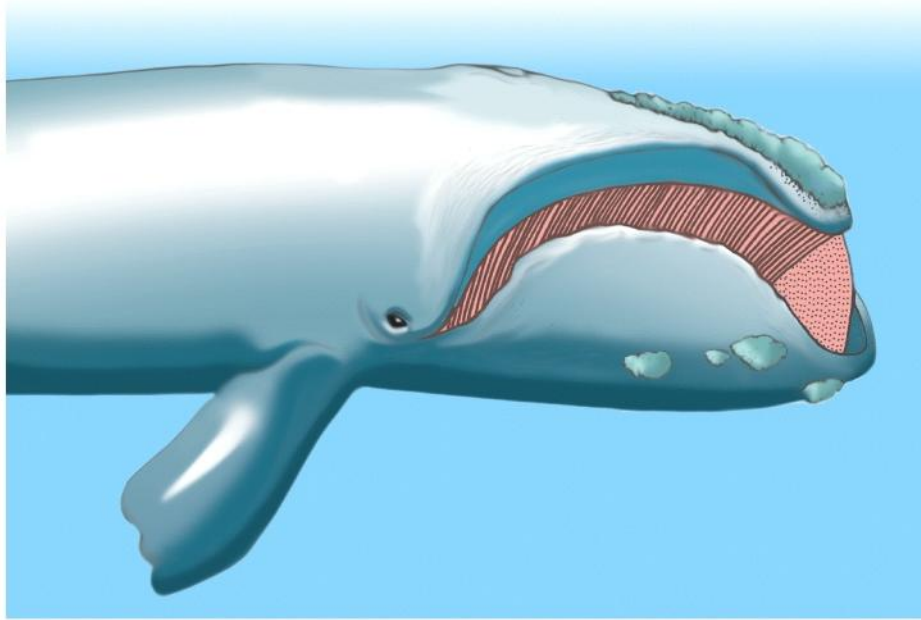


(a)



(b)



(c)

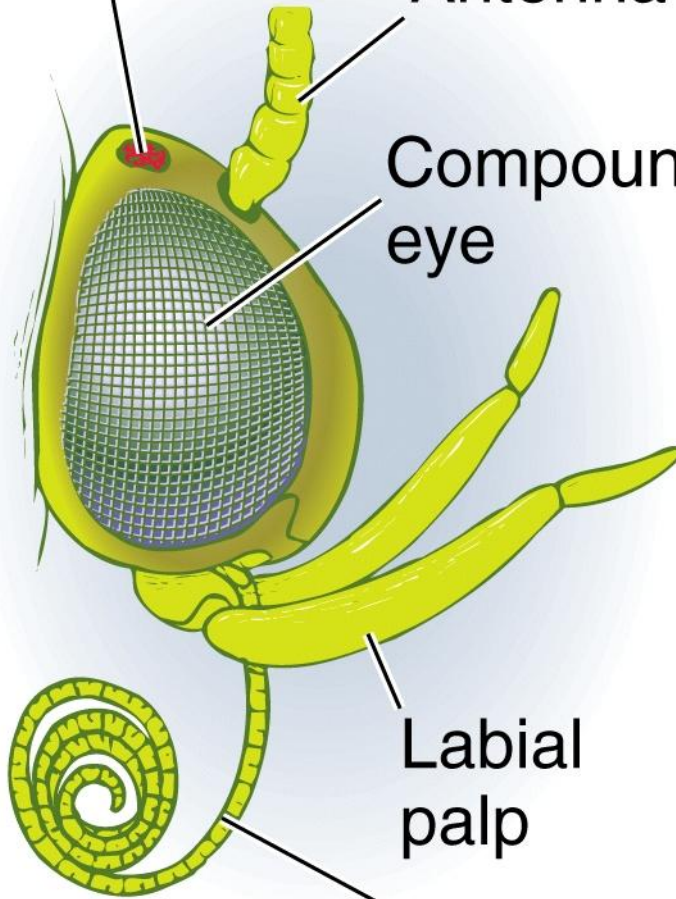
Ocellus

Antenna

Compound eye

Labial palp

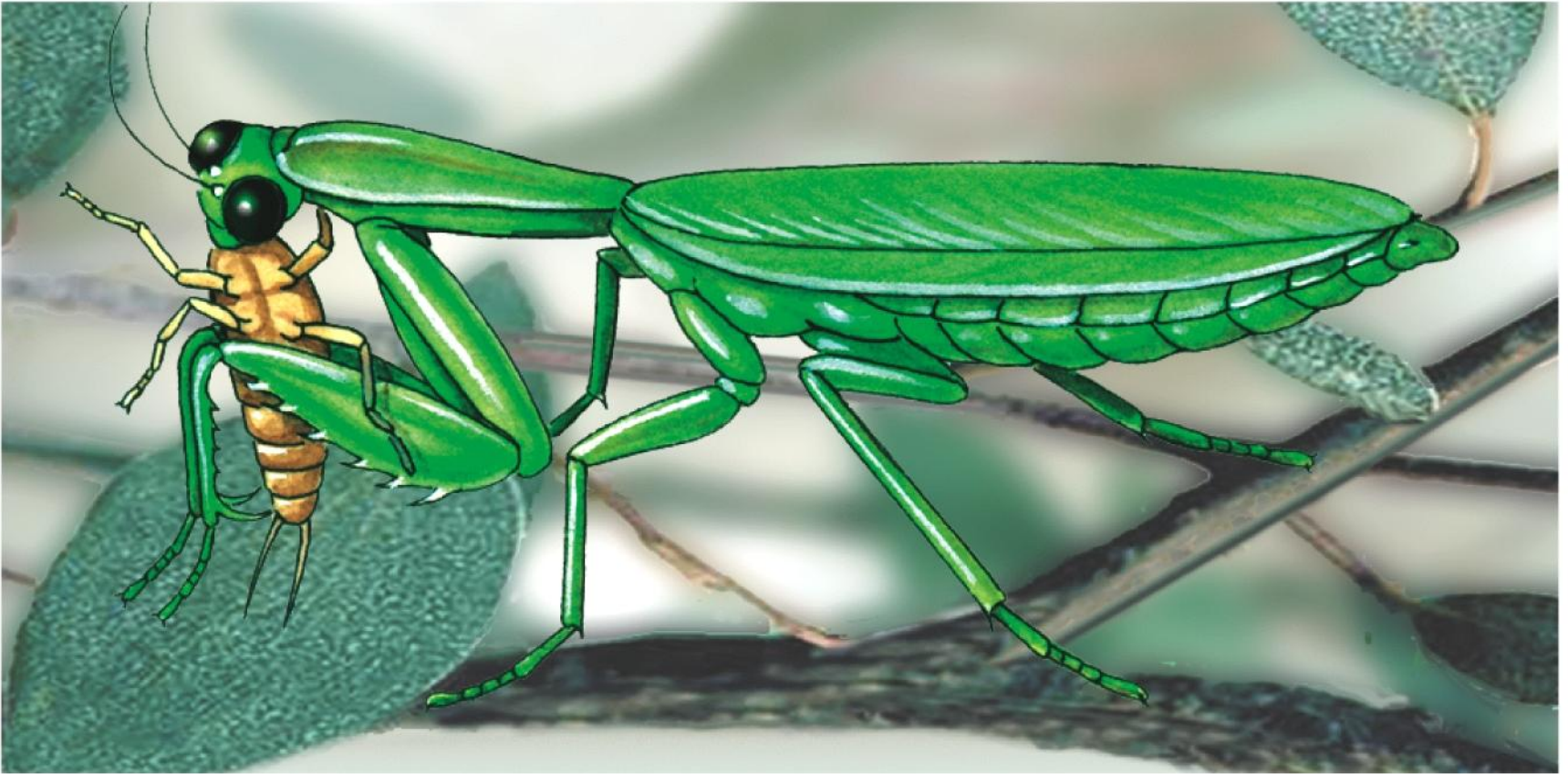
Maxillary proboscis



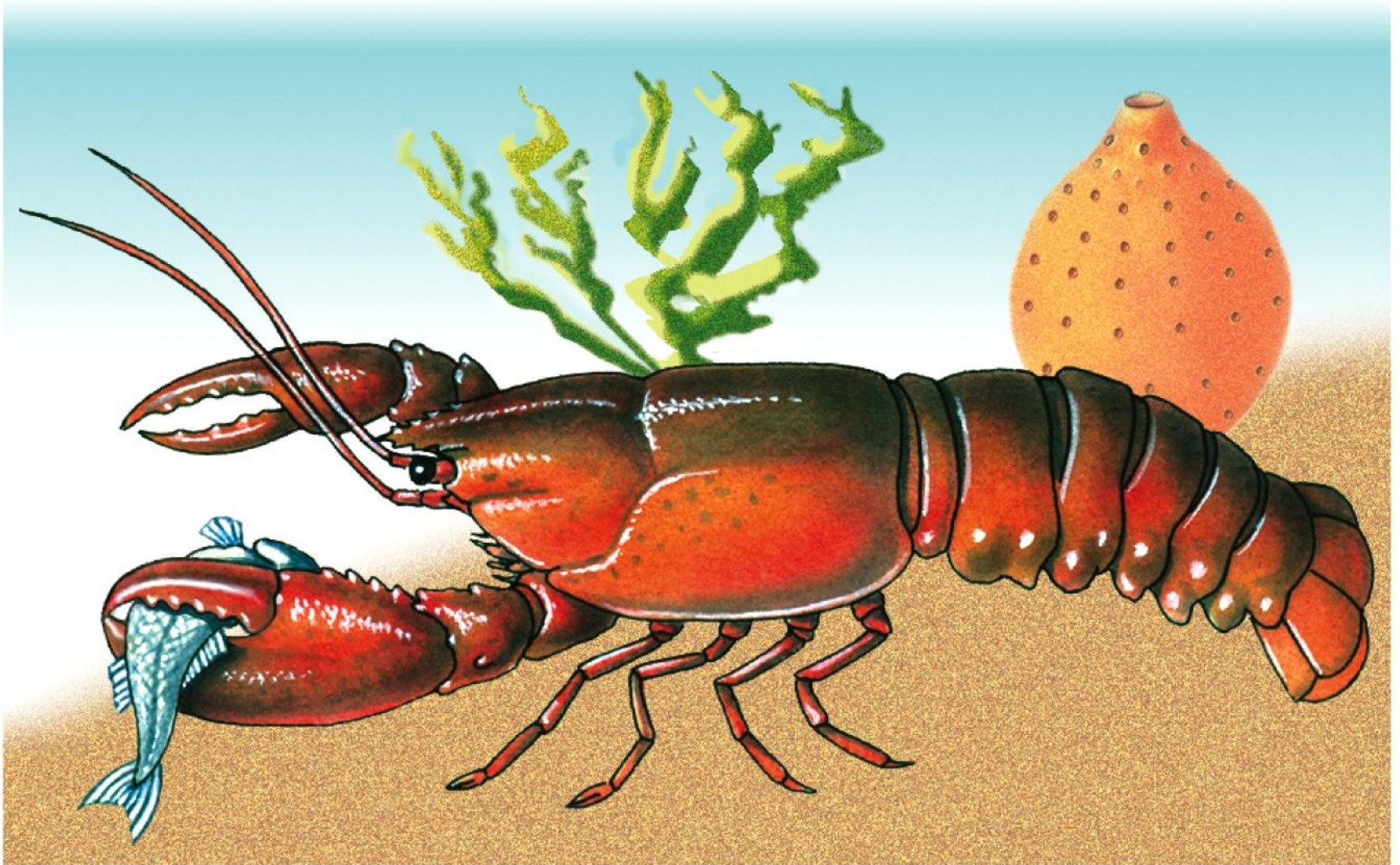




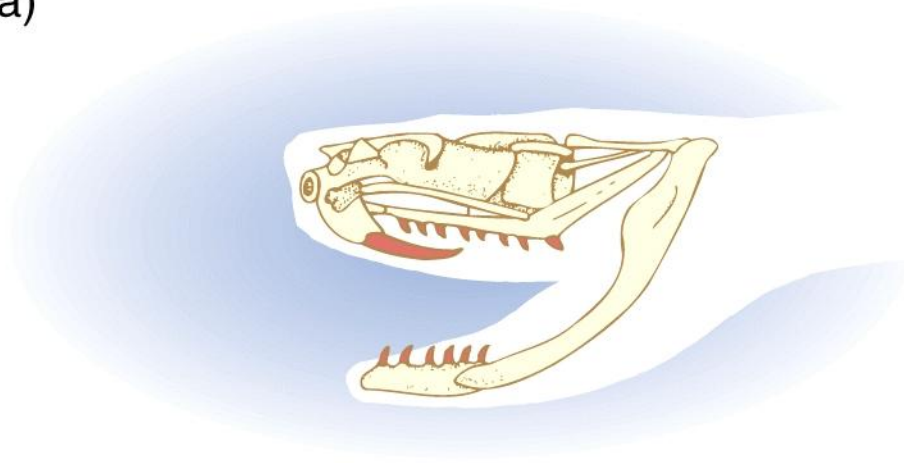
(a)



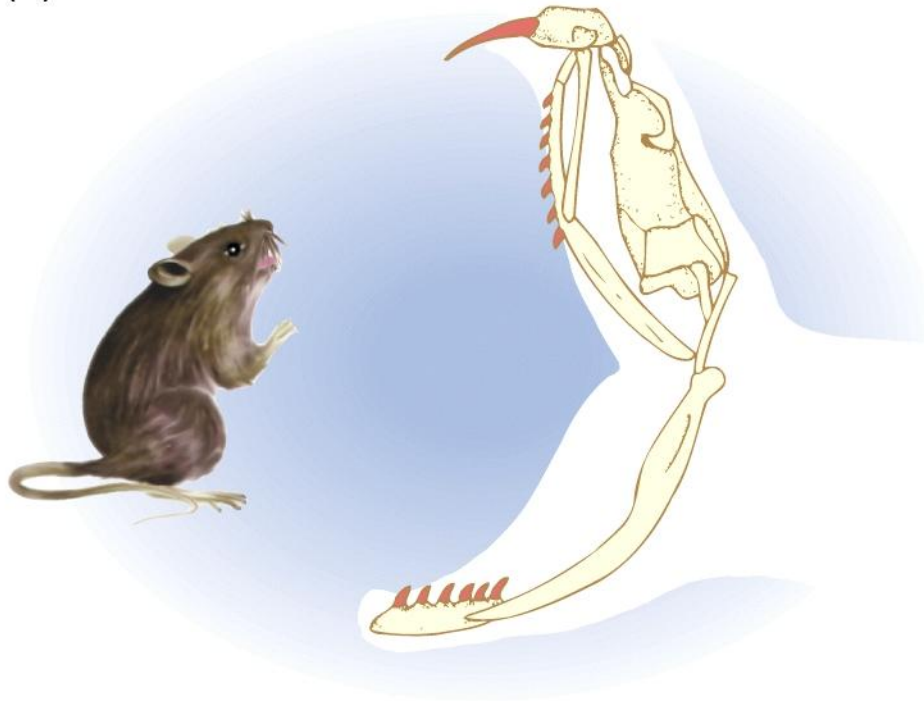
(b)



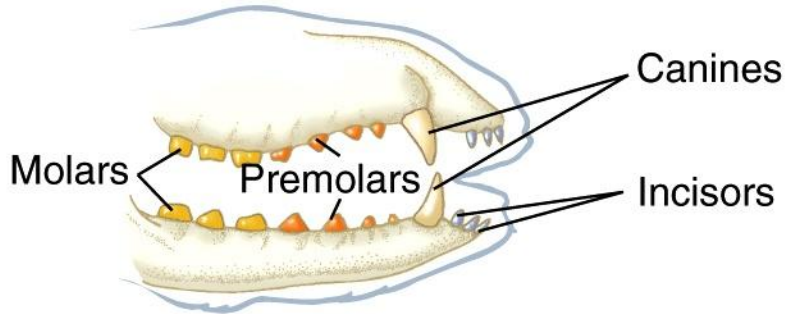
(a)



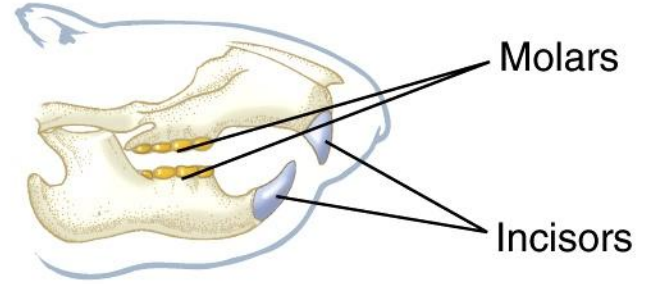
(b)



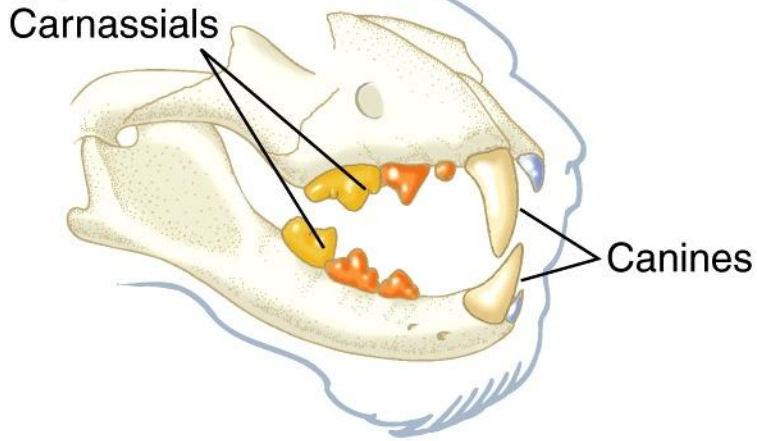
(a) **Generalized placental mammal**



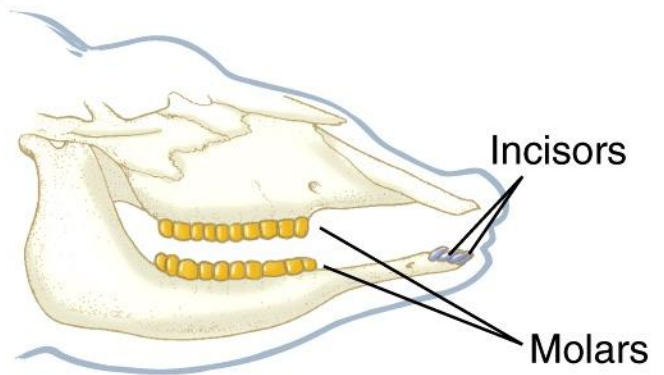
(b) **Squirrel**



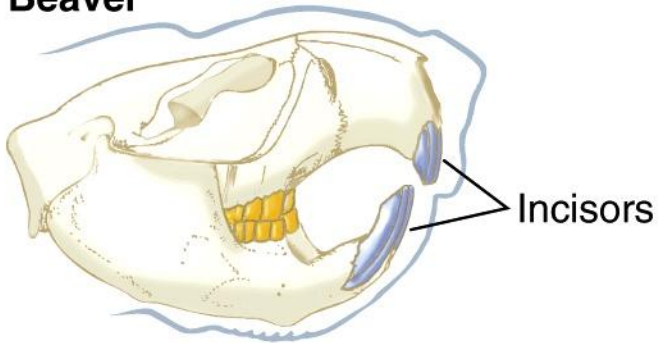
(c) **African Lion**

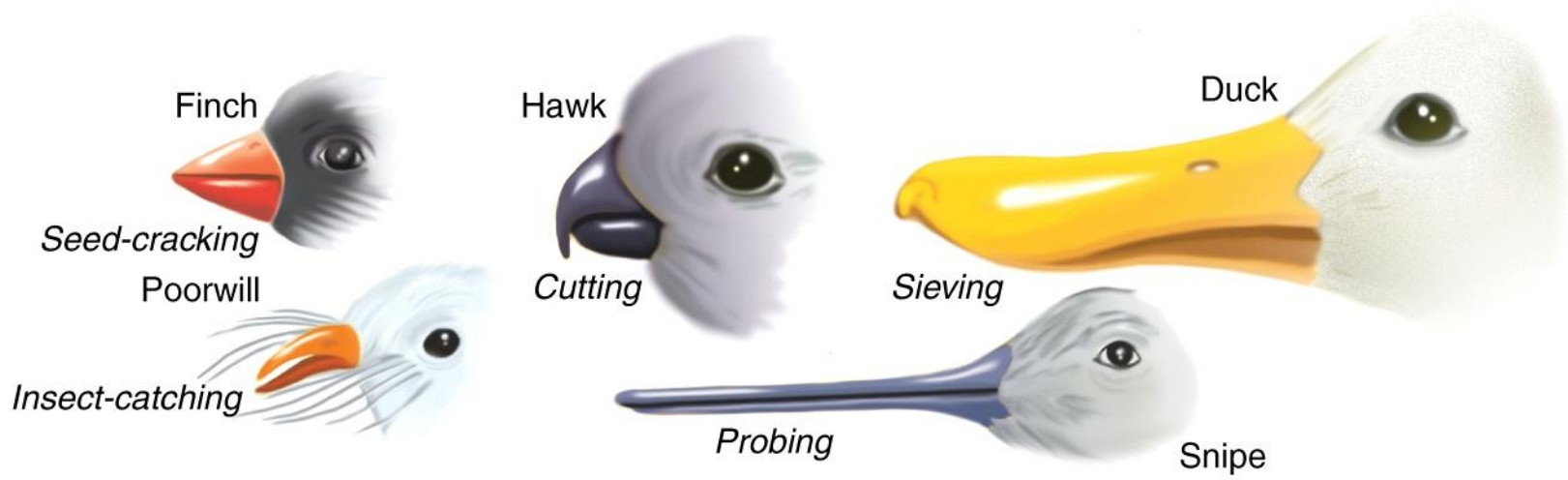


(d) **Ox**



(e) **Beaver**





Finch

*Seed-cracking*

Poorwill

*Insect-catching*

Hawk

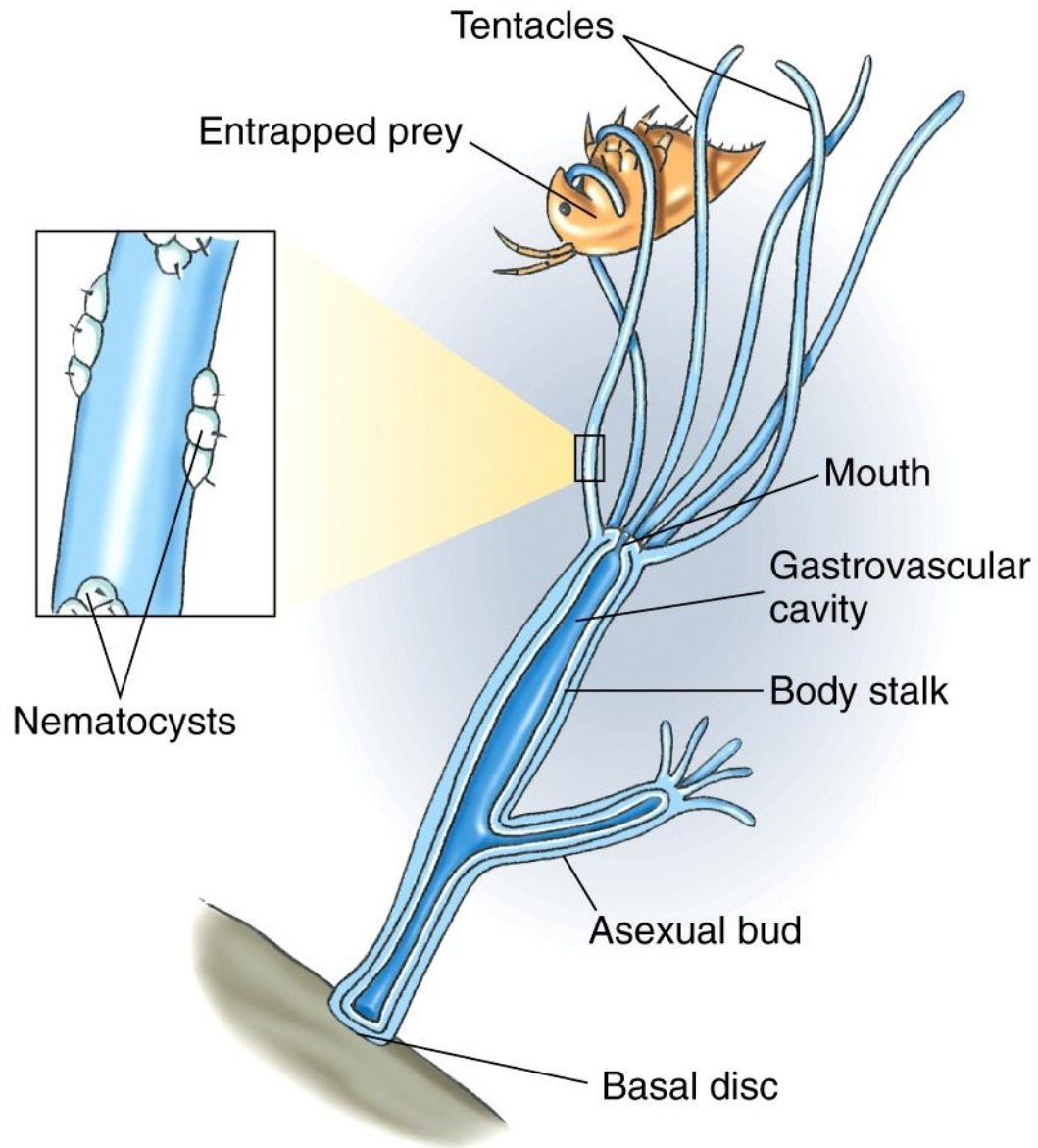
*Cutting*

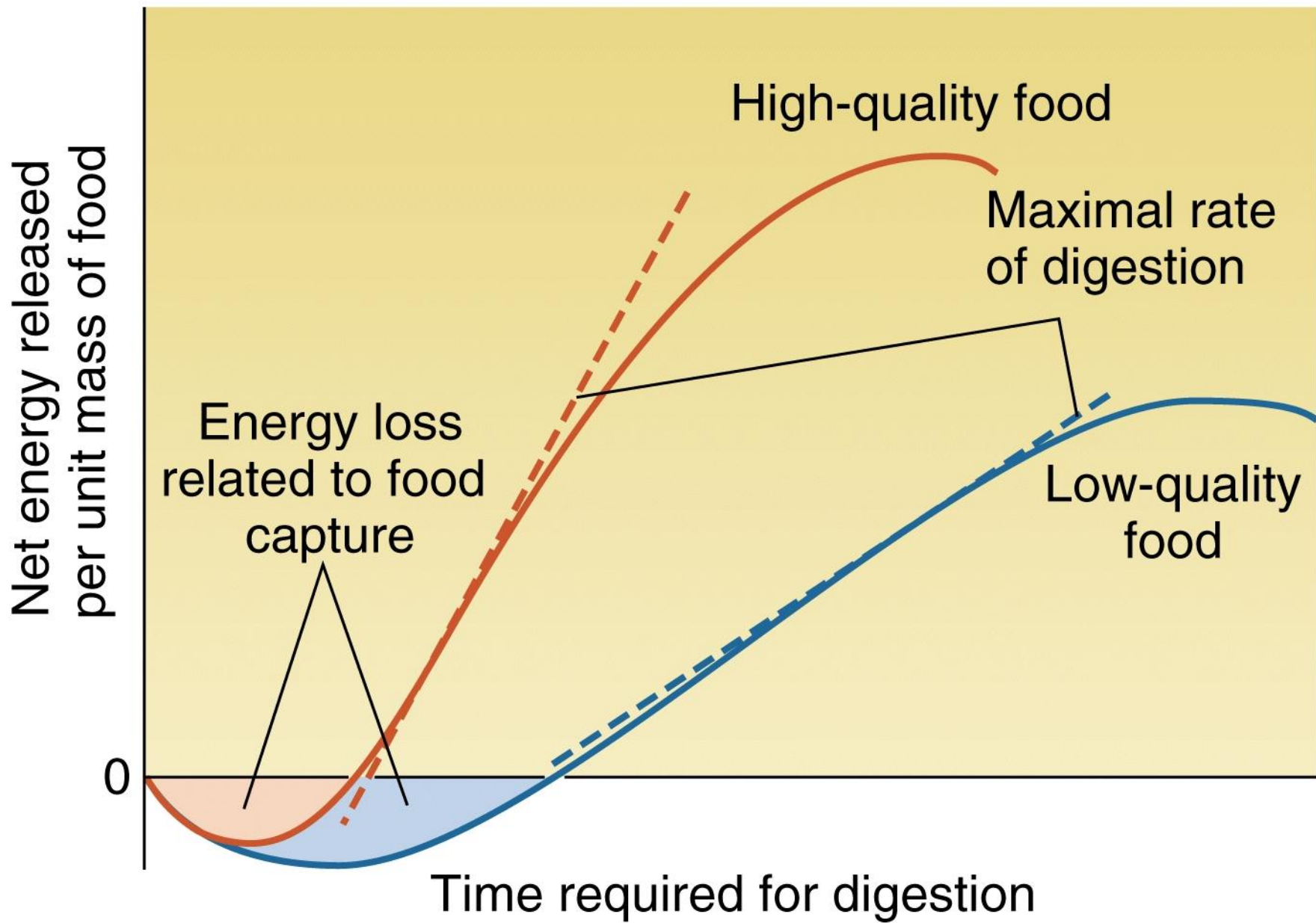
Duck

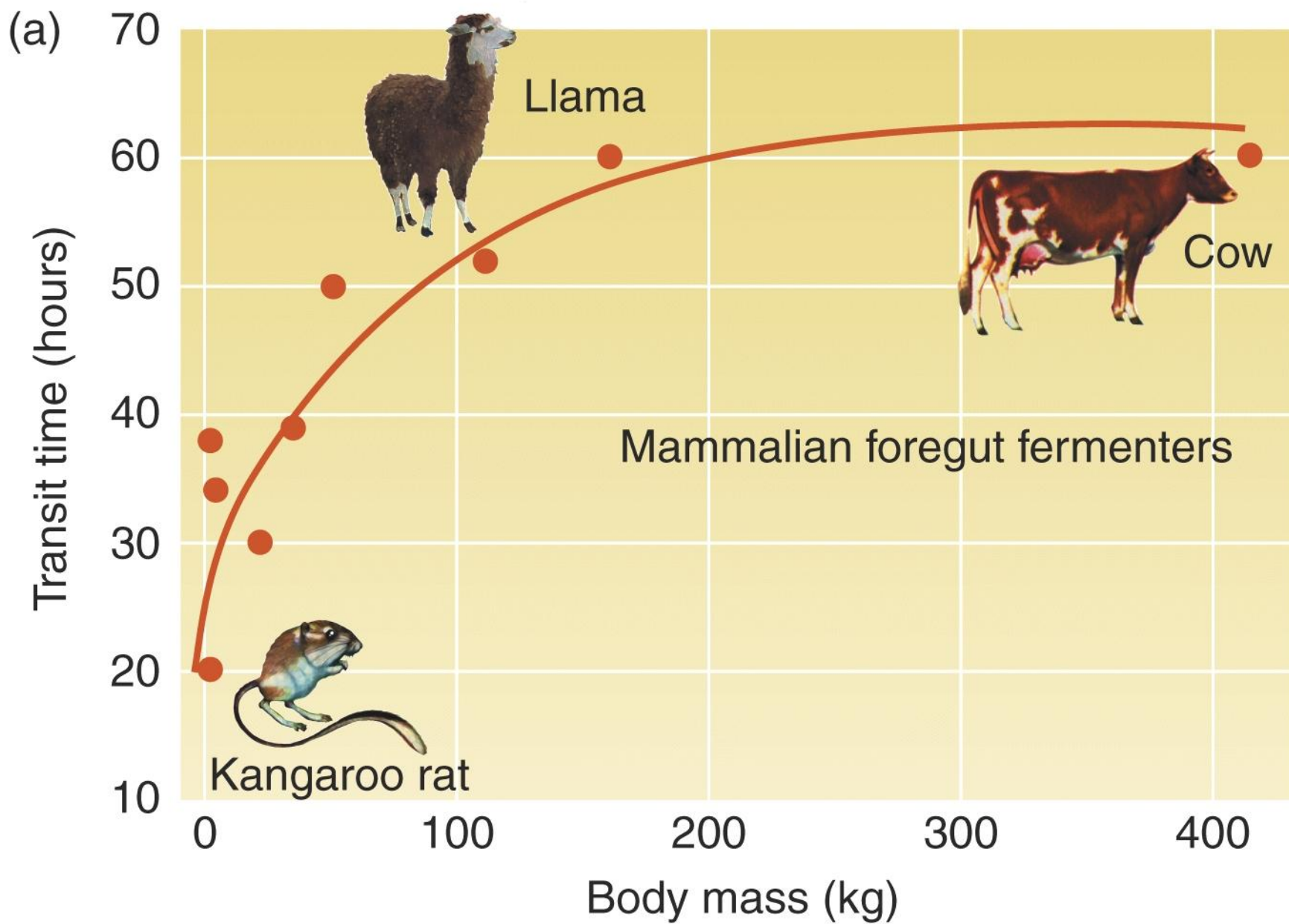
*Sieving*

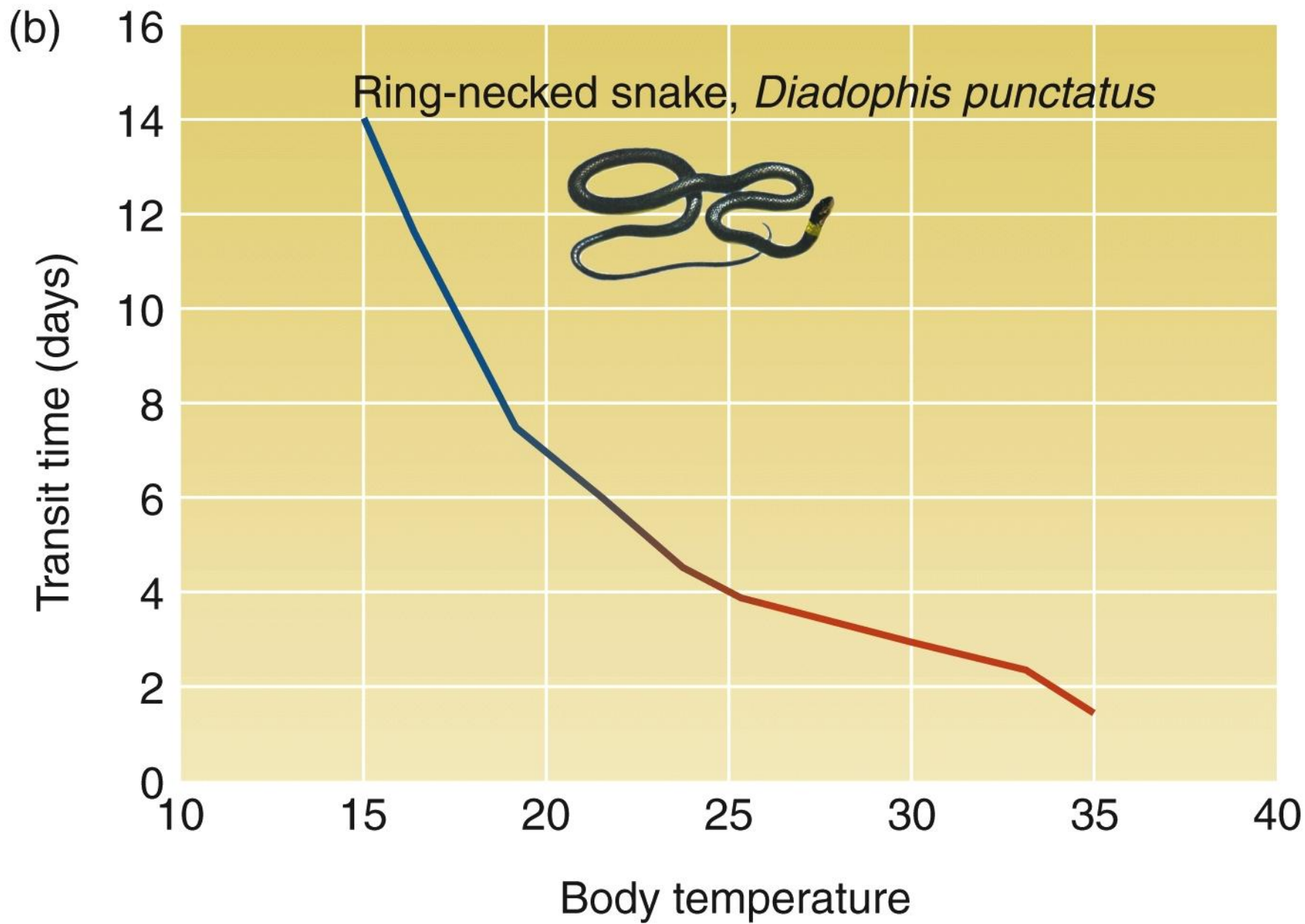
*Probing*

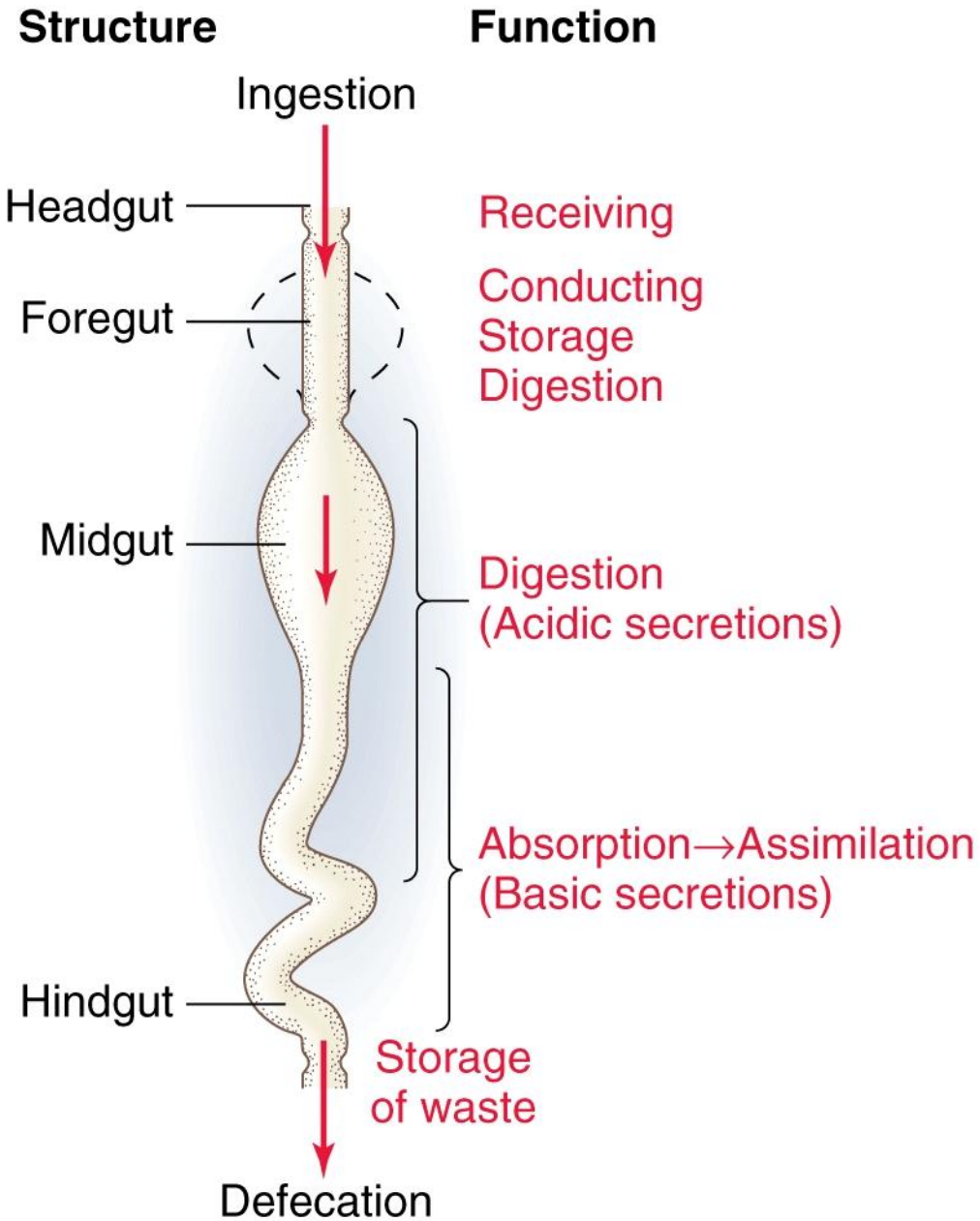
Snipe



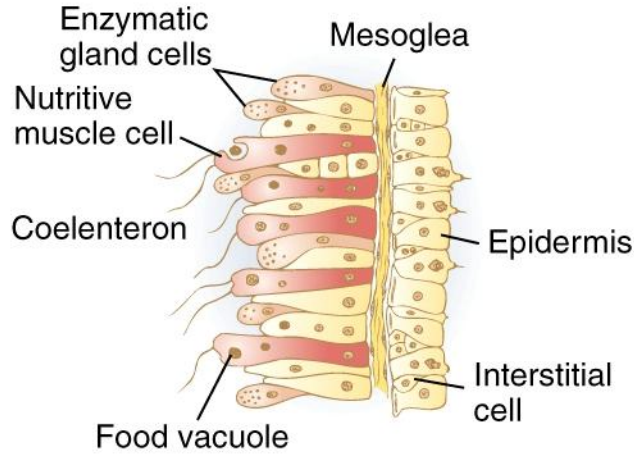




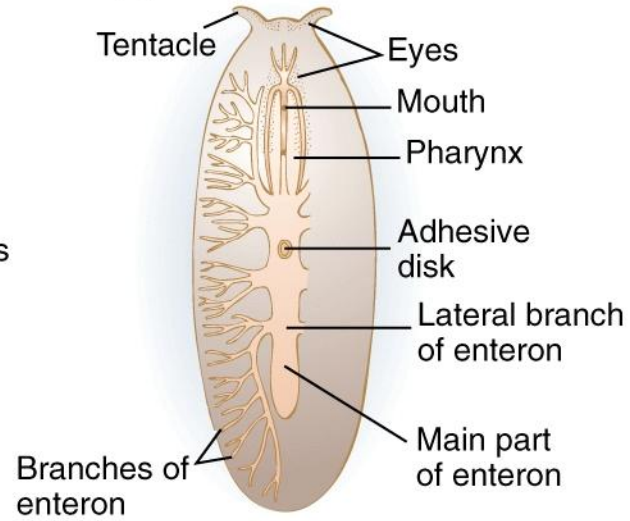




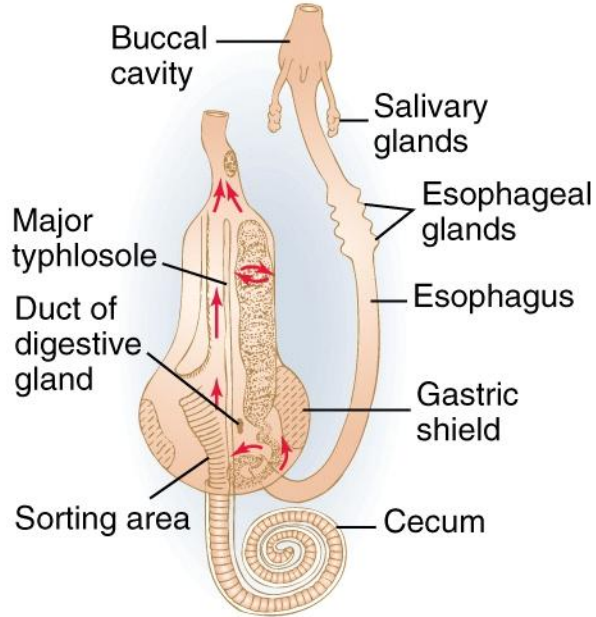
(a) **Hydra**



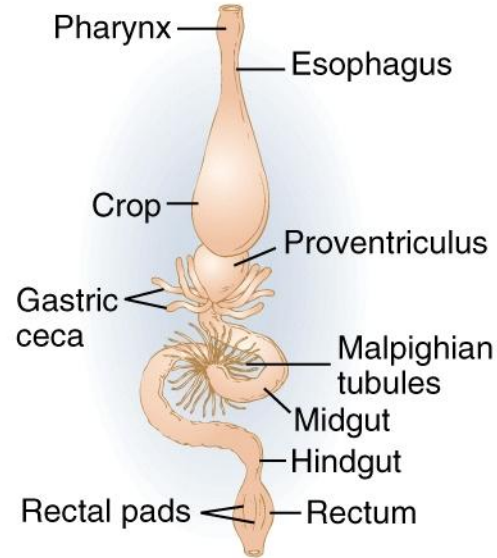
(b) **Flatworm**



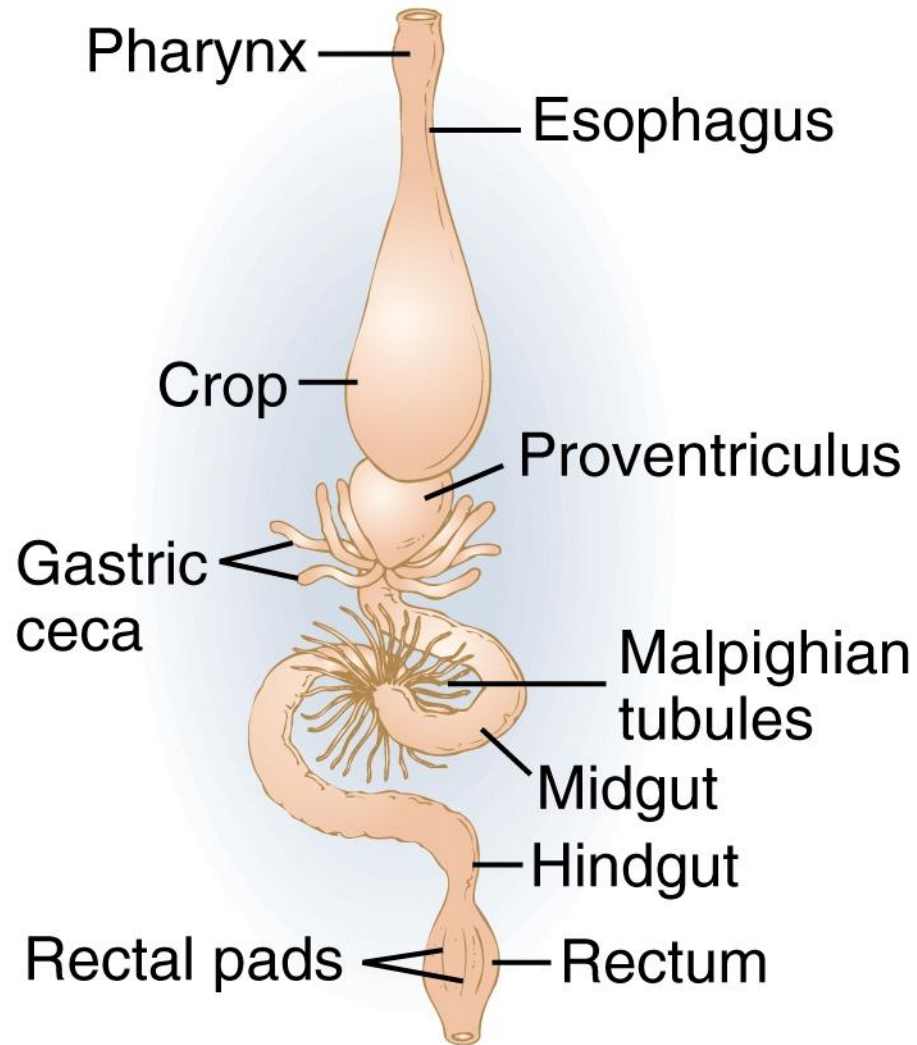
(c) **Mollusk**



(d) **Cockroach**



**(d) Cockroach**



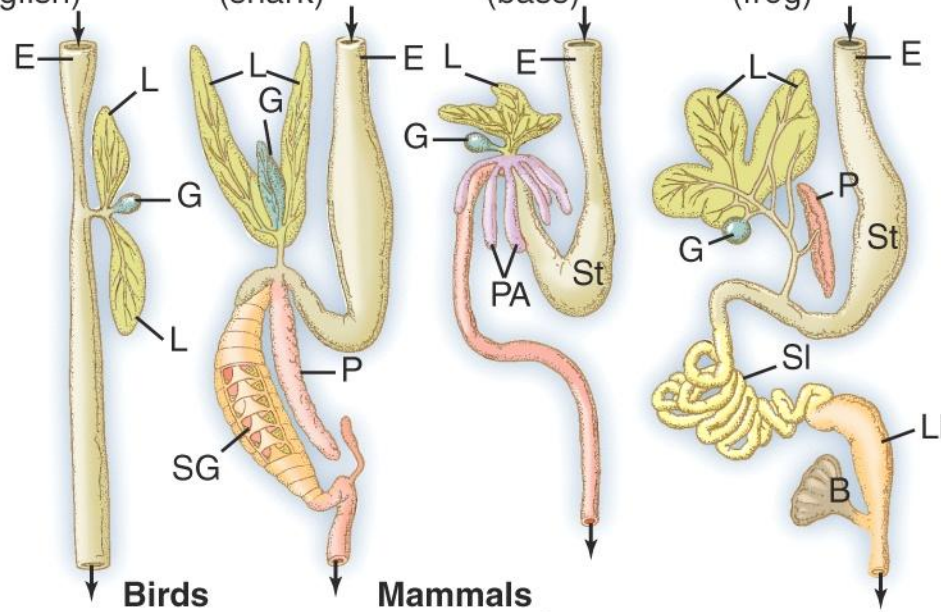
**Cyclostomes Elasmobranchs Teleost fishes Amphibians**

(hagfish)

(shark)

(bass)

(frog)

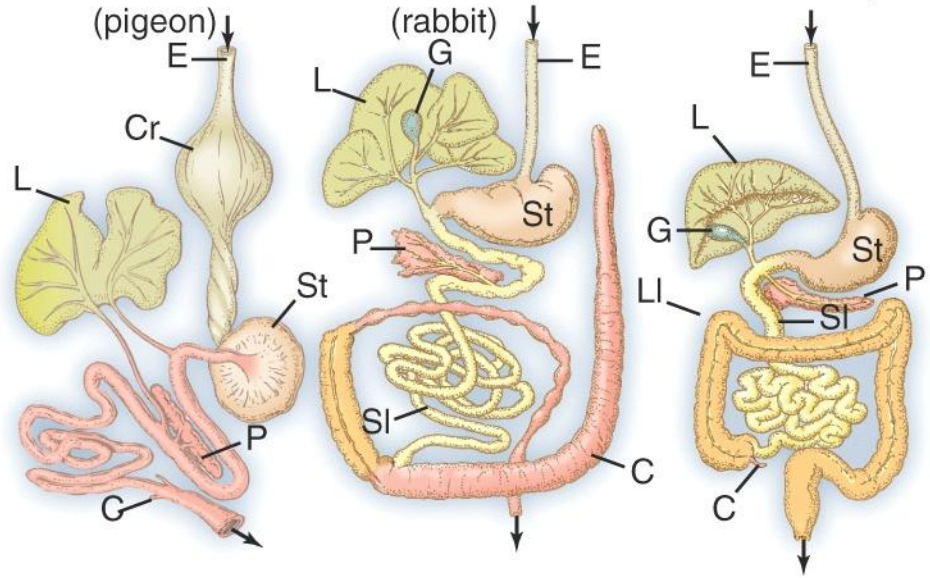


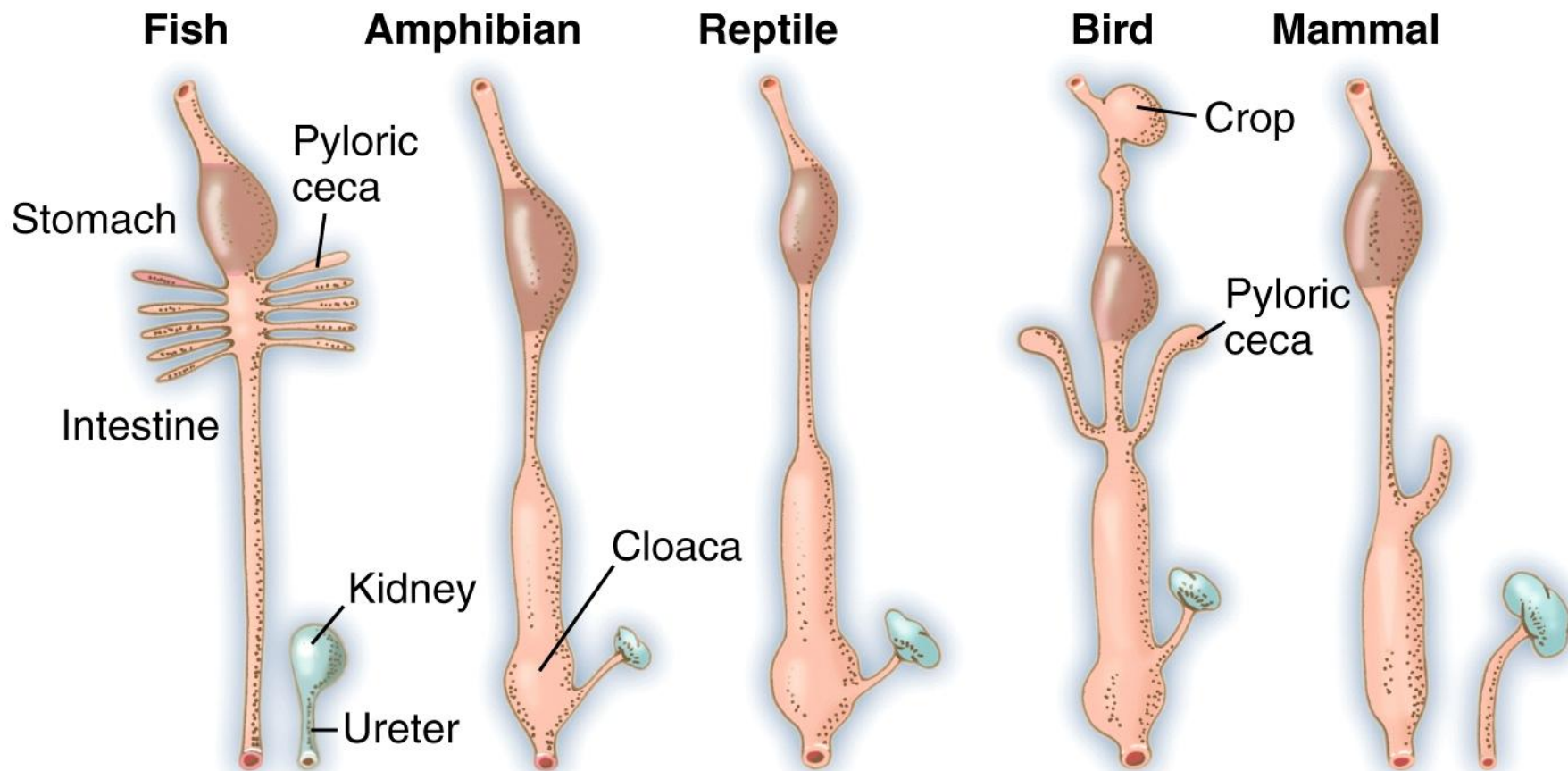
**Birds**

**Mammals**

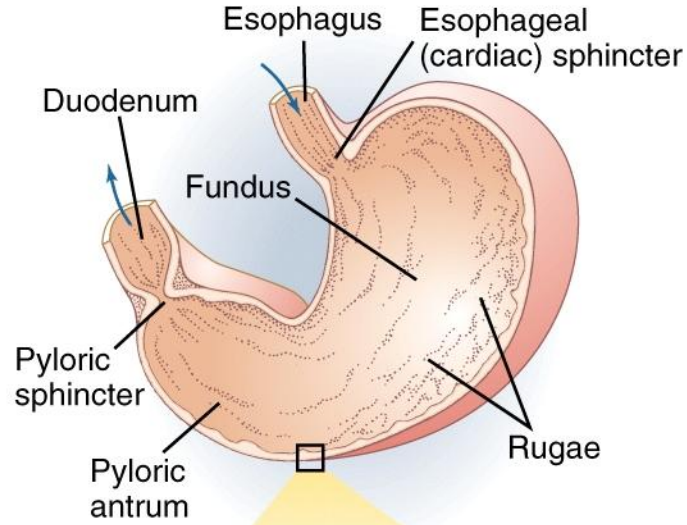
(pigeon)

(rabbit)

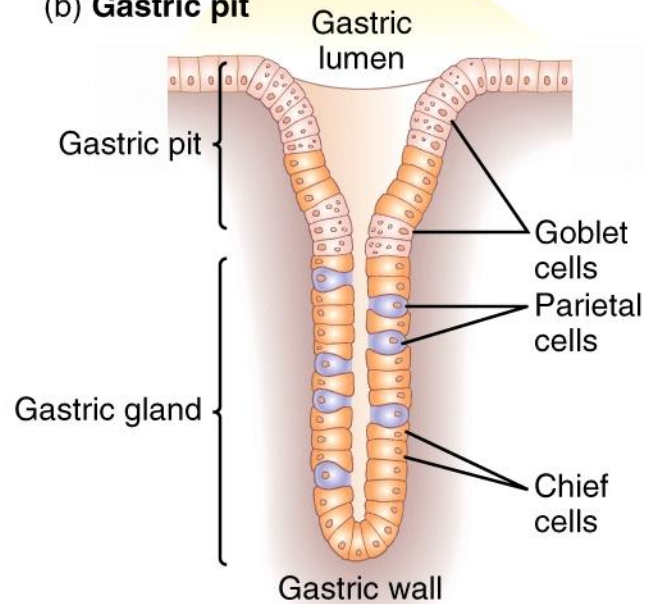




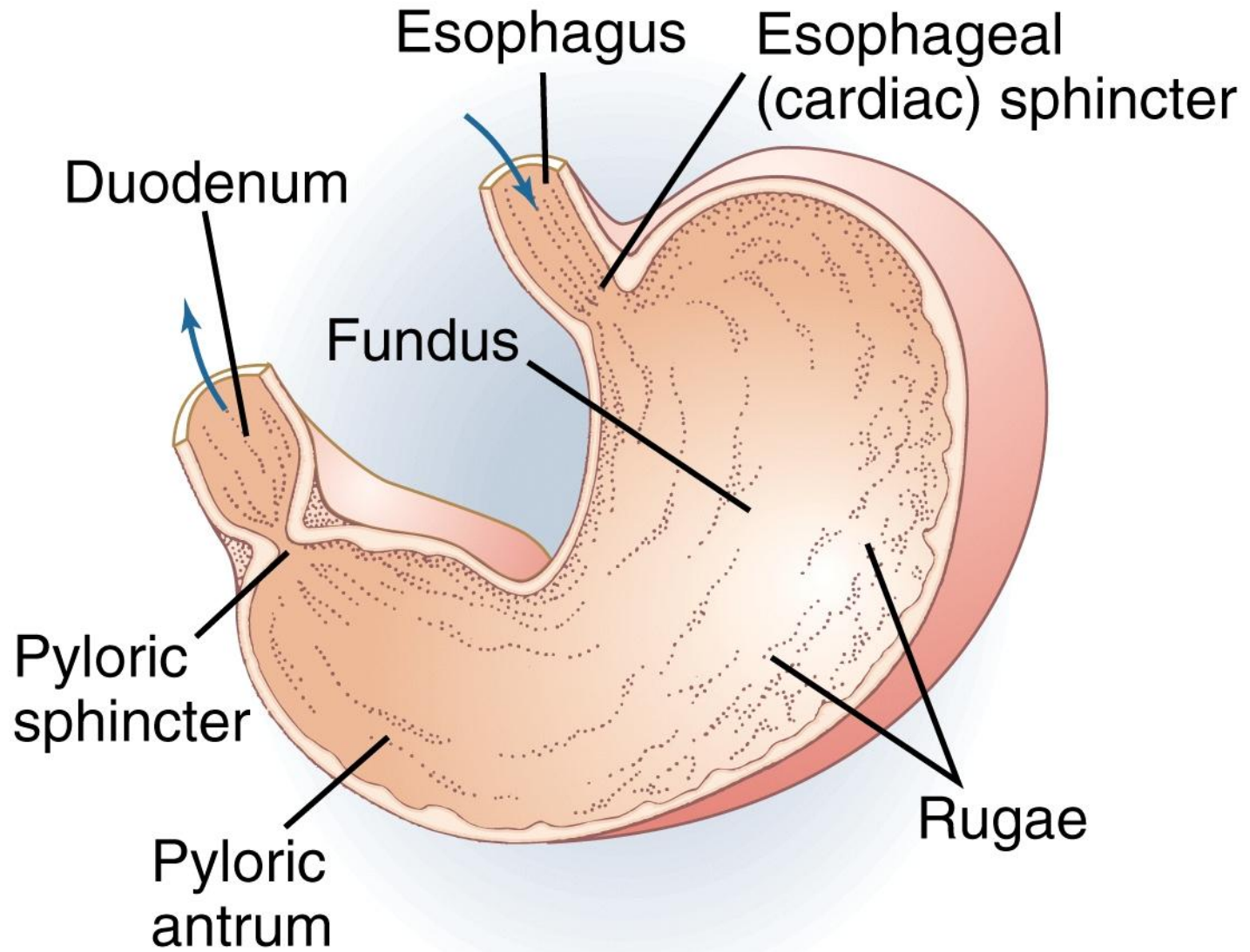
(a) **Monogastric stomach**



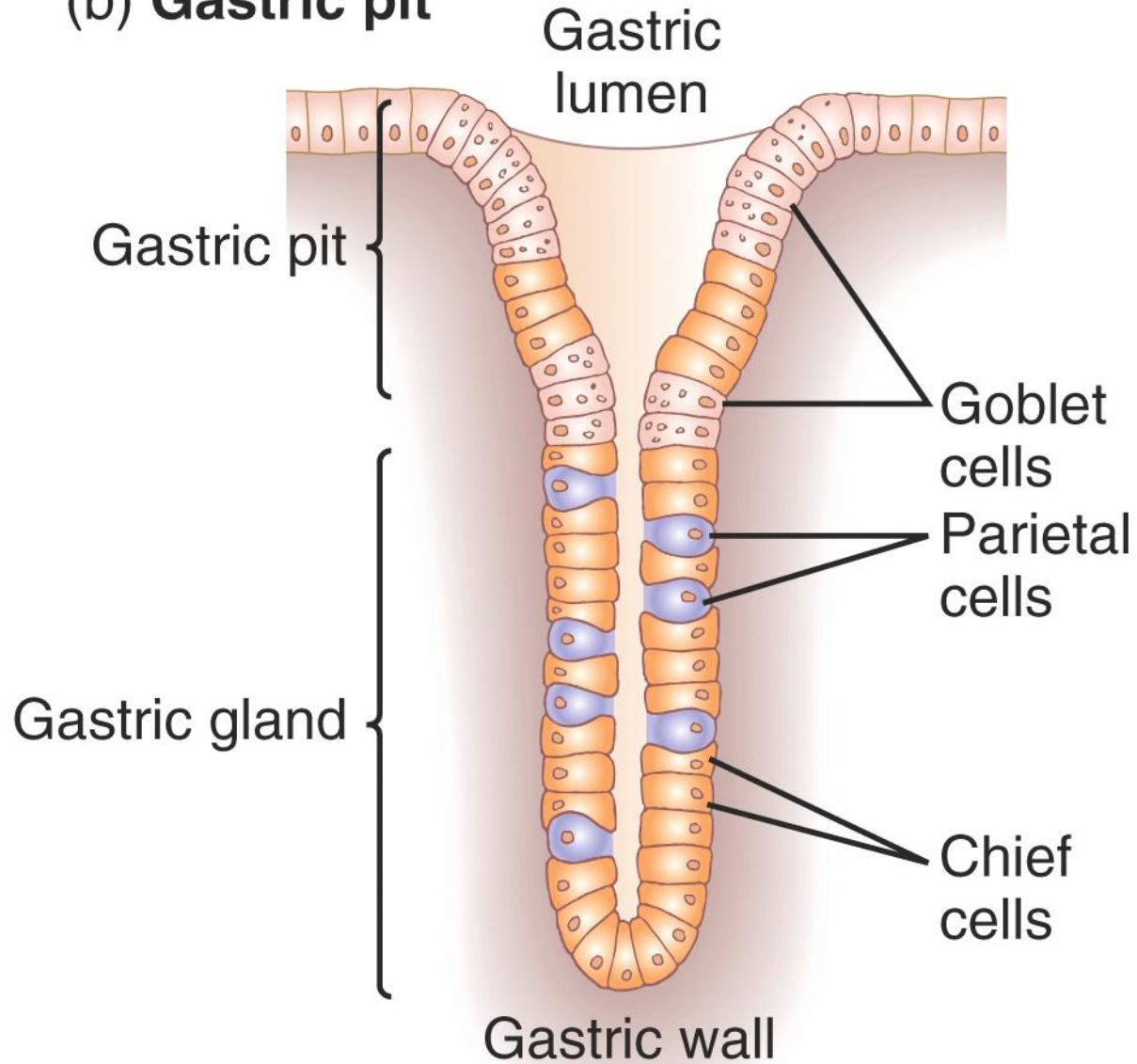
(b) **Gastric pit**

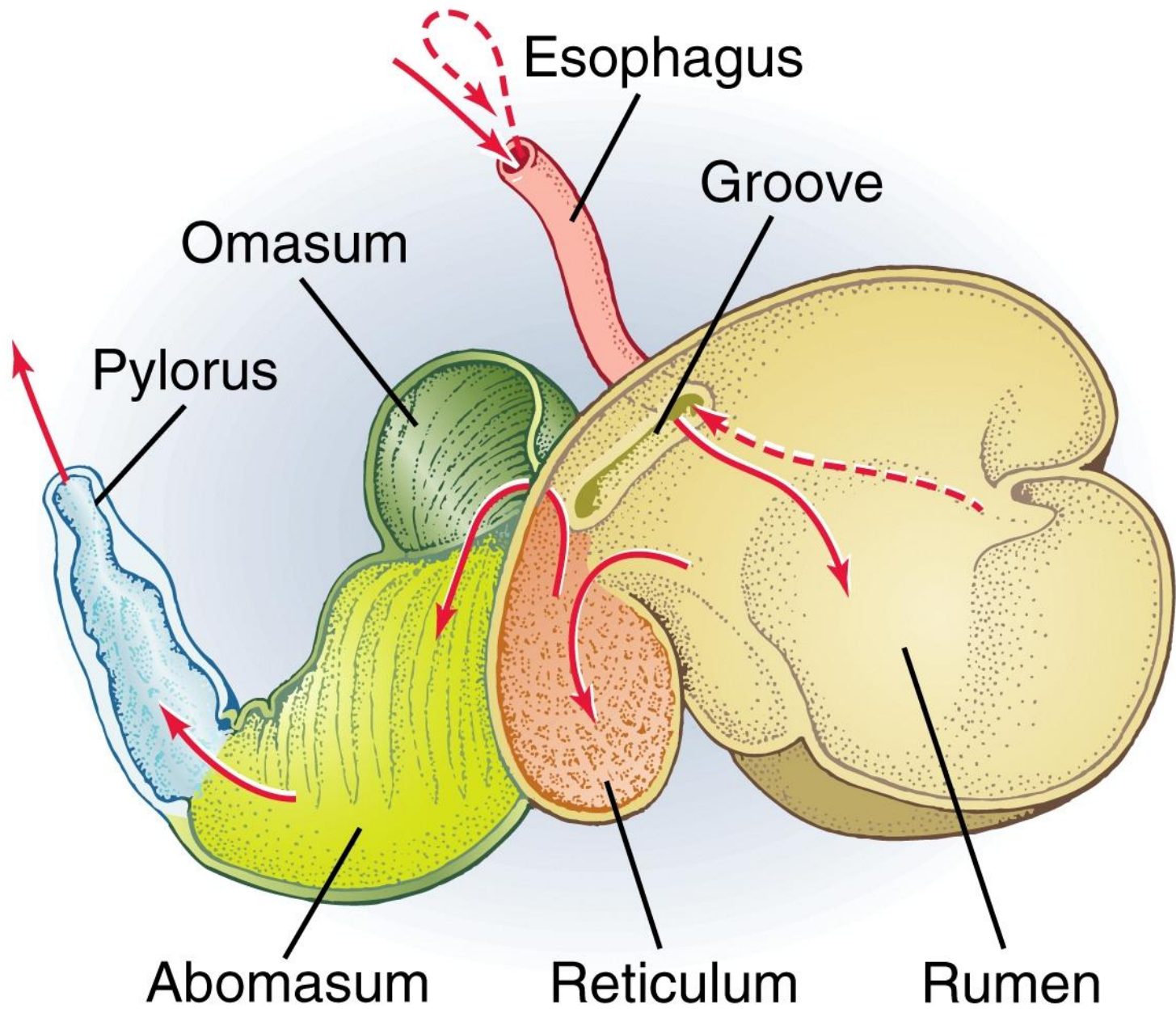


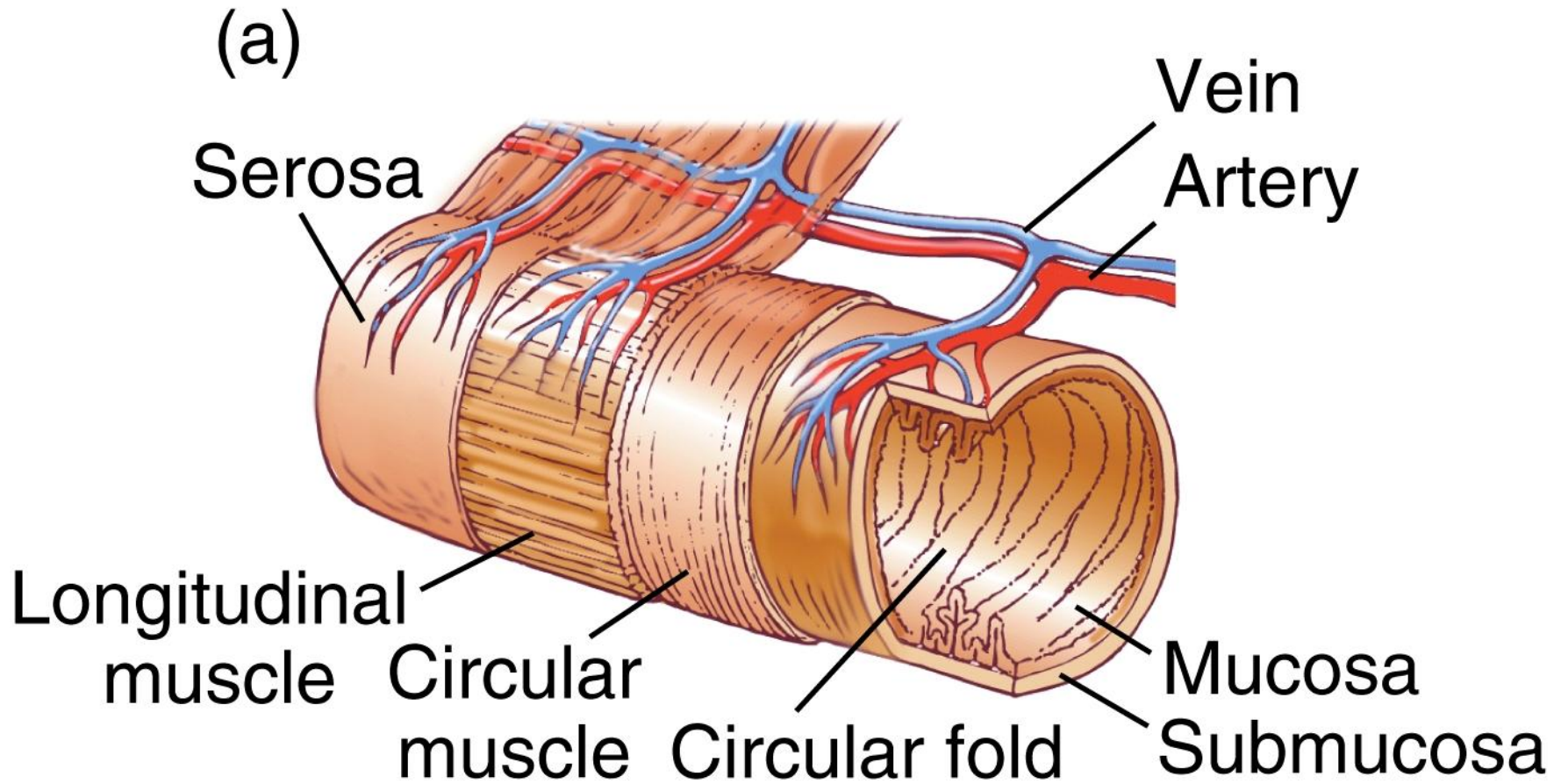
# (a) Monogastric stomach

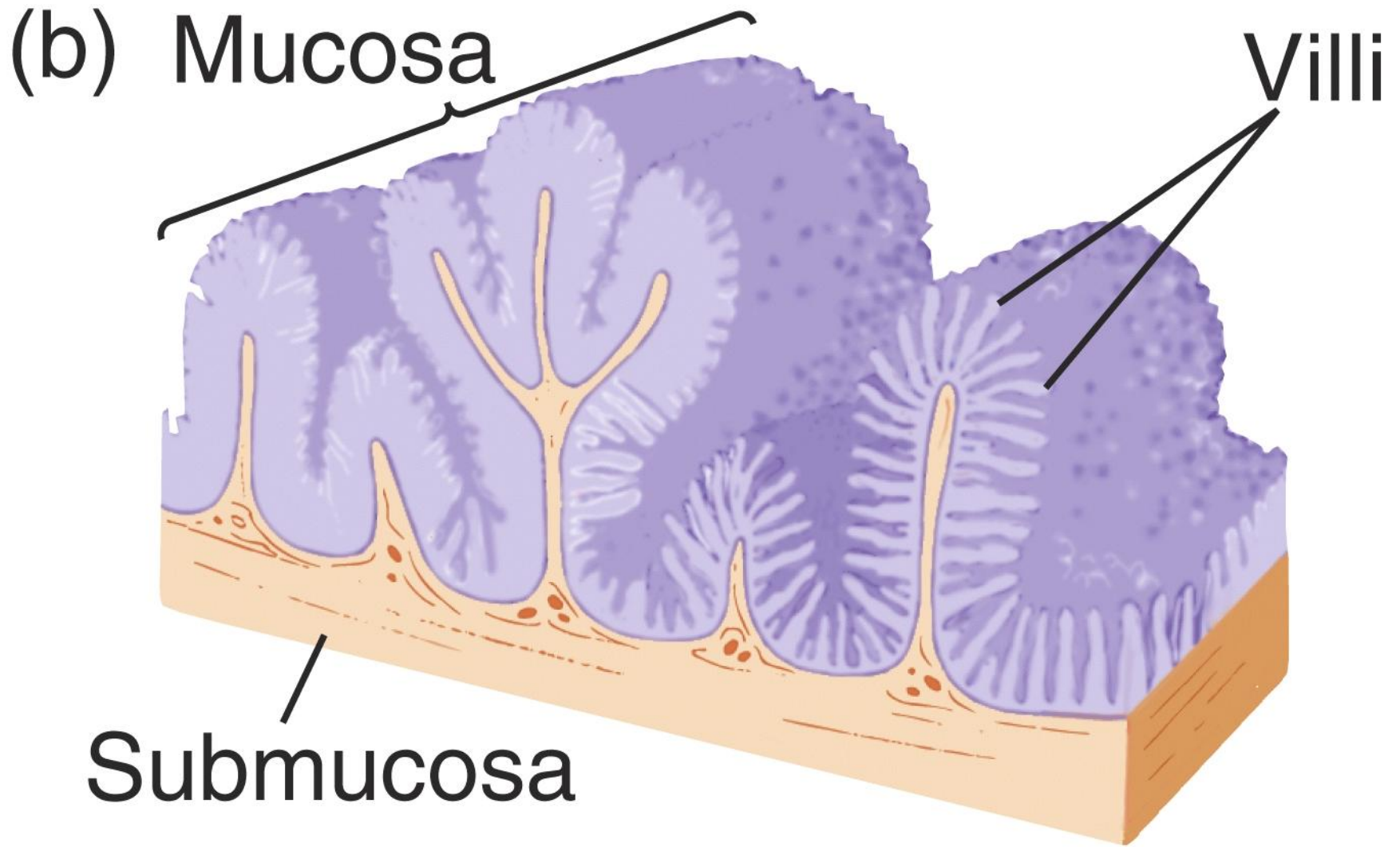


**(b) Gastric pit**





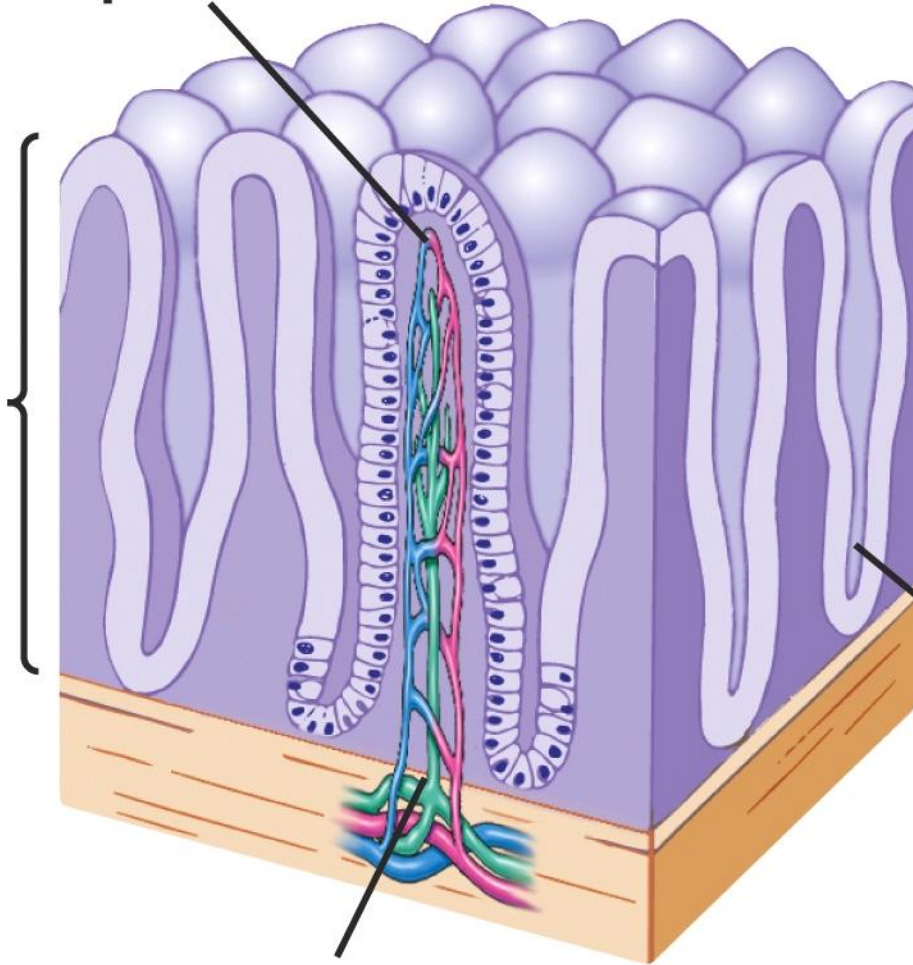




(c)

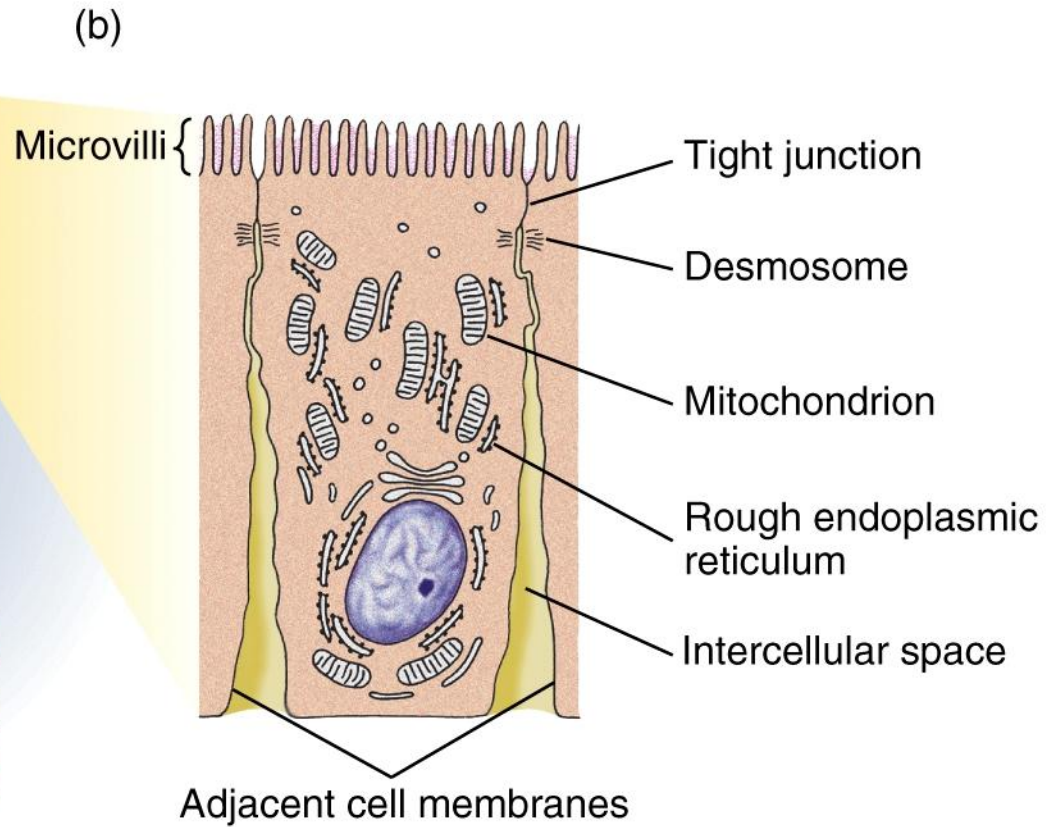
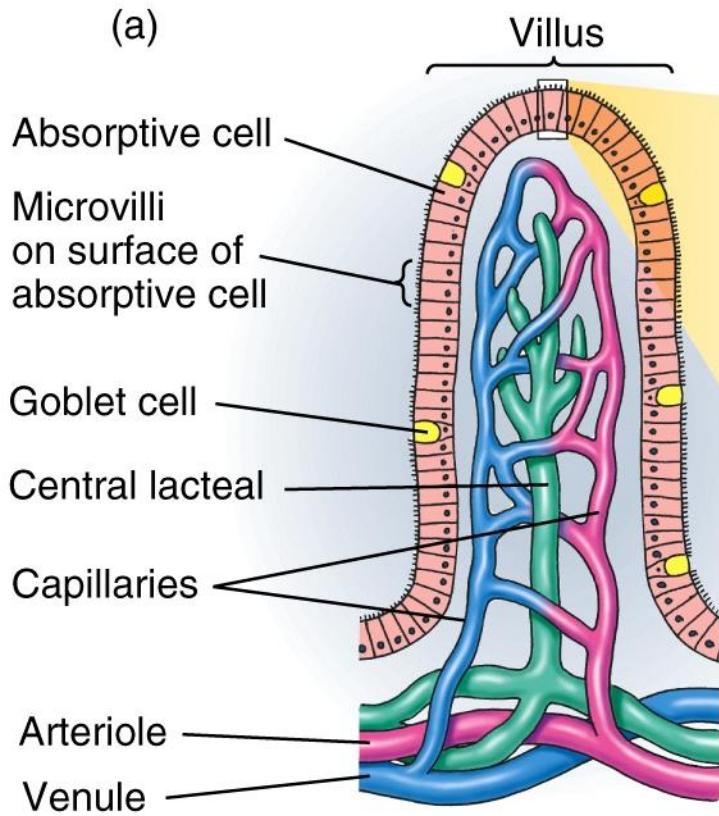
Capillaries

Villus

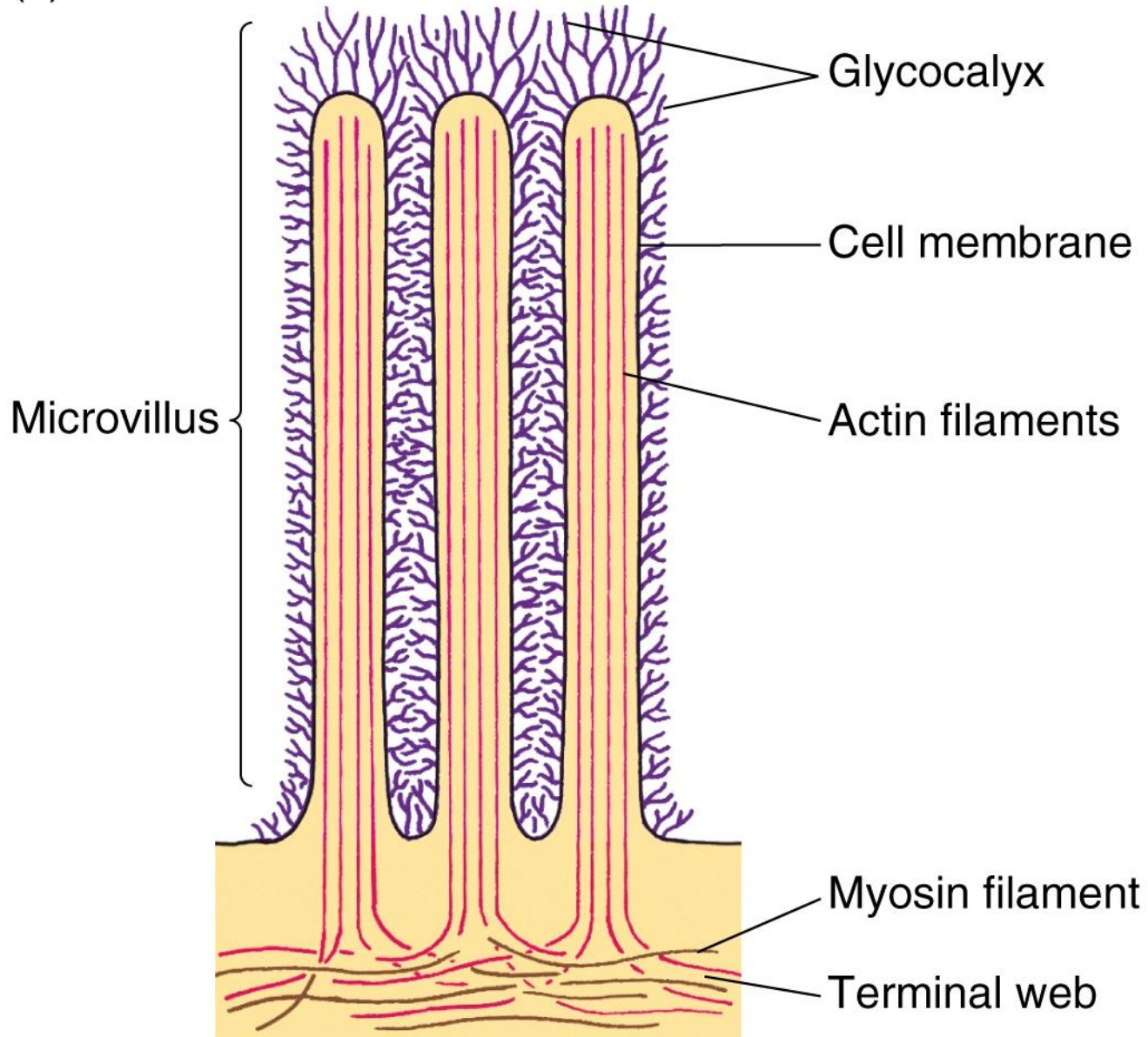


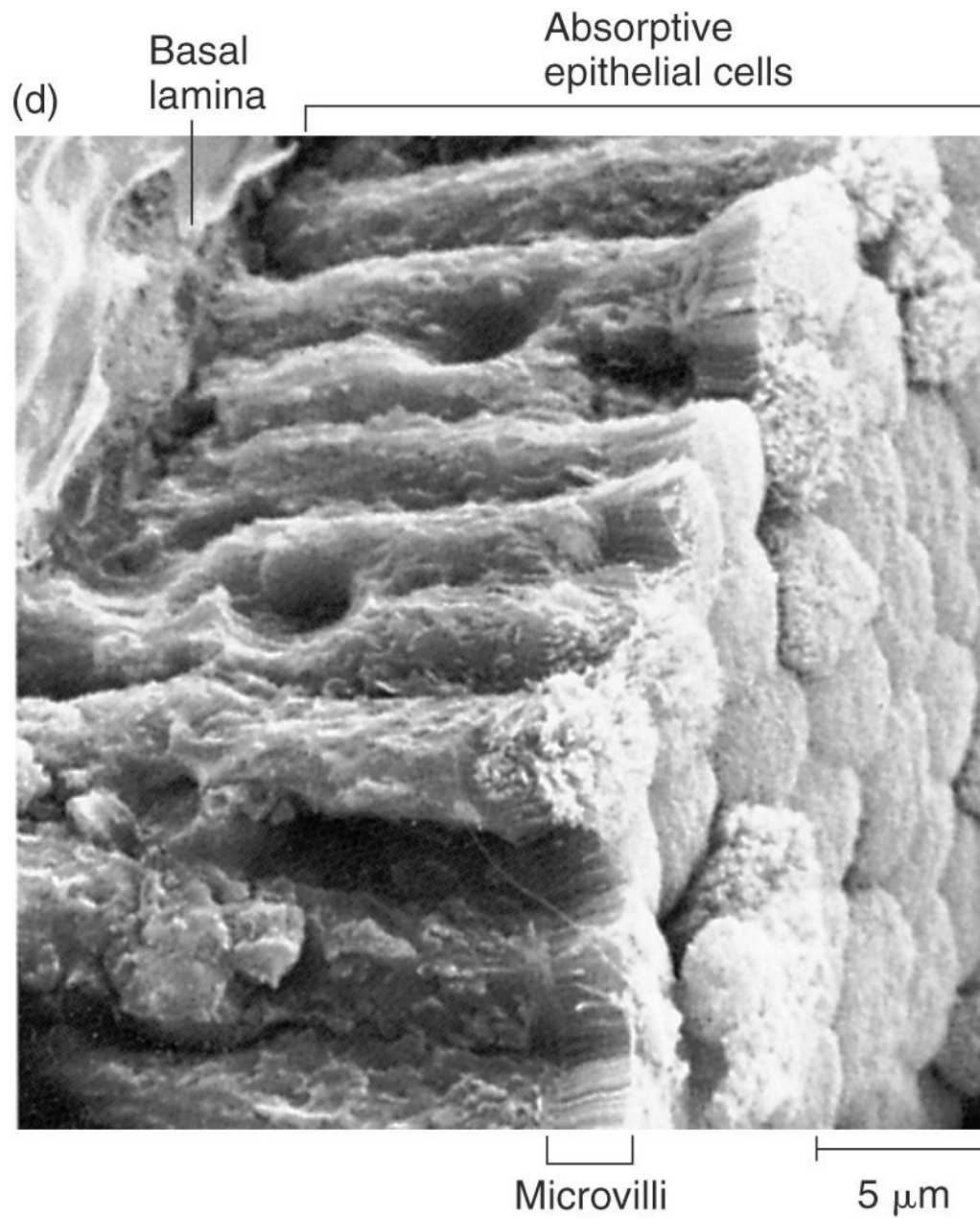
Crypt of  
Lieberkühn

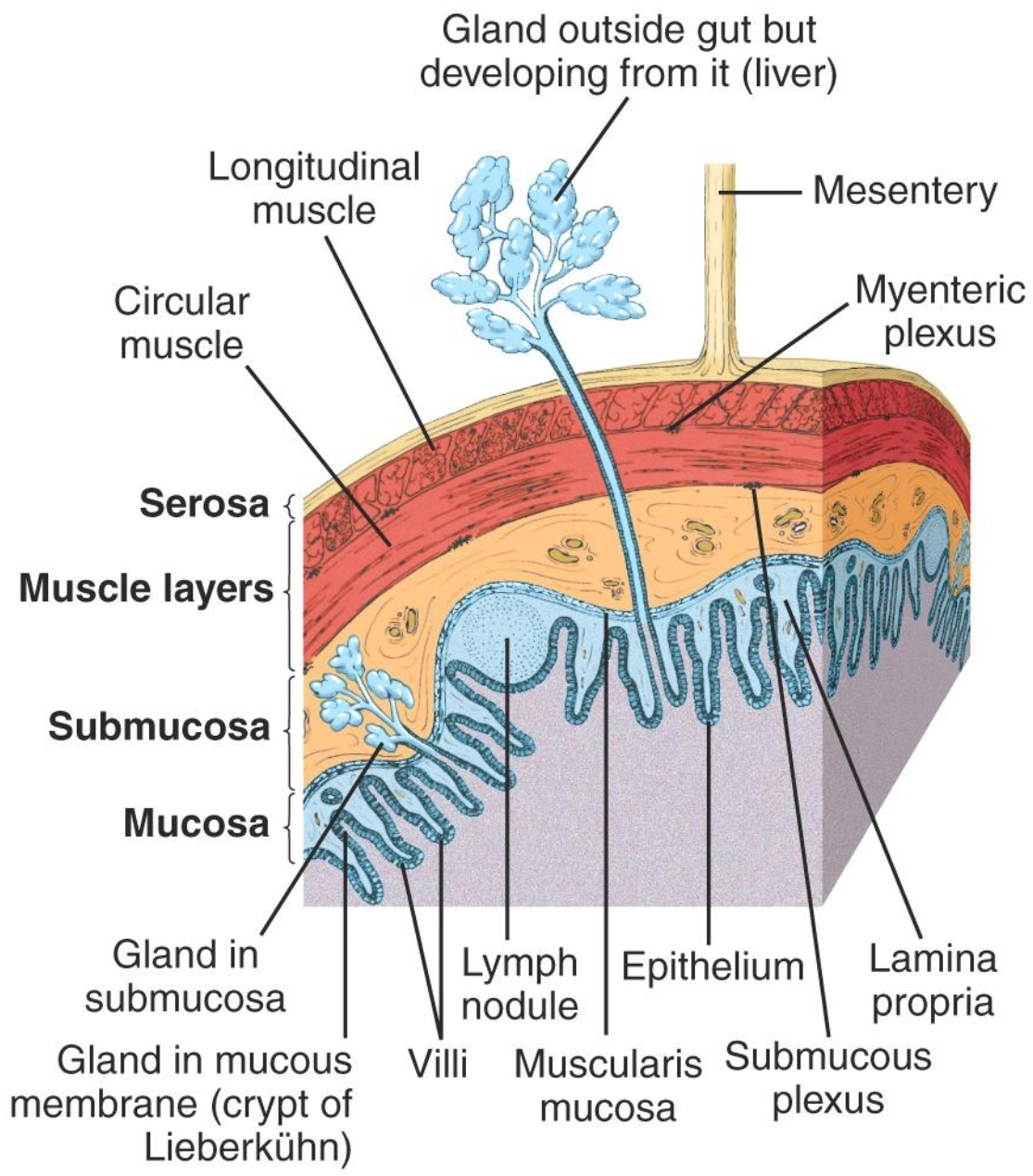
Central lacteal



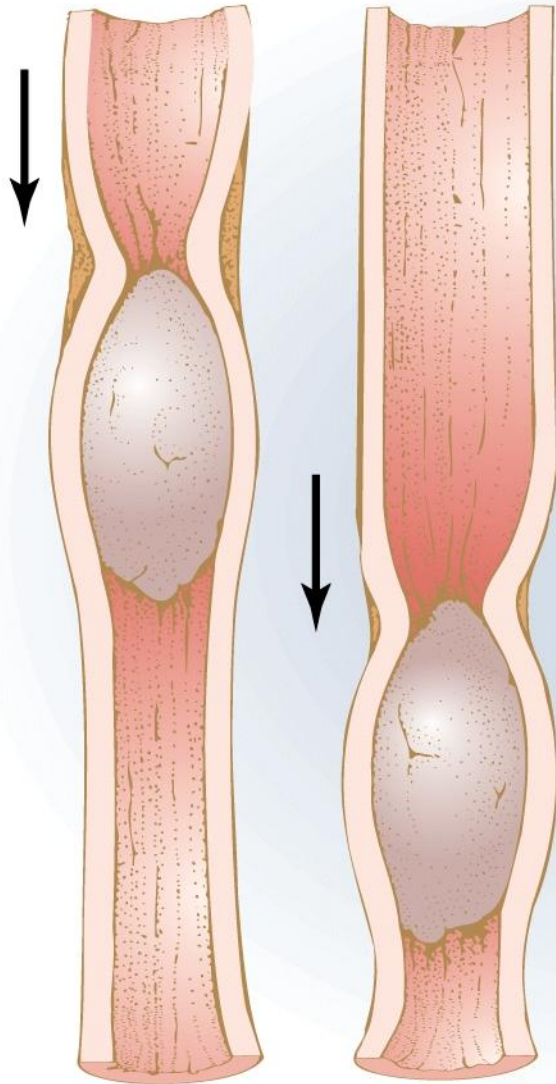
(c)



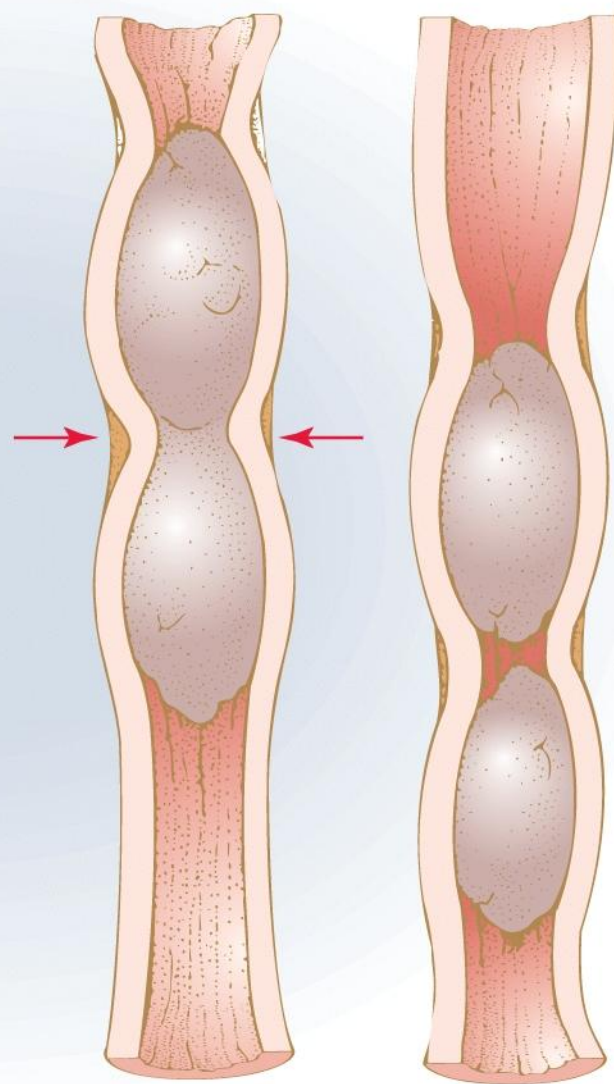


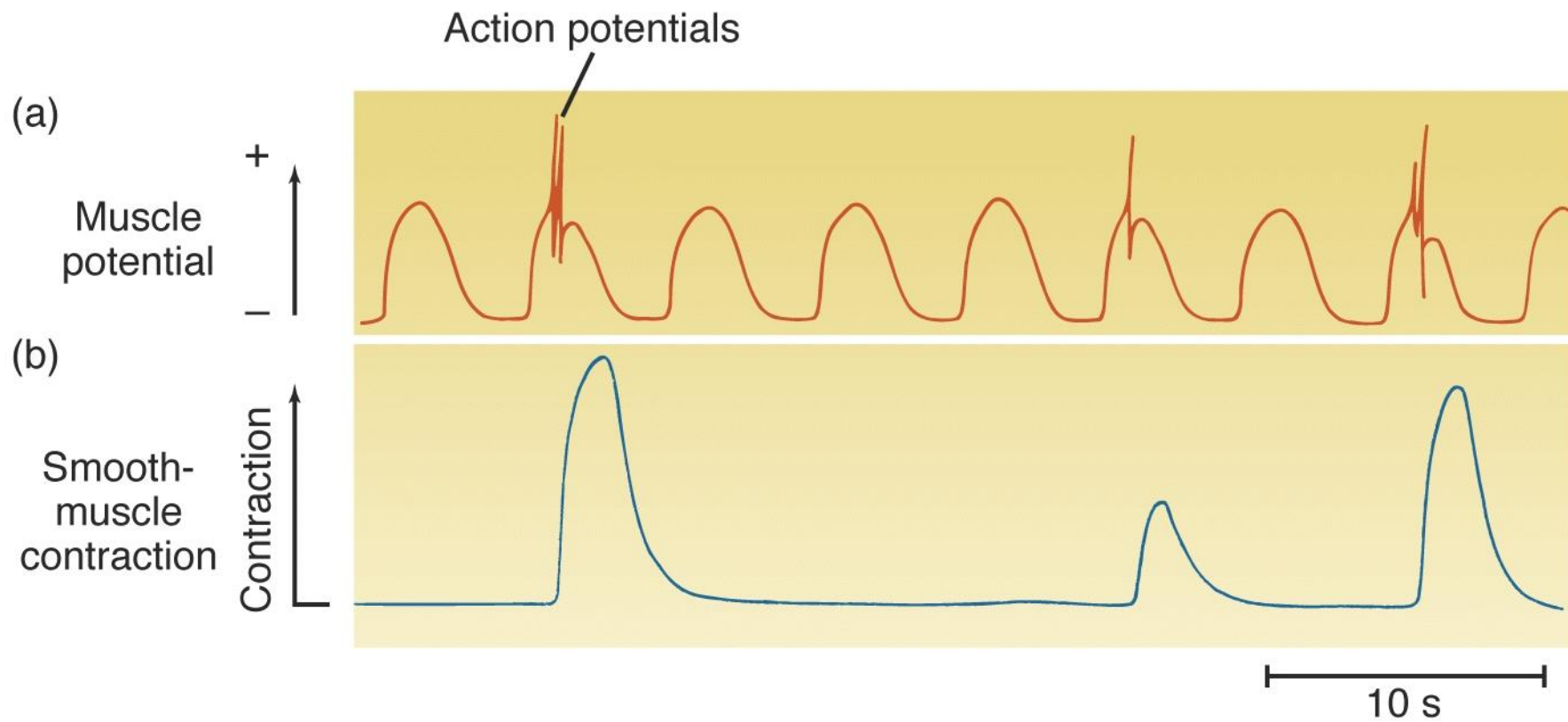


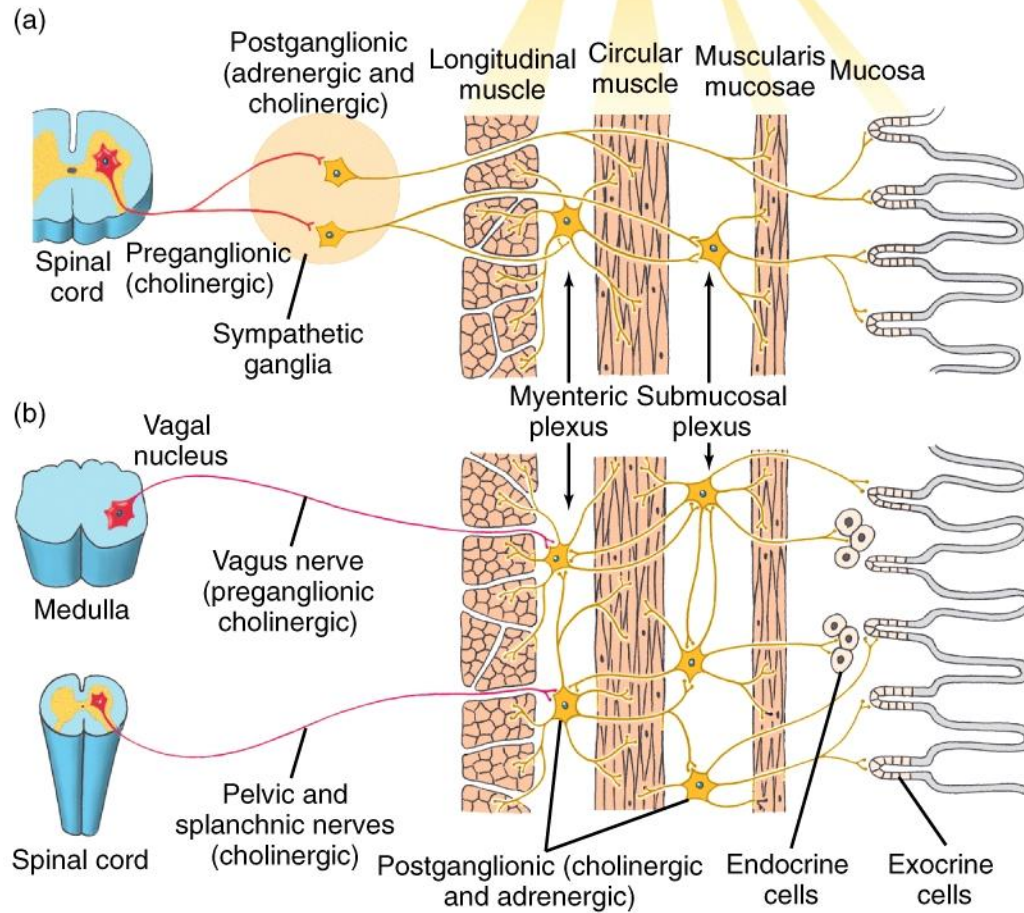
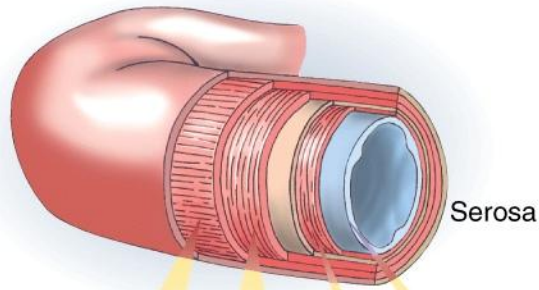
(a) Peristalsis

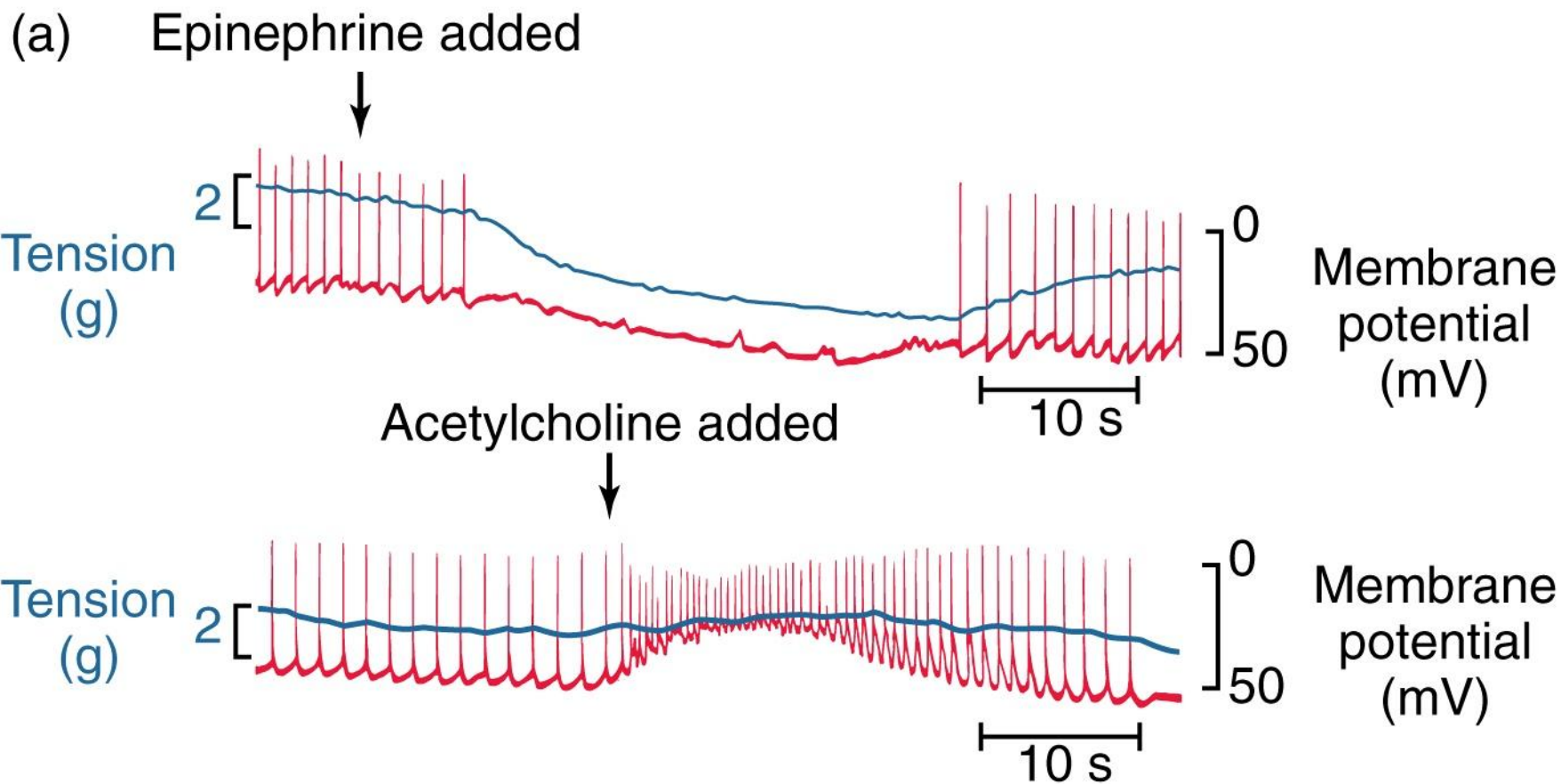


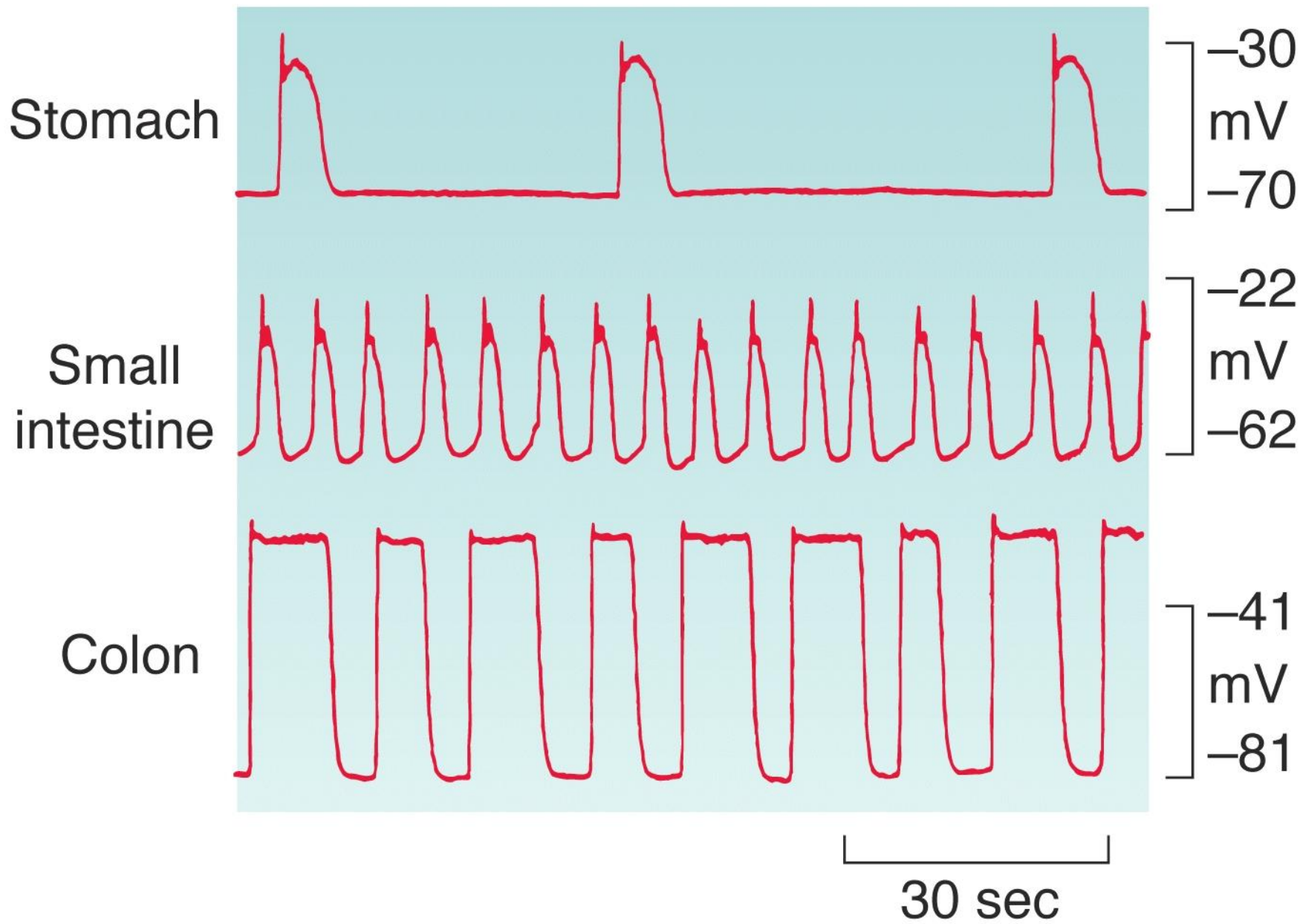
(b) Segmentation

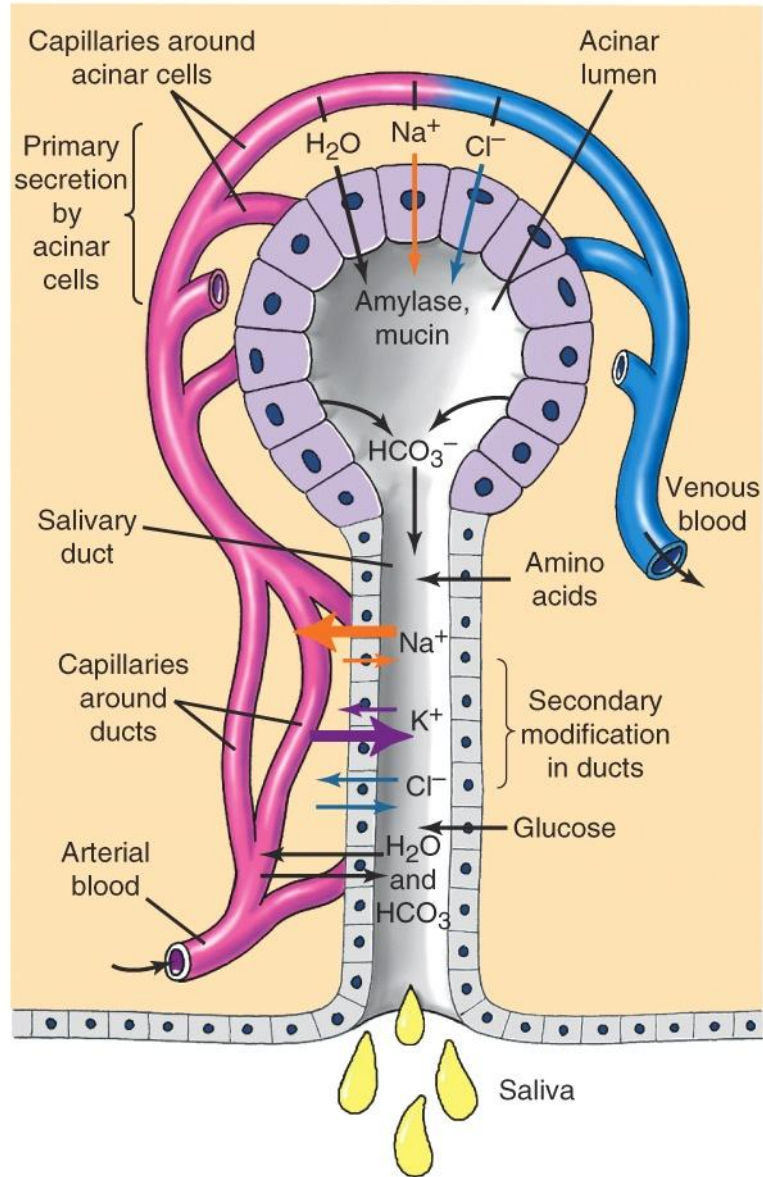












Region	Secretion	Daily amount (L)	pH	Composition*
Buccal cavity	Saliva	1+	6.5	Amylase, bicarbonate
Esophagus	Gastric juice	1—3	1.5	Pepsinogen, HCl, rennin in infants, intrinsic factor
Stomach	Pancreatic juice	1	7—8	Trypsinogen, chymotrypsinogen, carboxy- and aminopeptidase, lipase, amylase, maltase, nucleases, bicarbonate
Pancreas	Bile	1	7—8	Fats and fatty acids, bile salts and pigments, cholesterol
Gall-bladder	Succus entericus	1	7—8	Enterokinase, carboxy- and aminopeptidases, maltase, lactase, sucrase, lipase, nucleases
Duodenum				
Jejunum				
Ileum				
Cecum				
Colon				
Rectum				

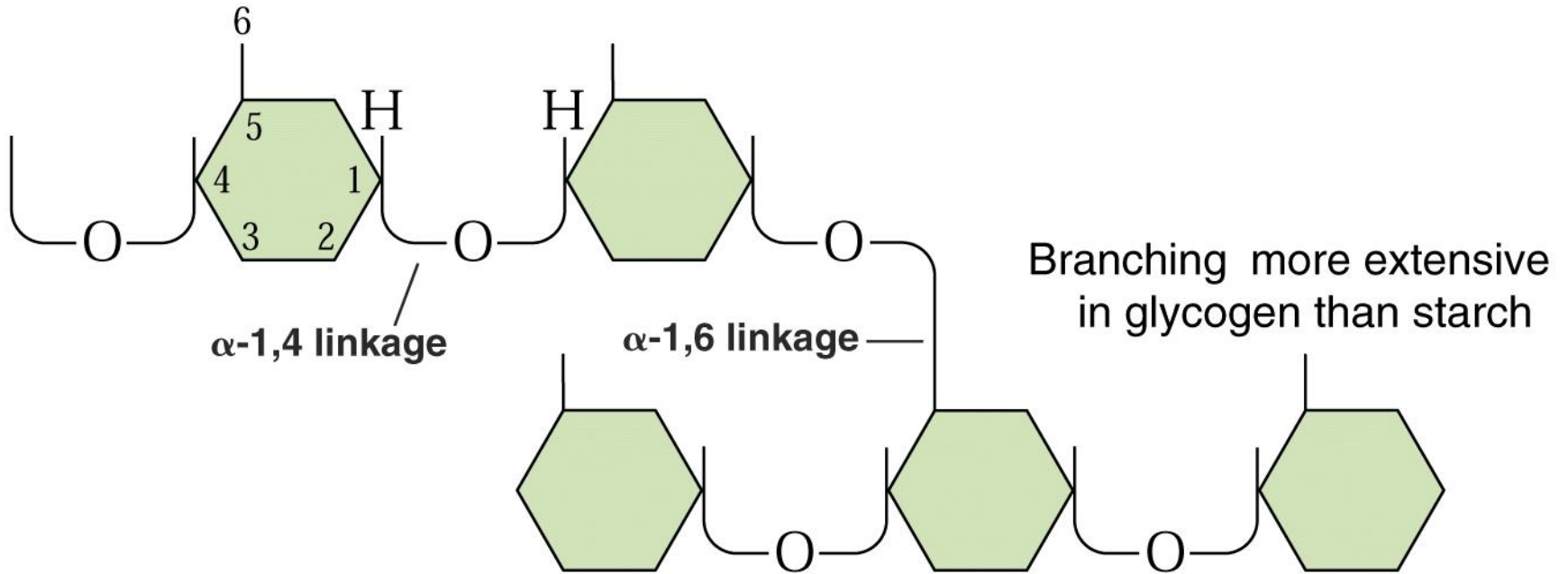
\*Excluding mucus and water, which together make up some 95% of the actual secretion.

**Table 15-1** Action of the major enzymes secreted in the mouth, stomach, pancreas, and small intestine

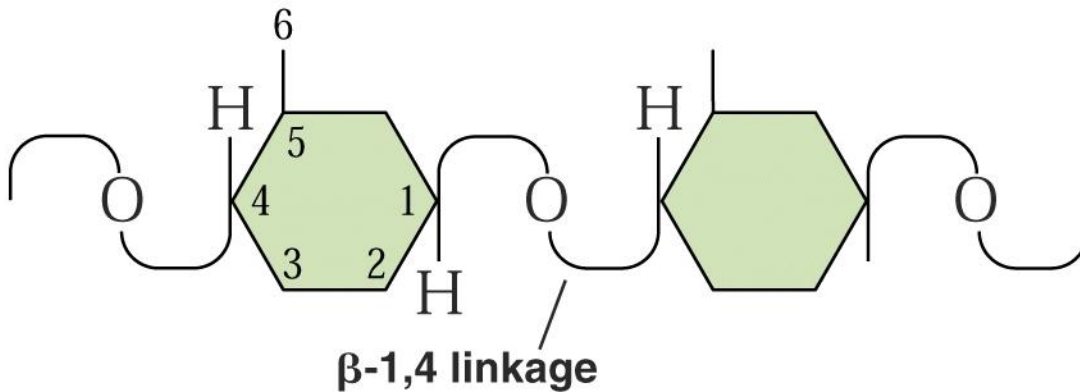
Enzyme	Site of action	Substrate	Products of action
<b>Mouth</b>			
Salivary $\alpha$ -amylase	Mouth	Starch	Disaccharides (few)
<b>Stomach</b>			
Pepsinogen:pepsin	Stomach	Proteins	Large peptides
<b>Pancreas</b>			
Pancreatic $\alpha$ -amylase	Small intestine	Starch	Disaccharides
Trypsinogen:trypsin	Small intestine	Proteins	Large peptides
Chymotrypsin	Small intestine	Proteins	Large peptides
Elastase	Small intestine	Elastin	Large peptides
Carboxypeptidases	Small intestine	Large peptides	Small peptides (oligopeptides)
Aminopeptidases	Small intestine	Large peptides	Oligopeptides
Lipase	Small intestine	Triglycerides	Monoglycerides, fatty acids, glycerol
Nucleases	Small intestine	Nucleic acids	Nucleotides
<b>Small intestine</b>			
Enterokinase	Small intestine	Trypsinogen	Trypsin
Disaccharidases	Small intestine*	Disaccharides	Monosaccharides
Peptidases	Small intestine*	Oligopeptides	Amino acids
Nucleotidases	Small intestine*	Nucleotides	Nucleosidases, phosphoric acid
Nucleosidases	Small intestine*	Nucleosides	Sugars, purines, pyrimidines

\*Intracellular

## Glycogen and starch



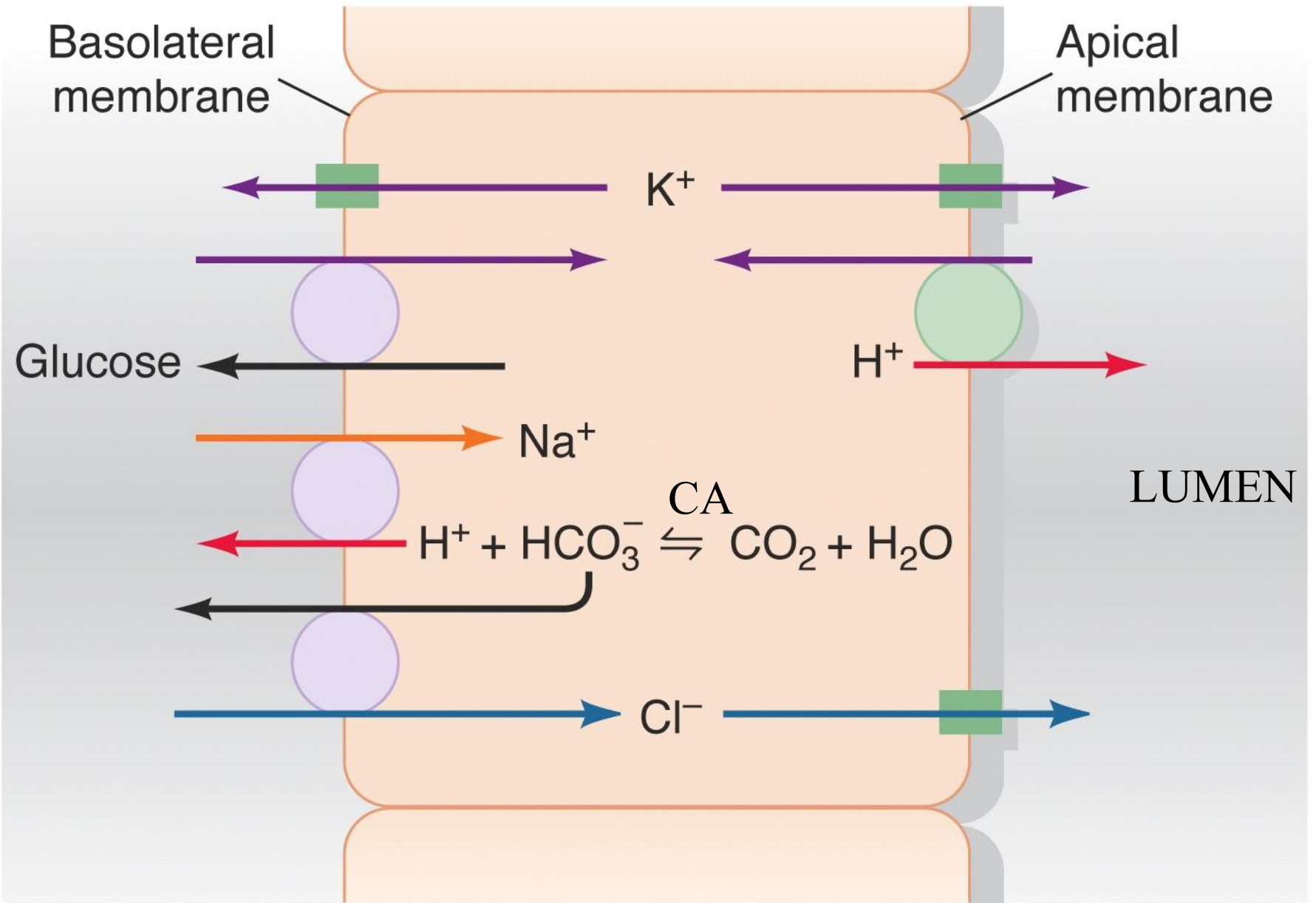
## Cellulose

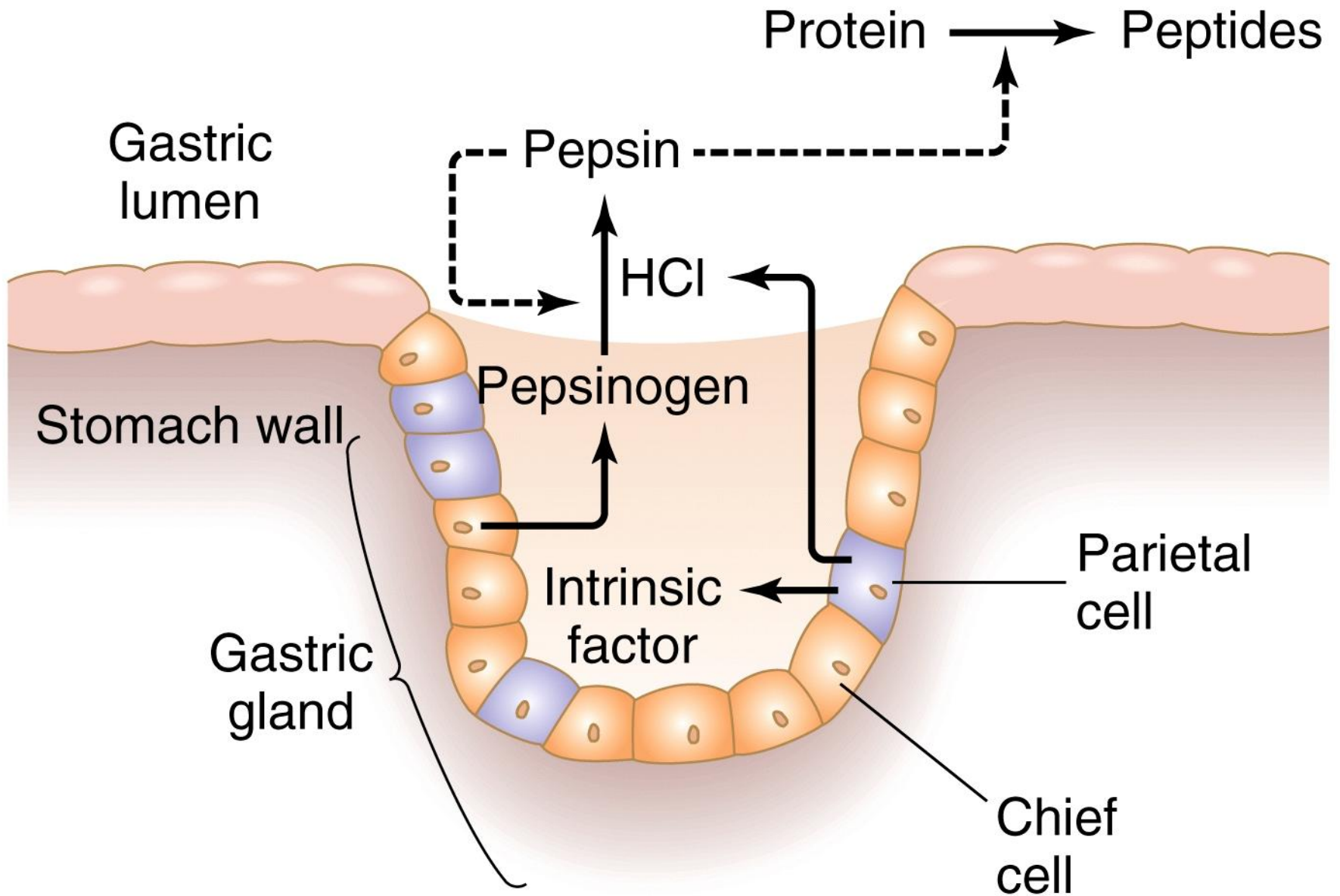


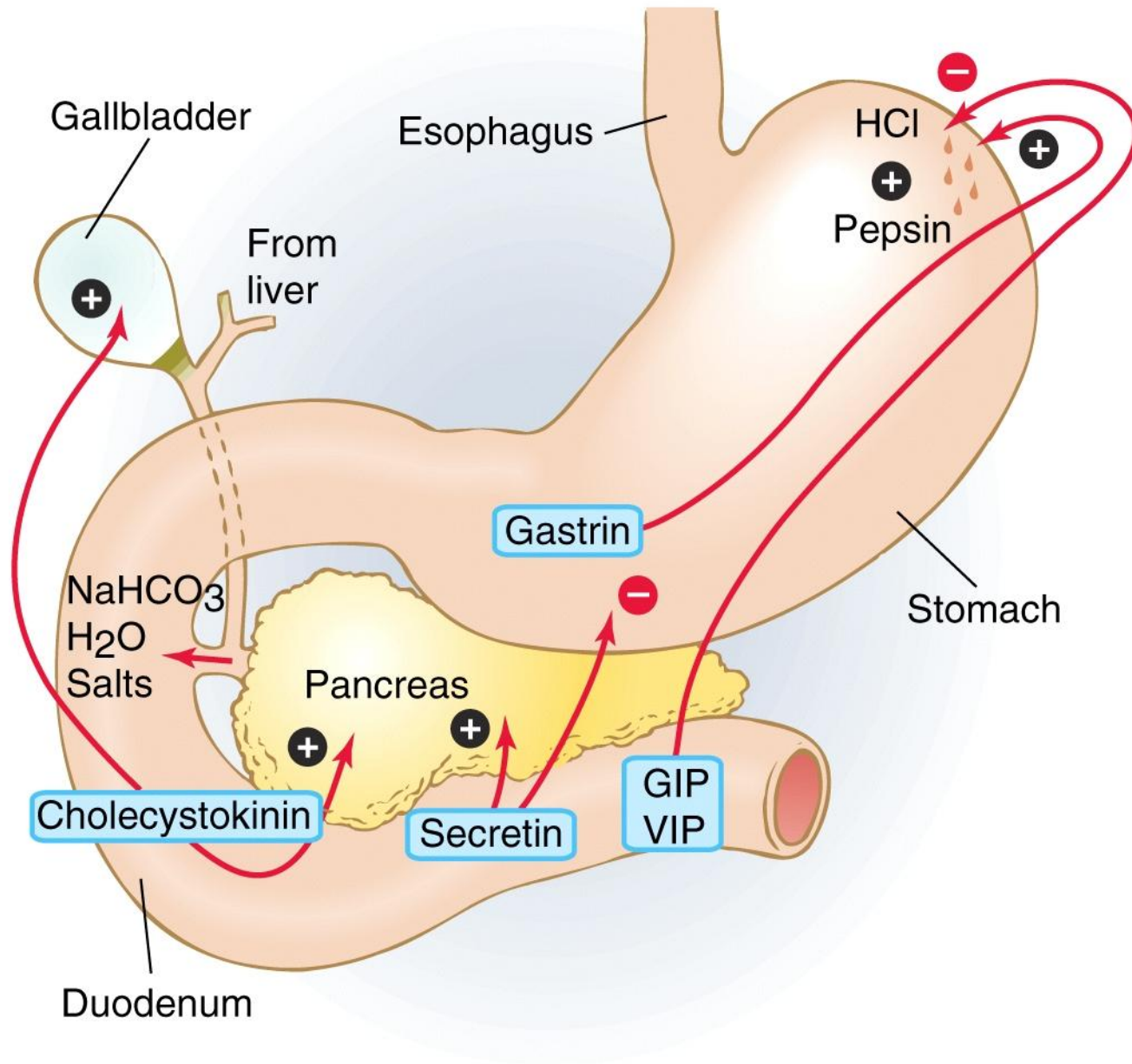
**Table 15-2** The major gastrointestinal peptide hormones

Hormone	Tissues of origin	Target tissue	Primary action	Stimulus to secretion
Gastrin	Stomach and duodenum	Secretory cells and muscles of stomach	HCl production and secretion; stimulation of gastric motility	Vagus nerve activity; peptides and proteins in stomach
Cholecystokinin (CCK)*	Upper small intestine	Gallbladder	Contraction of gallbladder	Fatty acids and amino acids in duodenum
Secretin*	Duodenum	Pancreas, secretory cells, and muscles of stomach	Pancreatic juice secretion Water and NaHCO <sub>3</sub> secretion; inhibition of gastric motility	Food and strong acid in stomach and small intestine
Gastric inhibitory peptide (GIP)	Upper small intestine	Gastric mucosa and musculature	Inhibition of gastric secretion and motility	Monosaccharides and fats in duodenum
Bulbogastrone	Upper small intestine	Stomach	Inhibition of gastric secretion and motility	Acid in duodenum
Vasoactive intestinal peptide (VIP)*	Duodenum	Stomach, intestine	Increase of blood flow; secretion of thin pancreatic fluid; inhibition of gastric secretion	Fats in duodenum
Enteroglucagon	Duodenum	Jejunum, pancreas	Inhibition of motility and secretion	Carbohydrates in duodenum
Enkephalin*	Small intestine	Stomach, pancreas, intestine	Stimulation of HCl secretion; inhibition of pancreatic enzyme secretion and intestinal motility	Basic conditions in stomach and intestine
Somatostatin*	Small intestine	Stomach, pancreas, intestine, splanchnic arterioles	Inhibition of HCl secretion, pancreatic secretion, intestinal motility, and visceral blood flow	Acid in lumen of stomach

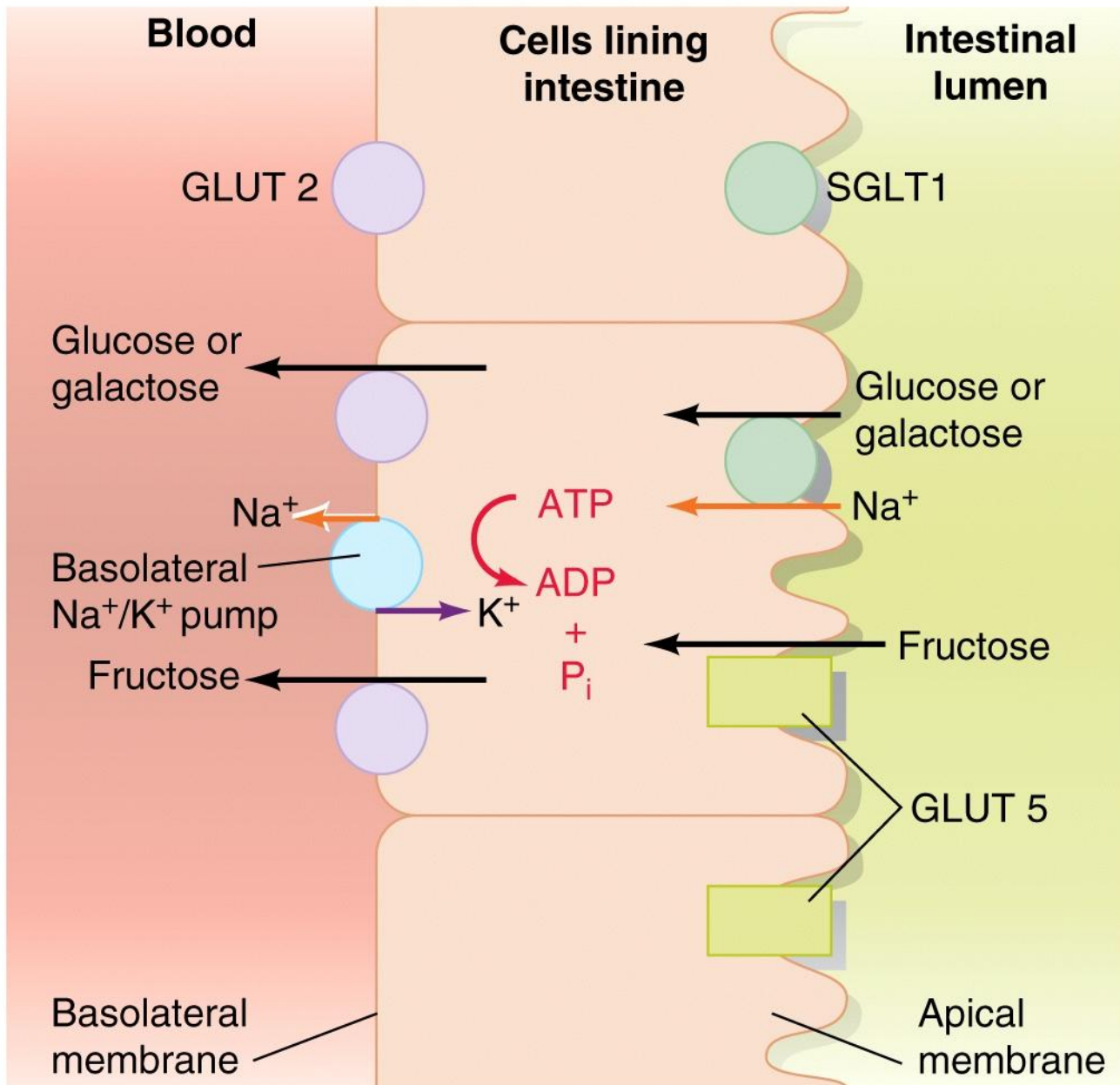
\*These peptides are also found in central nervous tissue as neuropeptides. Additional unlisted neuropeptides identified in both brain and gut tissue include substance P, neurotensin, bombesin, insulin, pancreatic polypeptide, and ACTH.

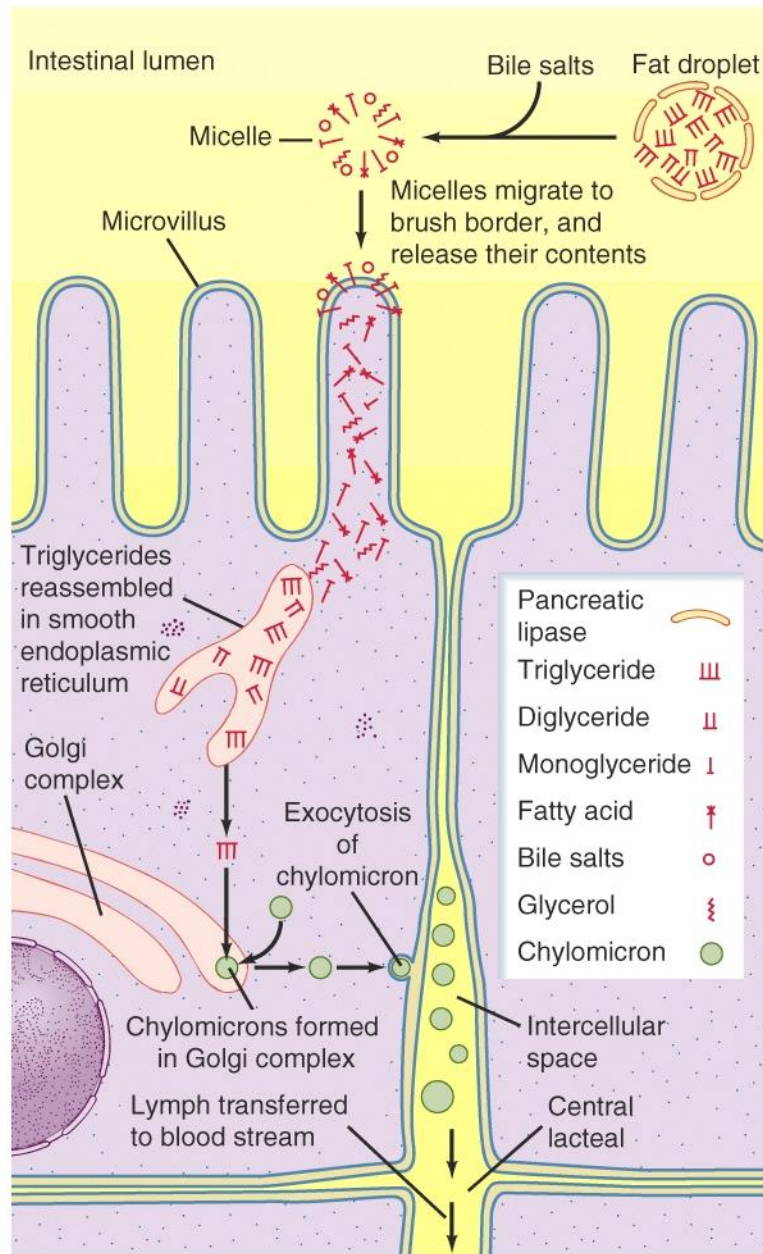






# **Pavlov's experiments**

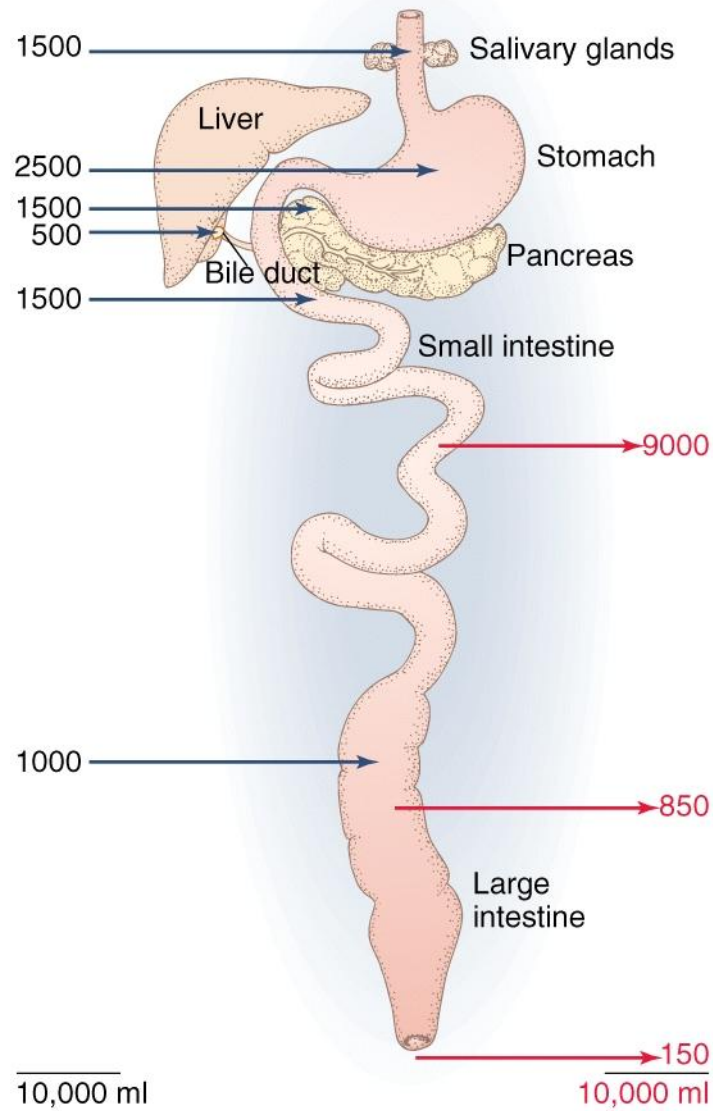




**Fluid entering  
alimentary canal**

**Fluid  
absorbed**

1500 ml



**Table 15-3** Some mammalian vitamins

Vitamin	Major dietary sources; solubility <sup>°</sup>	Uptake; storage	Function in mammals <sup>†</sup>	Deficiency symptoms
Ascorbic acid (C)	Citrus fruits; WS	Absorbed from gut; little storage	Vital element for collagen; antioxidant	Scurvy (failure to form connective tissue)
Biotin	Egg yolk, tomatoes, liver, synthesis by intestinal flora; WS	Absorbed from gut	Protein and fatty acid synthesis; CO <sub>2</sub> fixation; transamination	Scaly dermatitis, muscle pains, weakness
Cyanocobalamin (B <sub>12</sub> )	Liver, kidney, brain, fish, eggs, synthesis by intestinal flora; WS	Absorbed from gut; stored in liver, kidney, brain	Nucleoprotein synthesis; formation of erythrocytes	Pernicious anemia, malformed erythrocytes
Folic acid (folacin, pteroylglutamic acid)	Meats; WS	Absorbed from gut; utilized as acquired	Nucleoprotein synthesis; formation of erythrocytes	Failure of erythrocytes to mature, anemia
Niacin	Lean meat, liver, whole grains; WS	Absorbed from gut; distributed to all tissues	Coenzyme in hydrogen transport (NAD, NADP)	Pellagra, skin lesions, digestive disturbances, dementia
Pantothenic acid	Many foods; WS	Absorbed from gut; stored in all tissues	Constituent of coenzyme A (CoA)	Neuromotor, cardiovascular disorders
Pyridoxine (B <sub>6</sub> )	Whole grains, traces in many foods; WS	Absorbed from gut; half appears in urine	Coenzyme for amino and fatty acid metabolism	Dermatitis, nervous disorders
Riboflavin (B <sub>2</sub> )	Milk, eggs, lean meat, liver, whole grains; WS	Absorbed from gut; stored in kidney, liver, heart	Flavoproteins in oxidative phosphorylation	Photophobia, fissuring of the skin
Thiamine (B <sub>1</sub> )	Brain, liver, kidney, heart, whole grains, nuts, beans, potatoes	Absorbed from gut; stored in liver, brain, kidney	Formation of cocarboxylase enzyme involved in decarboxylation (citric acid cycle)	Stoppage of CH <sub>2</sub> O metabolism at pyruvate, beriberi, neuritis, heart failure

<sup>°</sup>FS = fat-soluble; WS = water-soluble.

<sup>†</sup>Most vitamins have numerous functions; the functions listed are a mere sampling.

Vitamins are classified as either fat soluble (vitamins A, D, E and K)...are stored in the body for long periods of time and generally pose a greater risk for toxicity when consumed in excess than water-soluble vitamins. Eating a normal, well-balanced diet will not lead to toxicity in otherwise healthy individuals. However, taking vitamin supplements .....