrogen (H^+) and chloride (Cl^-) ions - secreted by parietal cells in the gastric glands
  - Combine in the stomach to produce hydrochloric acid
- **Mucous** – produced by goblet cells in gastric glands; main constituent of the mucous coating

Comparative Anatomy Ruminant Stomach

Reticulum

Rumen

Omasum

Abomasum

Ruminant Viscera

Bassert Lab Manual – Page 278

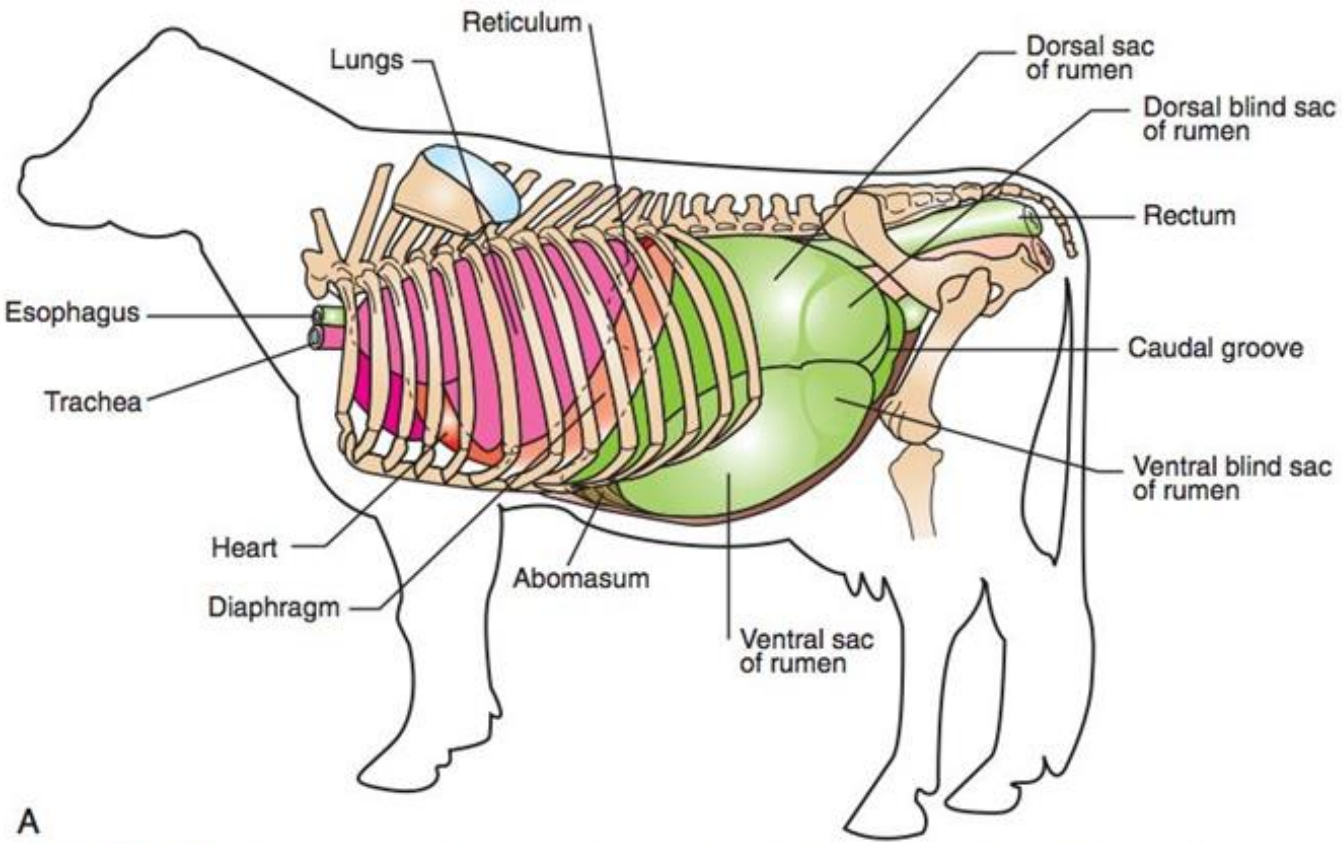
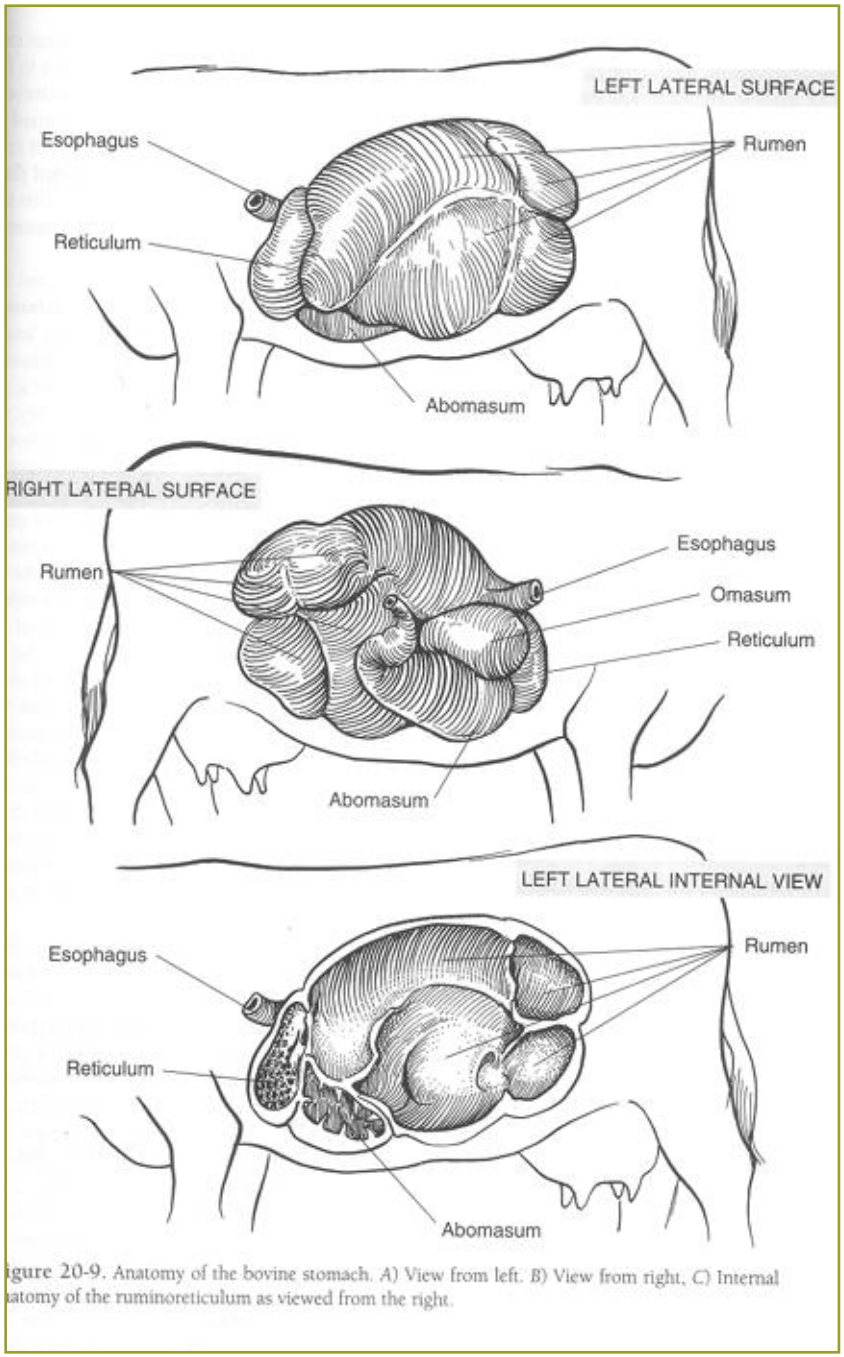


Figure 10-11 A, View from the left side of a cow showing the anatomical positions of the organs of the thorax and abdomen in situ.

Ruminant Stomach

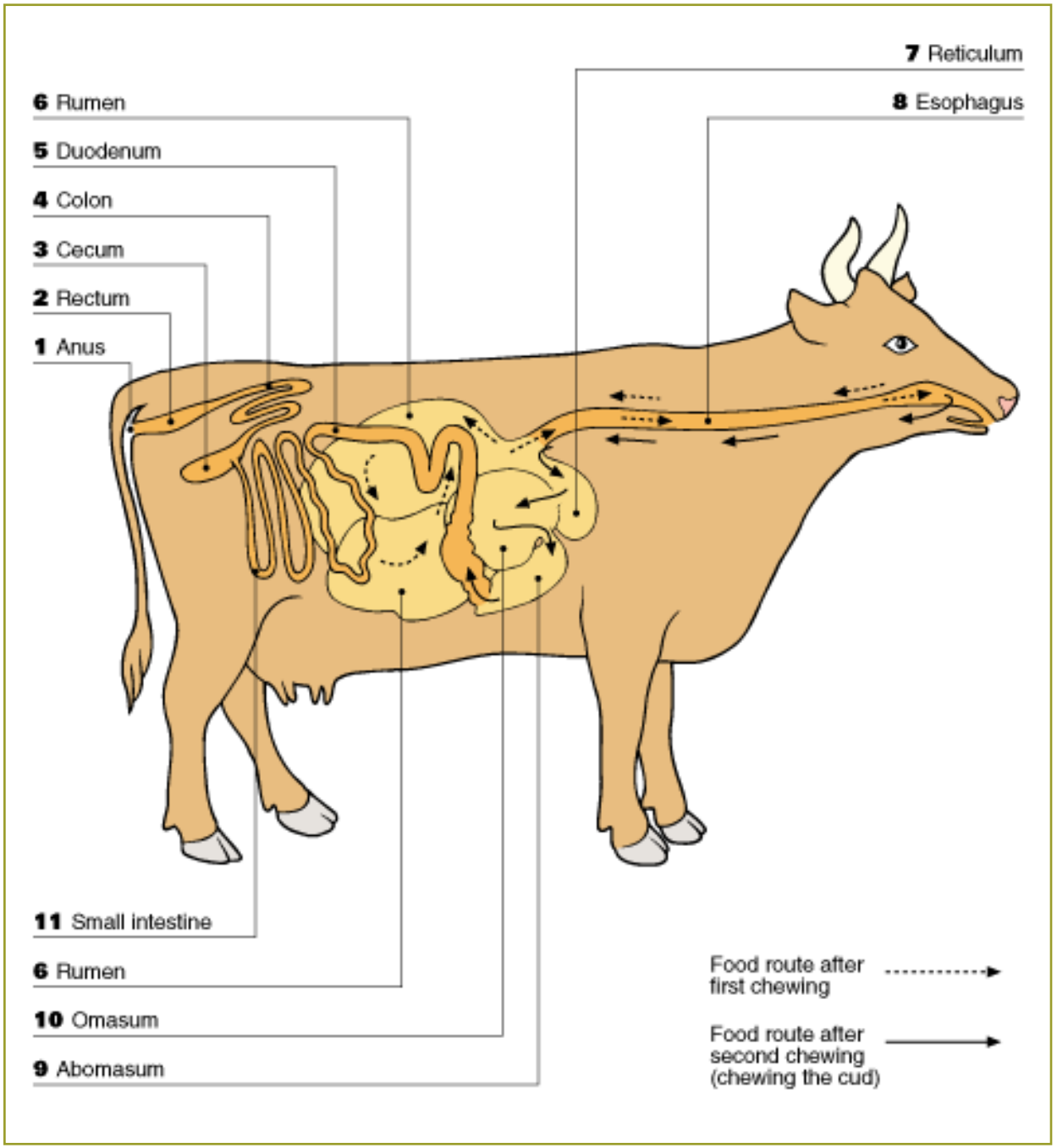
Figures 11-8 & 11-9, Page 274

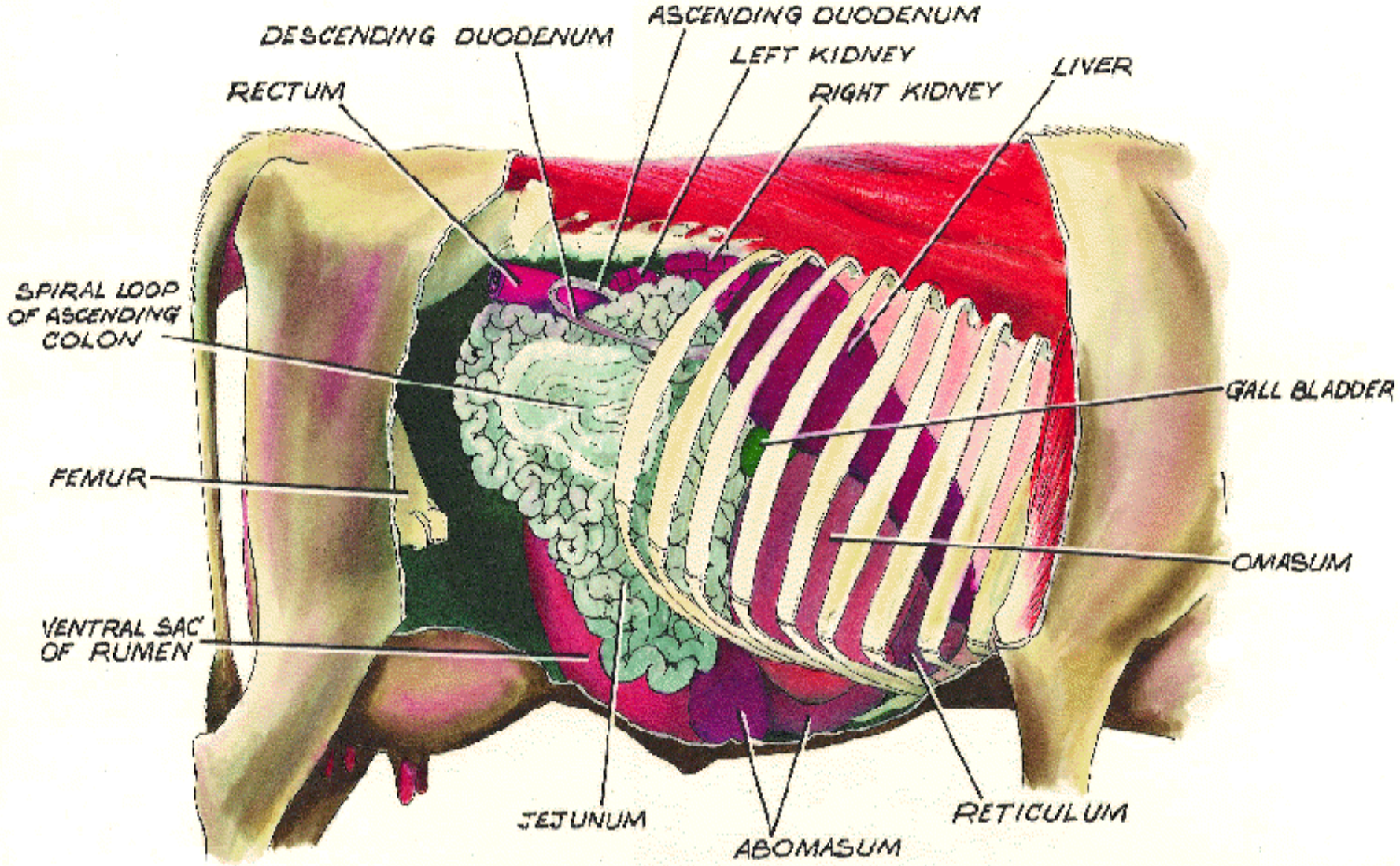
- Reticulum
- Rumen
- Omasum
- Abomasum



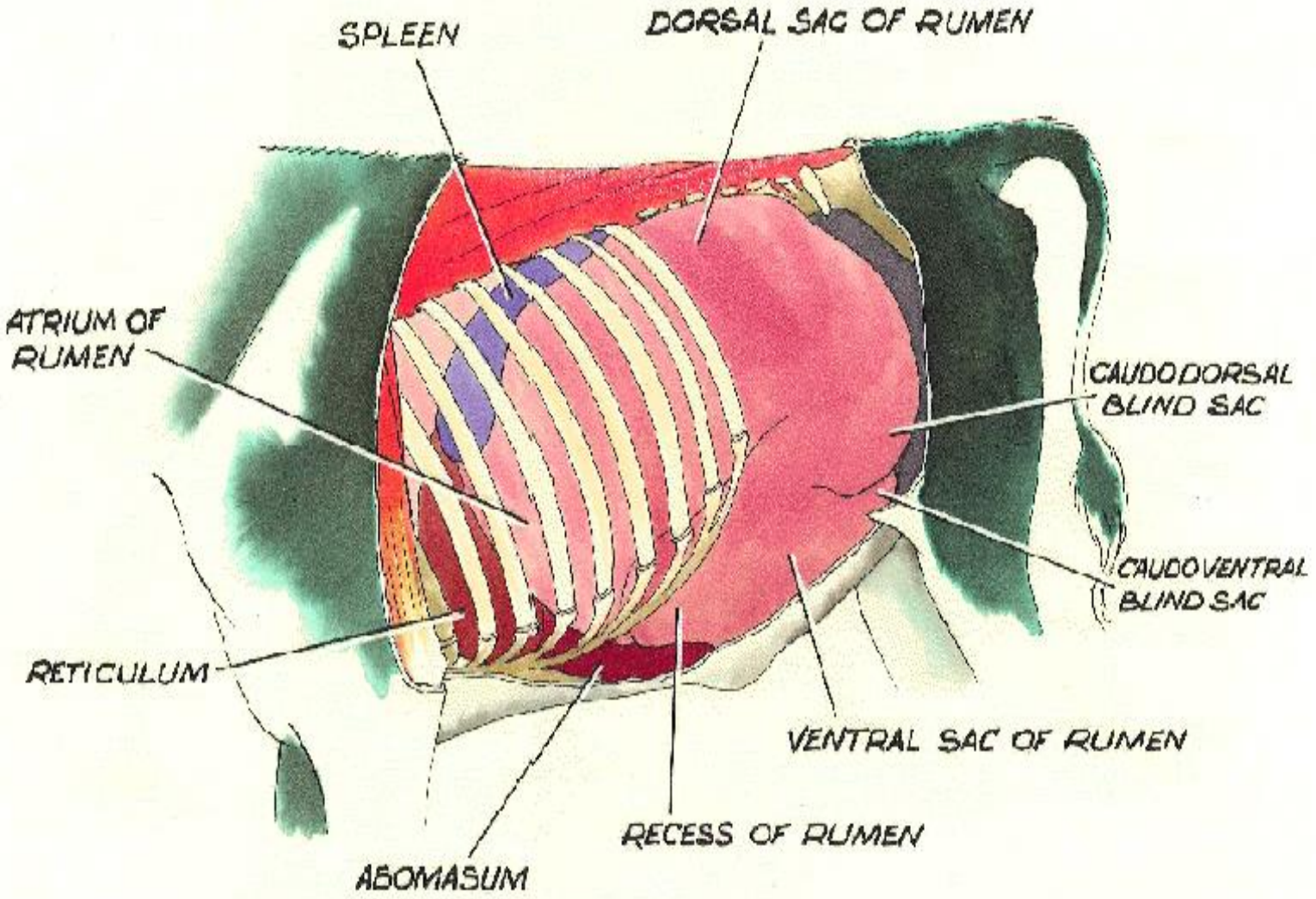
igure 20-9. Anatomy of the bovine stomach. *A*) View from left. *B*) View from right. *C*) Internal natomy of the ruminoreticulum as viewed from the right.

Ruminant Digestive Tract



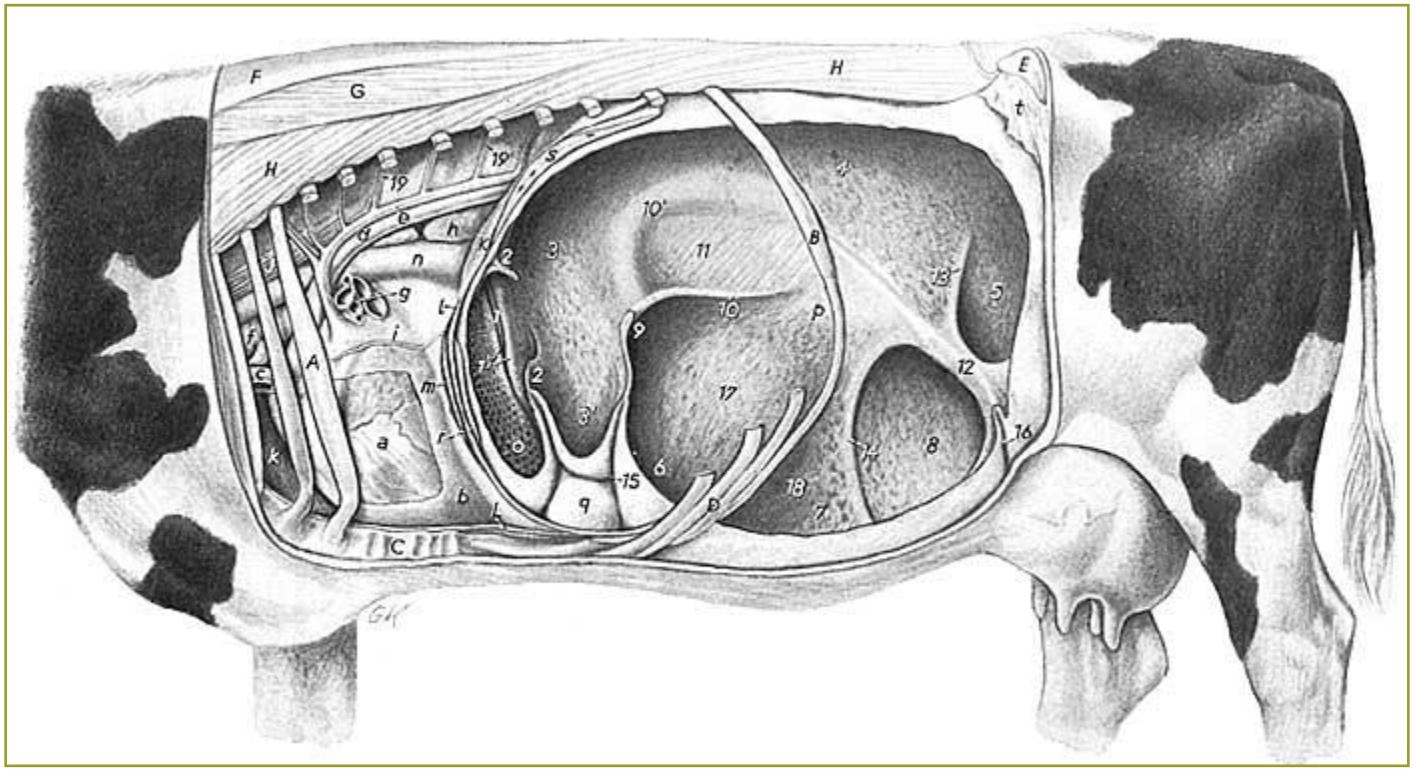


TOPOGRAPHY OF RIGHT SIDE OF ABDOMEN OF A FIVE-YEAR-OLD NON-PREGNANT COW



TOPOGRAPHY OF LEFT SIDE OF ABDOMEN OF 9-MONTH-OLD NON-PREGNANT HEIFER

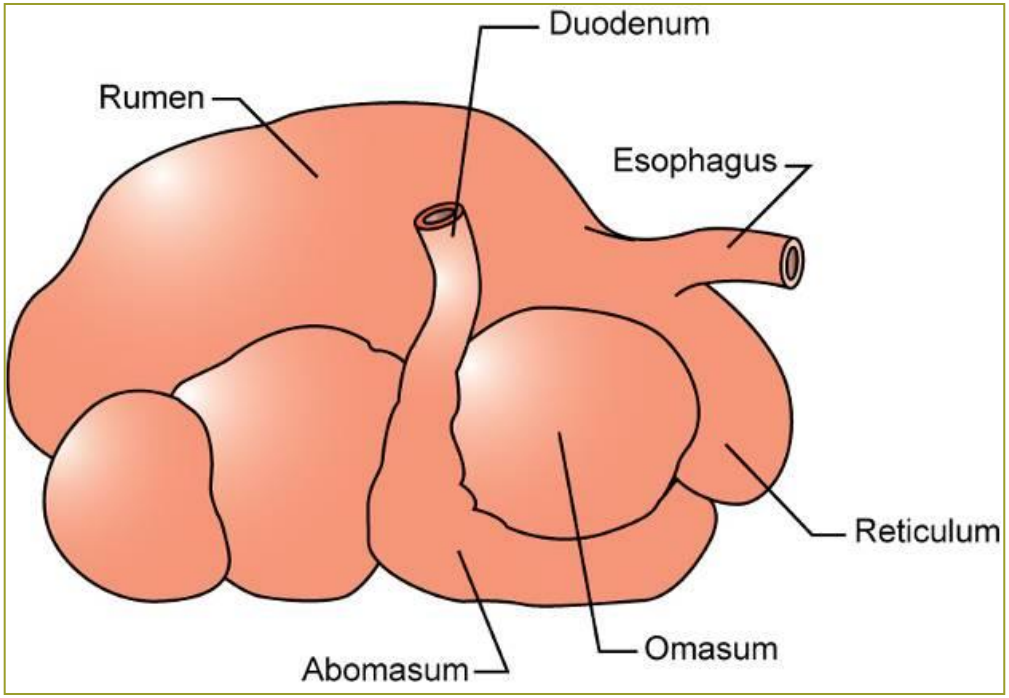
HUGE Bovine Stomach! ☺



Ruminants

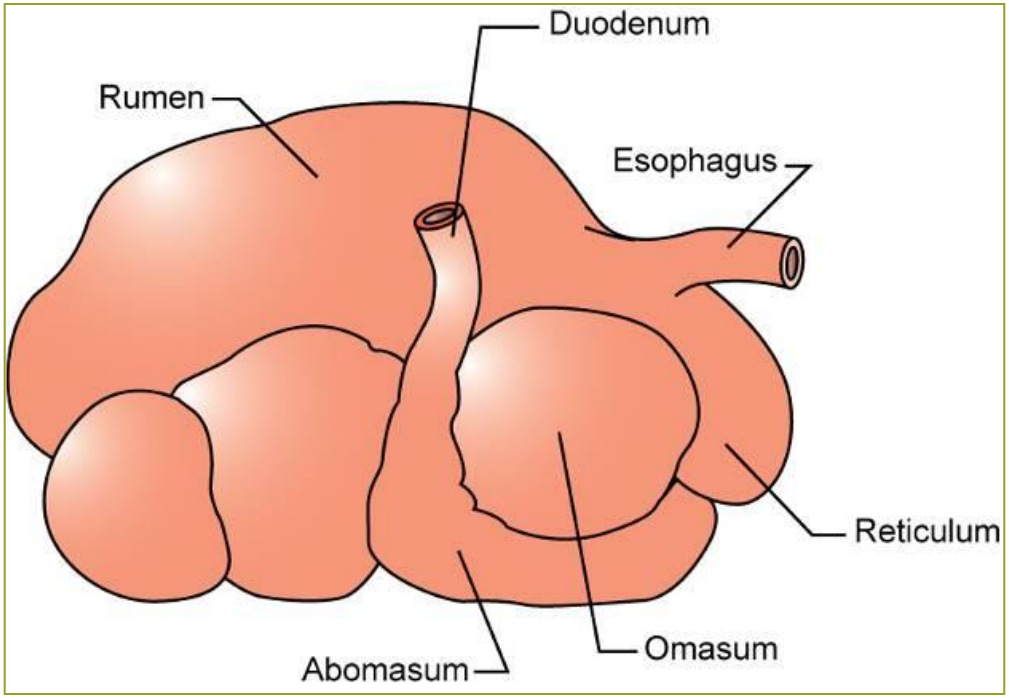
Figure 11-8, Page 274

- One true stomach and three forestomachs
- Ruminants swallow their food, regurgitate it to chew on it some more before swallowing it again (rumination)

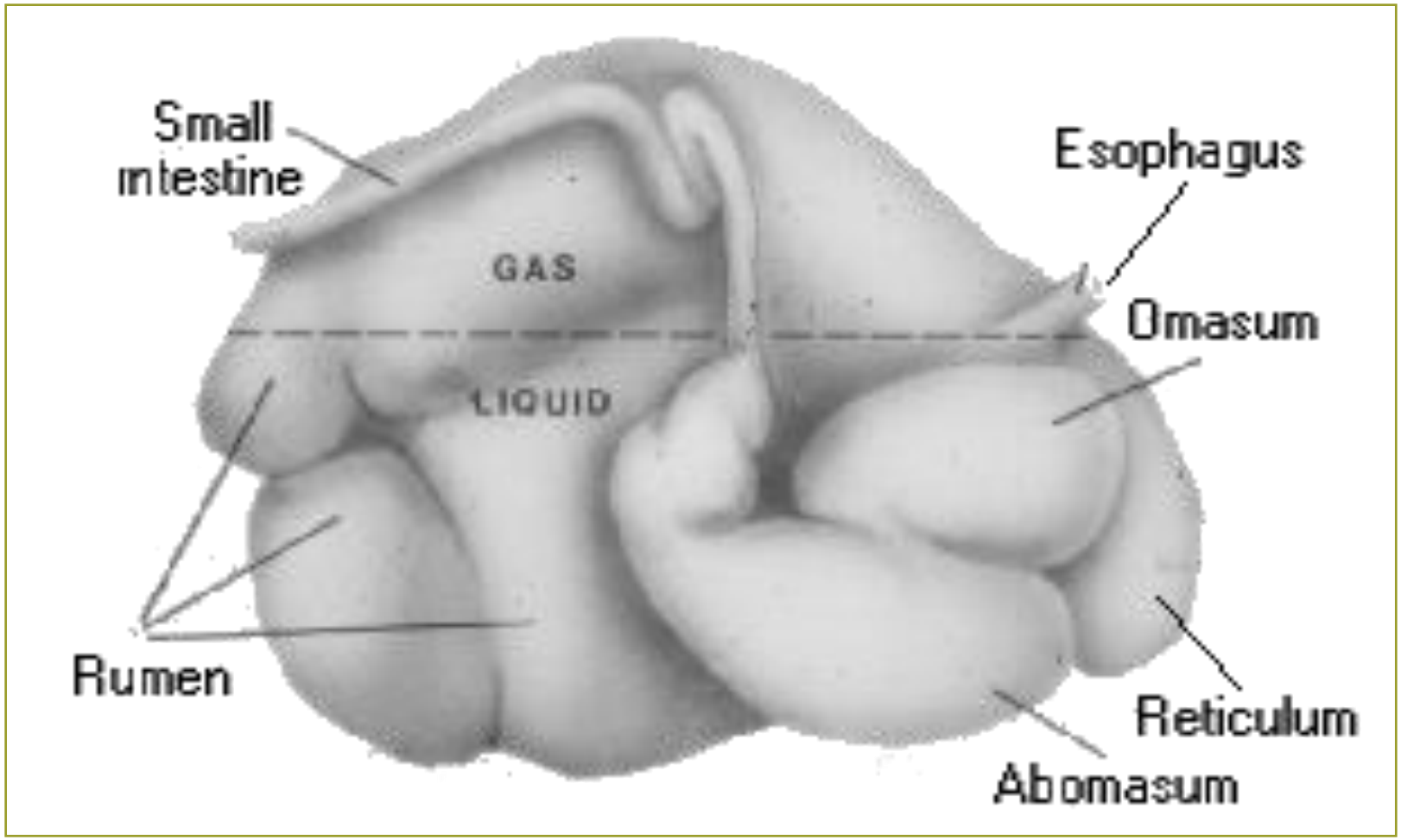


Ruminants

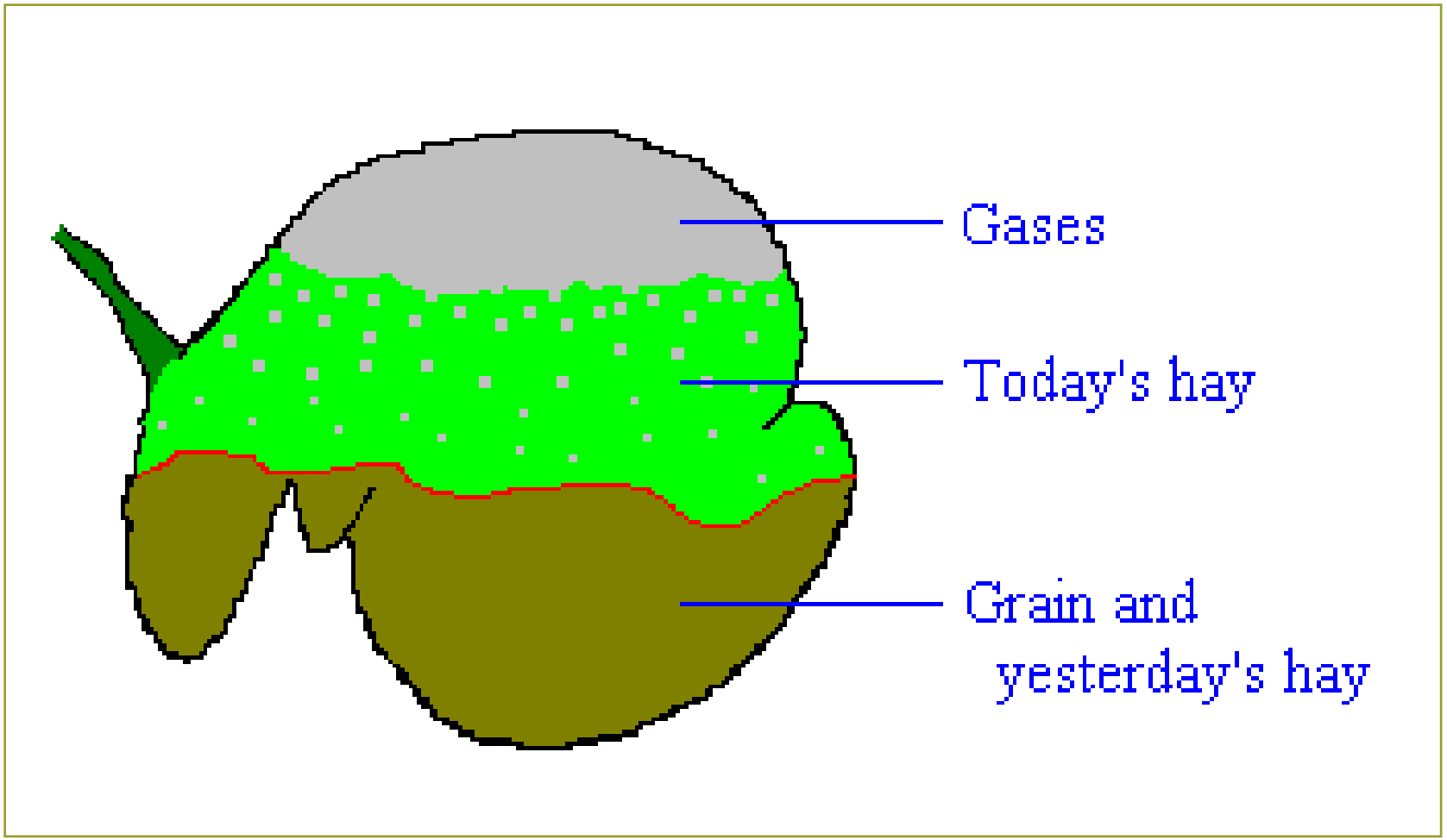
- Abomasum – true stomach
- Forestomachs
  - Reticulum
  - Rumen
  - Omasum



Fluid/Gas Lines



Fluid/Gas Lines



Reticulum

- Smallest, most cranial compartment of the forestomach compartments
- Lining composed of honeycomb arrangement of folds
- Hardware disease
- Reticulum and rumen – coordinated contractions

Reticulum

Rumen

- Series of muscular sacs partially separated from one another by long muscular folds of rumen wall called pillars
  - Pillars aid in mixing and stirring of ruminal contents
- Reticuloruminal contractions
  - Allow partially digested plant food to be regurgitated
  - Allow built-up carbon dioxide or methane gas to be expelled from the rumen

Physiology of Rumination

- **Rumination** – "chewing cud"
  - Regurgitation
  - Resalivation
  - Reswallowing of food
- **Eructation** – CO_2 or CH_4 gas from rumen
- Bacteria & protozoa digest cellulose (plant fiber)

Omasum and Abomasum

- **Omasum** – muscular organ with many muscular folds
- Breaks food particles down further
- **Abomasum** – true stomach
  - Functions much the same as monogastric stomach
  - On left side, just like **monogastric stomach**

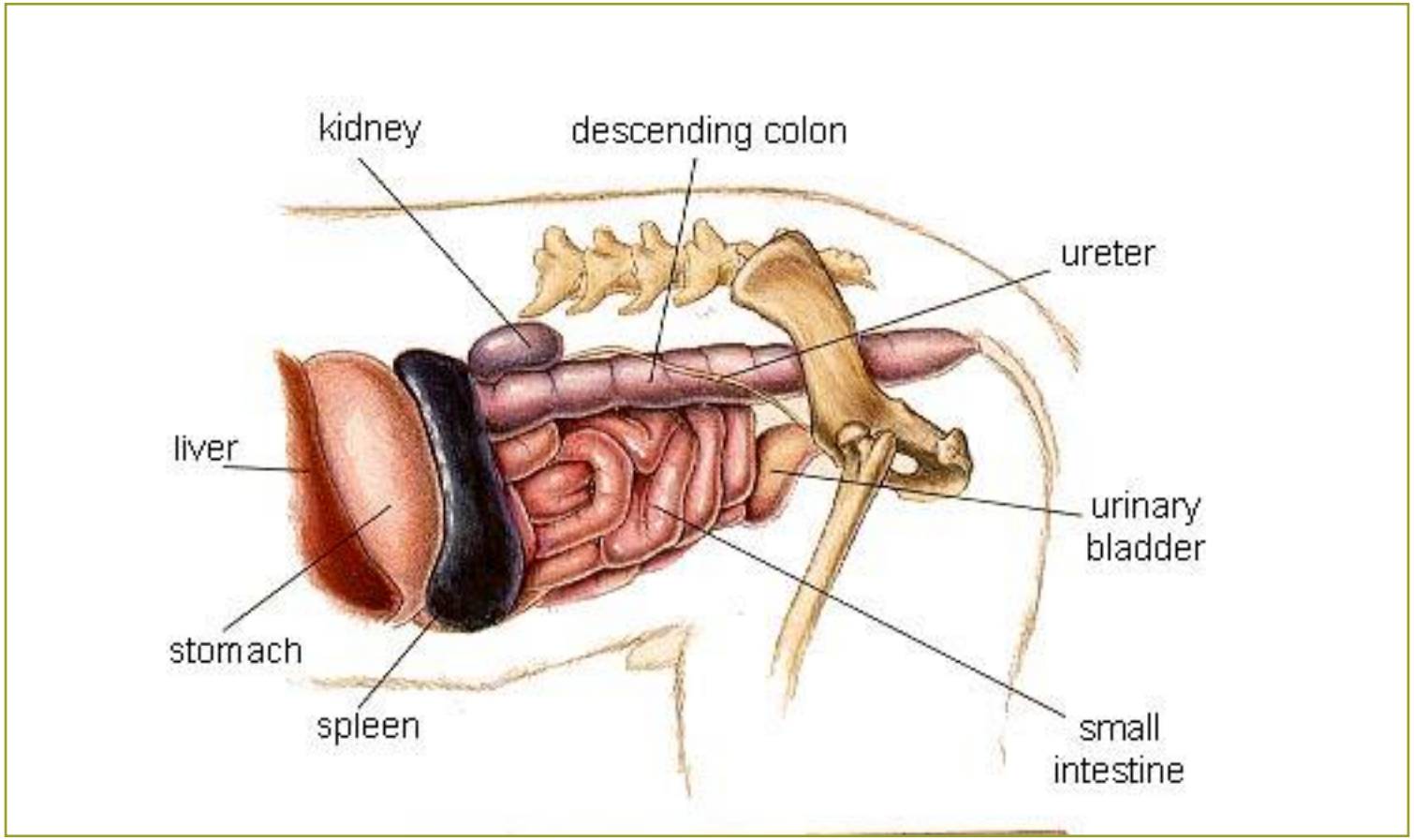
Small Intestine

Duodenum

Jejunum

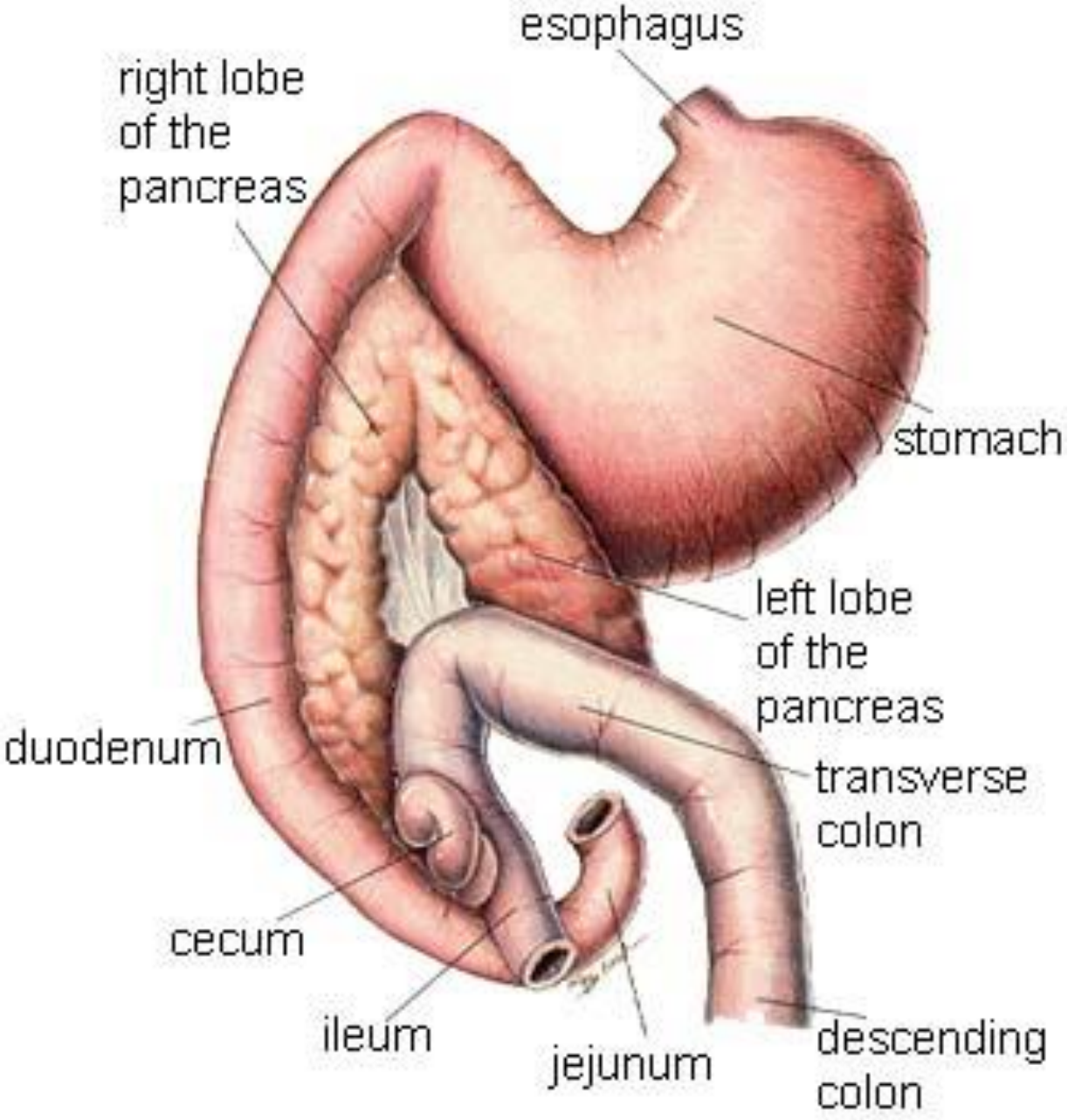
Ileum

Small Intestine

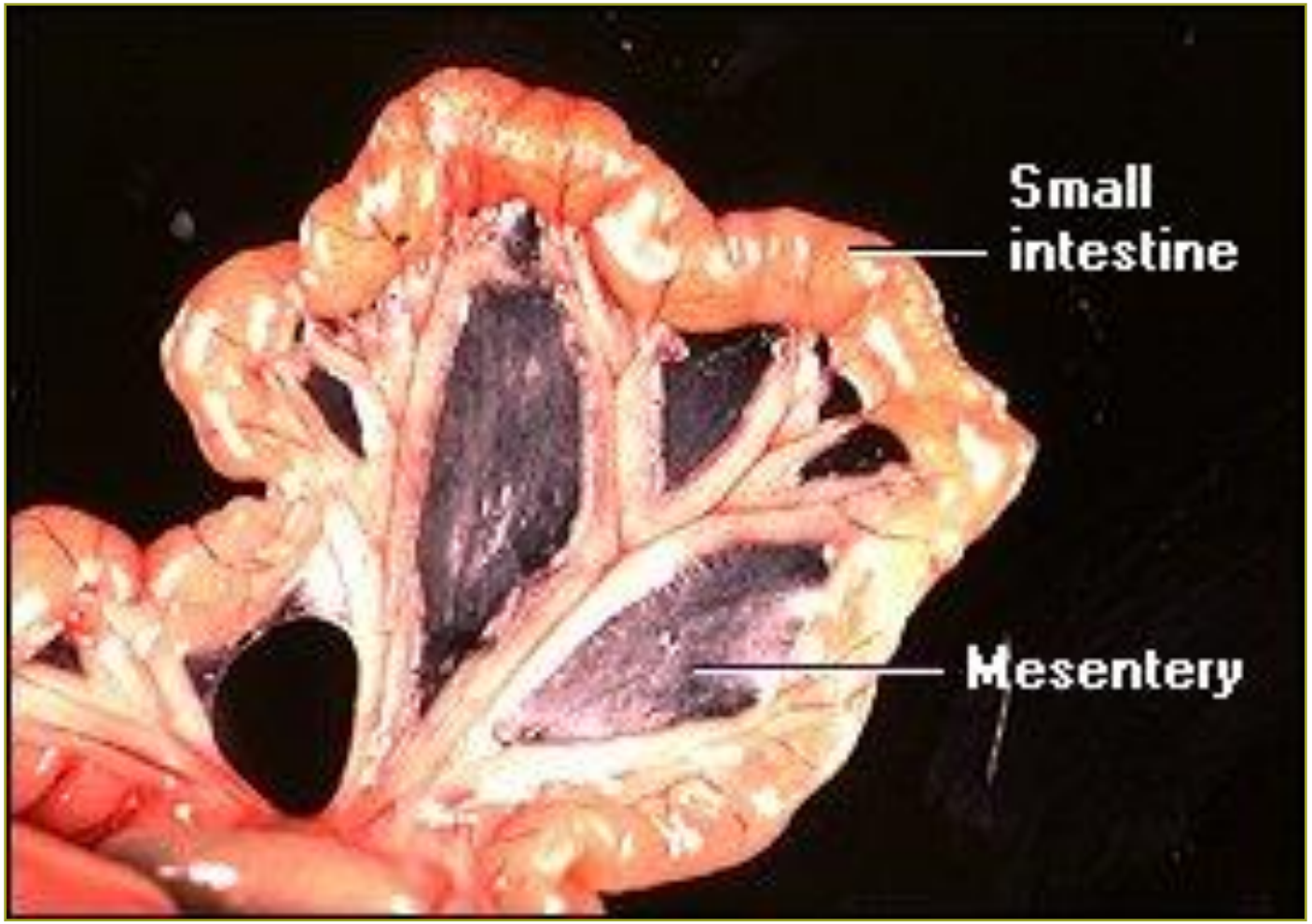


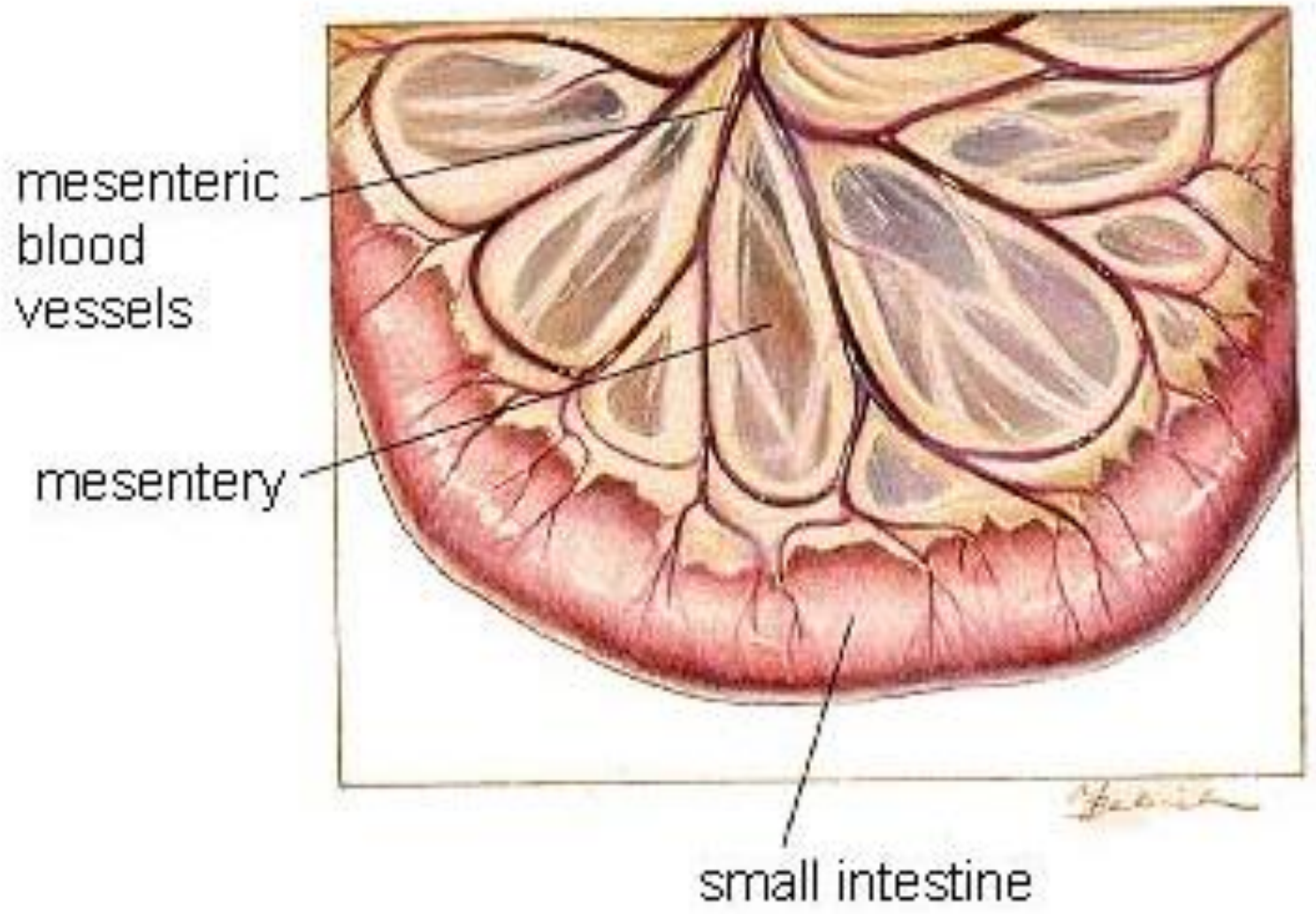
Small Intestine

- Duodenum – first short segment that leaves the stomach
- Jejunum – longest portion
- Ileum – separated from colon by ileocecal sphincter; regulates movement of materials from the small intestine into the colon or the cecum


esophagus
right lobe of the pancreas
stomach
left lobe of the pancreas
duodenum
transverse colon
cecum
ileum
jejunum
descending colon

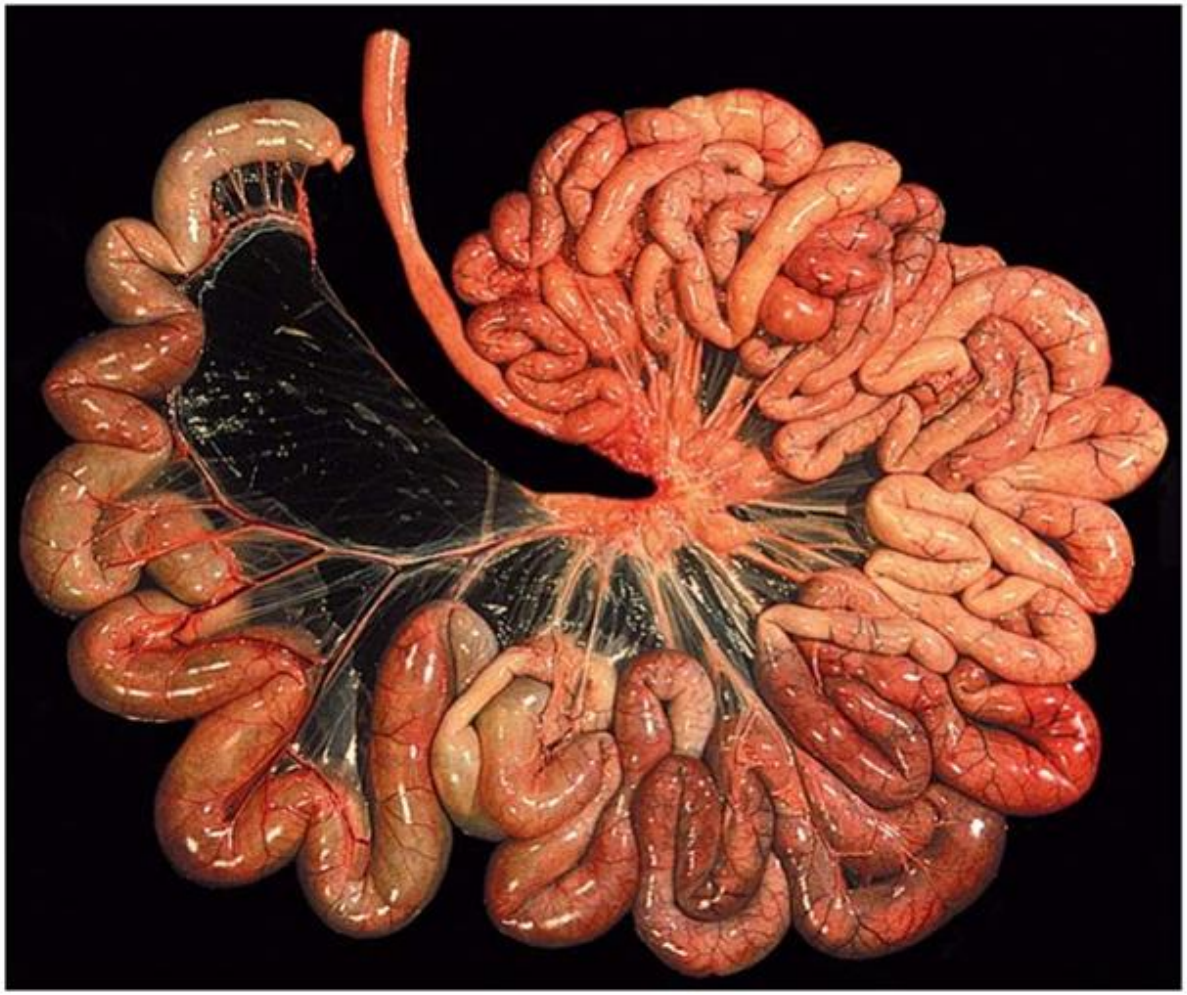
Jejunum




mesenteric blood vessels
mesentery
small intestine

Foal Small Intestine

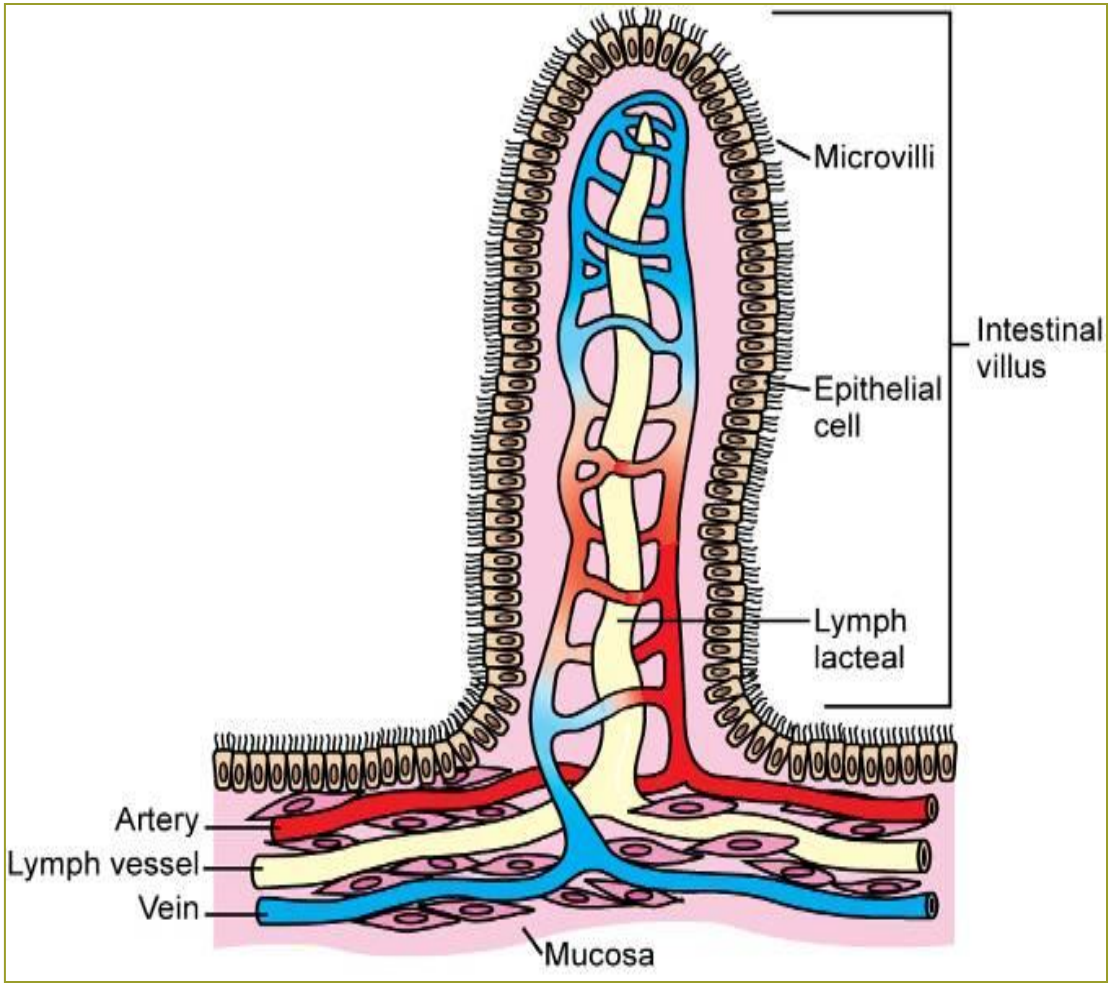
Bassert Lab Manual – Page 286

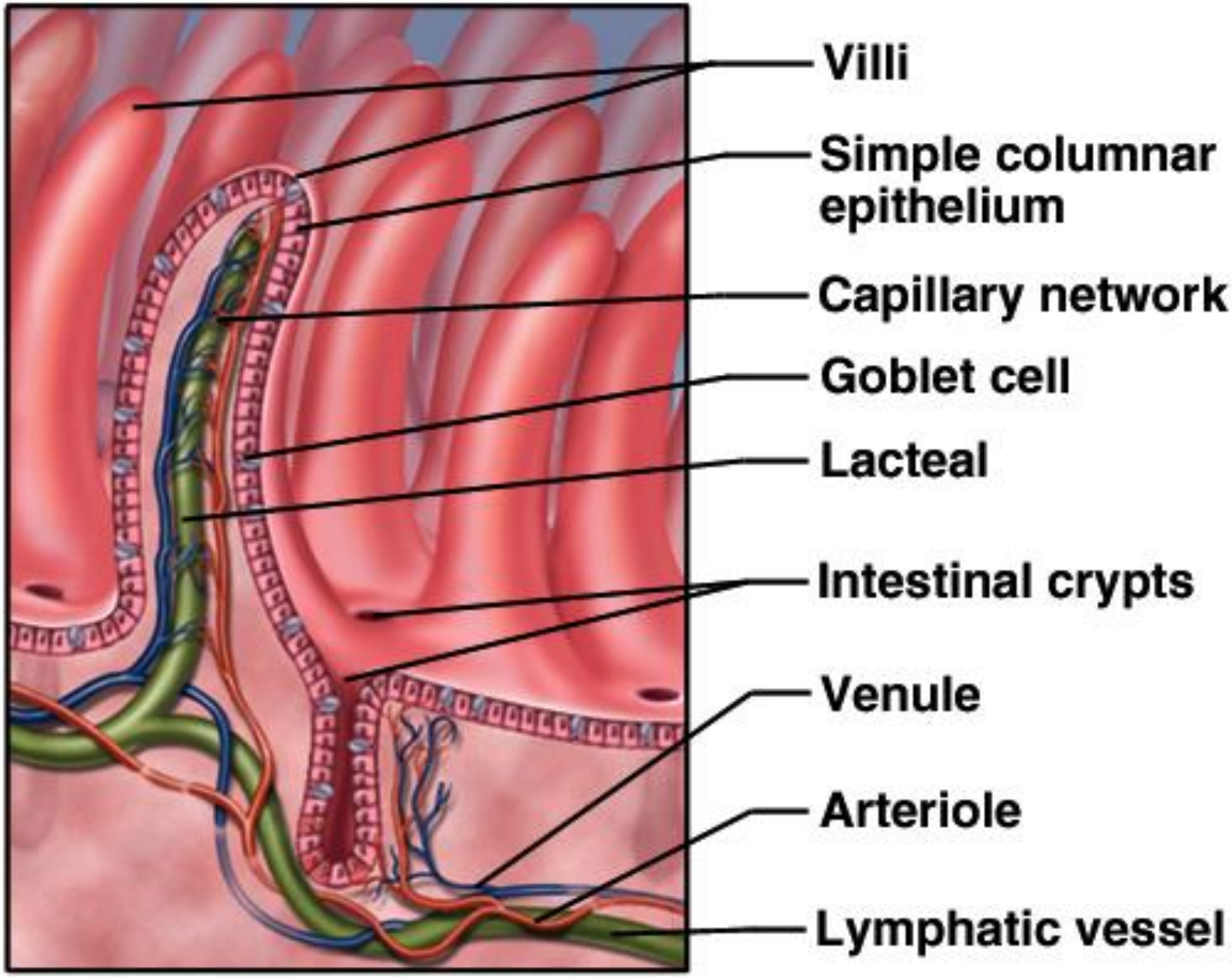


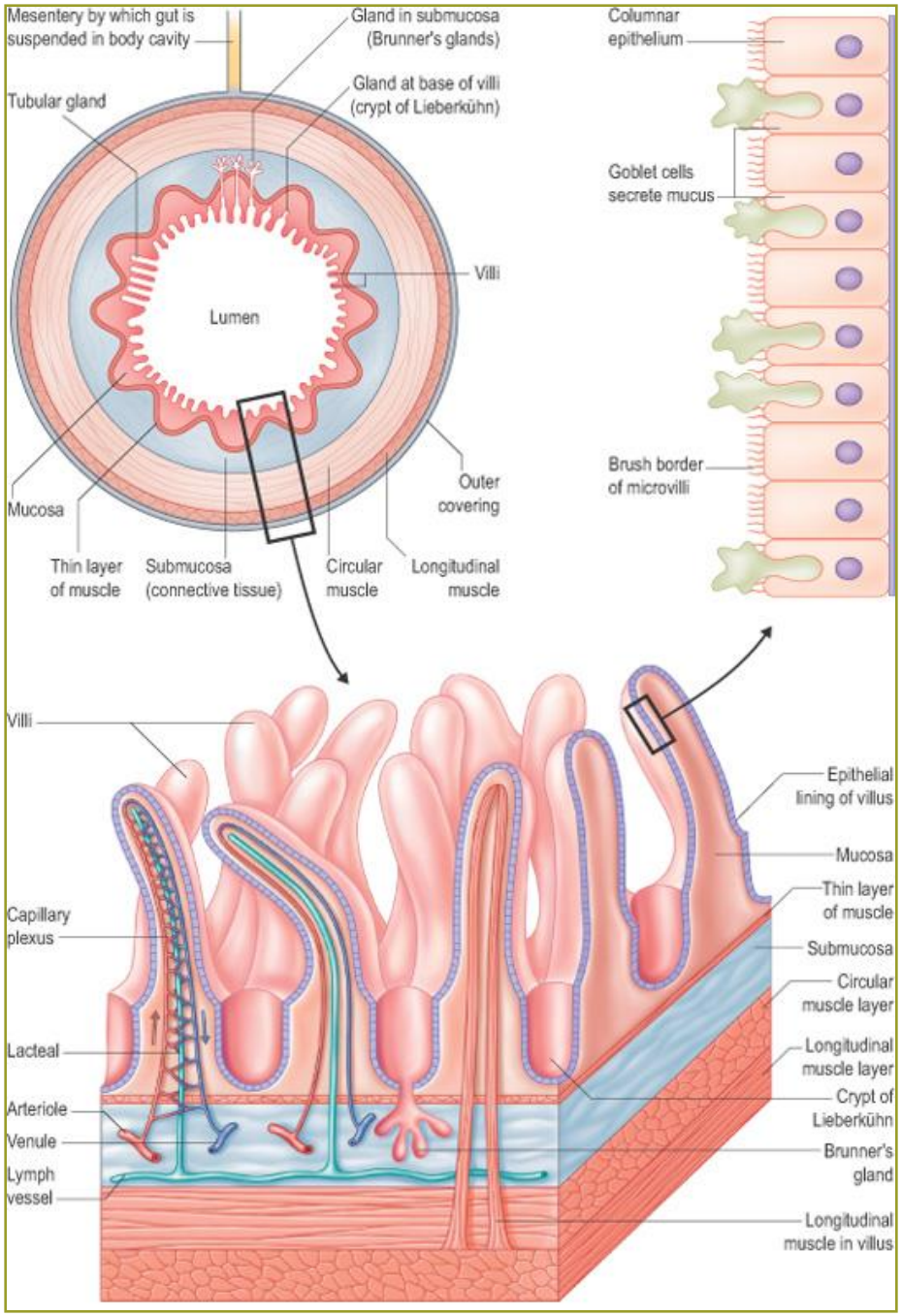
Small Intestine Mucosa

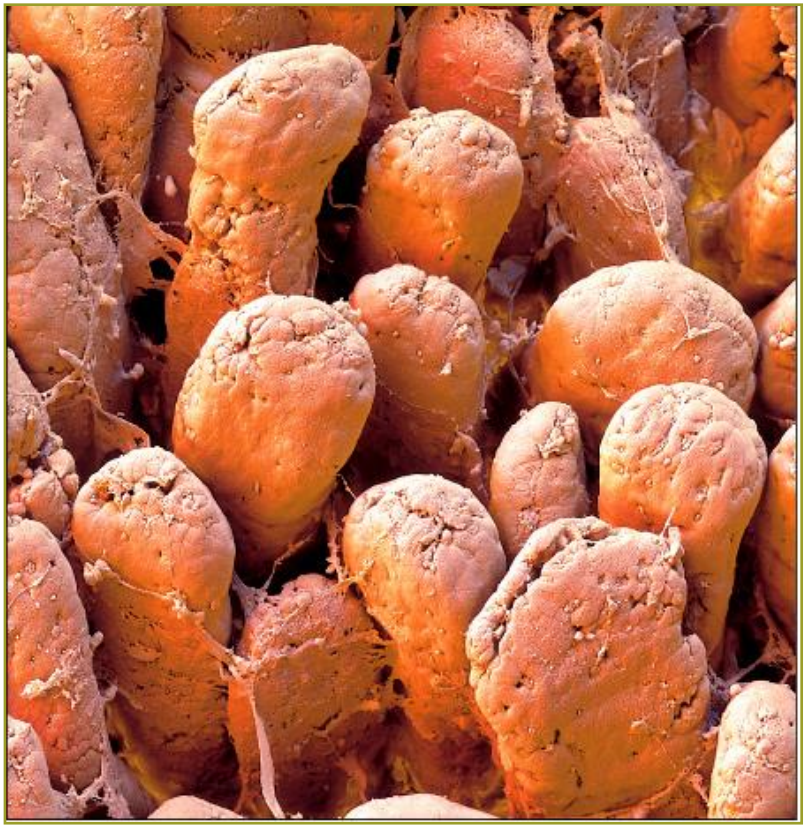
Figure 11-10, Page 277

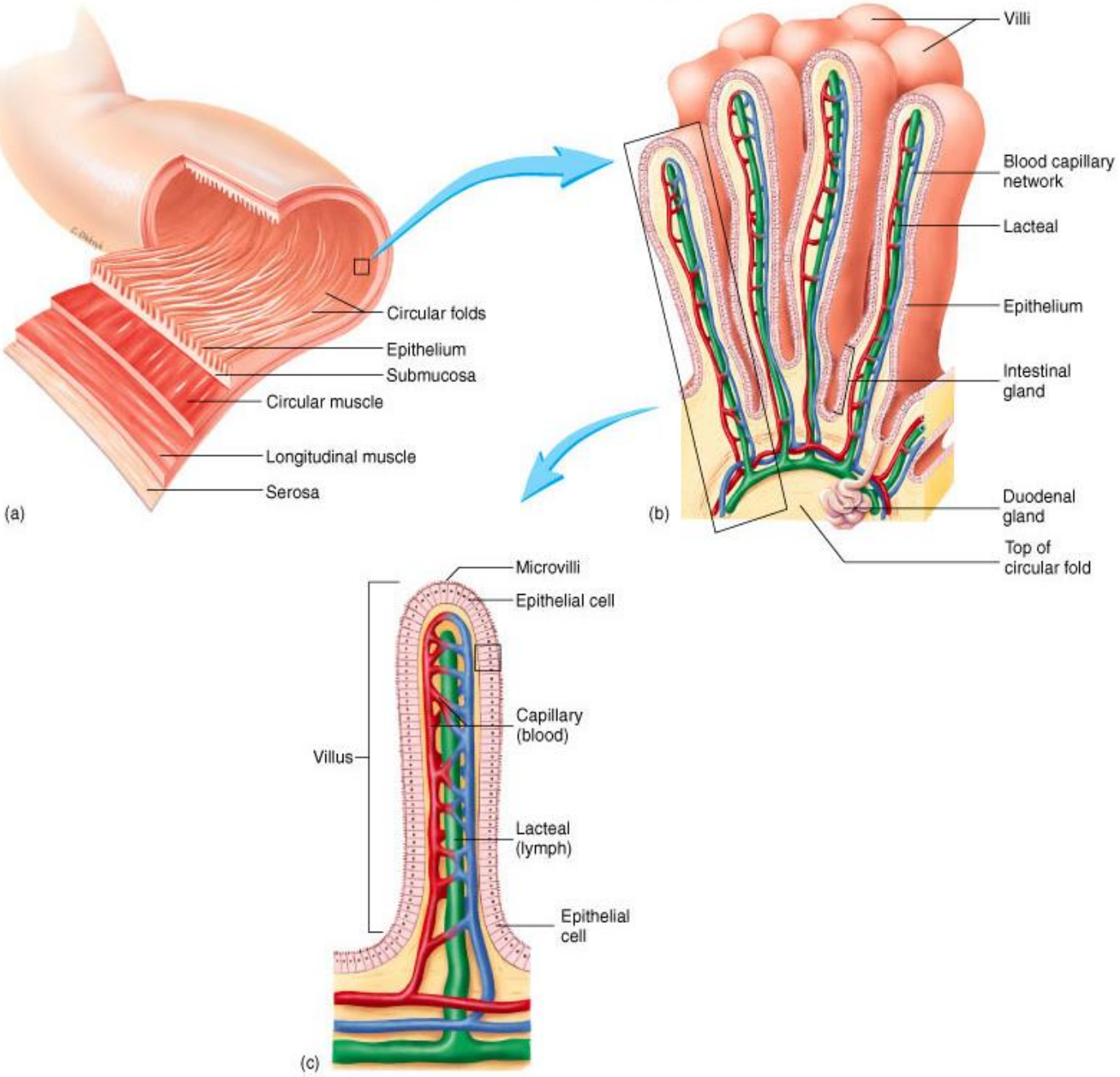
- **Mucosa** – many folds and **villi**
- Each villus contains thousands of **microvilli (brush border)**
- Microvilli – digestive enzymes and carrier molecules embedded in cell membranes

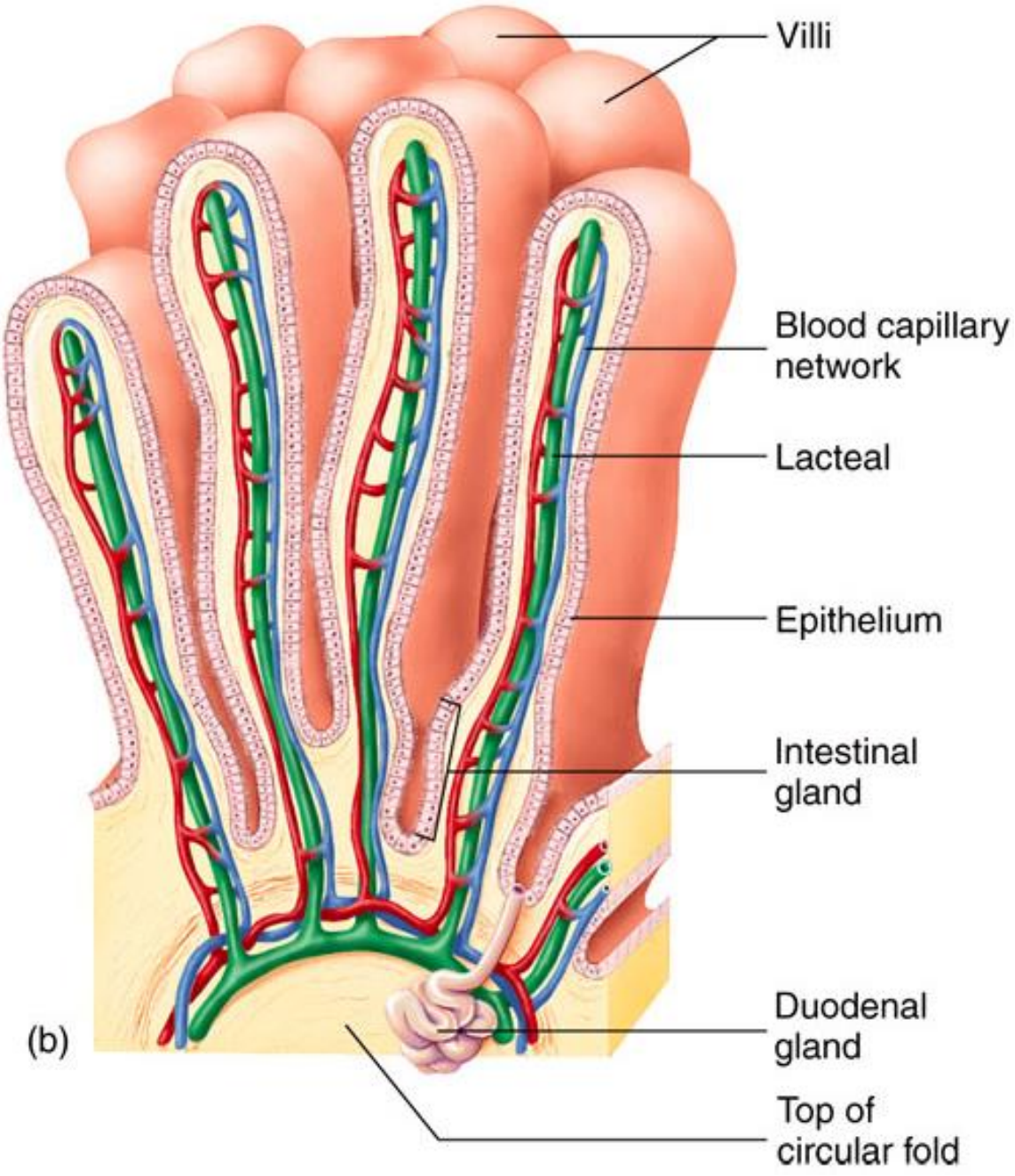


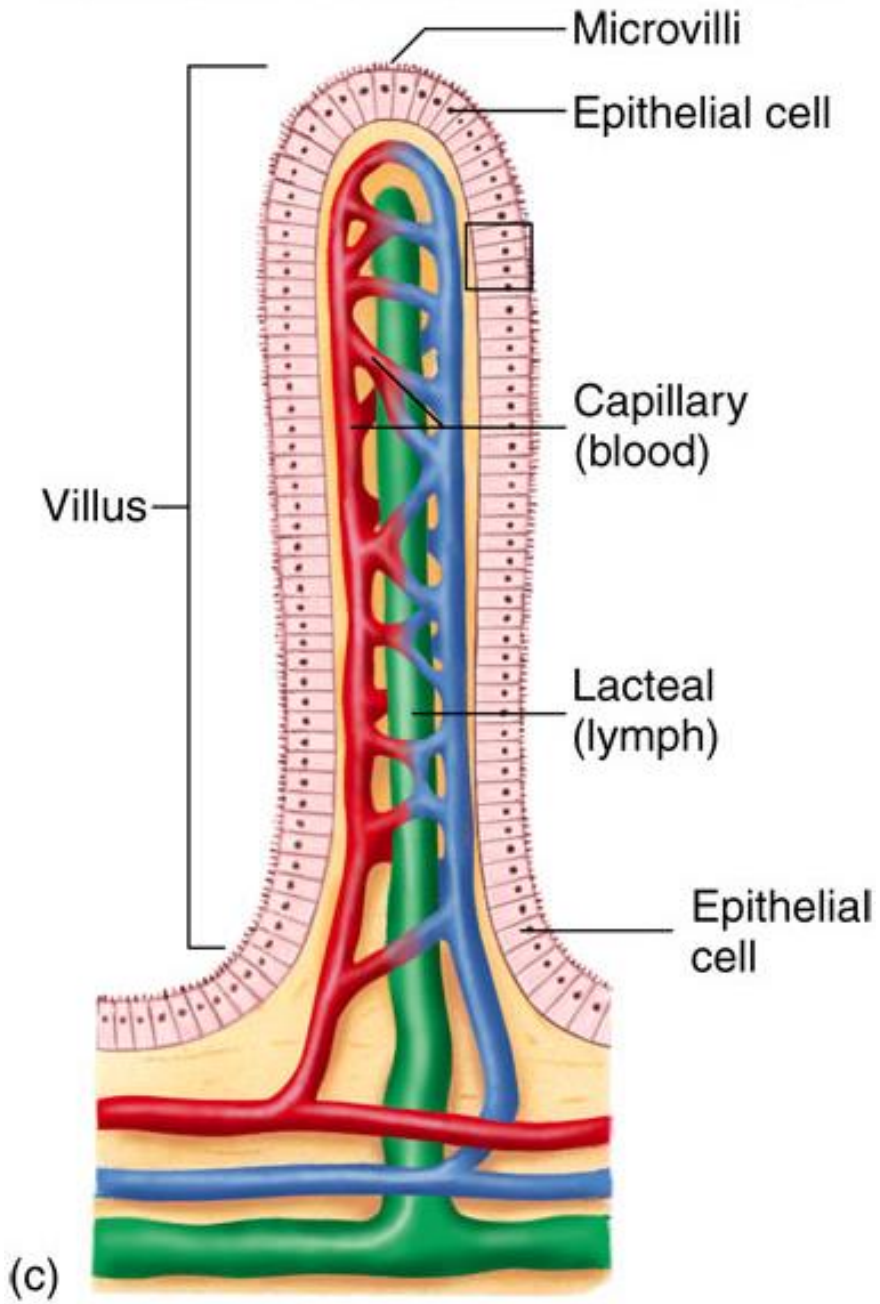

Villi
Simple columnar epithelium
Capillary network
Goblet cell
Lacteal
Intestinal crypts
Venule
Arteriole
Lymphatic vessel

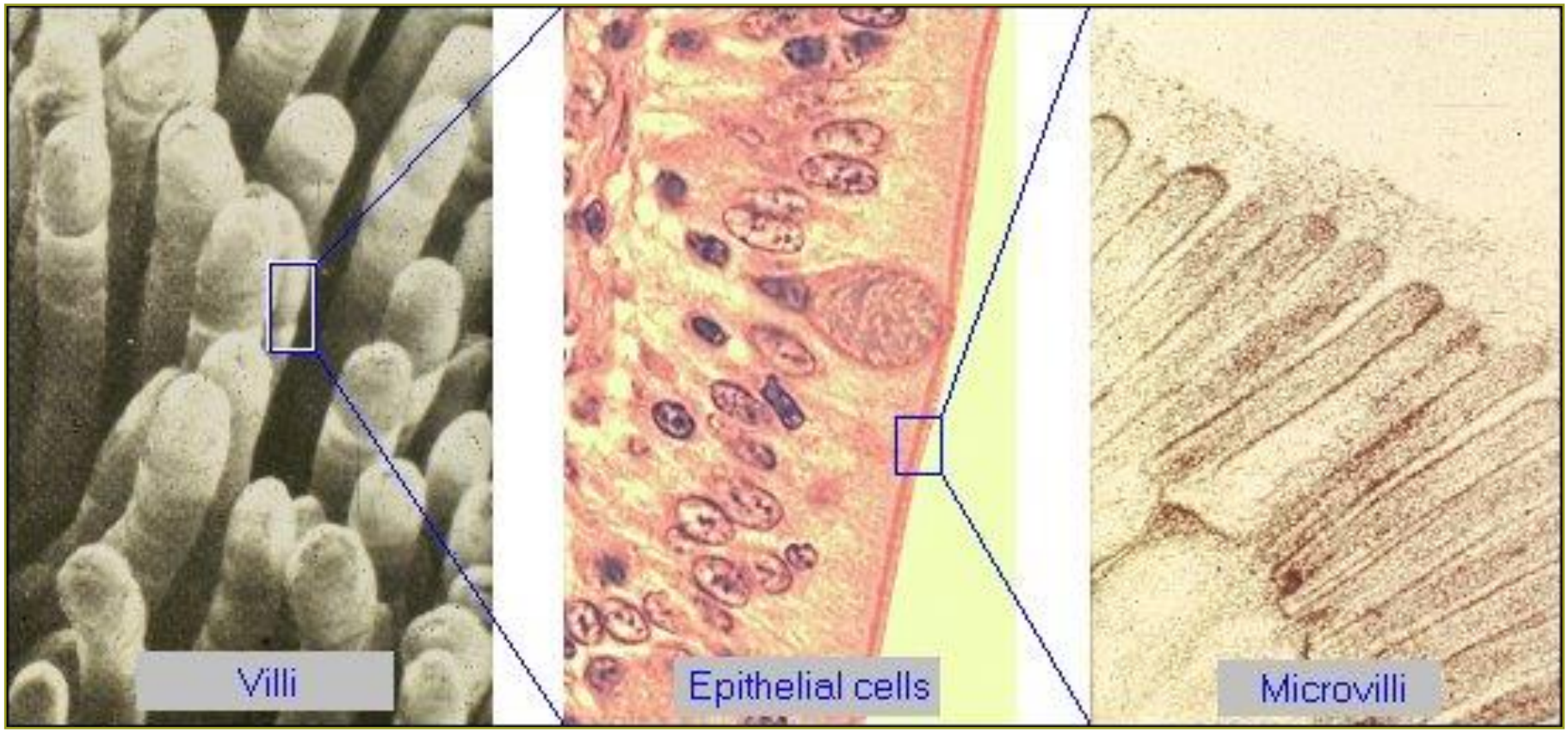

Mesentery by which gut is suspended in body cavity
Gland in submucosa (Brunner's glands)
Tubular gland
Gland at base of villi (crypt of Lieberkühn)
Villi
Lumen
Mucosa
Outer covering
Thin layer of muscle
Submucosa (connective tissue)
Circular muscle
Longitudinal muscle
Columnar epithelium
Goblet cells secrete mucus
Brush border of microvilli
Villi
Epithelial lining of villus
Mucosa
Thin layer of muscle
Capillary plexus
Submucosa
Circular muscle layer
Lacteal
Longitudinal muscle layer
Arteriole
Crypt of Lieberkühn
Venule
Brunner's gland
Lymph vessel
Longitudinal muscle in villus




Circular folds
Epithelium
Submucosa
Circular muscle
Longitudinal muscle
Serosa
(a)
Villi
Blood capillary network
Lacteal
Epithelium
Intestinal gland
Duodenal gland
Top of circular fold
(b)
Microvilli
Epithelial cell
Capillary (blood)
Villus
Lacteal (lymph)
Epithelial cell
(c)


Villi
Blood capillary network
Lacteal
Epithelium
Intestinal gland
Duodenal gland
Top of circular fold
(b)

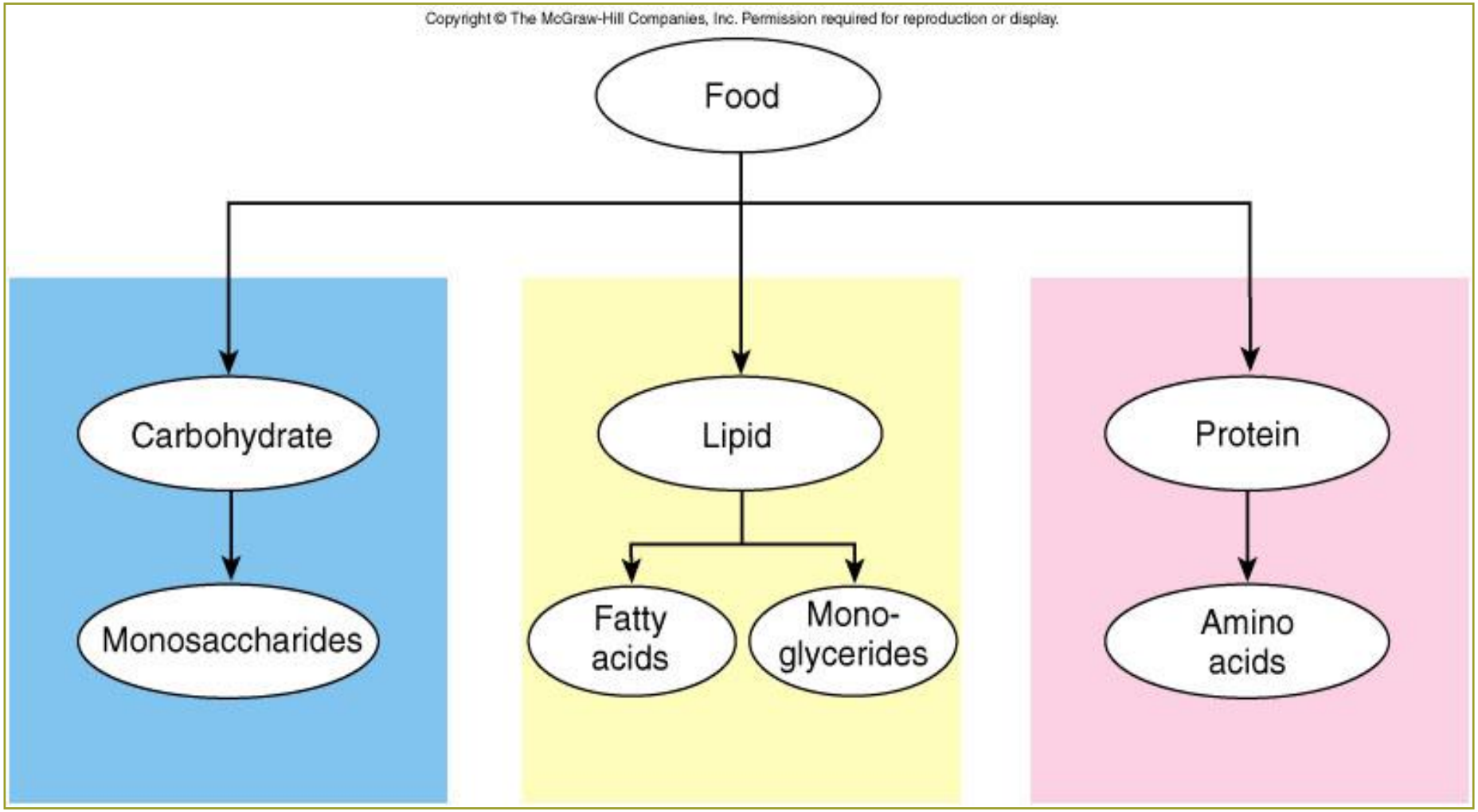

Microvilli
Epithelial cell
Capillary
(blood)
Villus
Lacteal
(lymph)
Epithelial
cell
(c)


Villi
Epithelial cells
Microvilli

Small Intestine Digestion

- Electrolytes, water, and vitamins – absorbed intact across the small intestine wall
  - Micronutrients
- Carbohydrates, proteins, and fats – chemically digested
  - Macronutrients

Digestion of Macronutrients



Carbohydrate Digestion

- **Starch** converted into disaccharides into lumen of the duodenum by **pancreatic amylase**
- Disaccharides further digested by enzymes in microvilli cell membranes
- Resulting **monosaccharides** transported across the microvilli cell membrane and absorbed into the blood

Protein Digestion

- Gastric pepsin breaks apart some protein chains into smaller polypeptides
- Five pancreatic proteases: trypsin, chymotrypsin, elastase, aminopeptidase, and carboxypeptidase
- Amino acids, dipeptides, and some tripeptides are then absorbed across the cell membrane

Fat Digestion

- Bile acids coat the fat droplets in duodenum
- Pancreatic lipases penetrate bile acid coating
  - Digest fat molecules to produce glycerol, fatty acids, and monoglycerides

Large Intestine
Chyme Becomes Feces

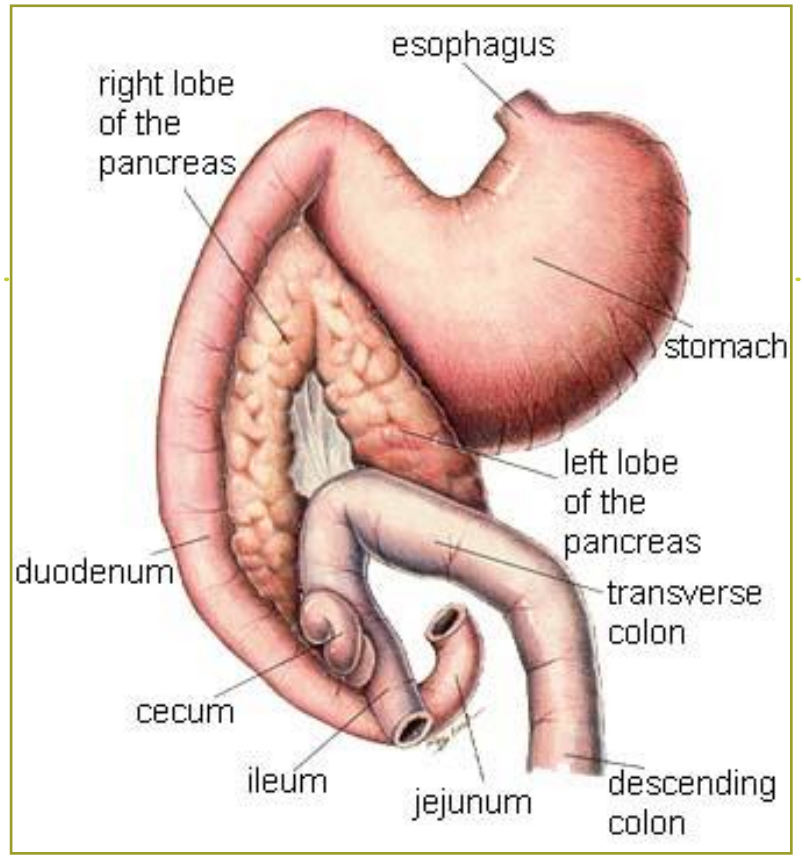
Cecum

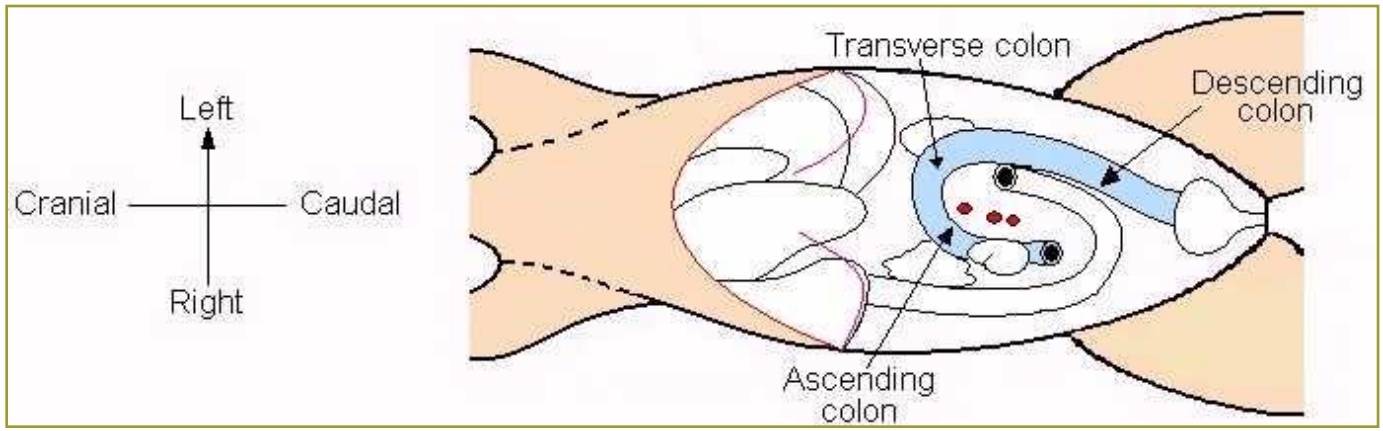
Colon

Rectum

Large Intestine

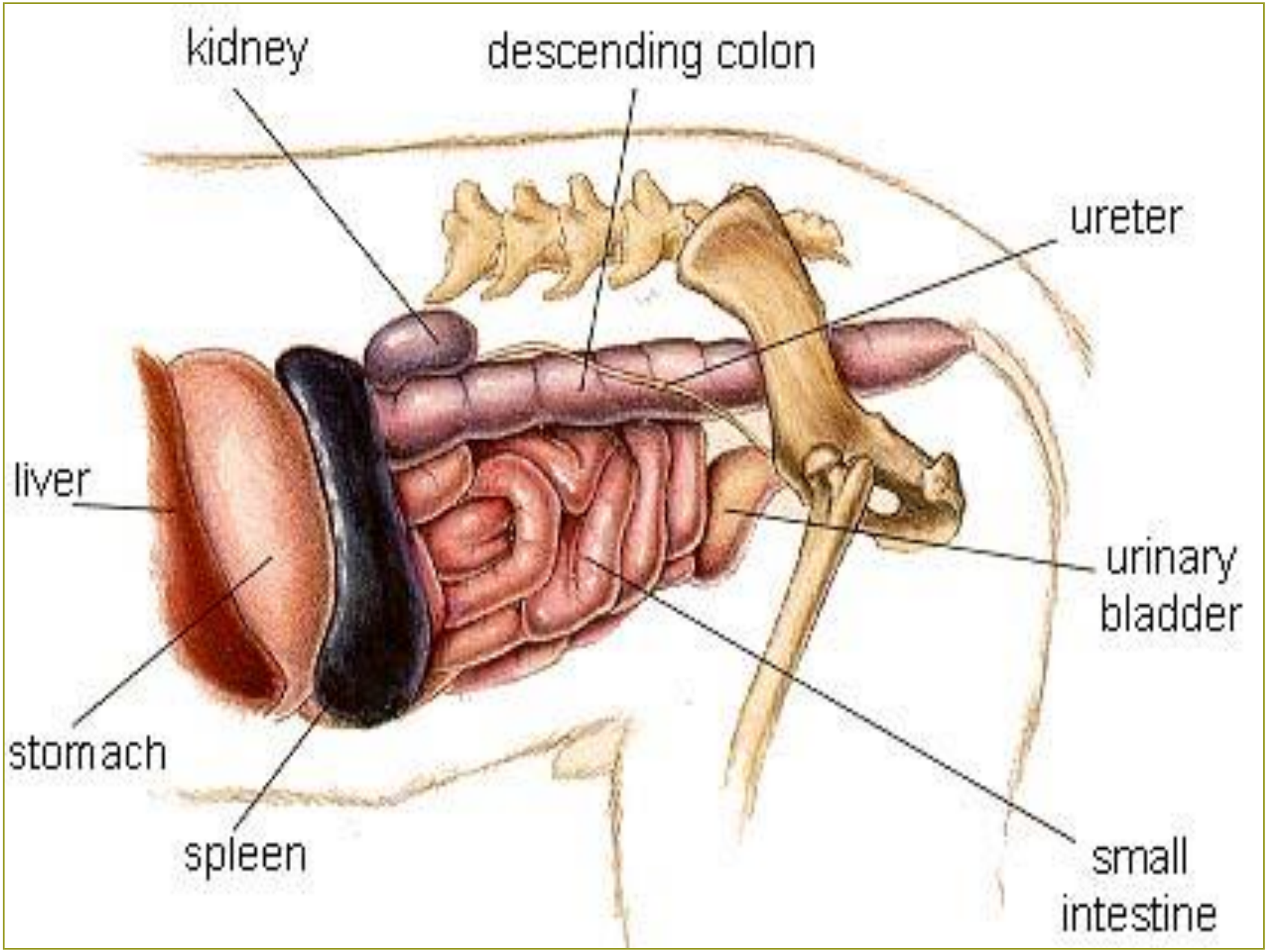
- Cecum
- Colon
  - Ascending
  - Transverse
  - Descending
- Rectum



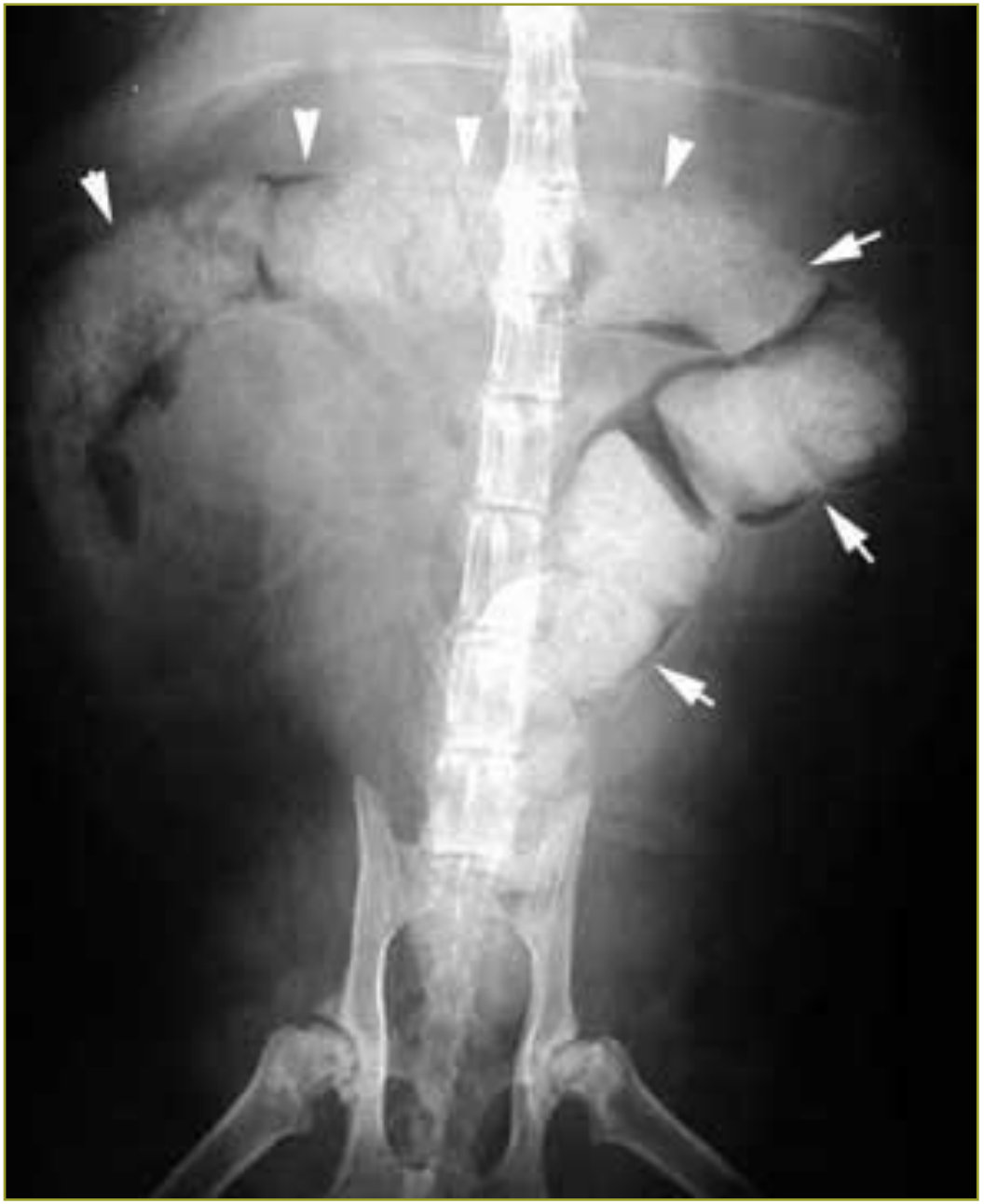


Large Intestine

- Components
  - **Cecum** – blind sac at ileocecal junction
  - **Colon** – some microbial digestion
  - **Rectum**
- Species variation in structure
- Primary functions
  - Recover fluid and electrolytes
  - Store feces until they can be eliminated


kidney
descending colon
ureter
liver
urinary bladder
stomach
spleen
small intestine

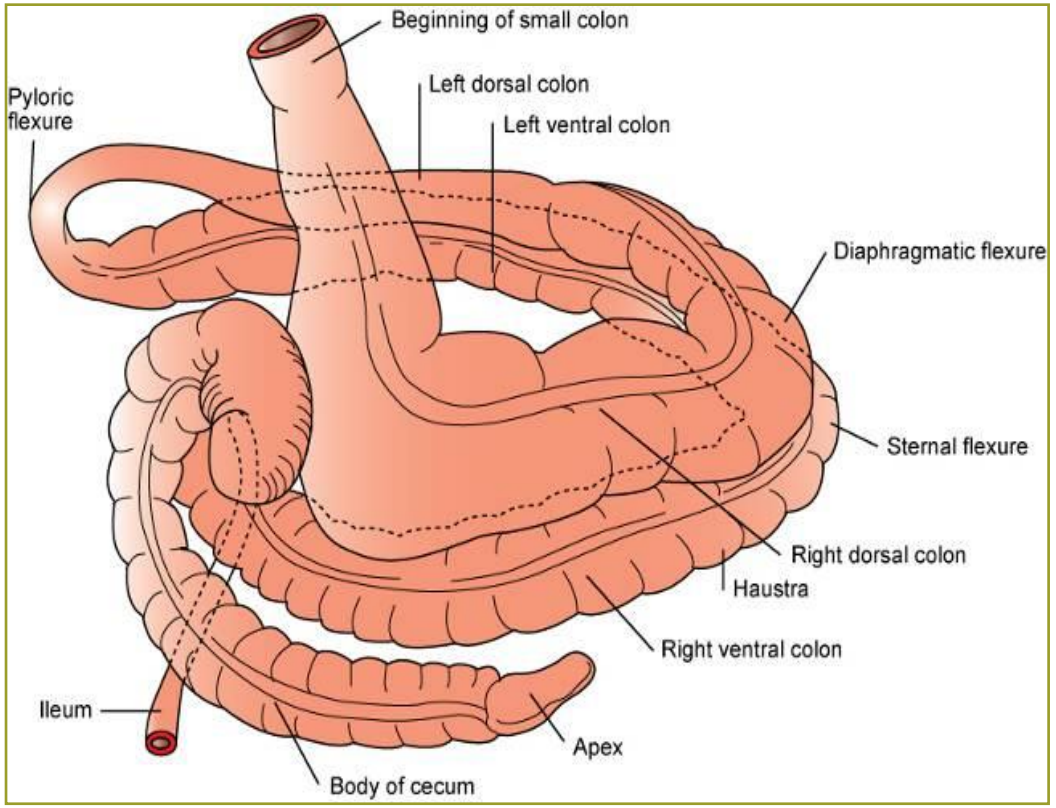
Colon on X-ray



Large Intestine Comparative Anatomy

Figure 11-11, Page 280

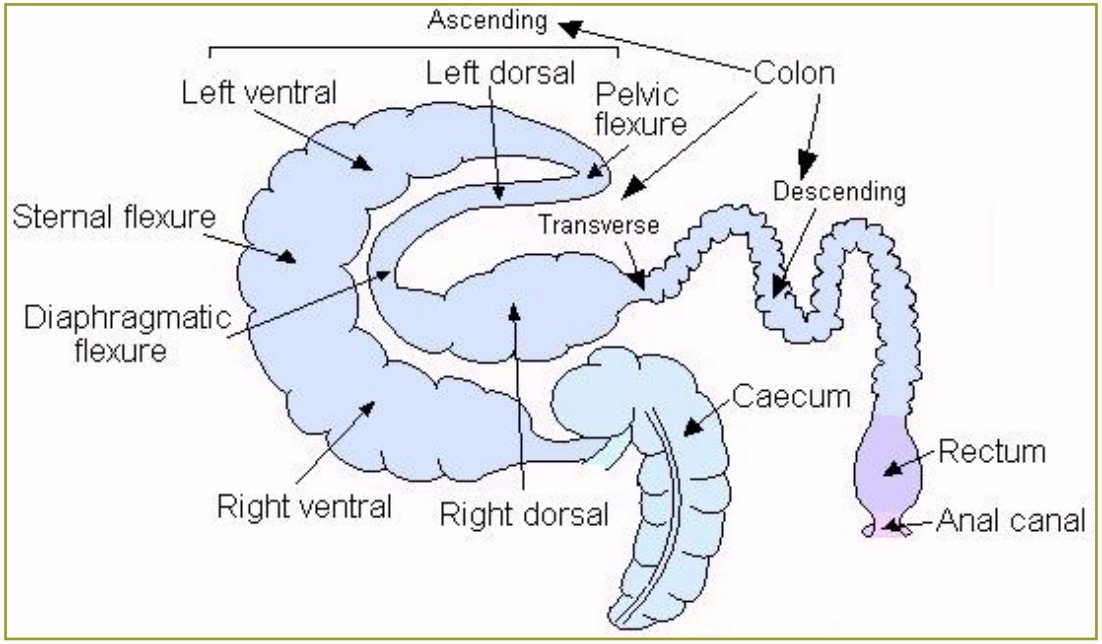
- **Carnivores**: simple, tubular colon; poorly developed cecum
- **Nonruminant herbivores**: very large colon and cecum (hindgut)
  - Fermentation site



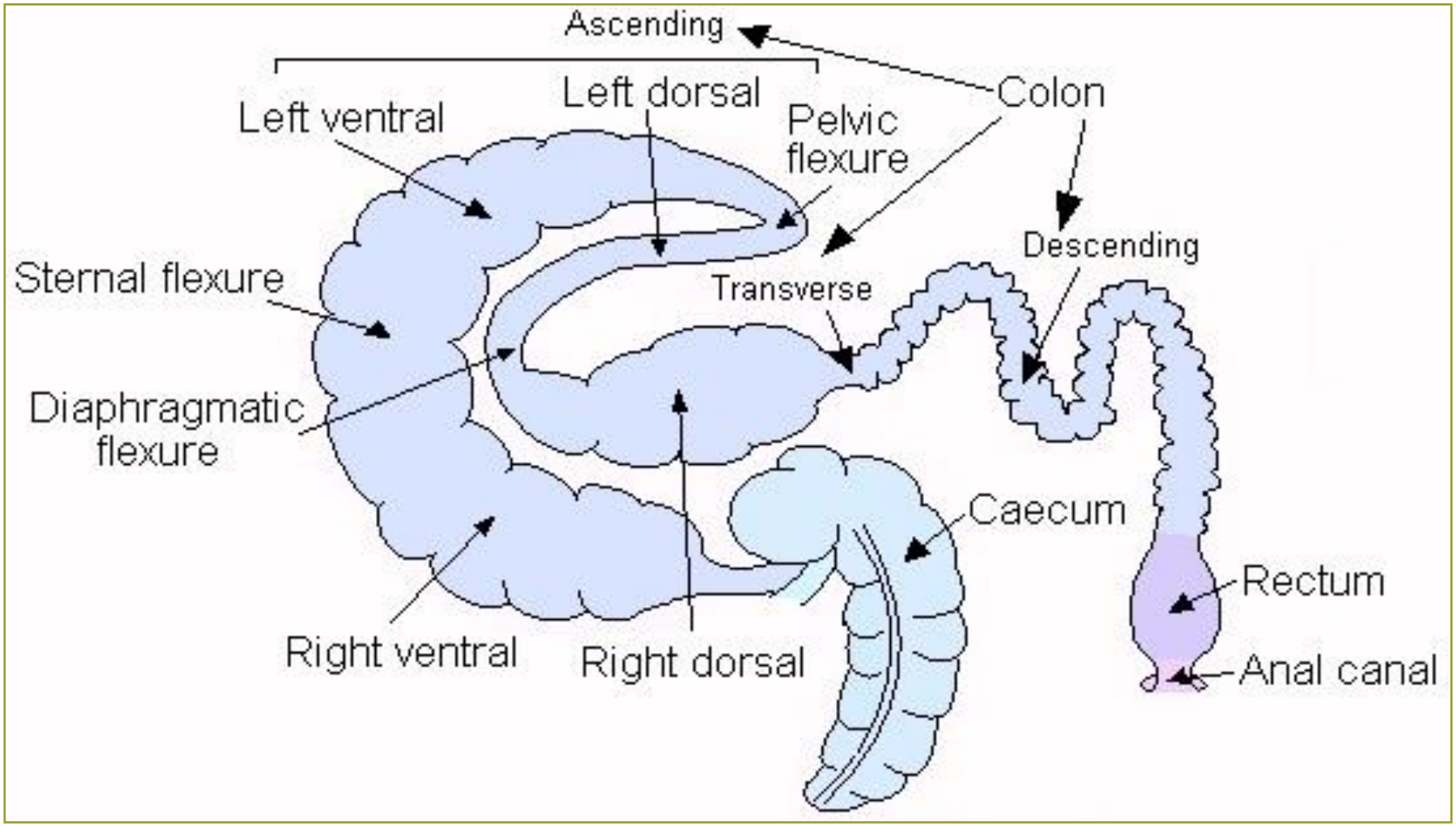
Comparative Anatomy – Ascending Colon

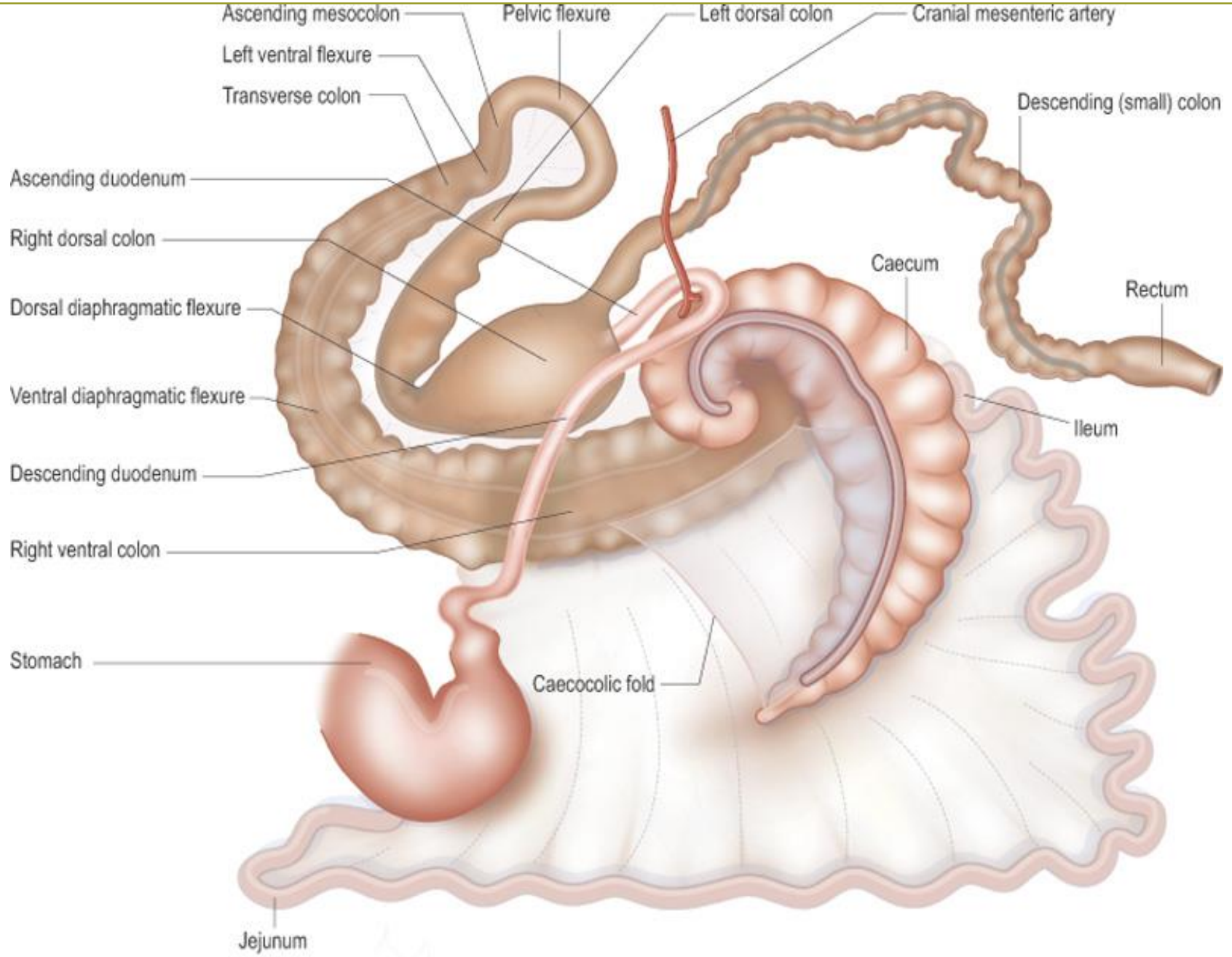
Figure 11-11, Page 280

- Equine – large colon
- Bovine – coiled colon
- Porcine – spiral colon

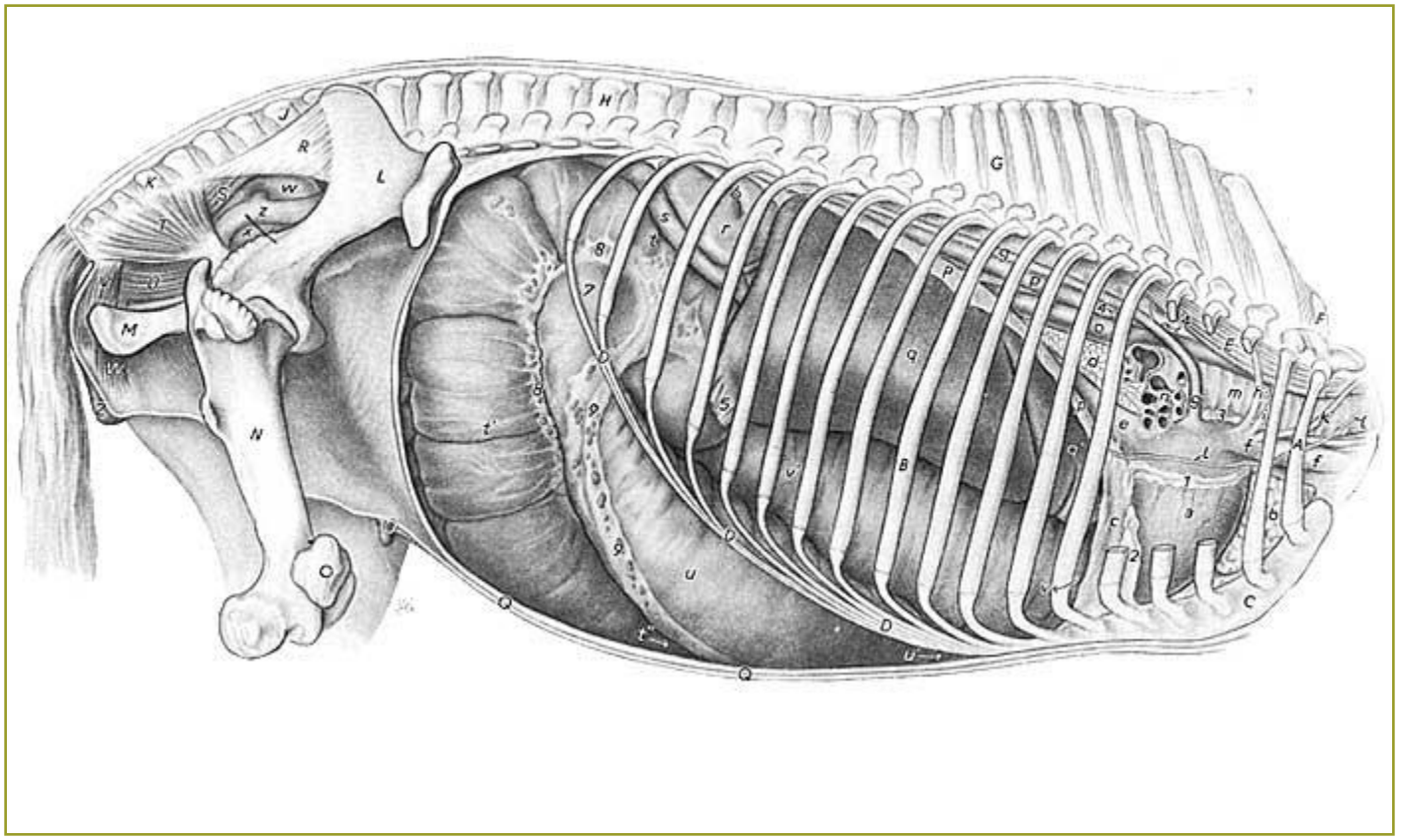


Equine Colon – Complex!

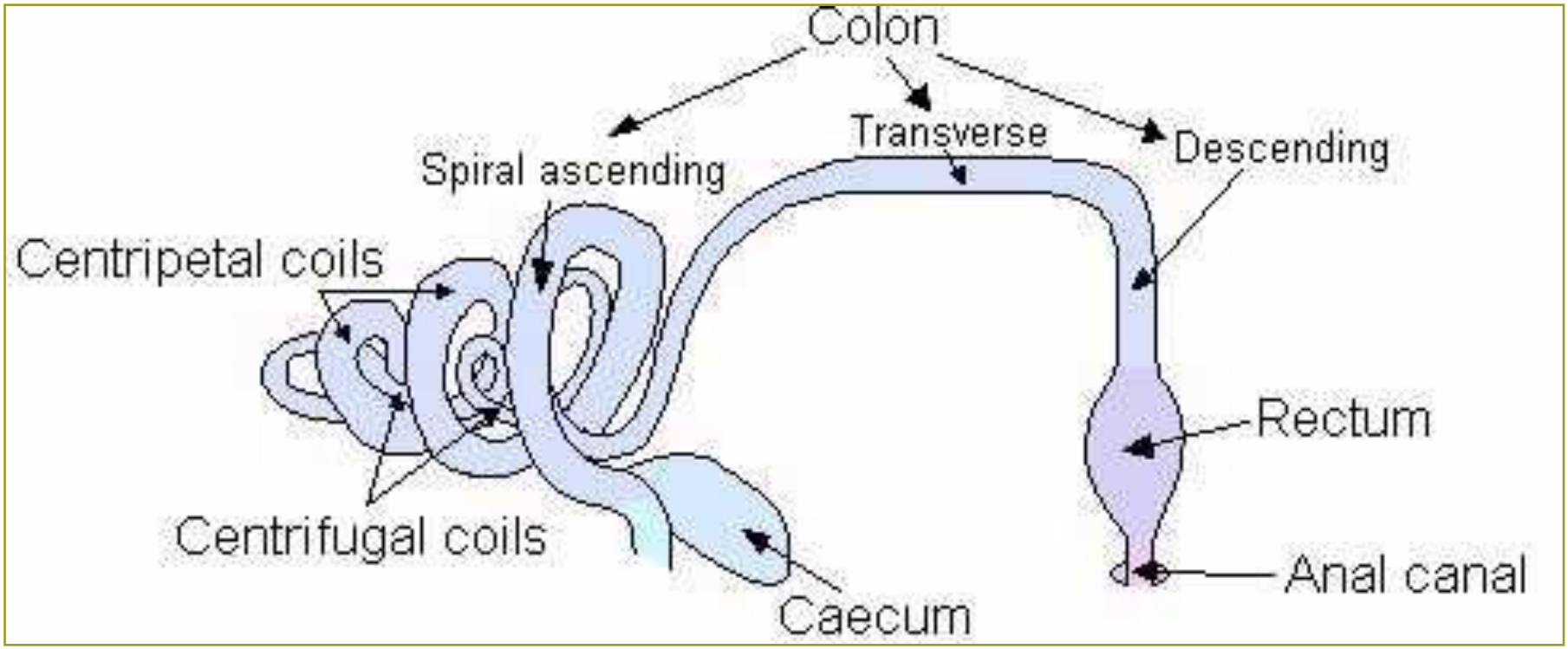




Equine Colon



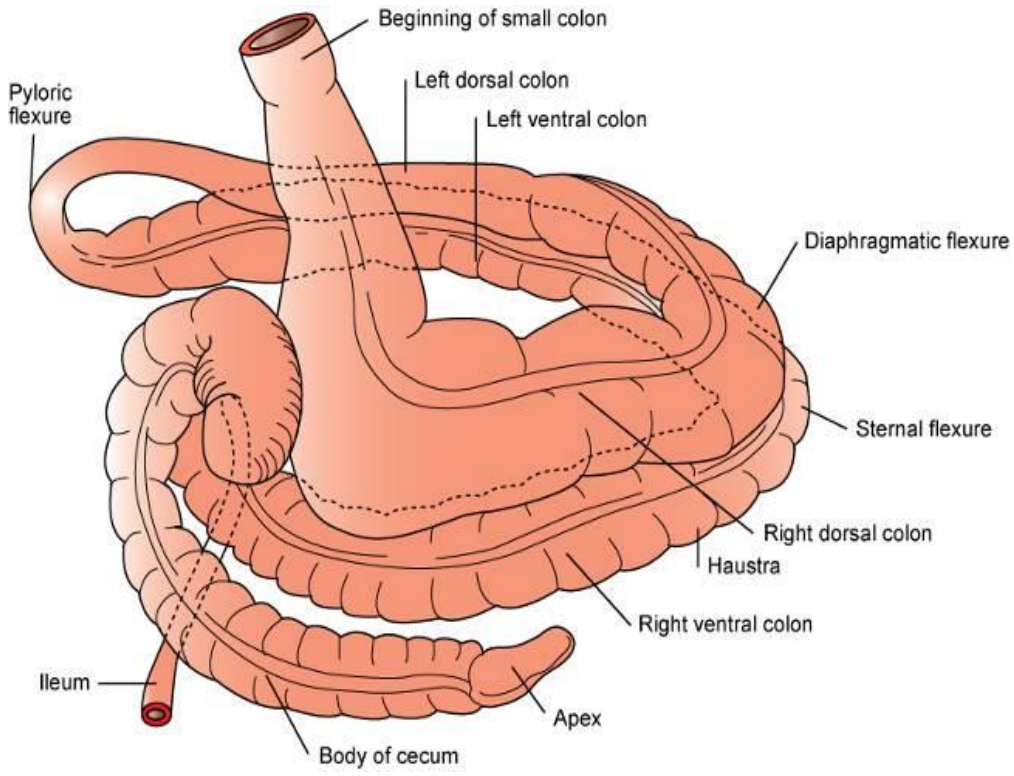
Porcine Ascending Colon – Spiral!



Equine Large Intestine

Figure 11-11, Page 280

- **Carnivores**: simple, tubular colon; poorly developed cecum
- **Nonruminant herbivores**: very large colon and cecum (hindgut)
  - Fermentation site



Hindgut Digestion

- Equine, guinea pigs, rats, rabbits
- Modifications of cecum and colon allow fermentative digestion in hindgut similar to rumen

Rectum

- Terminal portion of large intestine
- Nervous system control of motility and secretions is similar to that of the colon
- Numerous mucus-secreting glands lubricate and aid the passage of contents
- Sensory receptors detect stretching and stimulates the defecation response

Anus

- Composed of internal and external muscular sphincters
  - Internal sphincter is under autonomic control
  - External sphincter that is under voluntary control
- As the rectum distends, stretch receptors in rectum wall cause partial relaxation of the internal sphincter
- Anal mucosal receptors increase the sense or need for defecation

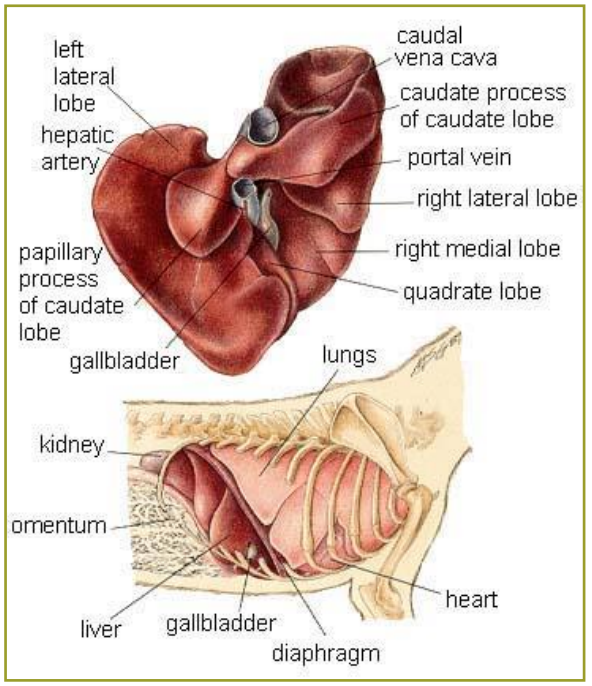
Accessory Organs

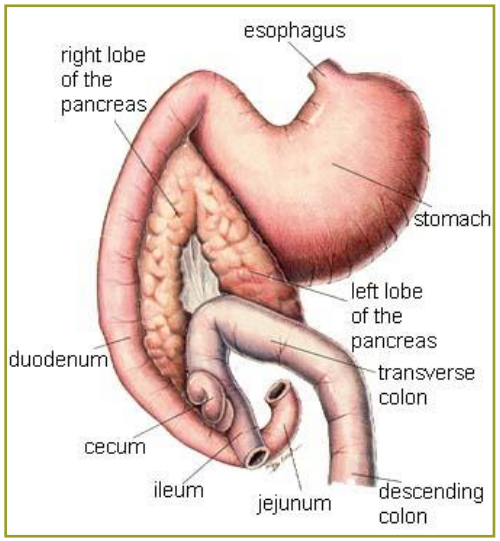
Liver

Pancreas

Related Organs

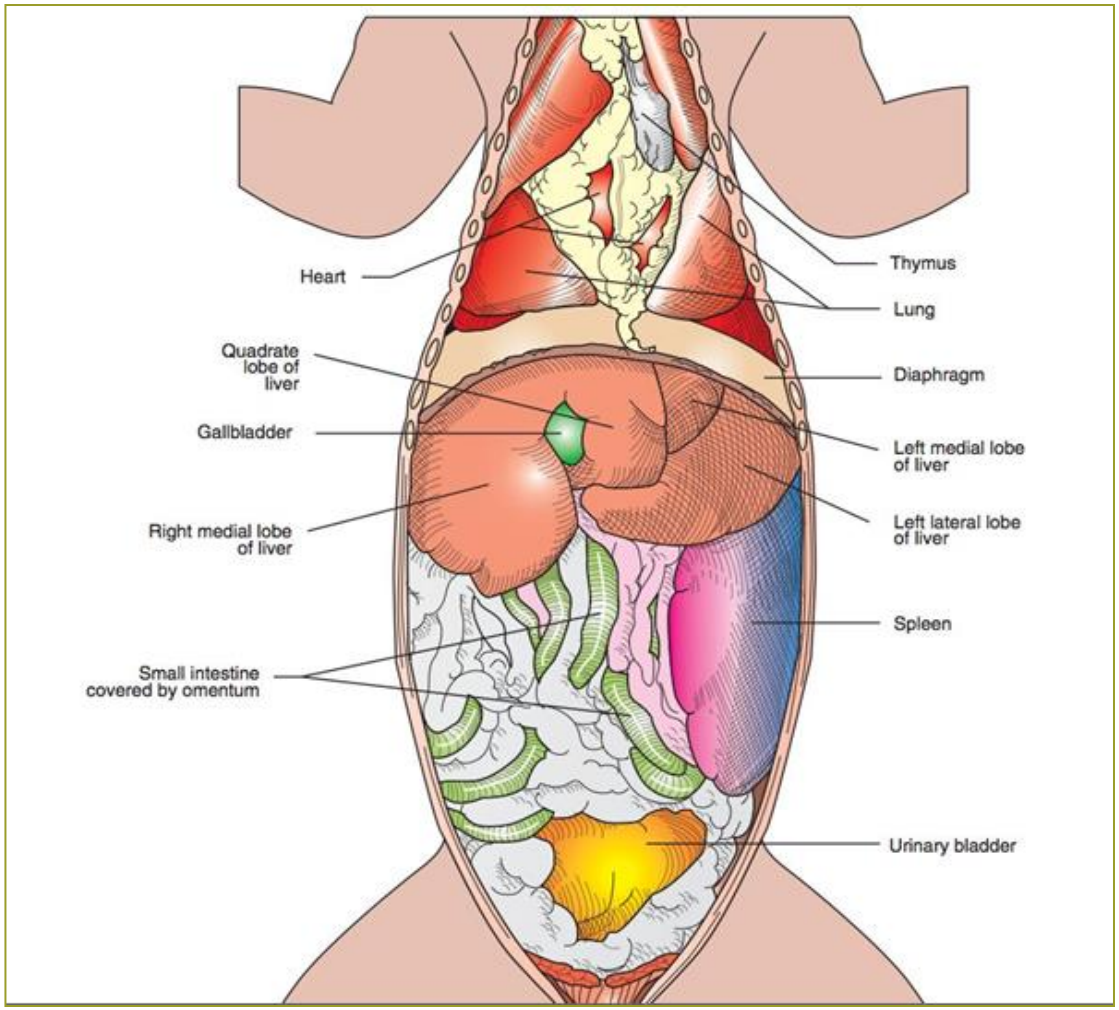
- Liver
  - Gall bladder
  - Common bile duct
- Pancreas
  - Exocrine functions
    - Pancreatic duct
  - Endocrine functions
    - Insulin
    - Glucagon



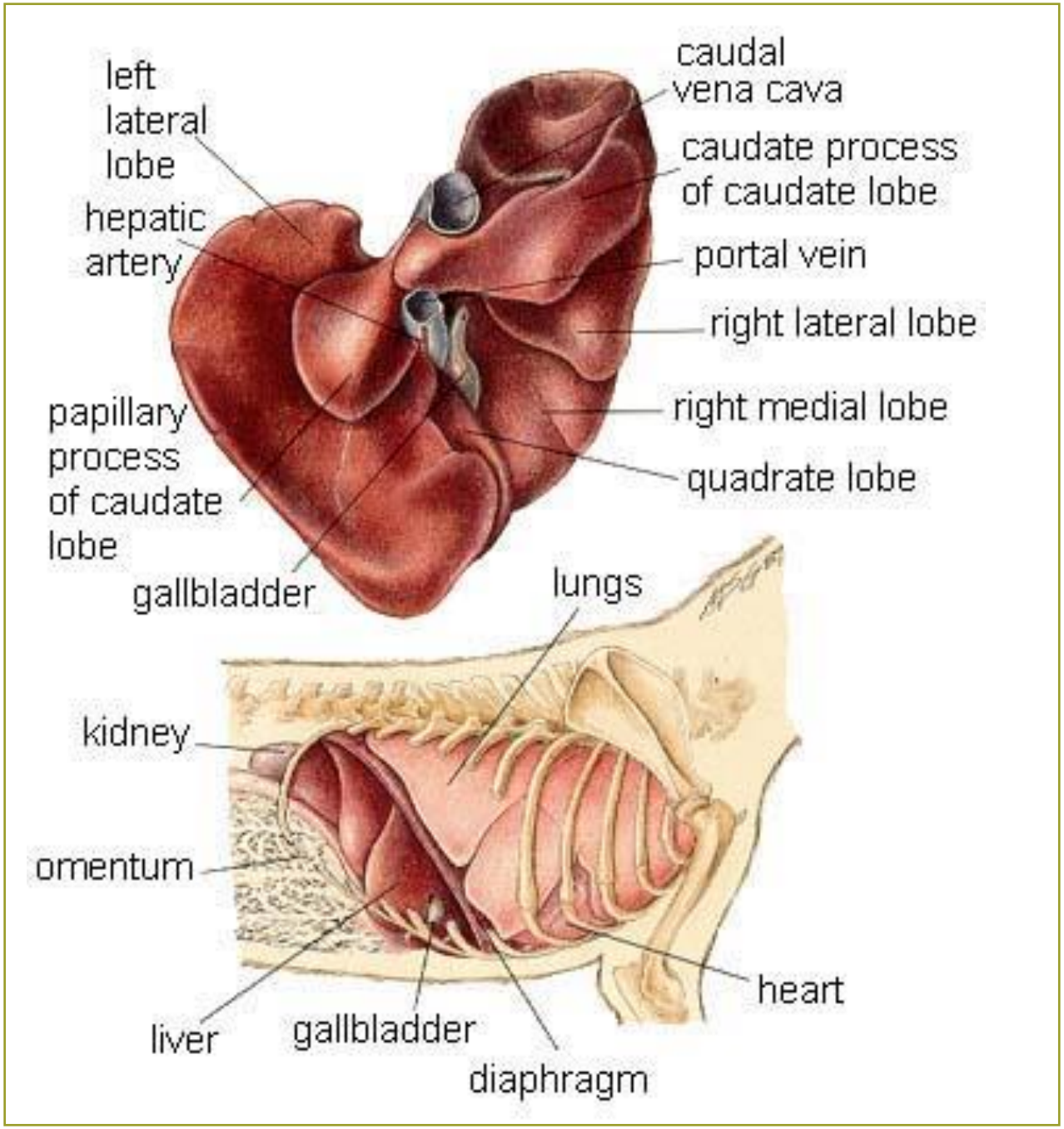


Location of Liver

Bassert Lab Manual – Page 284



Liver


caudal
vena cava
left
lateral
lobe
caudate process
of caudate lobe
hepatic
artery
portal vein
right lateral lobe
papillary
process
of caudate
lobe
right medial lobe
quadrate lobe
gallbladder
lungs
kidney
omentum
heart
liver
gallbladder
diaphragm

Functions of Liver

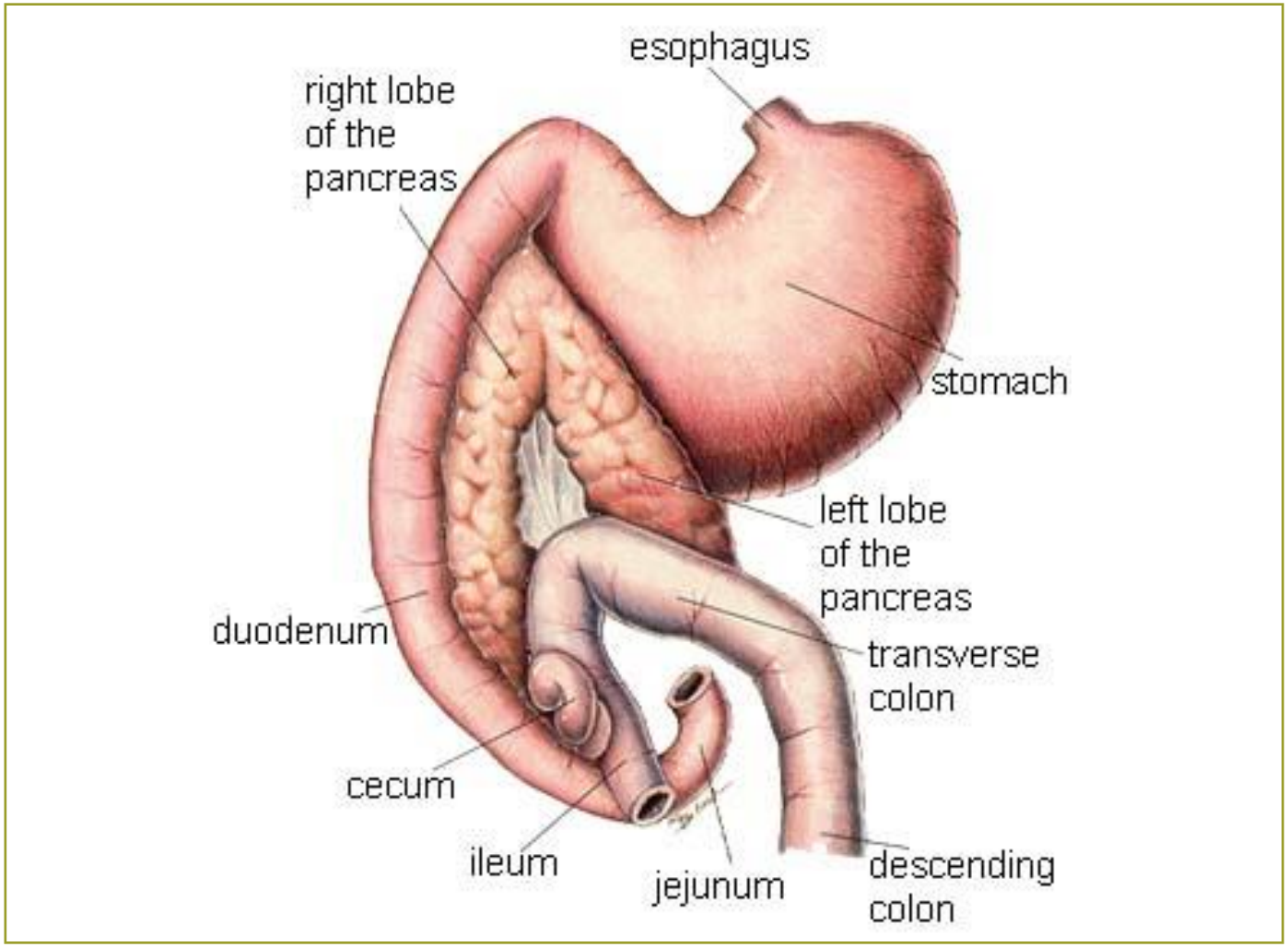
- Produces **bile** – bile acids, cholesterol, bilirubin
  - Secreted into bile ducts, on to hepatic duct, then to gallbladder for storage
- Removes toxins, infectious agents, and so forth that enter the body through the wall of the GI tract
- Stores or metabolizes nutrients absorbed from the GI tract
  - **Glucose → Glycogen**

Other Functions of Liver

Table 16.2 Functions of the Liver

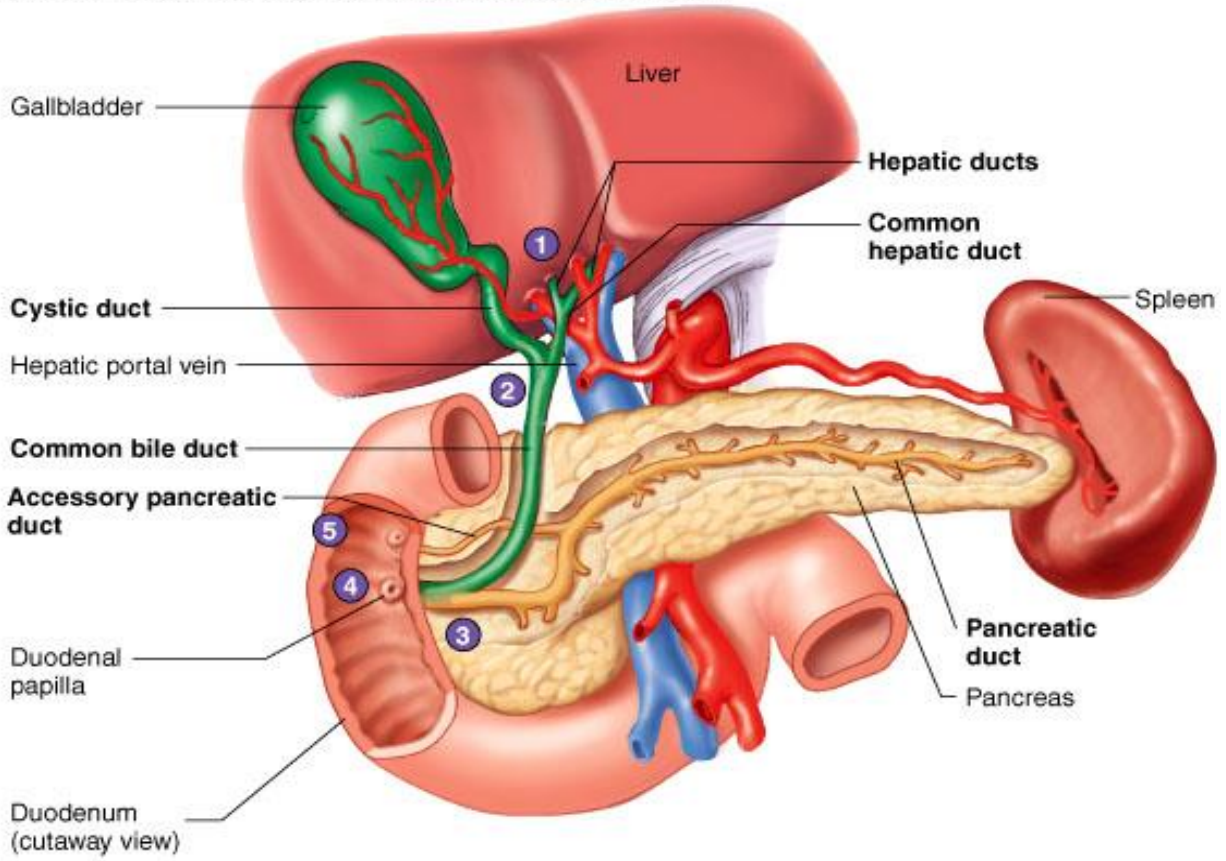
Function	Explanation
Digestion	Bile neutralizes stomach acid and emulsifies fats, which facilitates fat digestion
Excretion	Bile contains excretory products such as cholesterol, fats, and bile pigments, such as bilirubin, that result from hemoglobin breakdown
Nutrient storage	Liver cells remove sugar from the blood and store it in the form of glycogen; also store fat, vitamins (A, B_{12}, D, E, and K), copper, and iron
Nutrient conversion	Liver cells convert some nutrients into others, for example, amino acids can be converted to lipids or glucose; fats can be converted to phospholipids; vitamin D is converted to its active form
Detoxification of harmful chemicals	Liver cells remove ammonia from the circulation and convert it to urea, which is eliminated in the urine; other substances are detoxified and secreted in the bile or excreted in the urine
Synthesis of new molecules	Synthesizes blood proteins such as albumin, fibrinogen, globulins, and clotting factors

Location of Pancreas



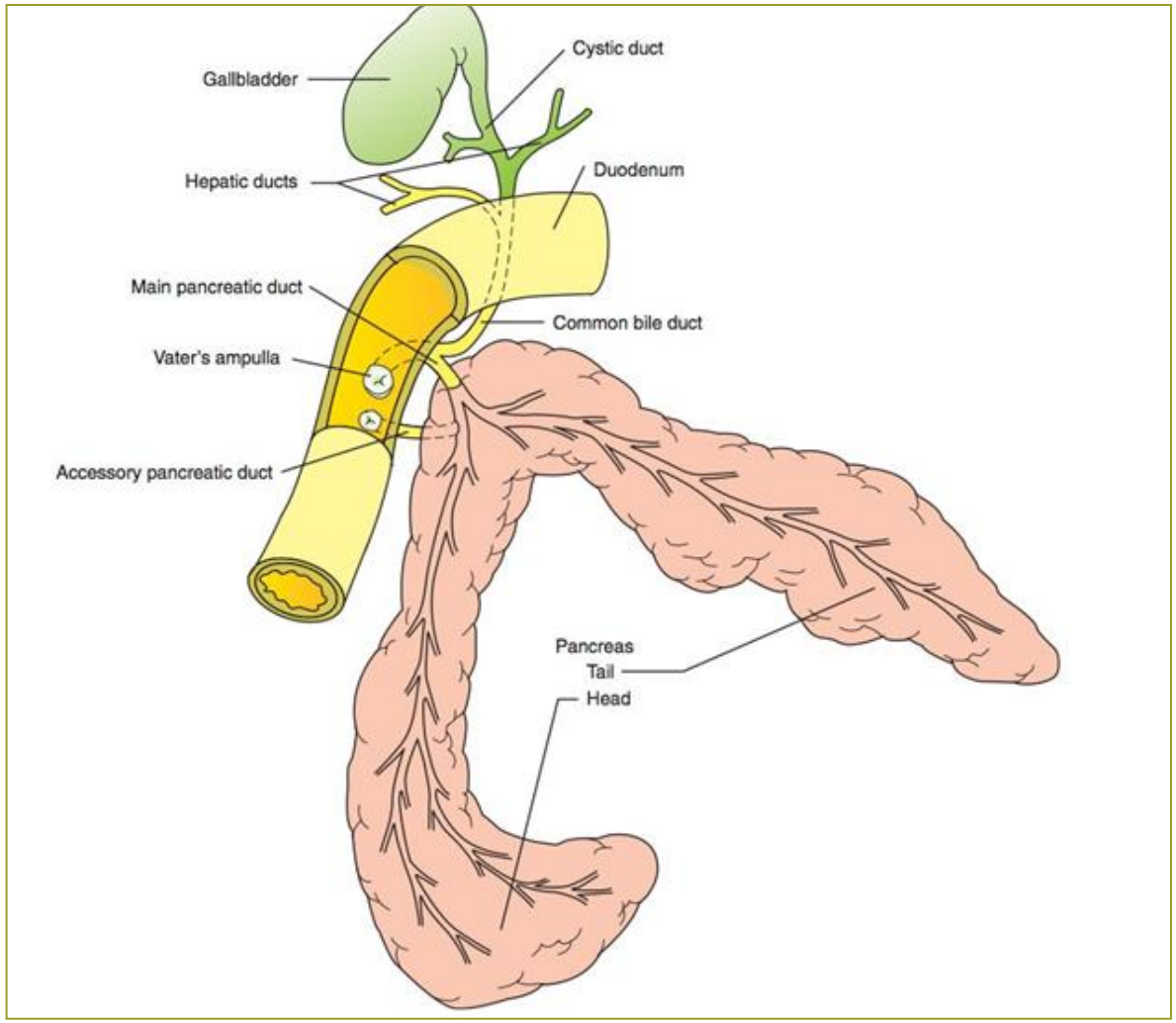
Liver, Pancreas, & Ducts

1. The hepatic ducts from the liver lobes combine to form the common hepatic duct.
2. The common hepatic duct combines with the cystic duct from the gallbladder to form the common bile duct.
3. The common bile duct joins the pancreatic duct.
4. The combined duct empties into the duodenum at the duodenal papilla.
5. Pancreatic secretions may also enter the duodenum through an accessory pancreatic duct, which also empties into the duodenum.



Pancreatic & Common Bile Ducts

Bassert Lab Manual – Page 285

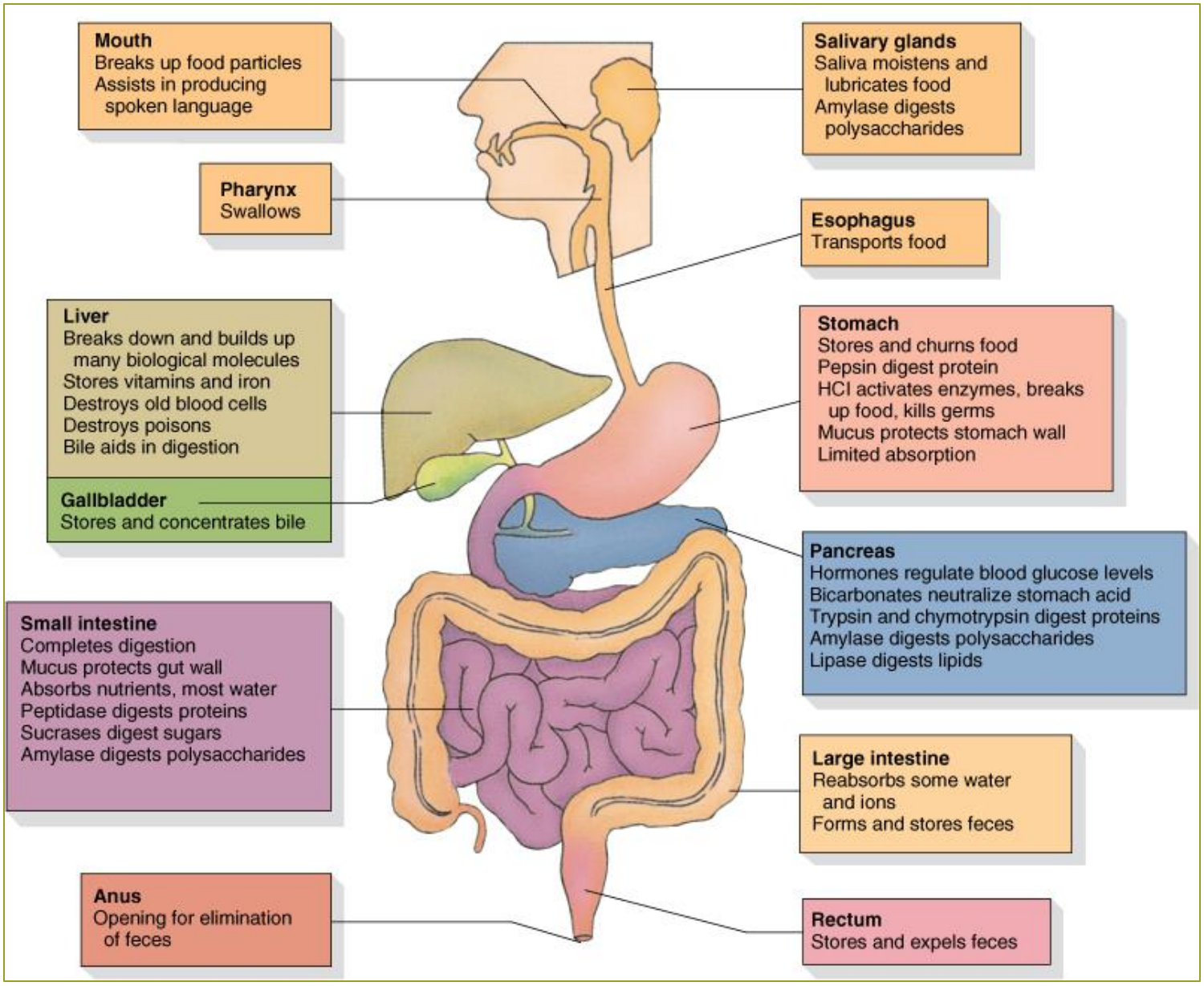


Functions of Pancreas

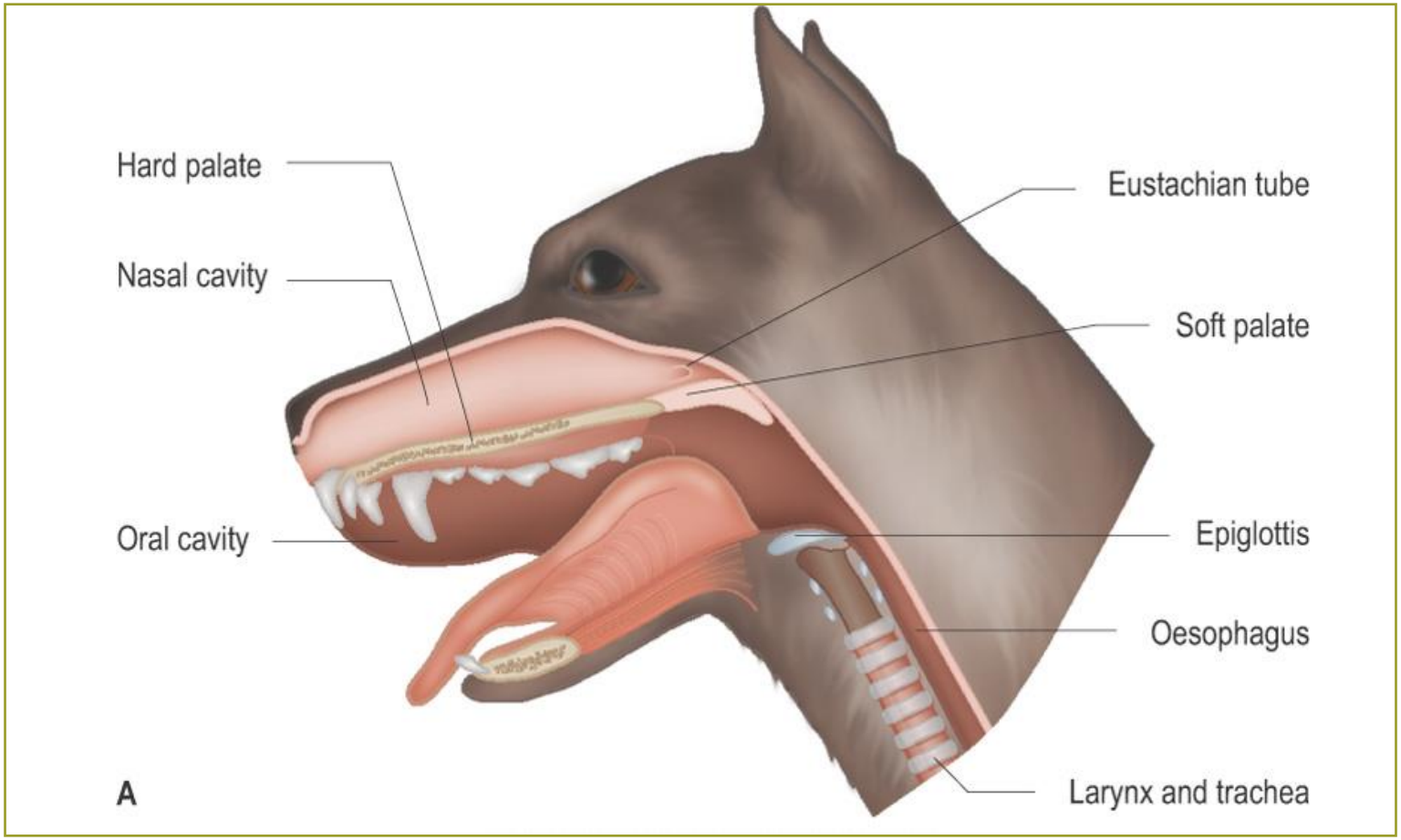
- Only gland in body with both exocrine and endocrine functions!!!
- Production of pancreatic amylase, proteases, and lipase
- Secretes bicarbonate into the duodenum
  - Helps neutralize acidity of contents and maintains the pH in the duodenum needed for proper enzyme function
- Produces **insulin and glucagon**
  - Help regulate blood glucose levels

GIT Physiology

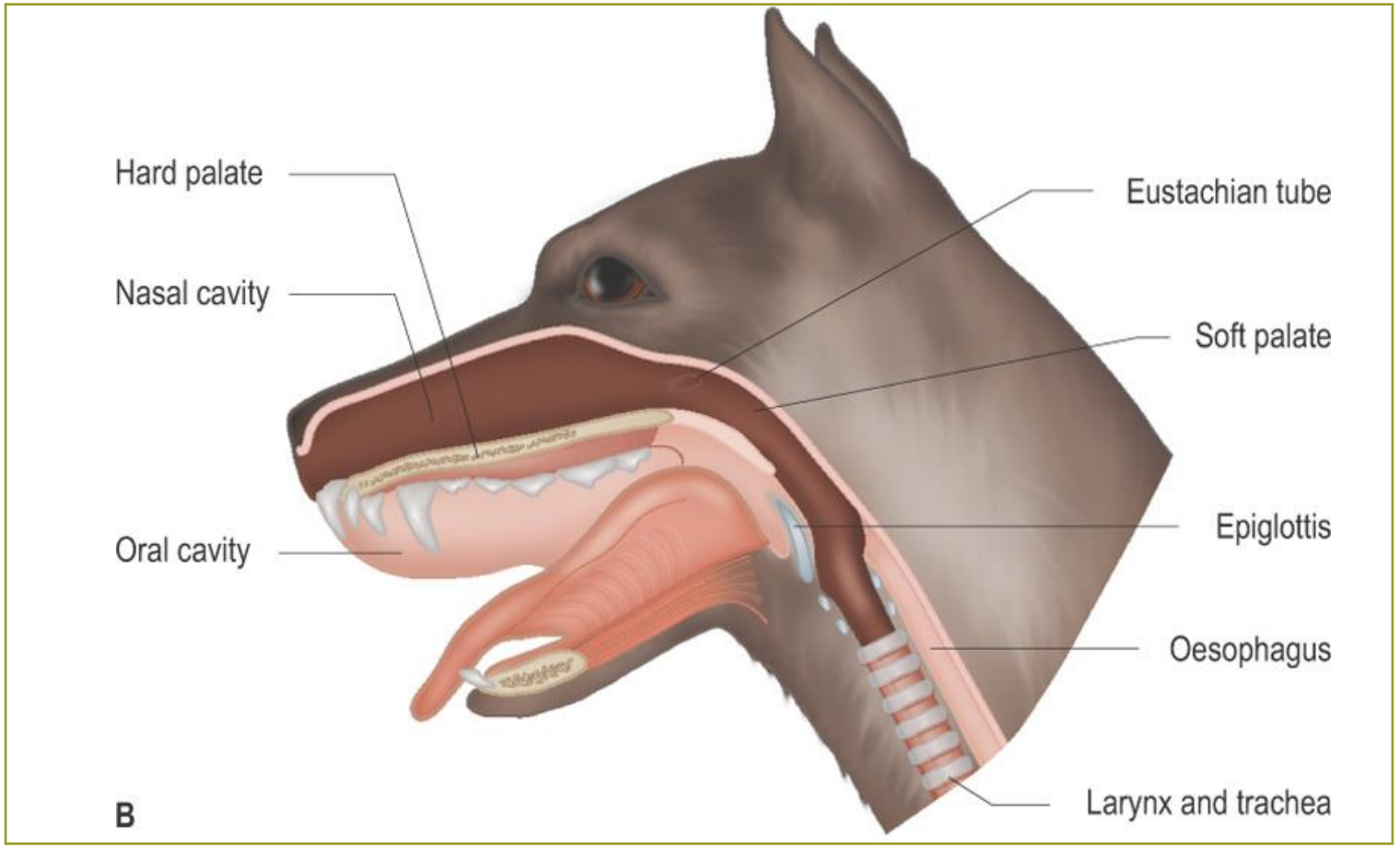
Lots going on! ☺


Mouth
Breaks up food particles
Assists in producing spoken language
Pharynx
Swallows
Liver
Breaks down and builds up many biological molecules
Stores vitamins and iron
Destroys old blood cells
Destroys poisons
Bile aids in digestion
Gallbladder
Stores and concentrates bile
Small intestine
Completes digestion
Mucus protects gut wall
Absorbs nutrients, most water
Peptidase digests proteins
Sucrases digest sugars
Amylase digests polysaccharides
Anus
Opening for elimination of feces
Salivary glands
Saliva moistens and lubricates food
Amylase digests polysaccharides
Esophagus
Transports food
Stomach
Stores and churns food
Pepsin digest protein
HCl activates enzymes, breaks up food, kills germs
Mucus protects stomach wall
Limited absorption
Pancreas
Hormones regulate blood glucose levels
Bicarbonates neutralize stomach acid
Trypsin and chymotrypsin digest proteins
Amylase digests polysaccharides
Lipase digests lipids
Large intestine
Reabsorbs some water and ions
Forms and stores feces
Rectum
Stores and expels feces

Swallowing


Hard palate
Nasal cavity
Oral cavity
Eustachian tube
Soft palate
Epiglottis
Oesophagus
Larynx and trachea
A

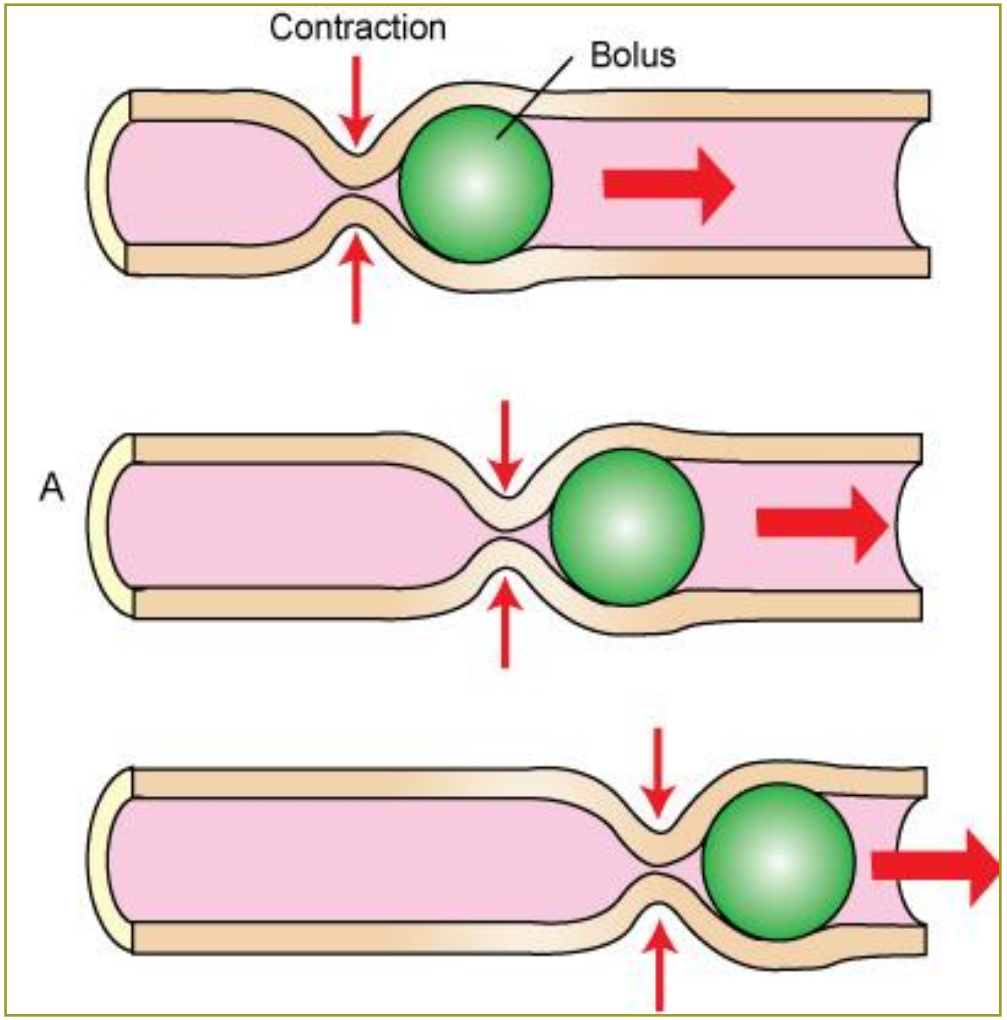
Breathing


Hard palate
Nasal cavity
Oral cavity
Eustachian tube
Soft palate
Epiglottis
Oesophagus
Larynx and trachea
B

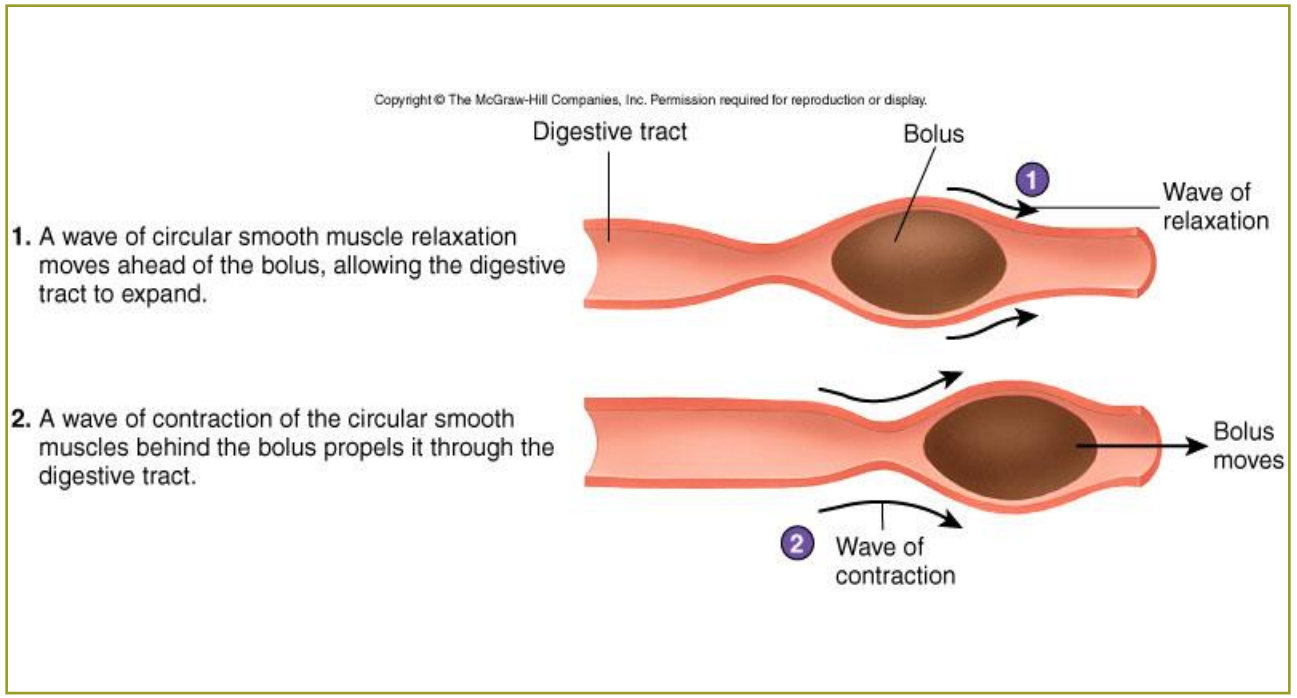
Peristalsis

Figure 11-3A, Page 267

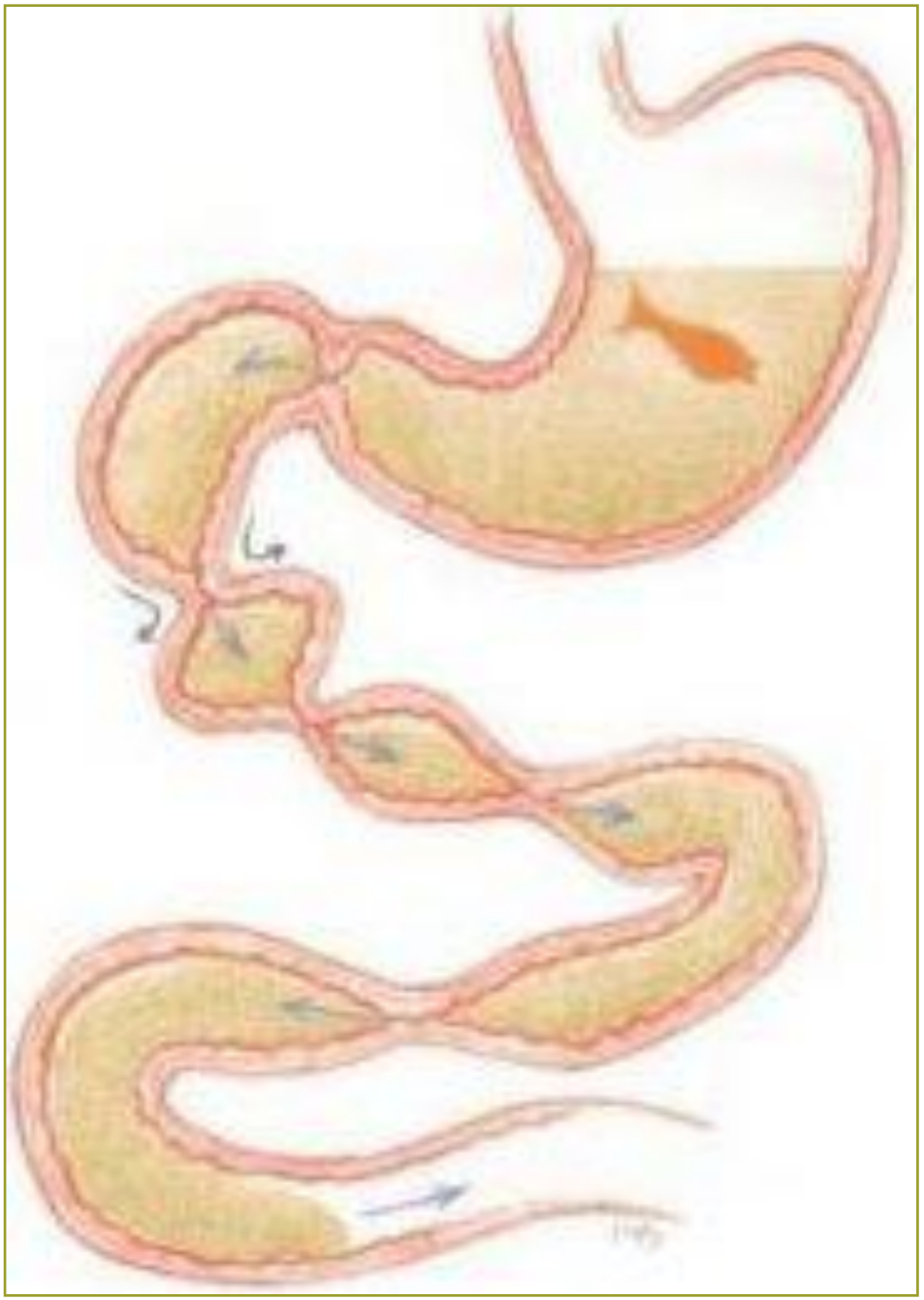
- Circular muscle contractions
- Wavelike movement along the tract
- Propel digestive tract contents along the tube ahead of them



Peristalsis



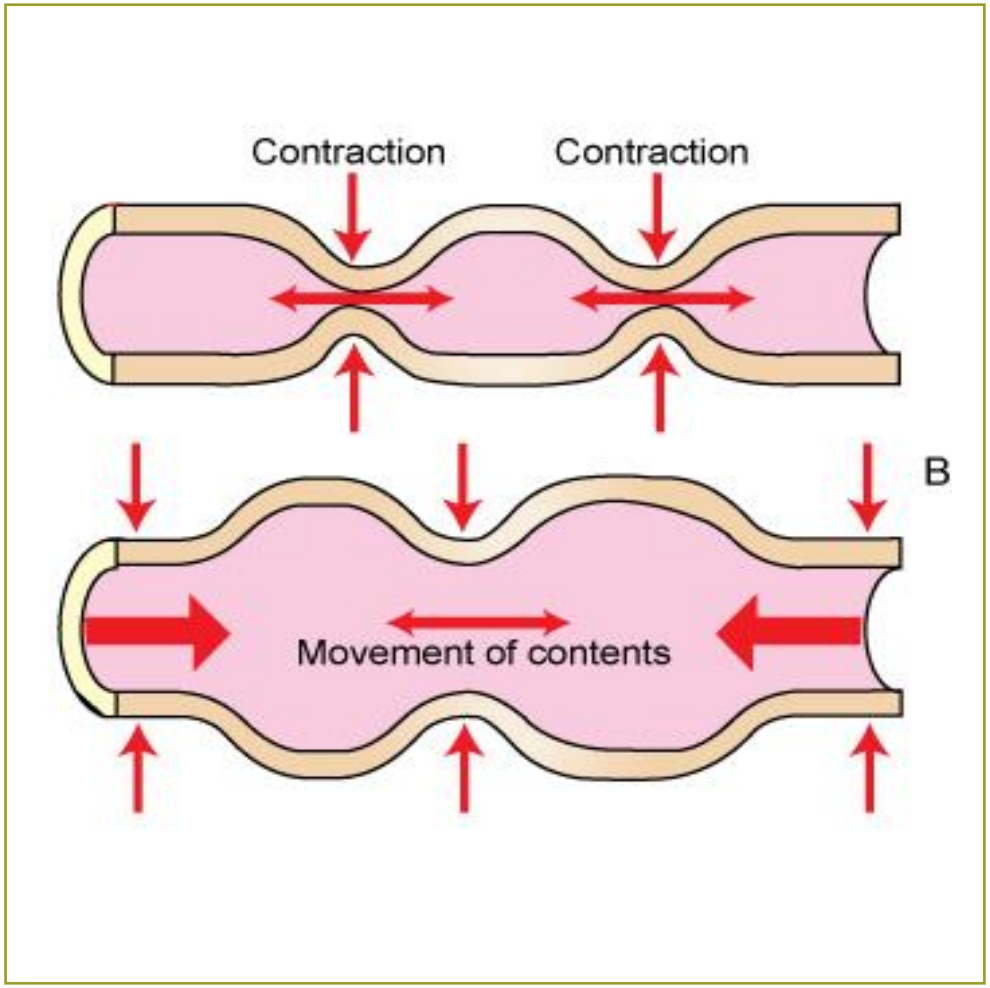
Peristalsis



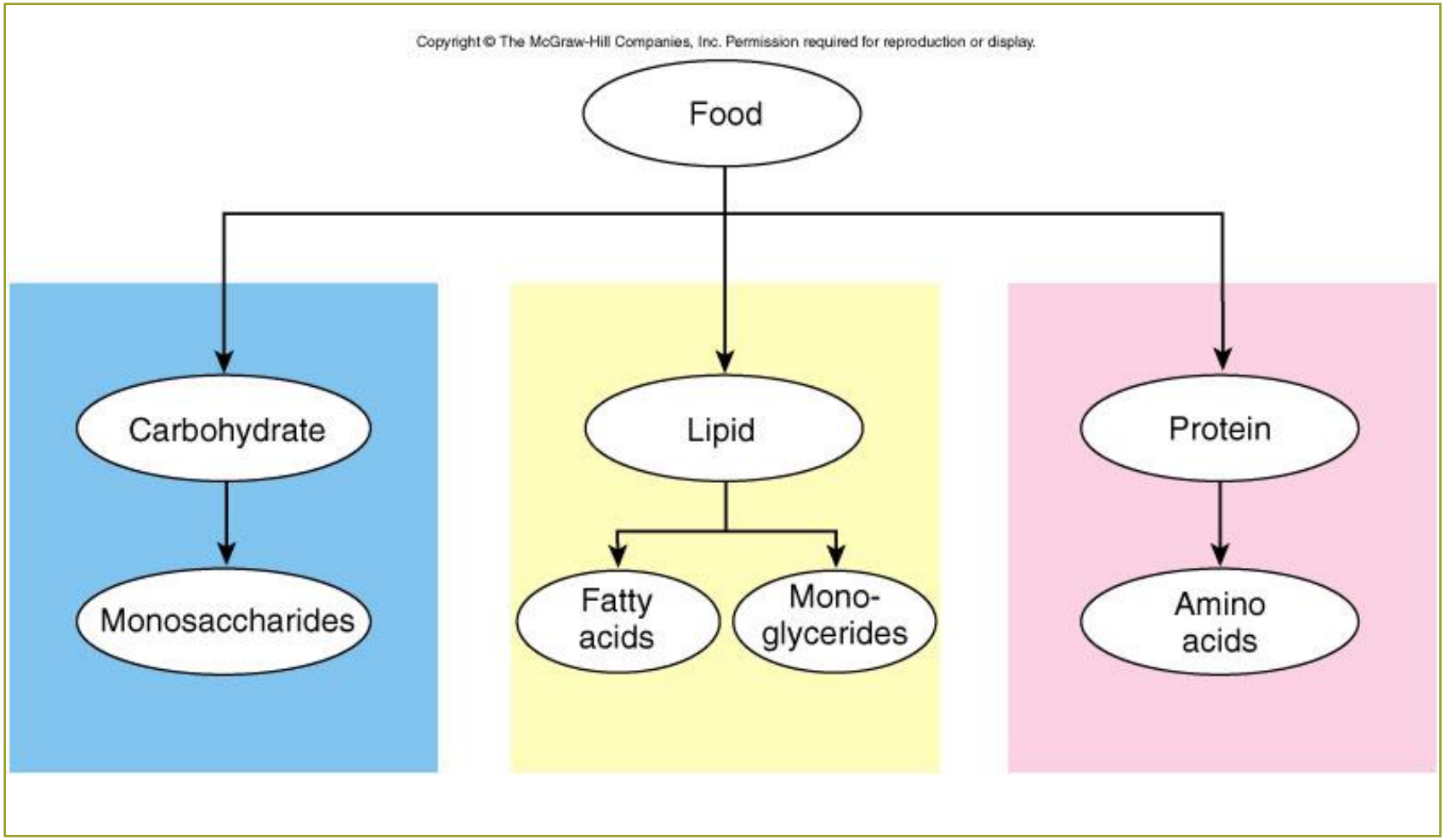
Segmental Contractions

Figure 11-3B, Page 267

- Periodic circular muscle contractions
- Occur in different adjacent sites
- Mixes digestive tract contents and slows their movement through GIT



Physiology of Digestion

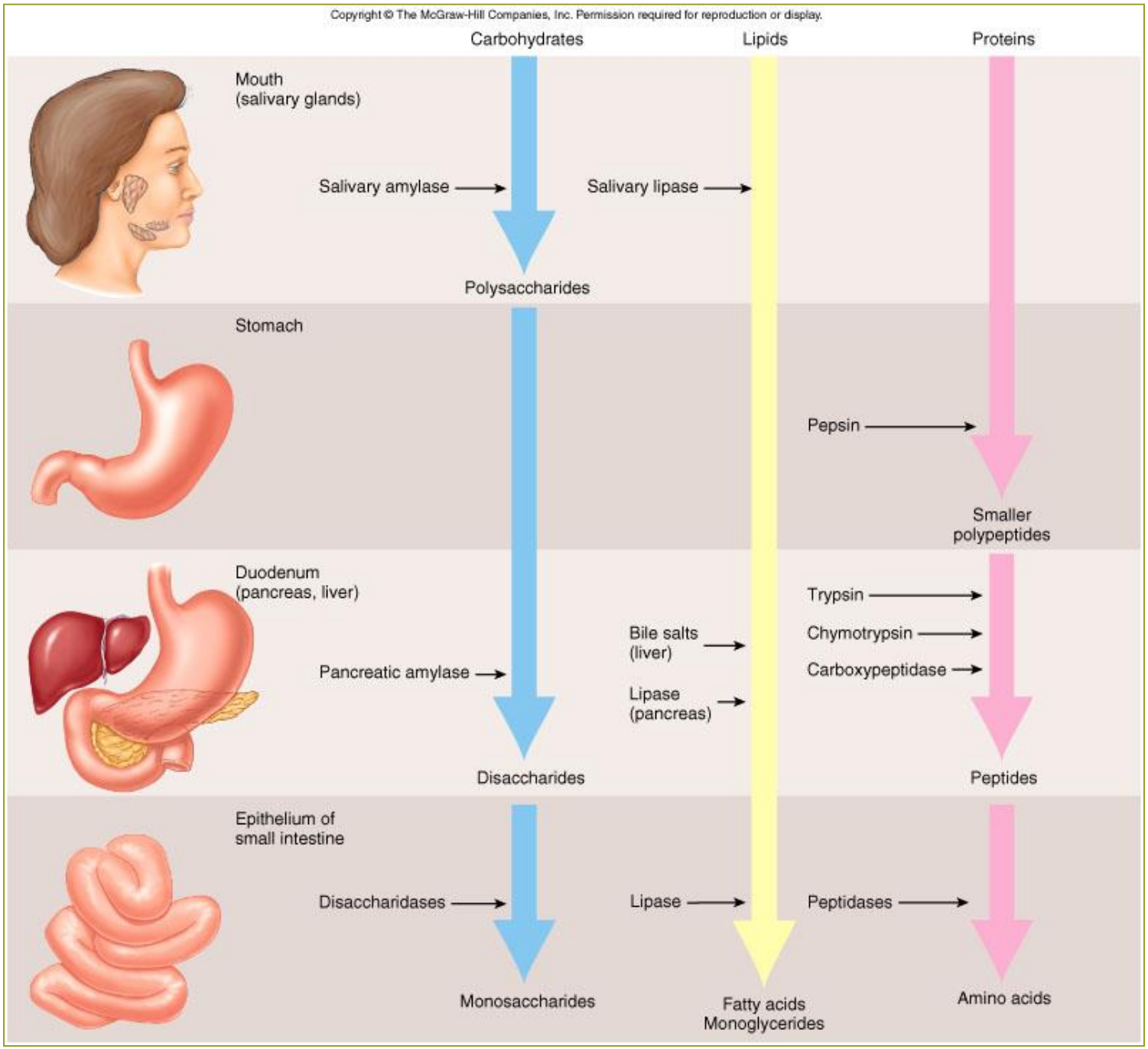


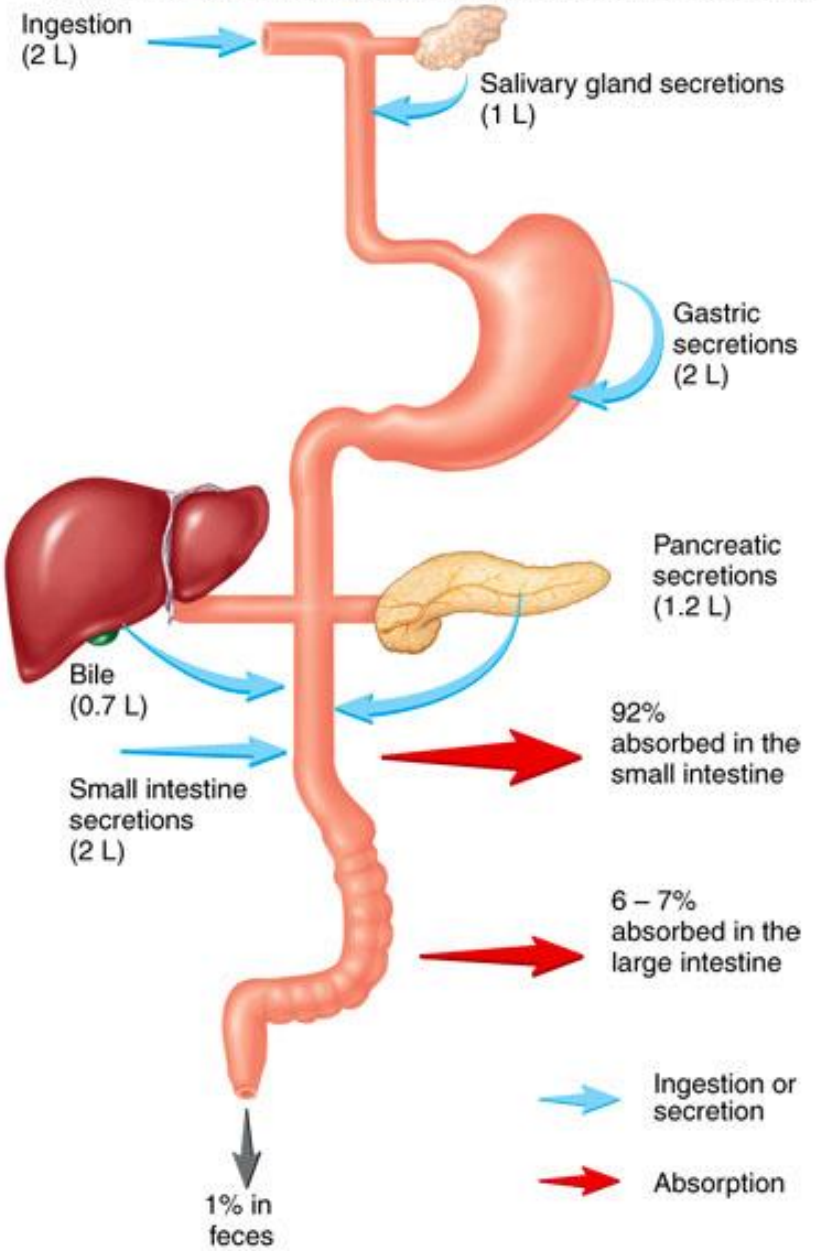
Pancreatic Digestive Enzymes

- **Amylase** – enzyme in saliva of omnivores
  - Breaks down amylose (sugar component of starch)
- **Lipase** – enzyme that digests lipids
  - May be found in the saliva of some young animals while they are nursing or on a high-milk diet
- **Protease** – enzyme that digests proteins

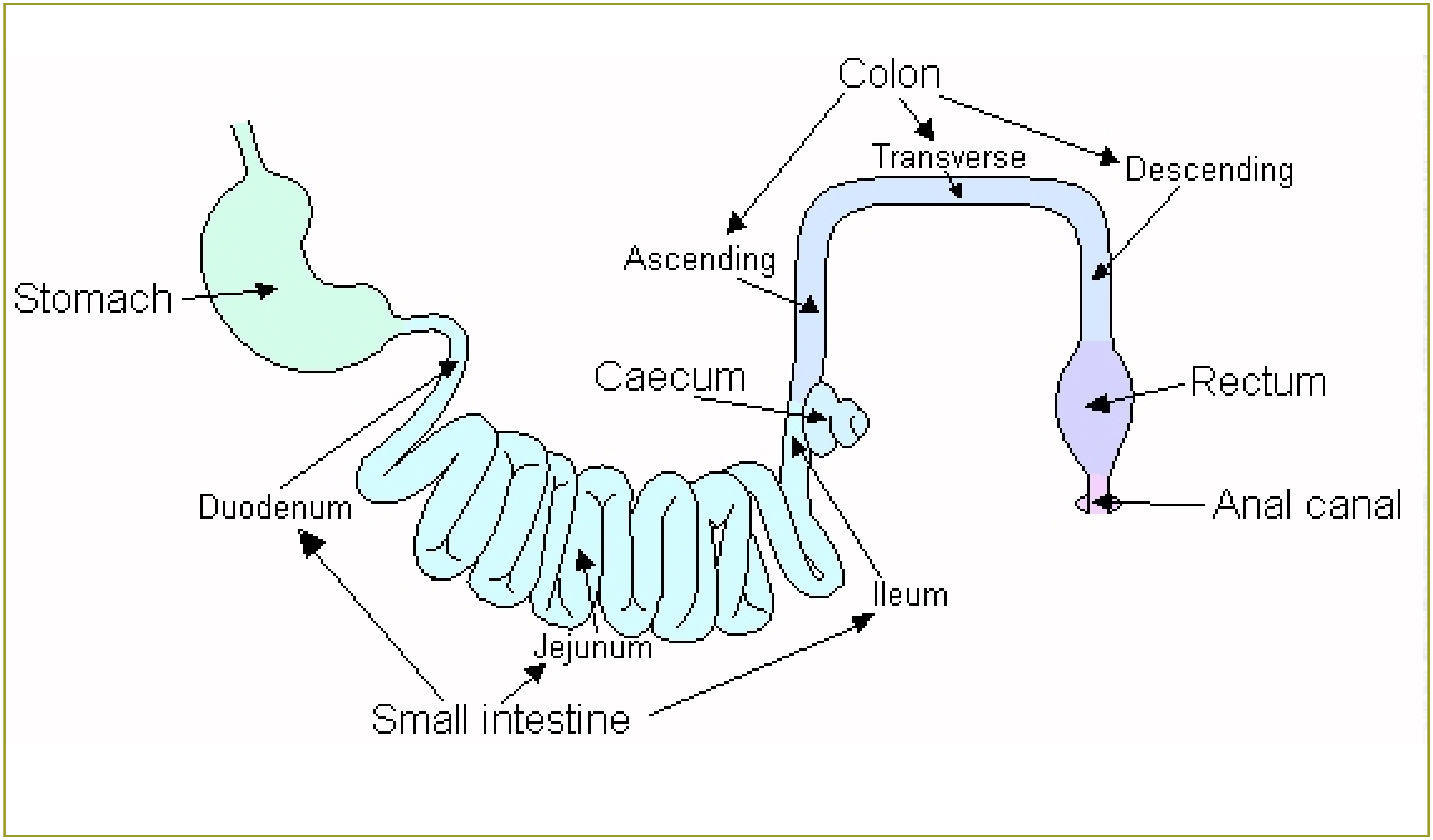
Nervous System & Digestion

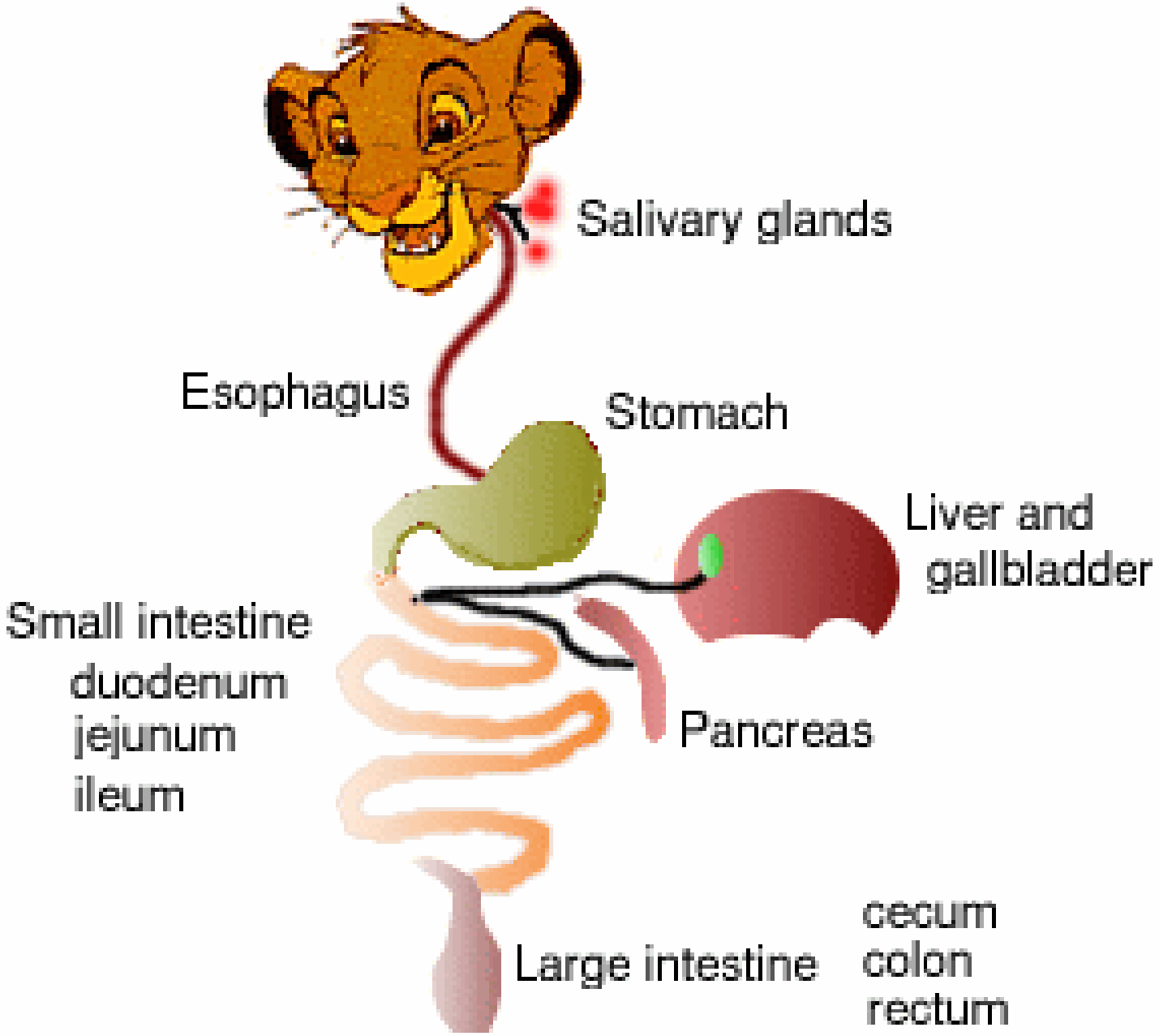
- Autonomic nervous system controls most of the glands in the digestive system
- Parasympathetic stimulation increases salivation.
  - Anticipation of eating can cause parasympathetic stimulation of the salivary glands
- Sympathetic nervous system stimulation decreases salivation
  - Fear or parasympathetic nervous system inhibitors like atropine produce dry mouth



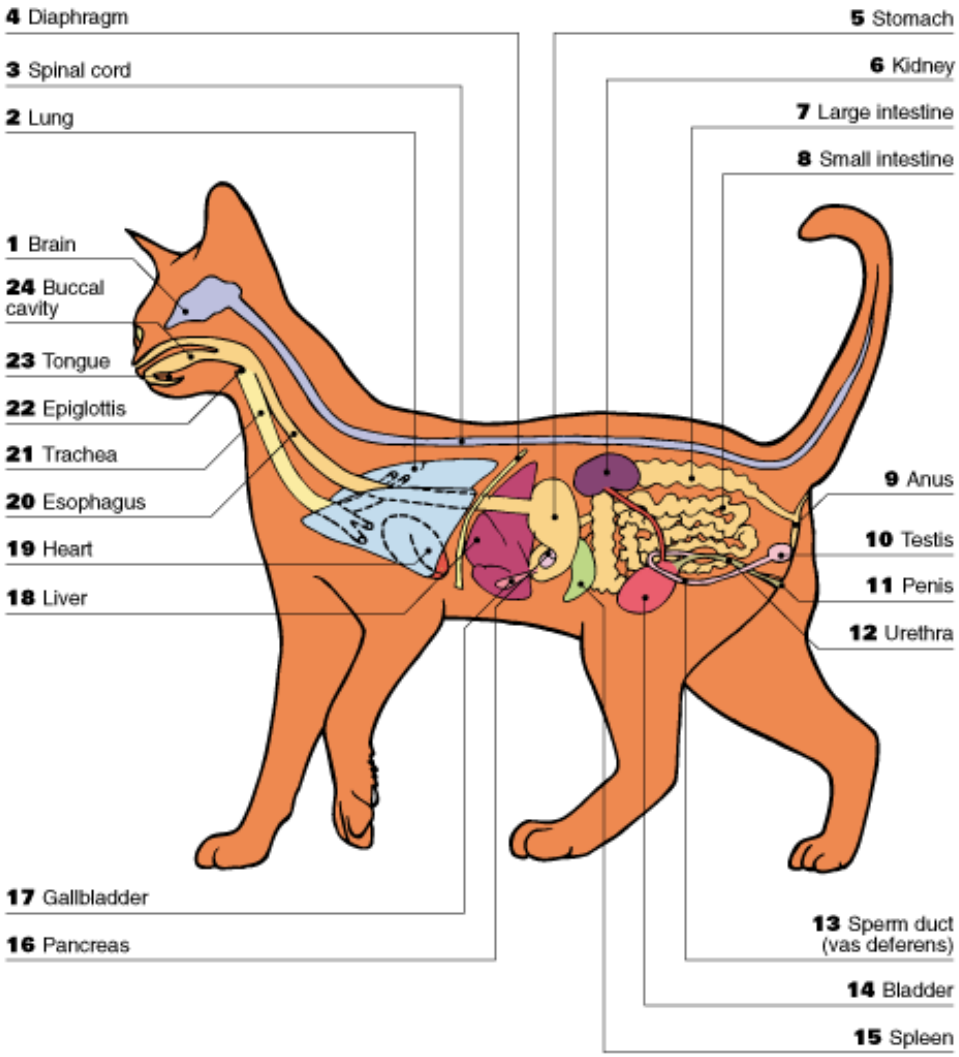


GIT Review – Trace a Bolus of Food

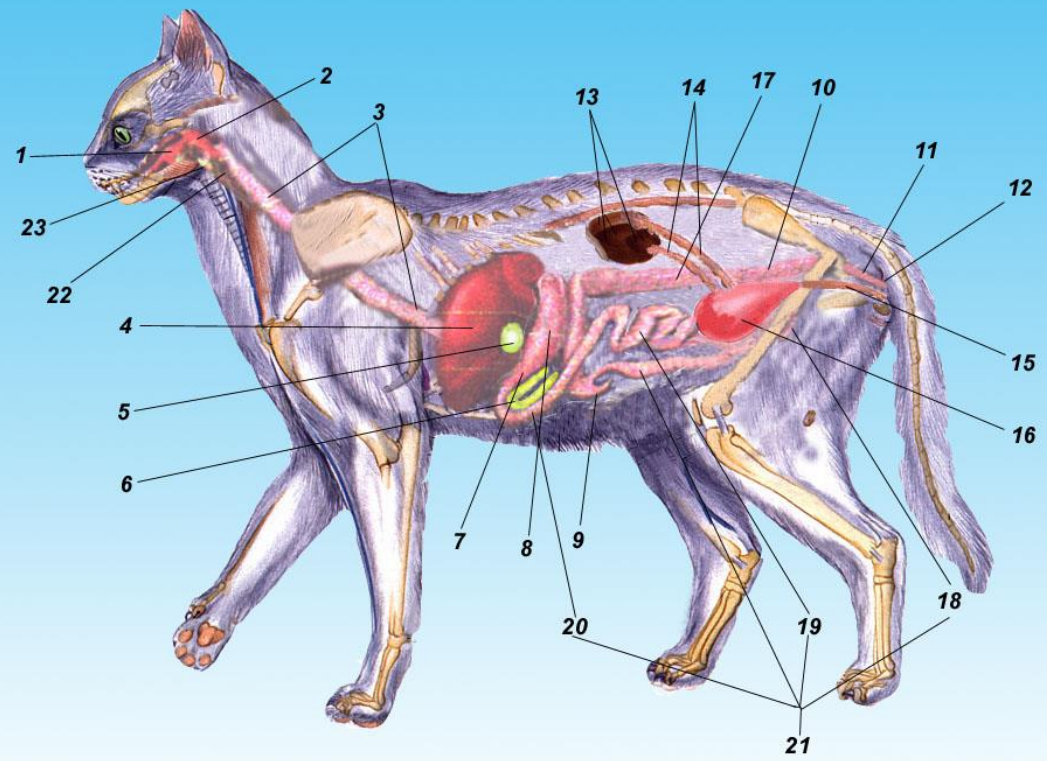



Salivary glands
Esophagus
Stomach
Liver and
gallbladder
Small intestine
duodenum
jejunum
ileum
Pancreas
Large intestine
cecum
colon
rectum

Male cat



Digestive & Urinary Systems



1. Tongue
2. Pharynx
3. Esophagus
4. Liver
5. Gall Bladder
6. Pancreas
7. Pylorus
8. Stomach
9. Cecum
10. Colon
11. Rectum
12. Anus
13. Kidneys
14. Ureters
15. Urethra
16. Urinary Bladder
17. Large Intestine
18. Ileum
19. Jejenum
20. Duodenum
21. Small Intestine
22. Trachea (cut)
23. Epiglottis

Parasites of GIT

Parasite	Location	Who?
Roundworms	S.I.	Puppies, Kittens
Hookworms	S.I.	Dogs, Cats
Whipworms	L.I.	Dogs
Tapeworms	S.I.	Dogs, Cats
Coccidia	S.I.	Puppies, Kittens

Small Animal GIT Pathology

- Stomatitis
- Glossitis
- Gingivitis
- Periodontitis
- Dental caries
- Pharyngitis
- Gastritis
- Gastroenteritis
- Enteritis
- Colitis

Small Animal GIT Pathology

- Prostaglandins & NSAIDS (Page 247)
- Canine gastric bloat
- Gastric torsion
- Hepatitis
  - Jaundice (icterus)
- Pancreatitis
- Diabetes mellitus
- Coprophagy
- Lactose intolerance

No Gall Bladder

- Horse
- Rat

- Terms to also know – stomatitis, glossitis, tenesmus, prehension, mastication, anorexia, laparotomy, enterotomy, colotomy, anastomosis, rumenotomy, abomasopexy, gastropexy, intussusception, etc.

Large Animal GIT Pathology

- Bovine bloat (rumen)
- Displaced abomasum (DA)
- Equine Colic

Test Yourself

KNOW THESE IN EVERY CHAPTER!

Pages 270, 273, 277, 279, 282

Clinical Applications

Pages 270, 270, 270, 274, 276, 279