

# Nutrition

- Autotrophs
  - plants, some protists & bacteria
  - producers

# Nutrition

- Heterotrophs
  - animals, fungi, some protists & bacteria
  - consumers

# Animal Nutrition

- Most obtain food by ingestion
  - take in their food whole or piece by piece

# Animal Nutrition

- Classify based on what they eat:
  - **Herbivores** (primary consumers)
    - eat autotrophs
  - **Carnivores** (secondary or higher consumers)
    - eat heterotrophs
  - **Omnivores**
    - eat both

# Stages of Food Processing

- **Ingestion**
  - eating
- **Digestion**
  - breaking down food into small molecules
  - mechanical and chemical (enzymatic hydrolysis)
- **Absorption**
  - body takes in small molecules
- **Elimination**
  - undigested material exits the body

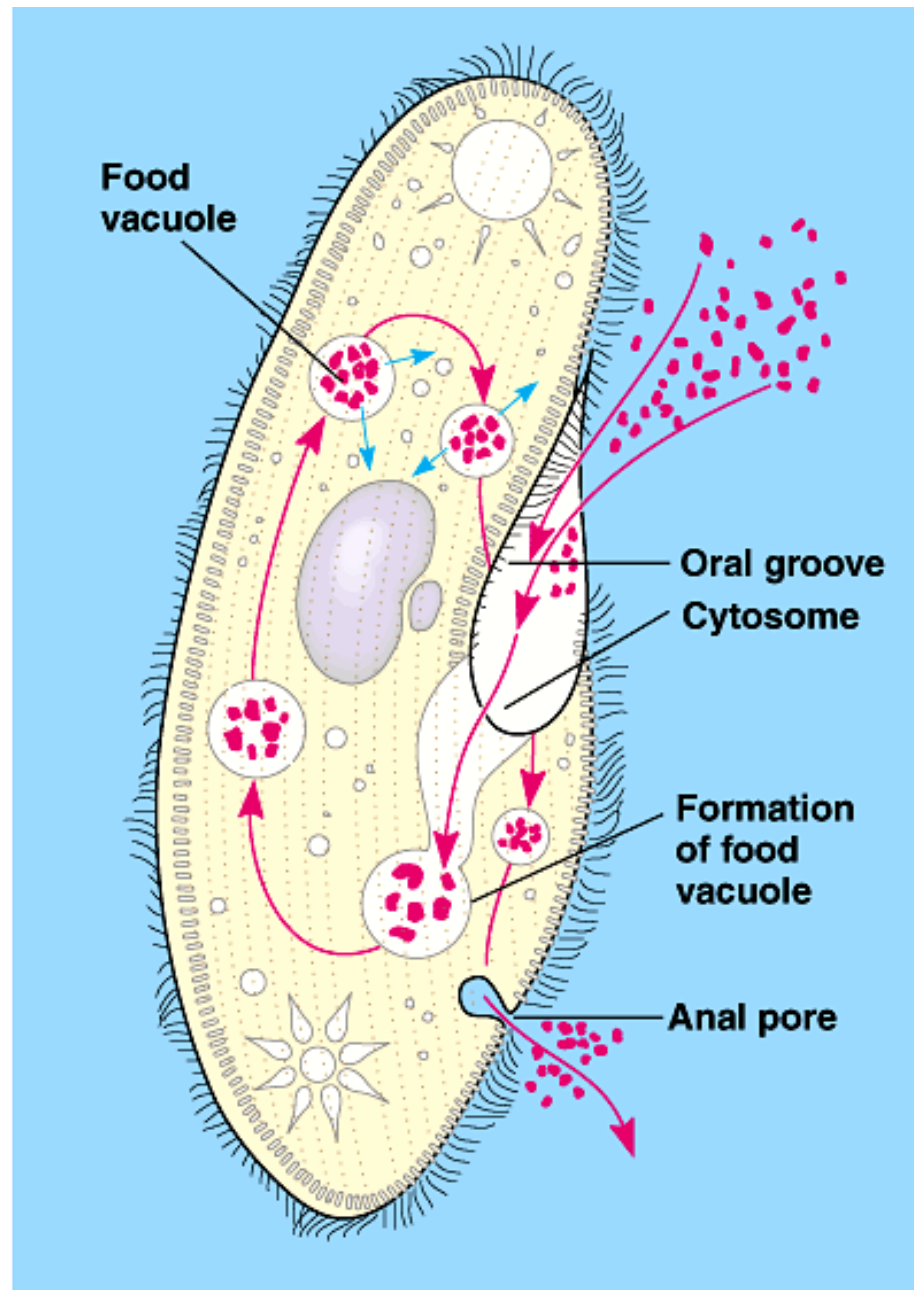
# Digestion

- Must take place in specialized compartments
- to avoid damage to body cells

# Food vacuoles

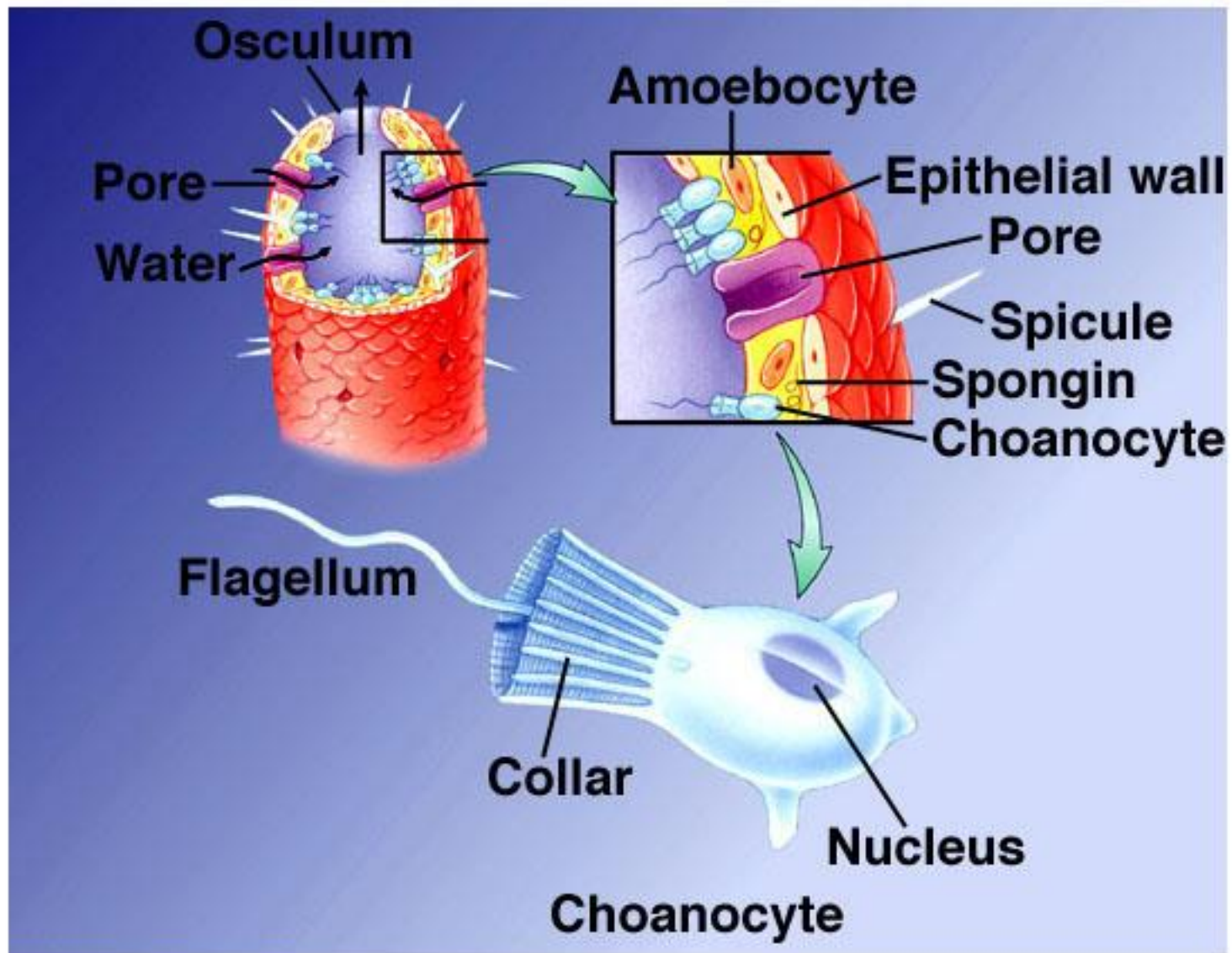
- food enters by endocytosis & then vacuole merges with lysosome
- Some protists
- Sponges
  - only animal with **only intracellular** digestion

Figure 41.10 Intracellular digestion in *Paramecium*





# Sponge Body Plan



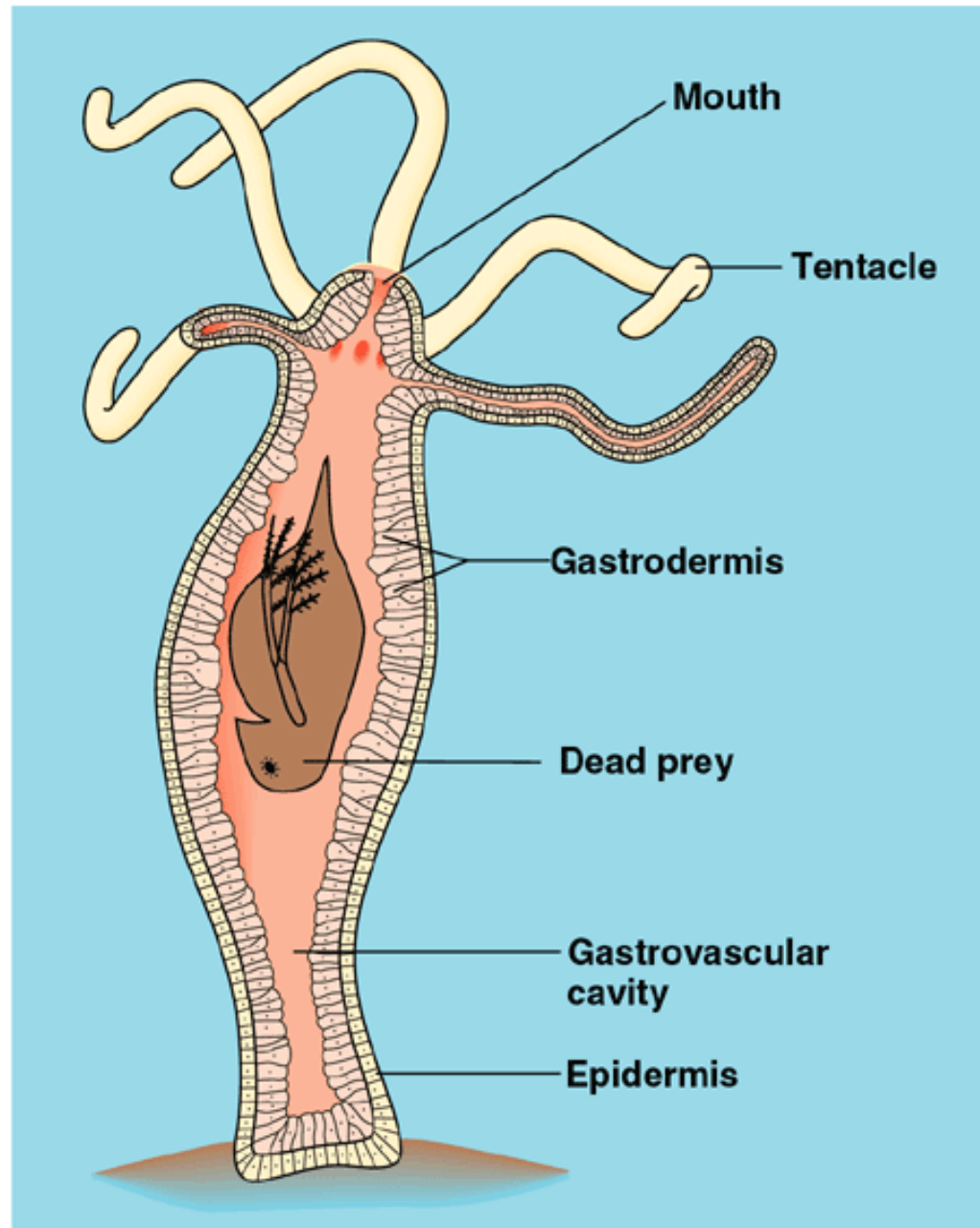
# Gastrovascular Cavities

- single opening
- serve to both digest & transport nutrients
- extracellular digestion, then intracellular
- Platyhelminthes (planaria) & Cnidarians (hydra)

What is the advantage of  
extracellular digestion?

Eat larger food

## Extracellular digestion in a gastrovascular cavity



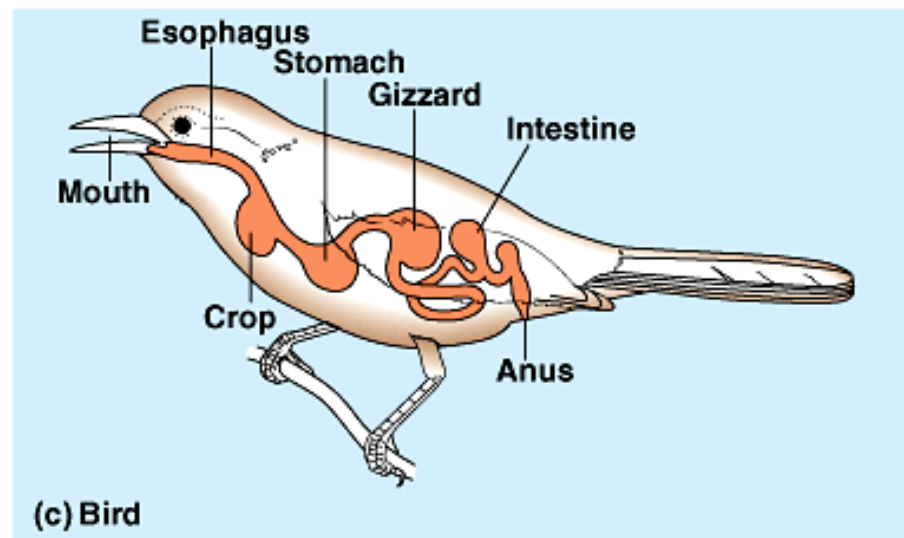
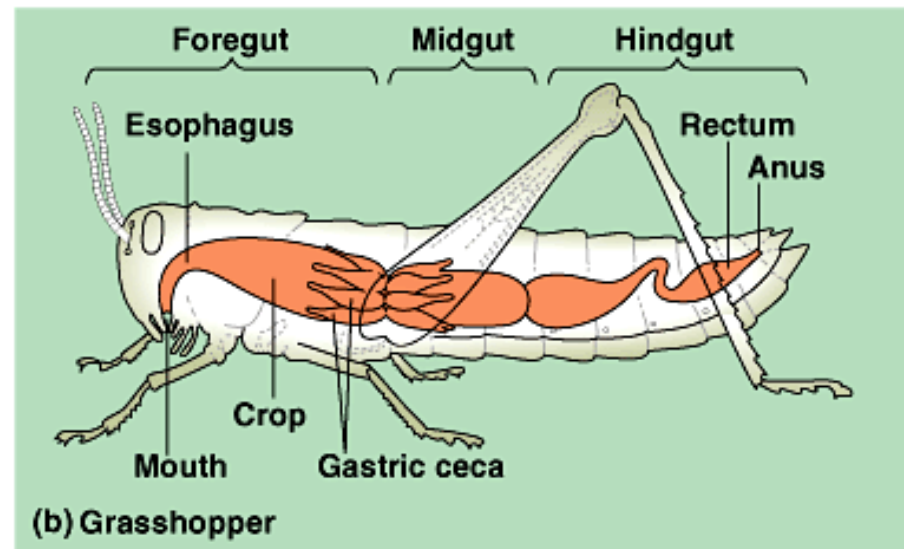
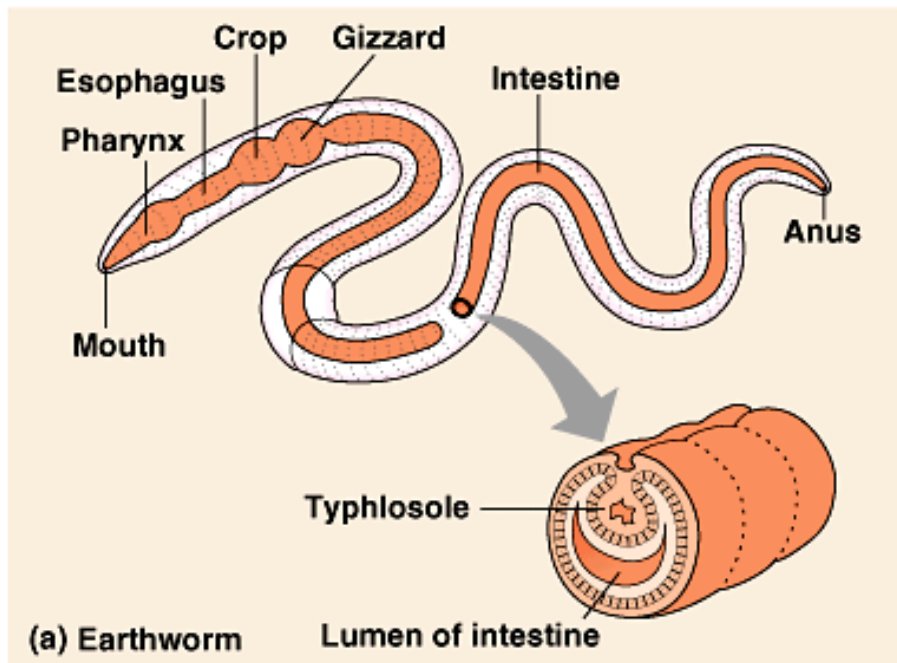
# Alimentary canals or Complete Digestive Tracts

- two openings: mouth & anus
- food passes in one direction
- Found in all other animals

# What is the advantage of one-way movement of food?

- Allows for specialization of different regions of the digestive tract

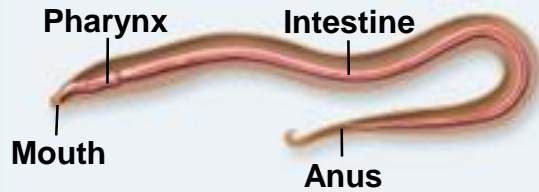
## Figure 41.12 Alimentary canals



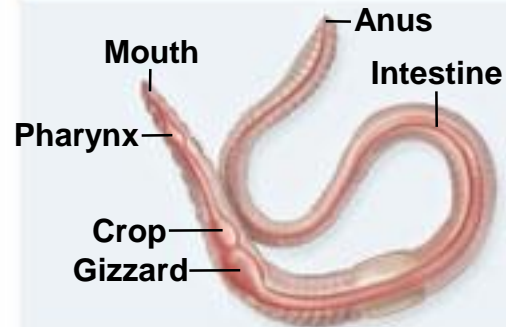
# Types of Digestive Systems

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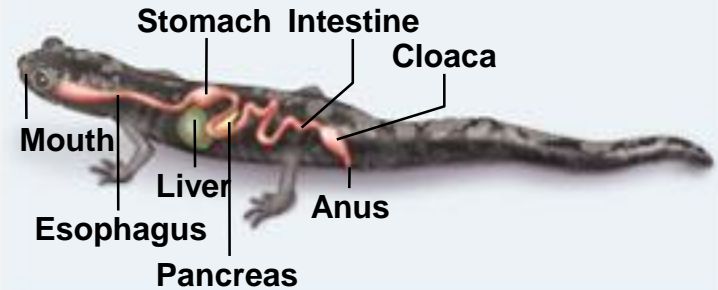
**Nematode**



**Earthworm**



**Salamander**

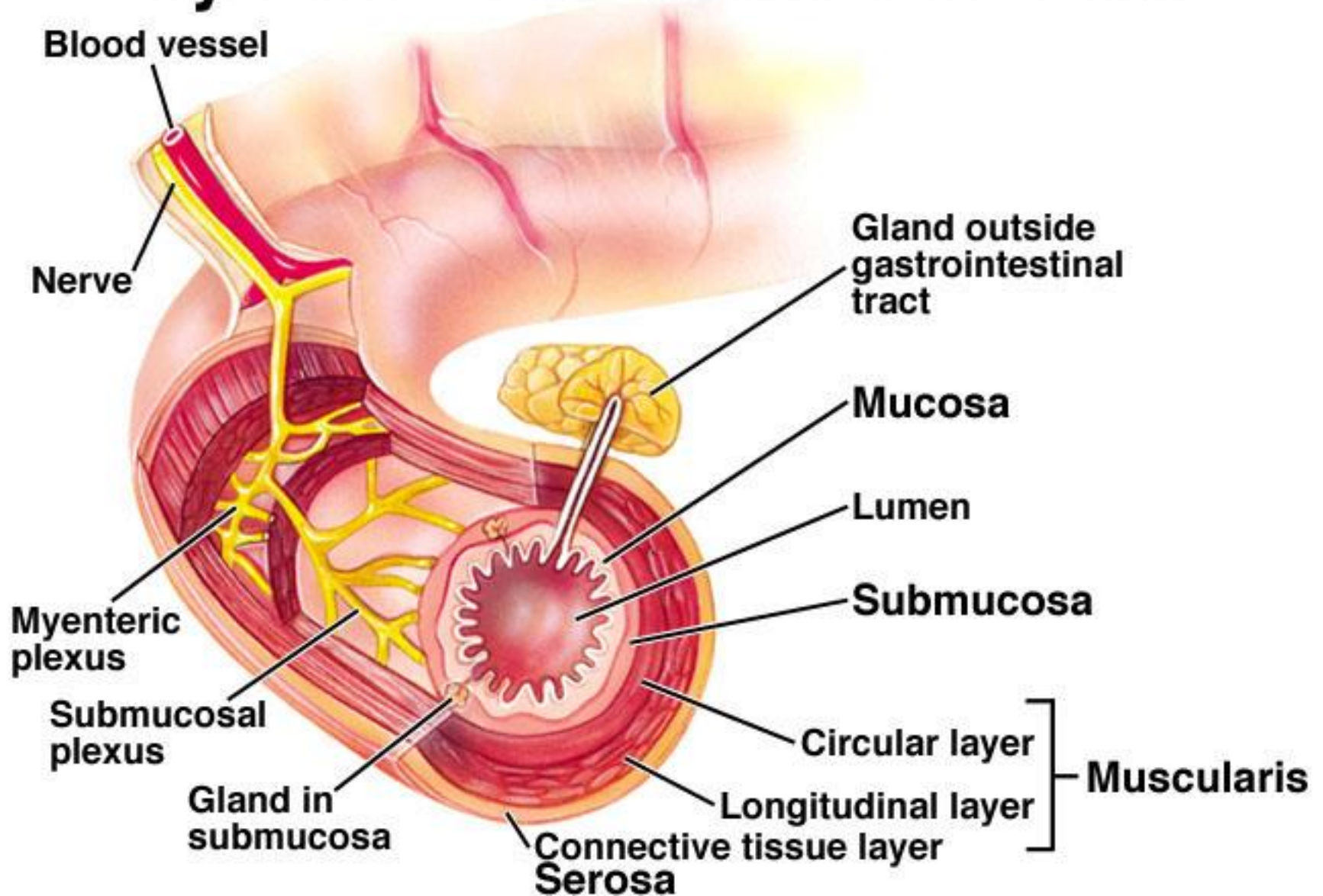


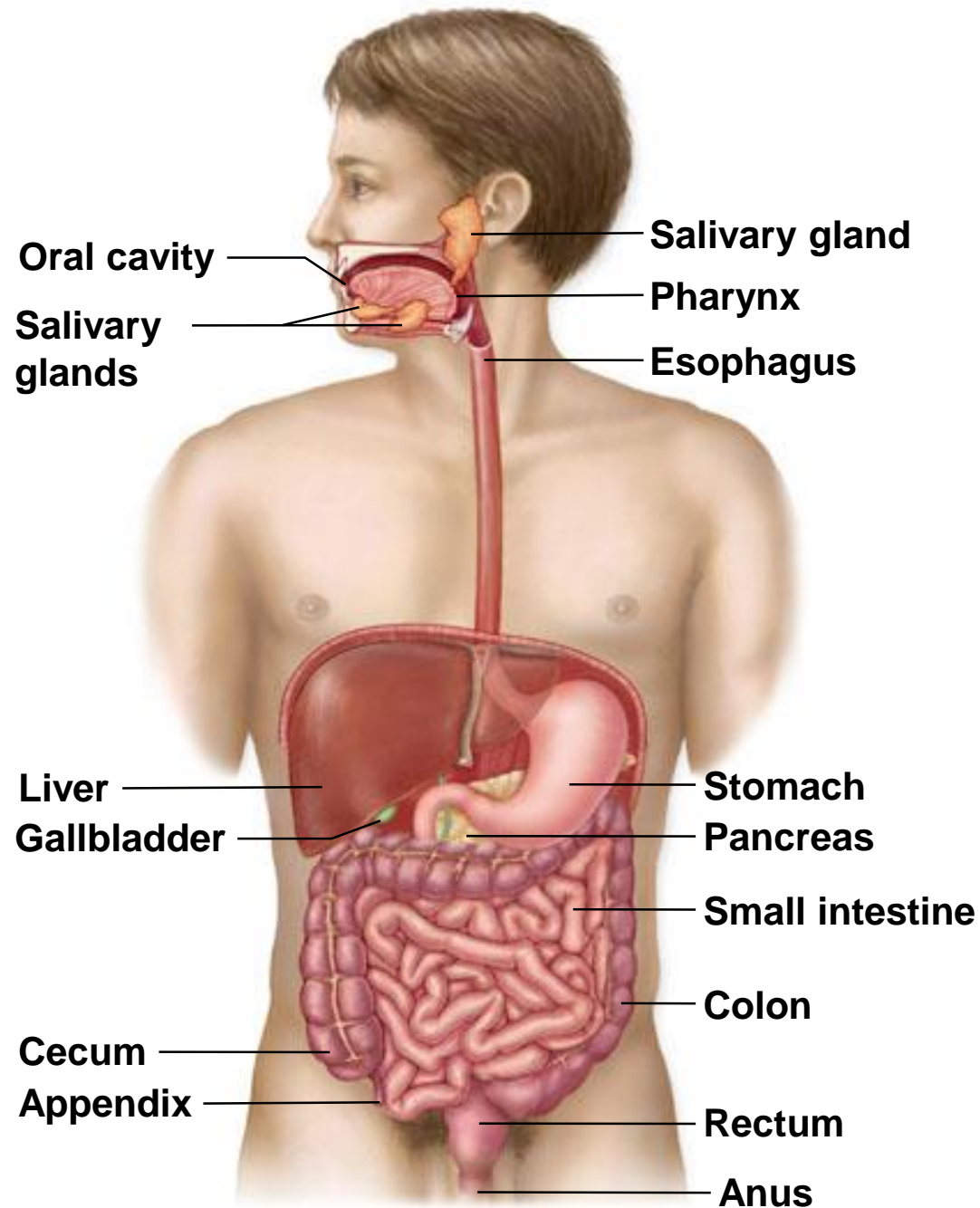


# Mammalian Digestive System

- Four-layered wall surrounds the lumen
  - Mucosa (epithelial tissue)
  - Submucosa (connective tissue)
  - Muscularis (muscle)
  - Serosa (connective tissue)

# Layers of Gastrointestinal Tract





# Human Digestive System

- Mouth

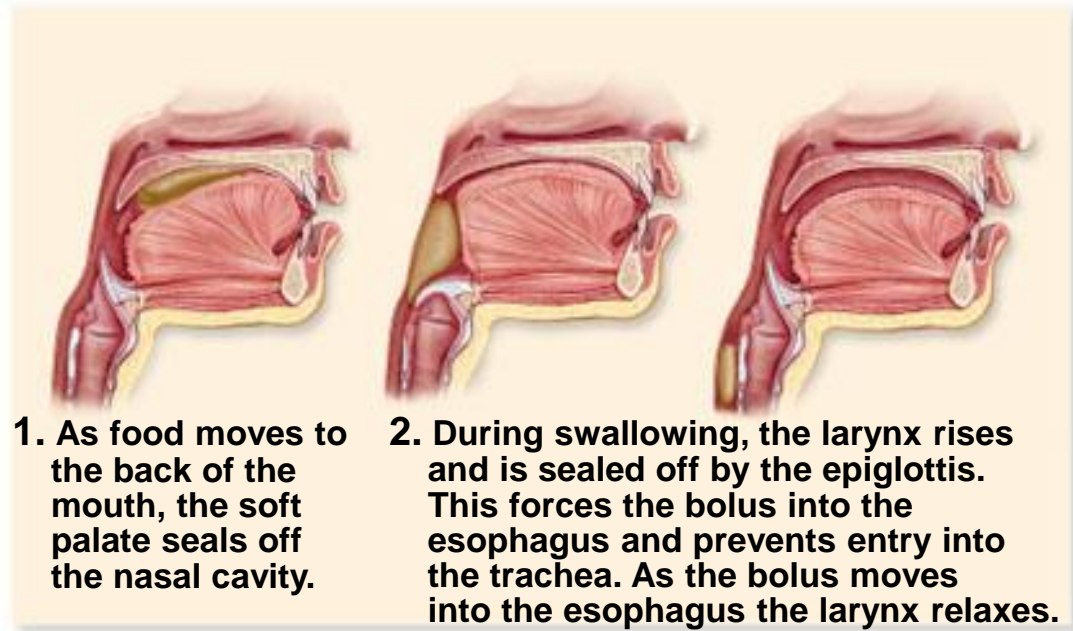
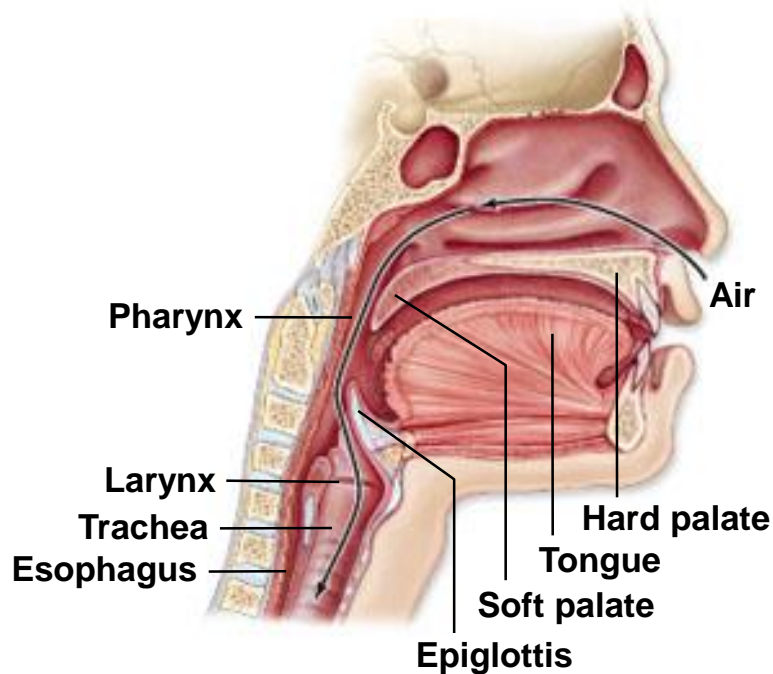
- teeth mechanically break down food
  - Similar in function to the gizzard of birds and worms
- saliva is secreted from salivary glands
  - mucous protects mouth
  - antibacterial agents
  - buffer to neutralize acidity
  - salivary amylase – hydrolyzes glucose polymers

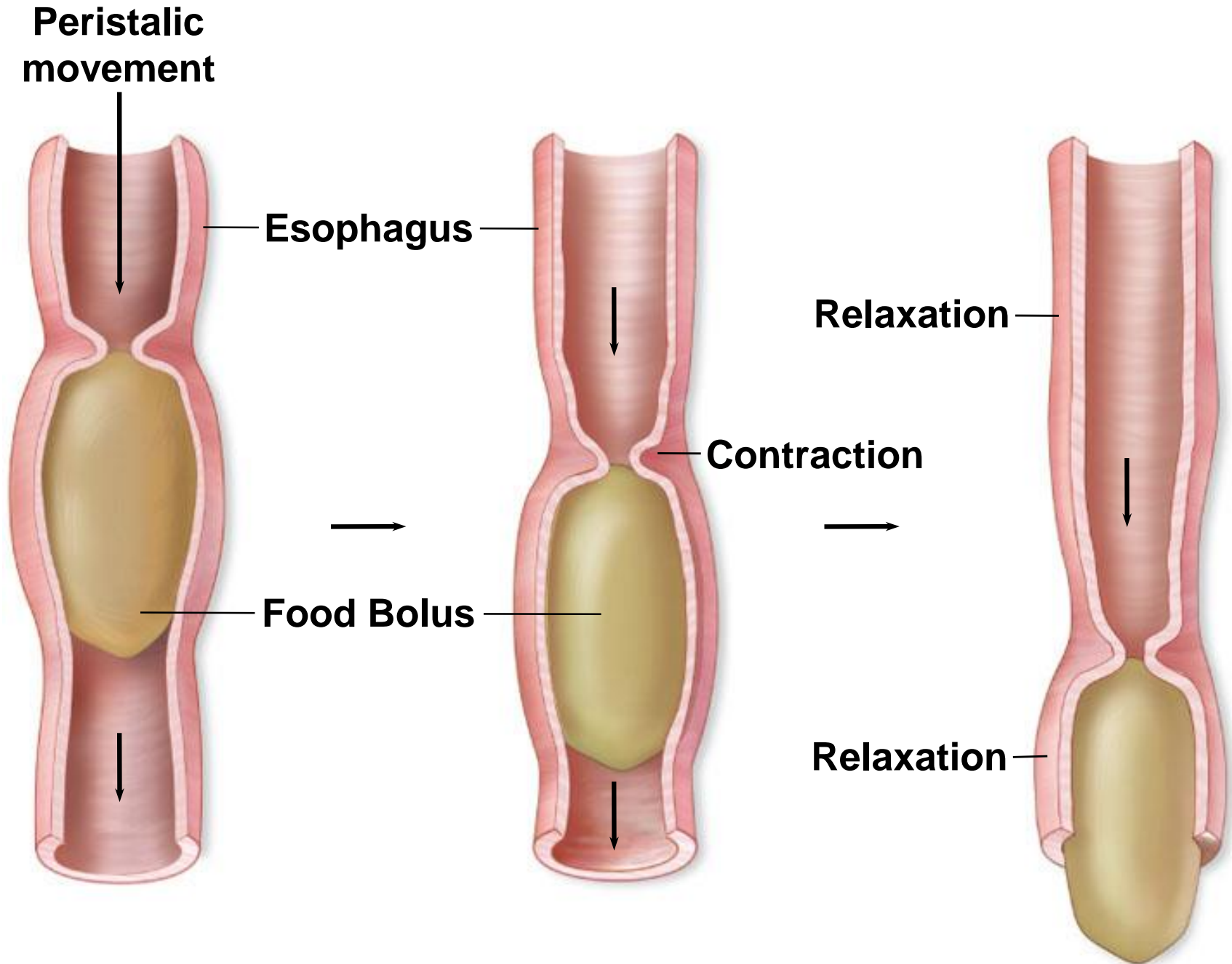
# Human Digestive System

- Pharynx (throat)
  - swallowing
- Esophagus
  - peristalsis

# Swallowing

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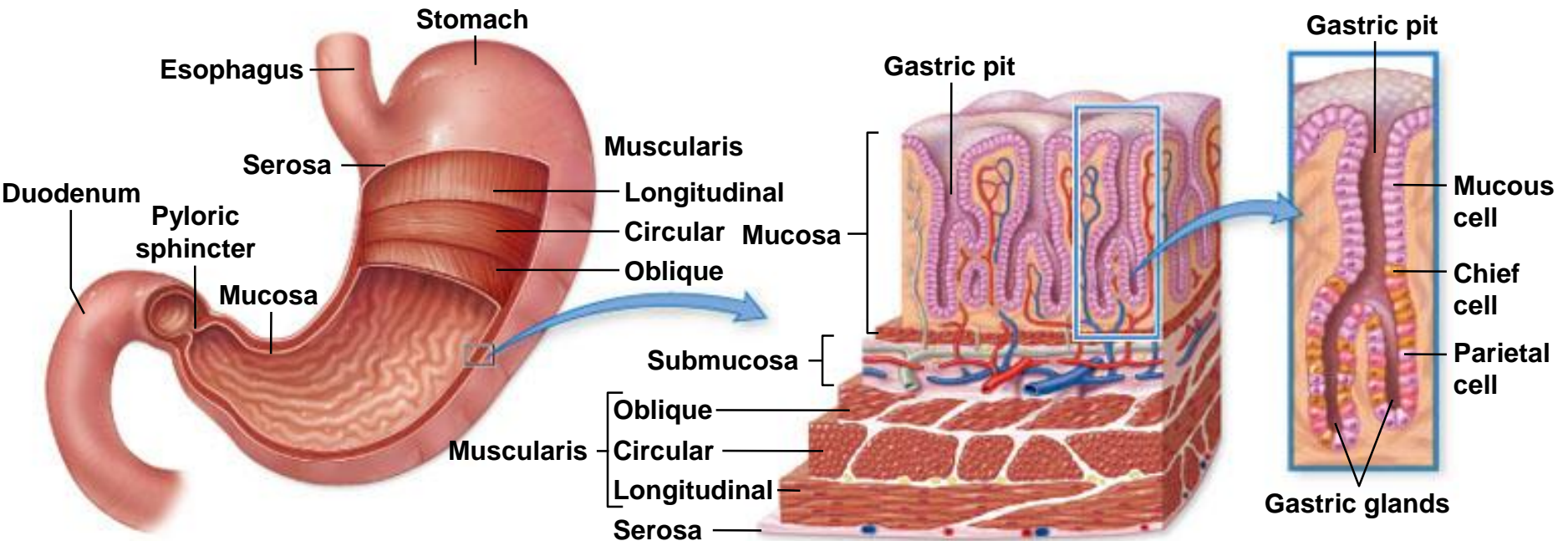
# Human Digestive System

- **Stomach**
- stores food (as does the crop in other organisms)
- lining secretes gastric juice
- Pepsinogen (inactive) becomes pepsin (active) in low pH
- smooth muscles churn the food
- Acid chyme



# The Stomach

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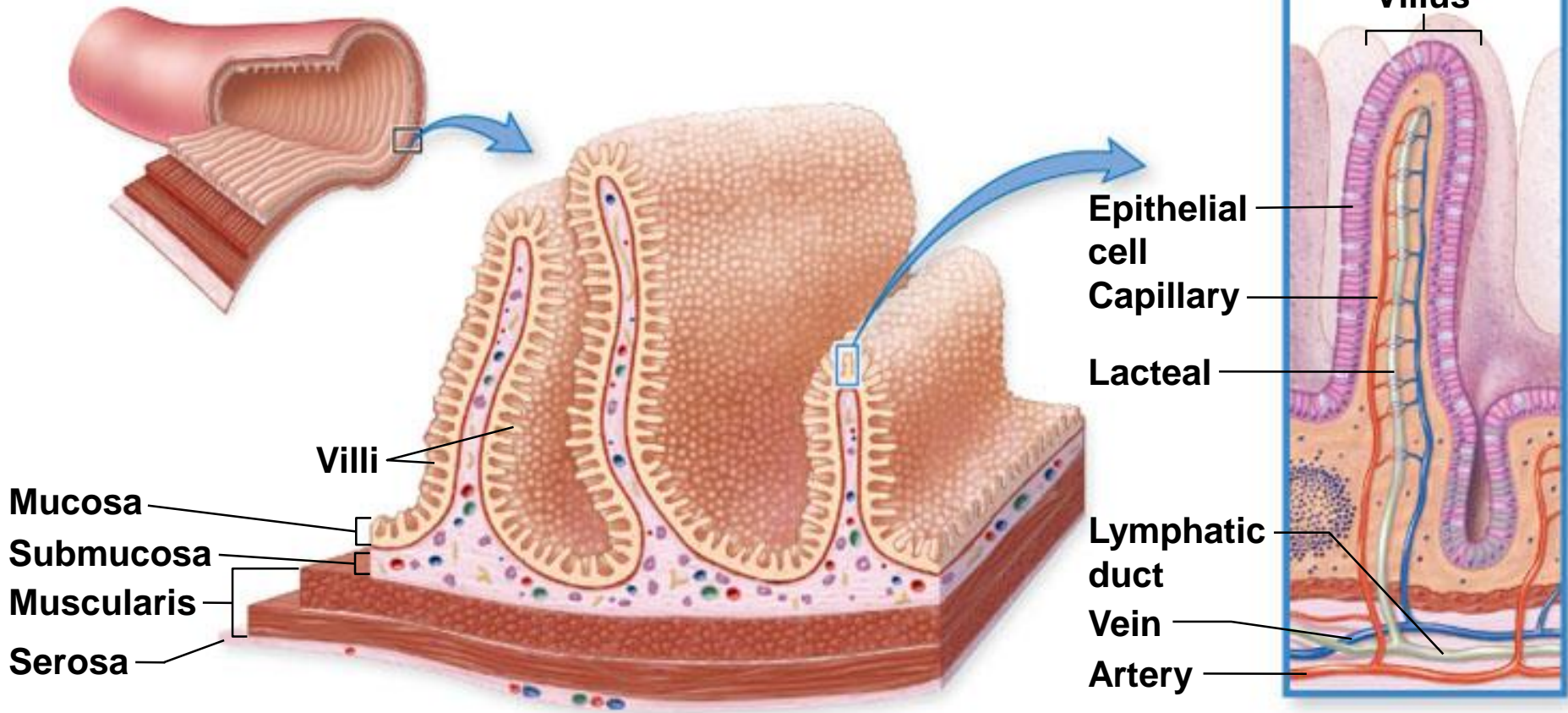


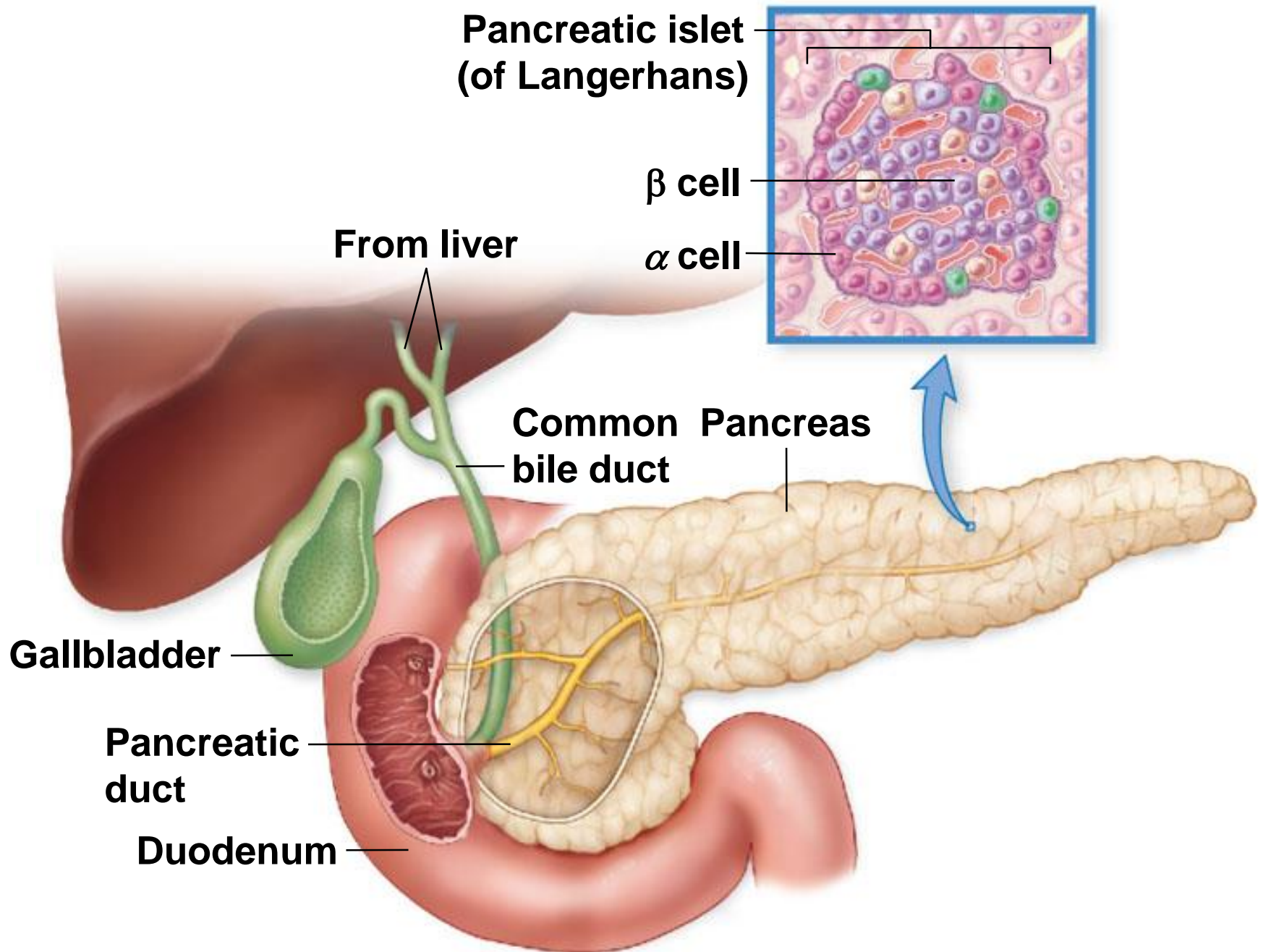
# Human Digestive System

- **Small Intestine**
- Longest part of the canal (6 m in humans)
- Duodenum (first 25 cm) – **most digestion** takes place
- Jejunum and ileum – mainly **absorption**
- Very large surface area (300 m<sup>2</sup>) – folds, villi & microvilli
  - Similar to mycelium in fungi & roots in plants

# The Small Intestine

Small intestine





# Human Digestive System

- **Accessory Glands:**

- Pancreas

- digestive enzymes

- Lipase-lipids; pancreatic amylase-starch; trypsin - proteins

- Bicarbonate- buffer

# Human Digestive System

- **Accessory Glands:**

- Liver

- produces bile salts which are stored in the **gallbladder** until needed
    - aid in the digestion of fats by emulsification

- Gallbladder

# Human Digestive System

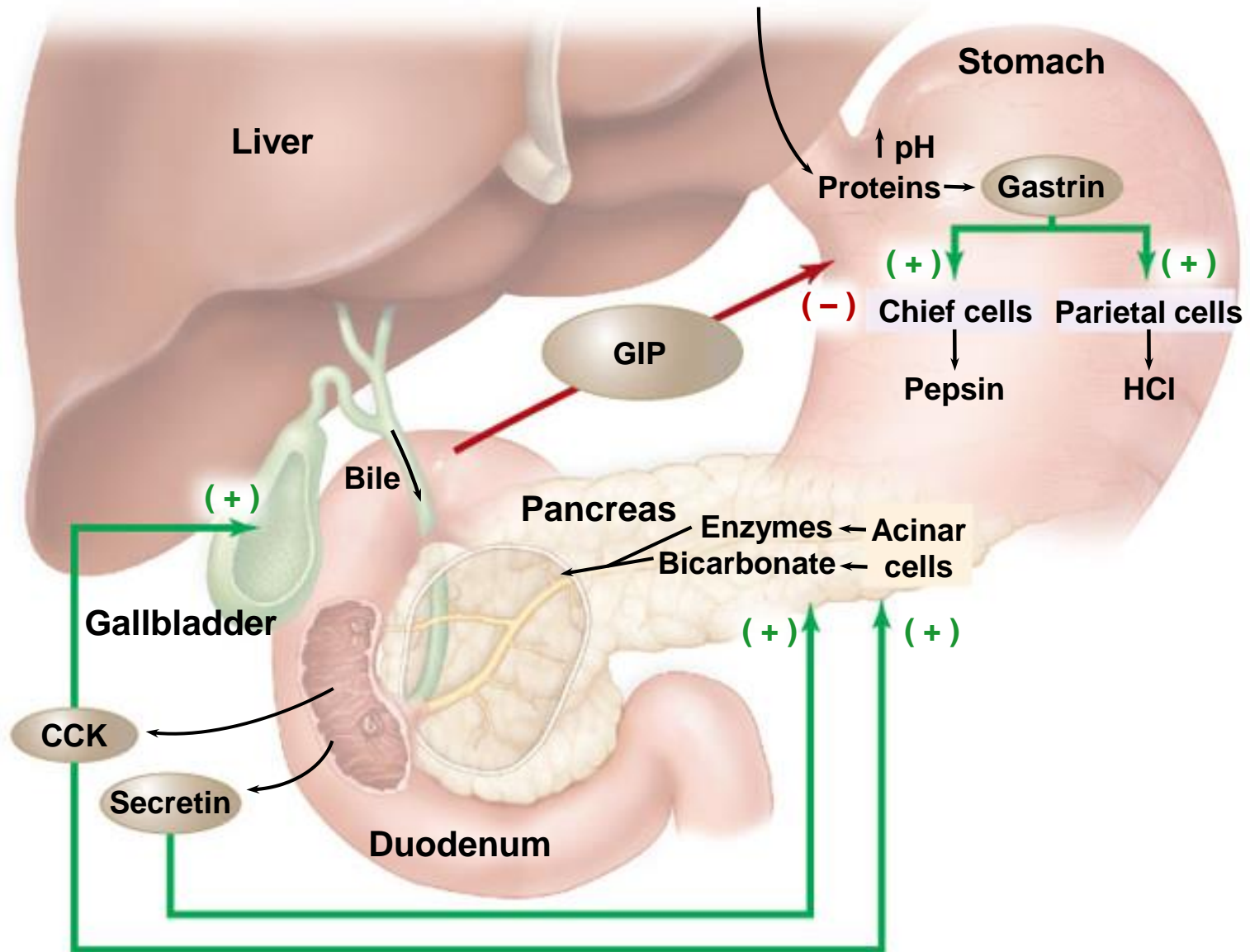
- **Large Intestine or Colon**
  - main function is concentration & storage of wastes
    - absorption of water, sodium, vitamin K
  - Feces are moved along by peristalsis and exit the body through the anus



# Hormonal Control of Digestion

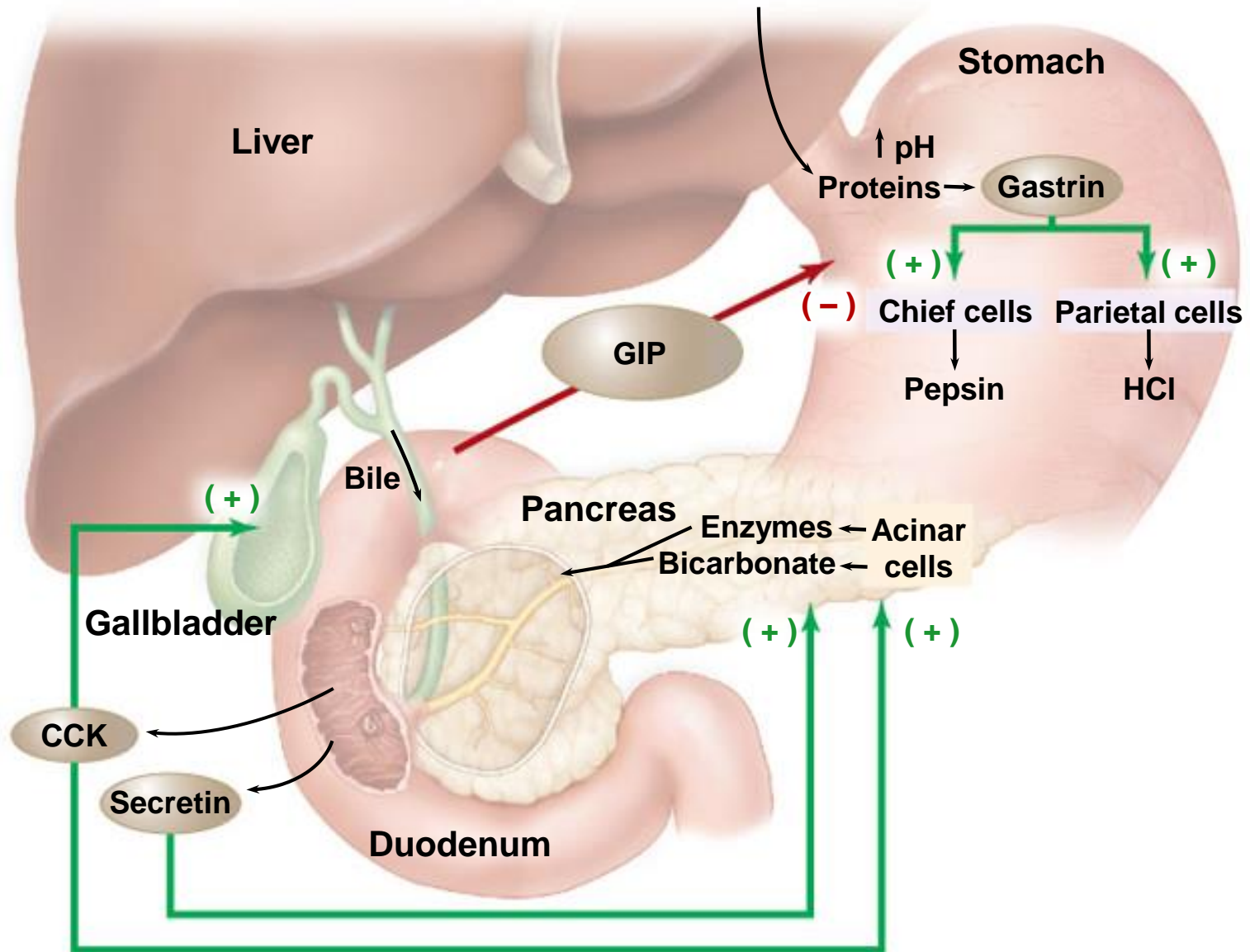
- **Gastrin**
  - released by the stomach
  - feeds back to cause the secretion of gastric juices
  - Low pH inhibits its production – negative feedback





# Hormonal Control of Digestion

- **Enterogastrones**
  - Released by duodenum of small intestine
  - inhibit peristalsis & secretions in the stomach
  - **Secretin**
    - Stimulated by low pH
    - causes pancreas to release bicarbonate
  - **CCK** (cholecystokinin)
    - Stimulated by high fat content
    - Stimulates gall bladder to release bile
  - **GIP** (gastric inhibitory peptide)
    - Inhibits emptying of the stomach

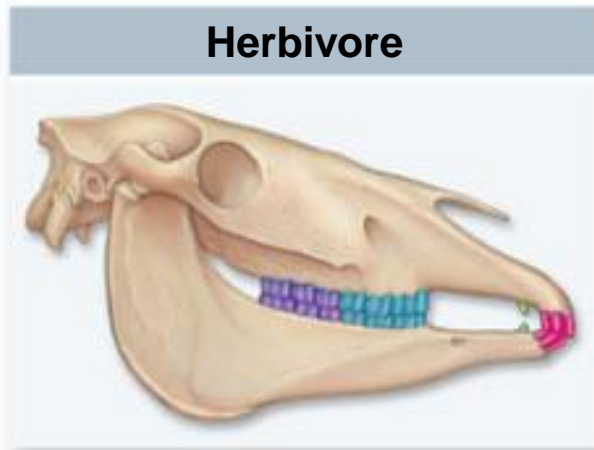


# Evolutionary Adaptations to Diet

- Teeth
  - pointed in carnivores, flat in herbivores

# Mouth and Teeth

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**Horse**



**Lion**



**Human**

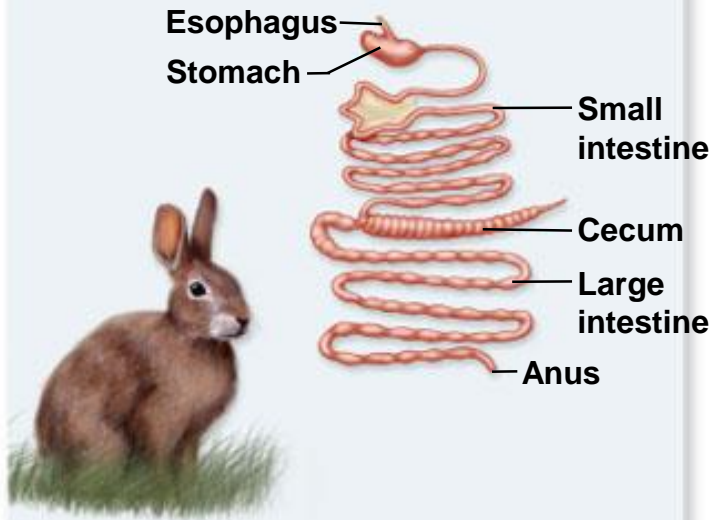


# Evolutionary Adaptations to Diet

- Length of gut
  - longer in herbivores than carnivores
- Cecum
  - houses bacteria that aid in digestion

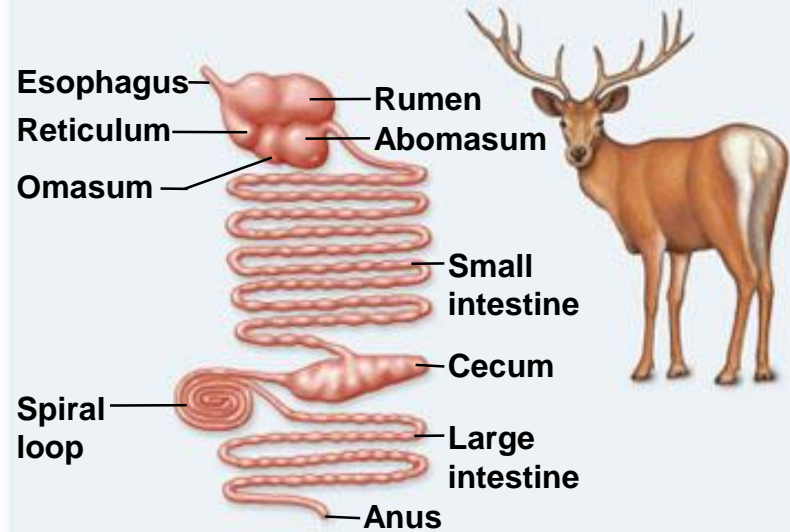
## Nonruminant Herbivore

Simple stomach, large cecum



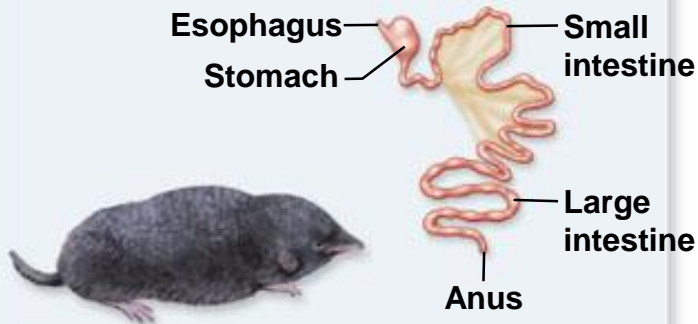
## Ruminant Herbivore

Four-chambered stomach with large rumen; long small and large intestine



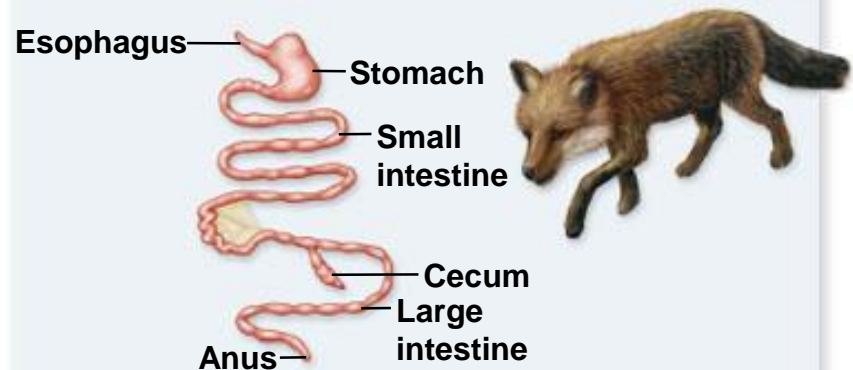
## Insectivore

Short intestine, no cecum



## Carnivore

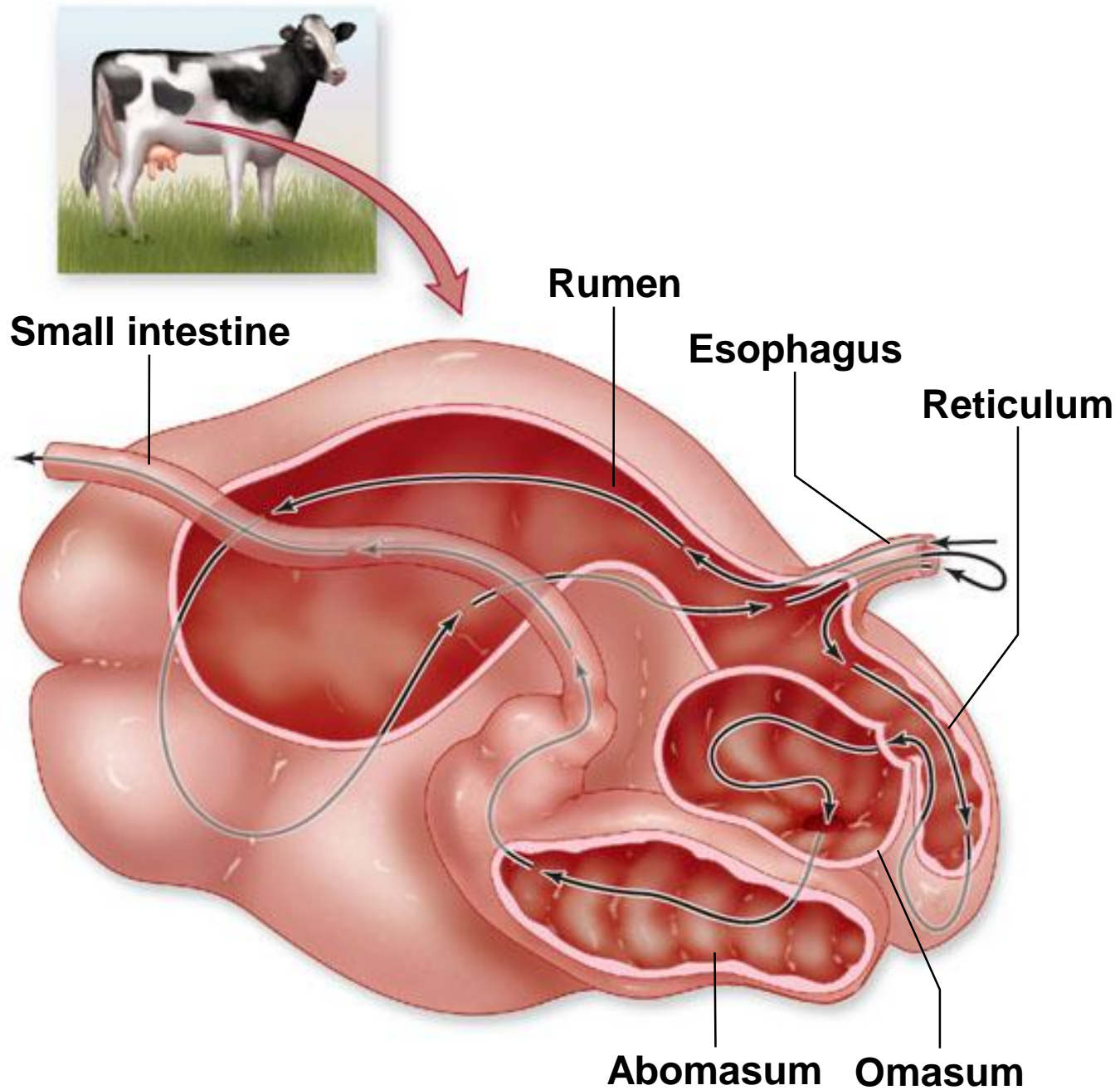
Short intestine and colon, small cecum



# Evolutionary Adaptations to Diet

- Ruminant Stomach- cows, deer





# Evolutionary Adaptations to Diet

- Coprophagy – rodents, rabbits