

Gastrointestinal physiology

Textbook of Medical Physiology,

GUYTON and HALL,

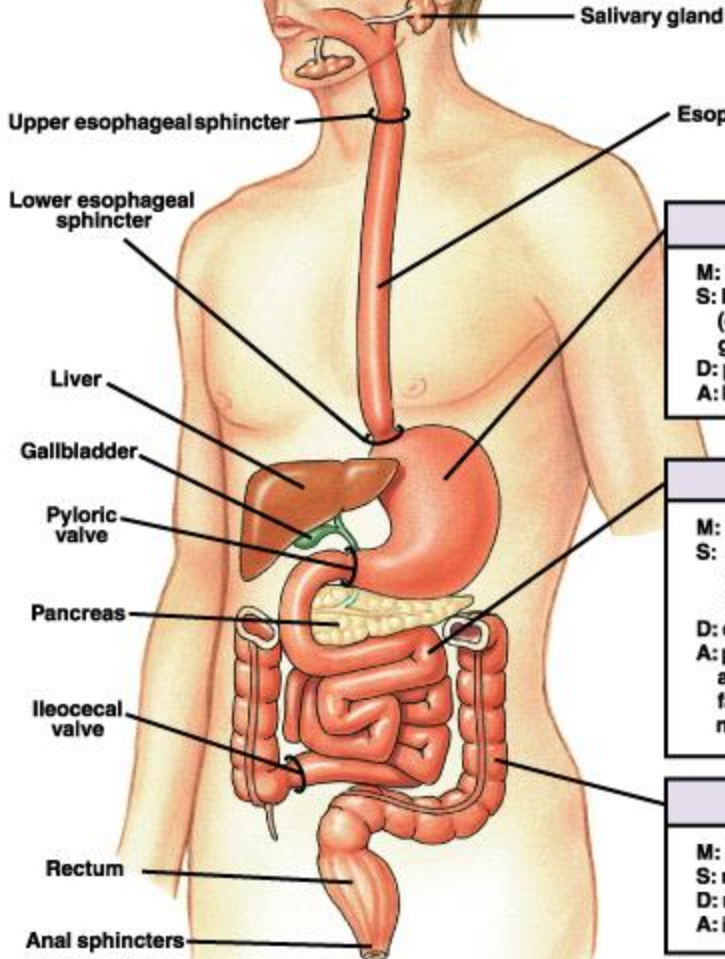
13th ed: pp797-847, pp: 887-907, 12th

Ed: pp753-803, pp: 843-863. 11th ed:

pp771-818, pp865-888.

KEY
M: motility
S: secretion
D: digestion
A: absorption

ORAL CAVITY AND ESOPHAGUS
M: swallowing, chewing
S: saliva(salivary glands), lipase
D: carbohydrates, fats(minimal)
A: none



STOMACH
M: peristaltic mixing and propulsion
S: HCl (parietal cells); pepsinogen and gastric lipase (chief cells); mucus and HCO_3^- (surface mucous cells); gastrin(G cells); histamine (ECL cells)
D: proteins, fats
A: lipid-soluble substances such as alcohol and aspirin

SMALL INTESTINE
M: mixing and propulsion primarily by segmentation;
S: enzymes; HCO_3^- and enzymes (pancreas); bile (liver); mucus (goblet cells); hormones: CCK, secretin, GIP, and other hormones
D: carbohydrates, fats, polypeptides, nucleic acids
A: peptides by active transport; amino acids, glucose, and fructose by secondary active transport; fats by simple diffusion; water by osmosis; ions, minerals, and vitamins by active transport

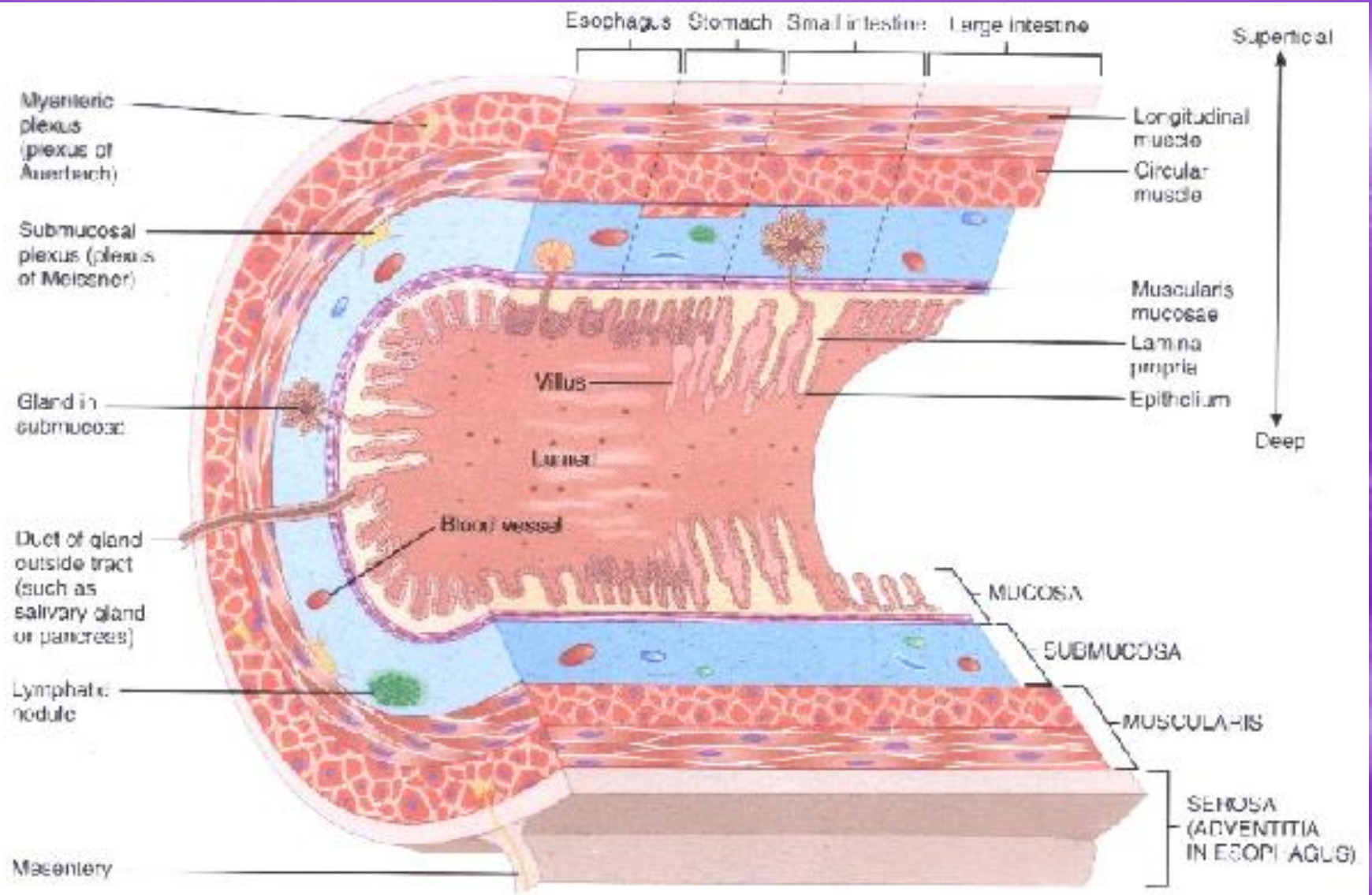
LARGE INTESTINE
M: segmental mixing; mass movement for propulsion
S: mucus(goblet cells)
D: none(except by bacteria)
A: ions, water, minerals, vitamins produced by bacteria

Physiological processes are taking place along the gastrointestinal (GI) tract.

- **1. Motility.**
- **2. Secretion**
- **3. Digestion.**
- **4. Absorption.**

Functional structures in the gastrointestinal tract

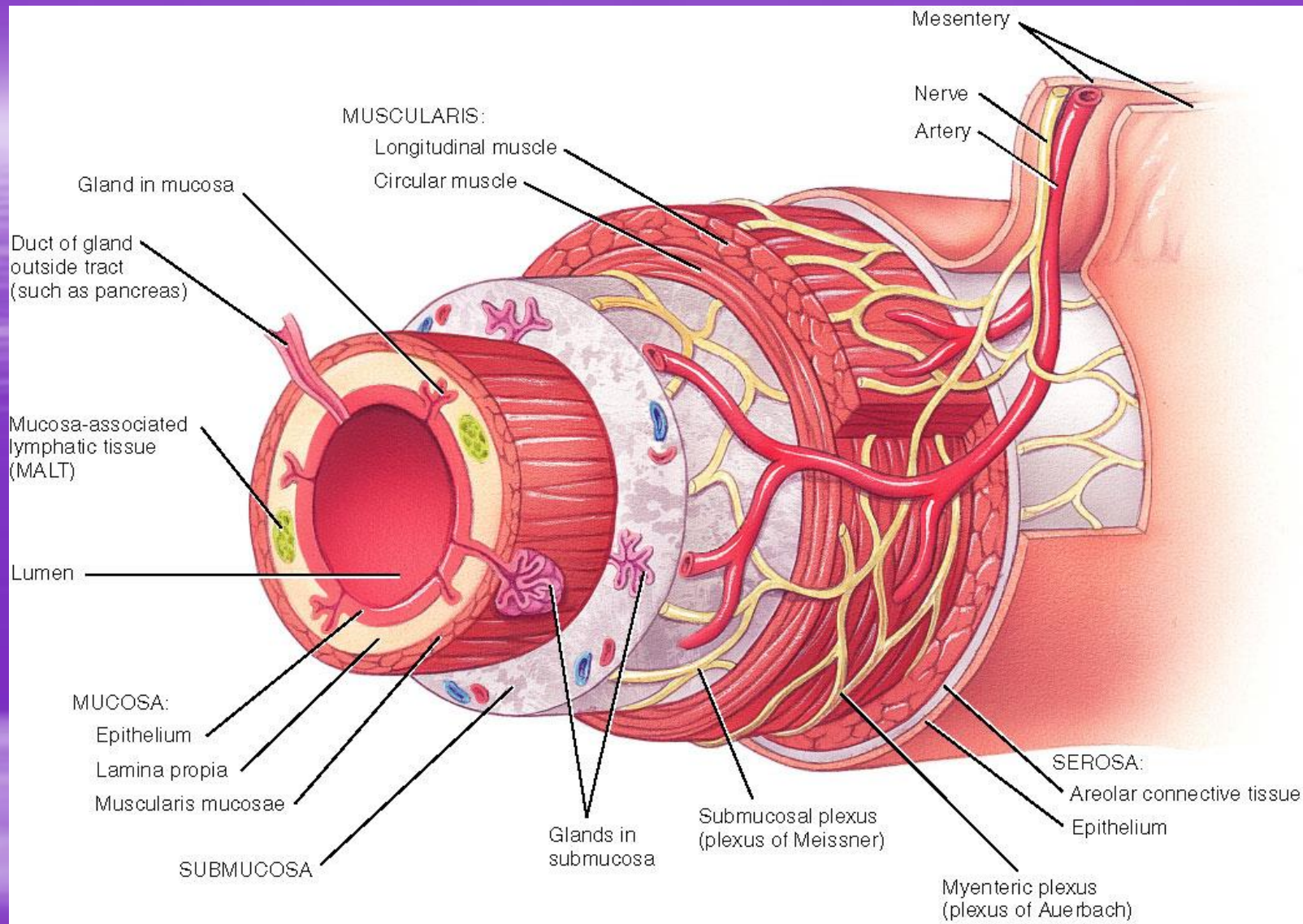
- Smooth muscle cells
- Interstitial cells of Cajal
- Secretory cells



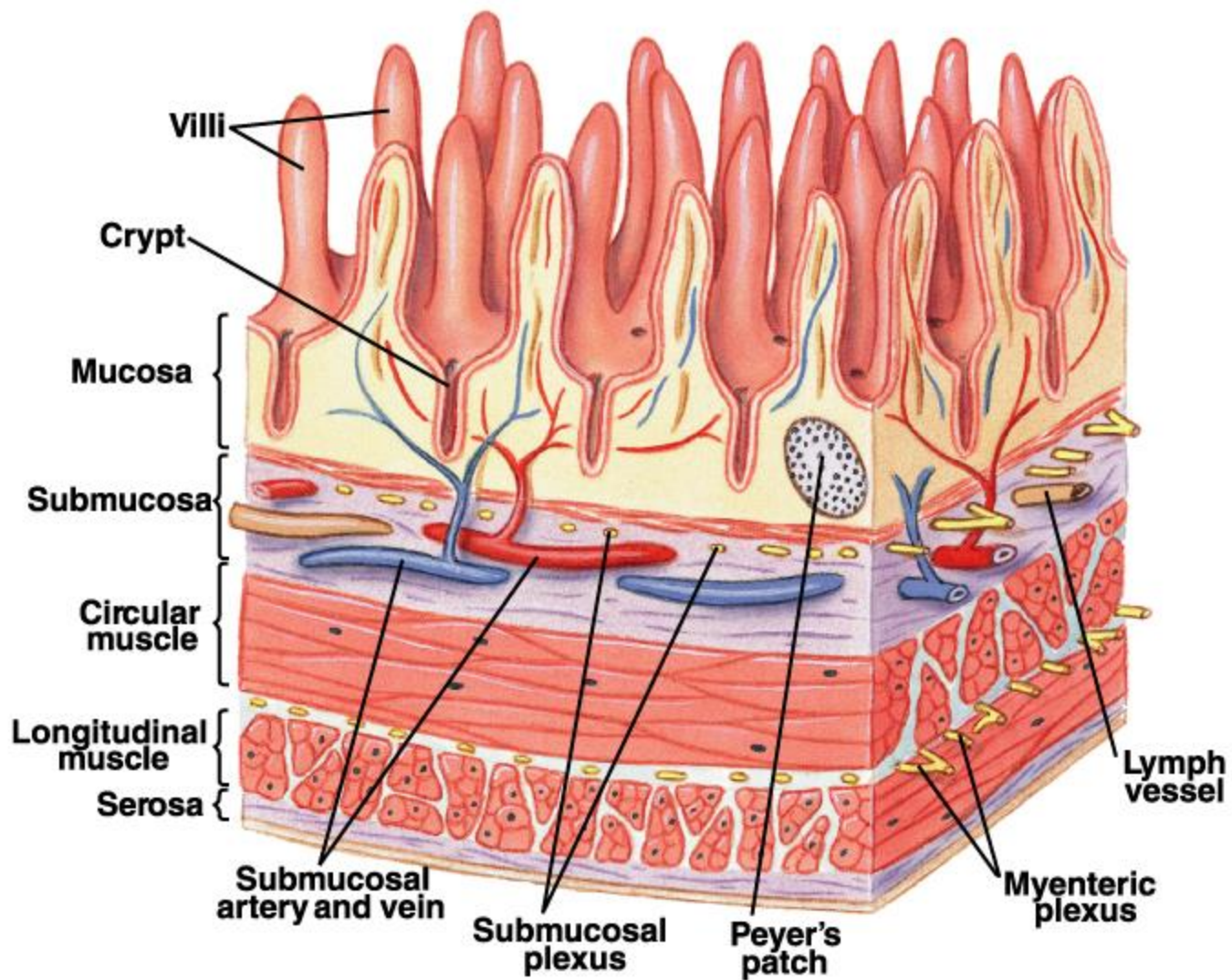
Sectional views of layers of the GI tract

Other related structures

- **Control systems of GI functions.**
 - **Neural control:**
 - **Enteric nervous system**
 - **Autonomic nervous system**
 - **Hormonal control: GI endocrine**
- **Blood flow to the GI.**

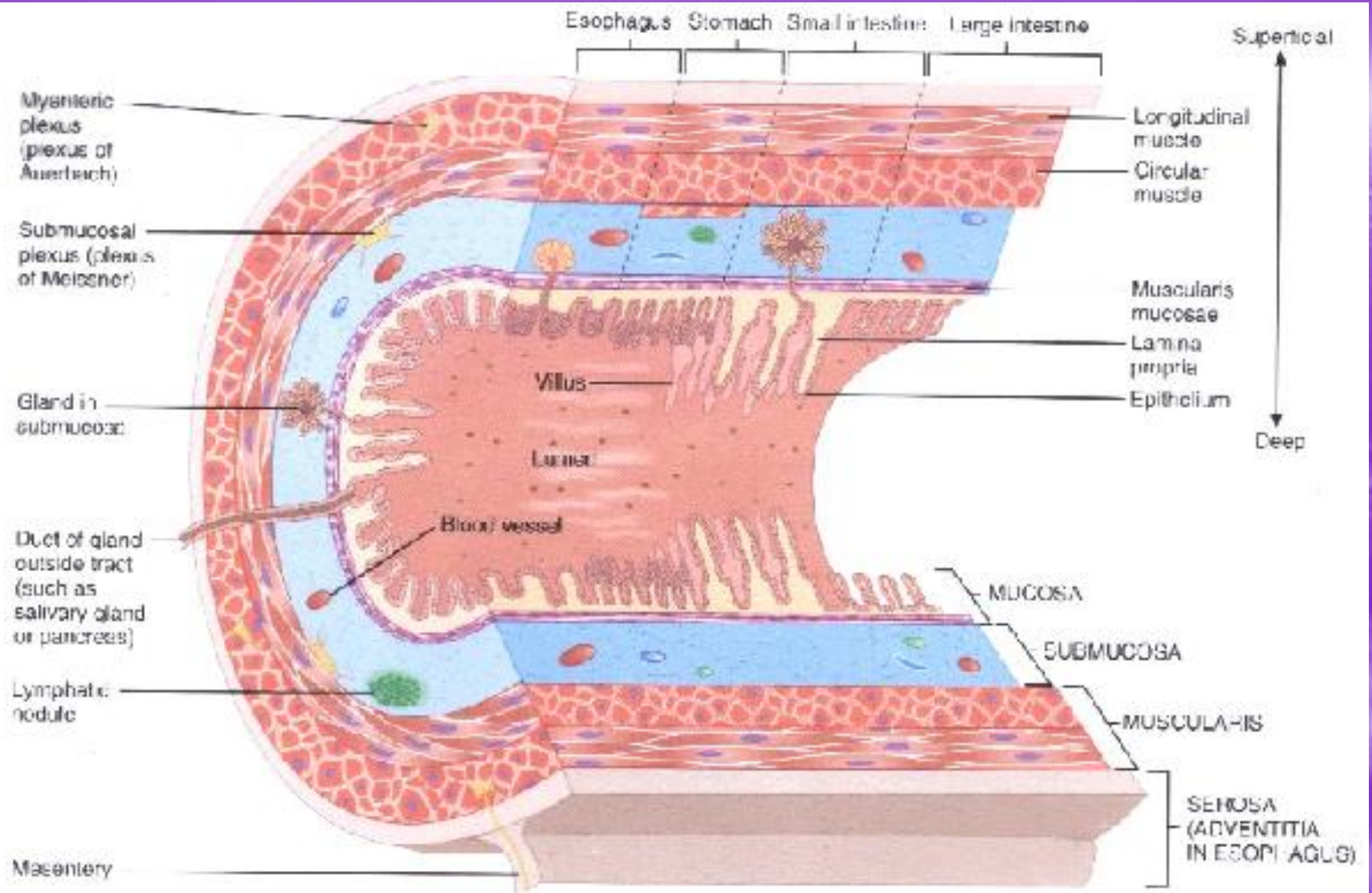


Intestinal surface area is enhanced by finger-like villi.

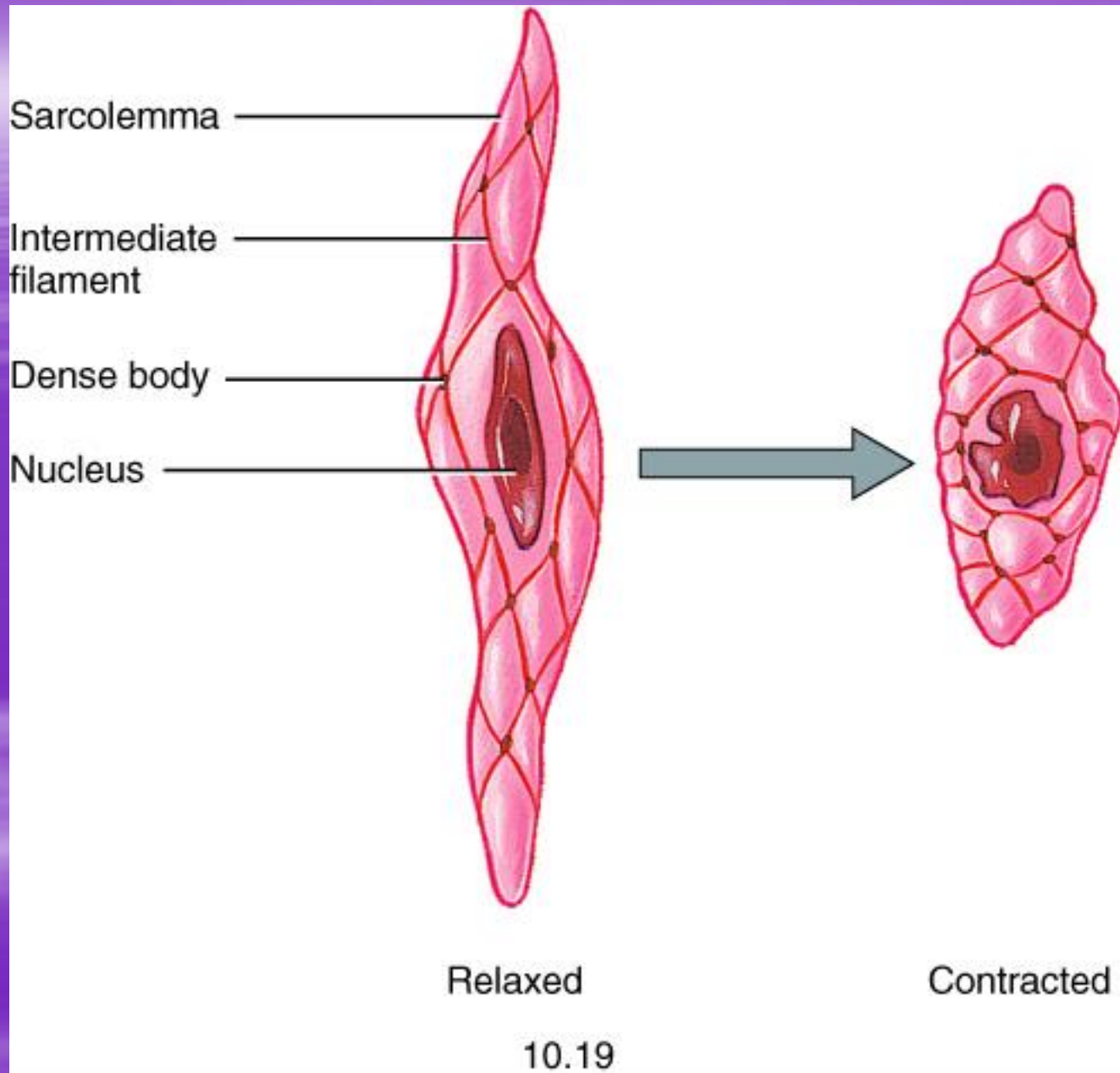


Functional structures in the gastrointestinal tract

Smooth muscle cells (SMCs)



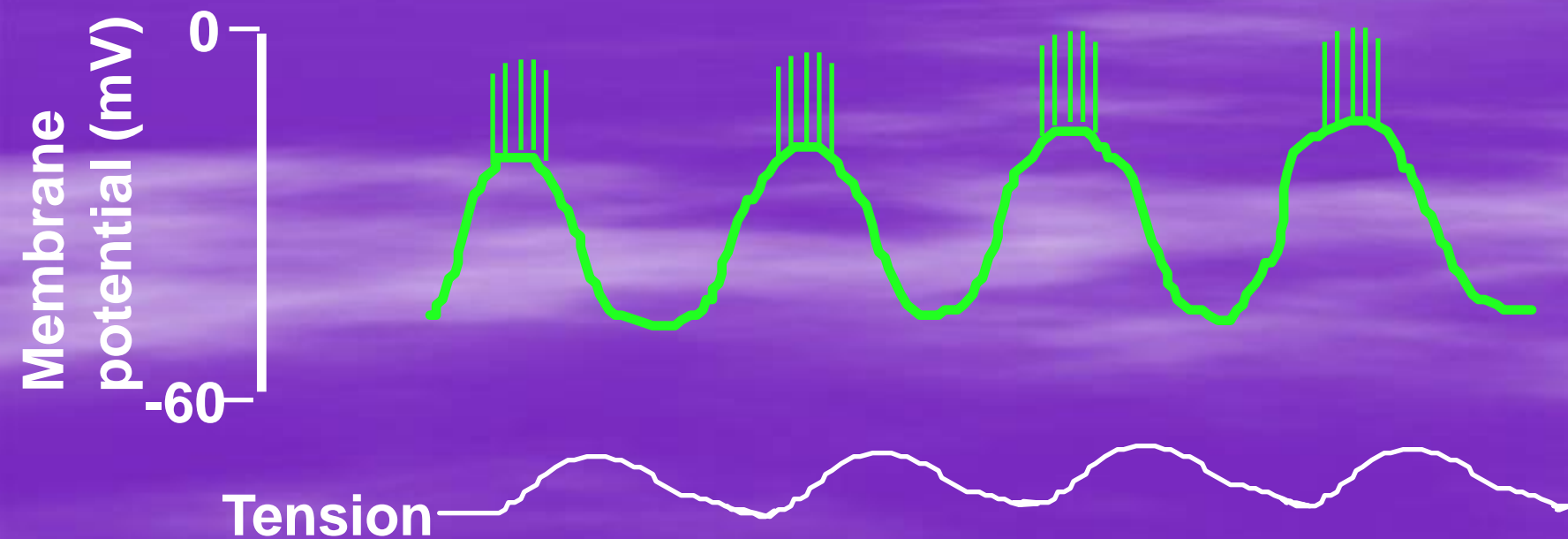
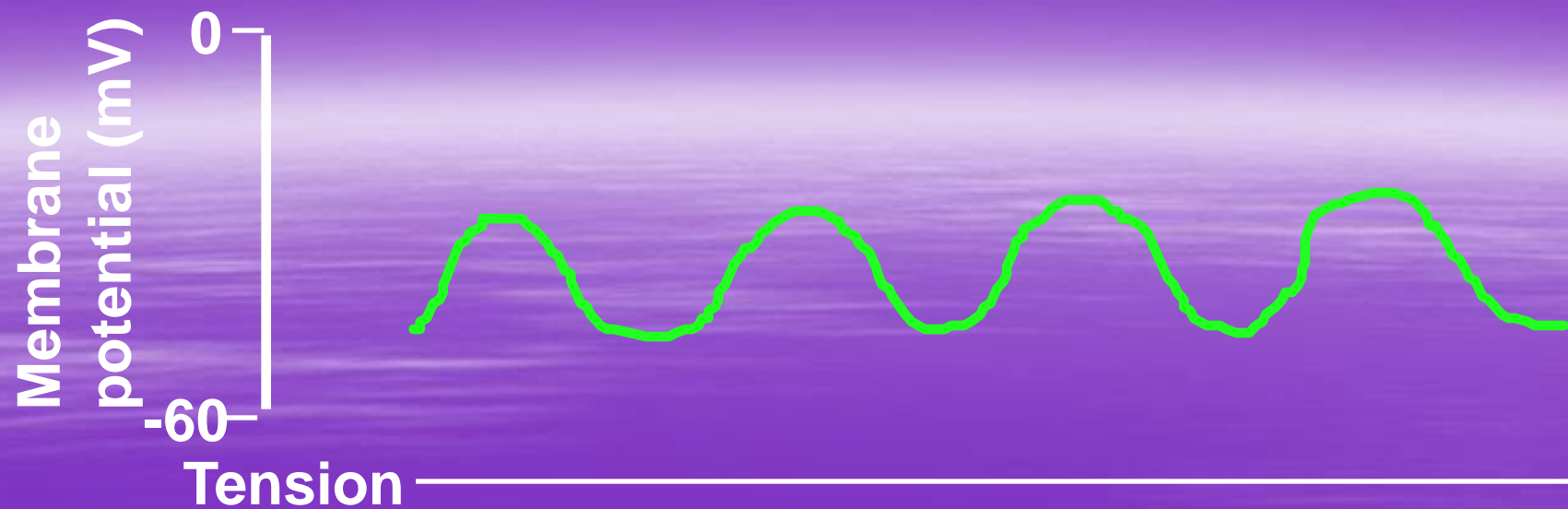
Sectional views of layers of the GI tract



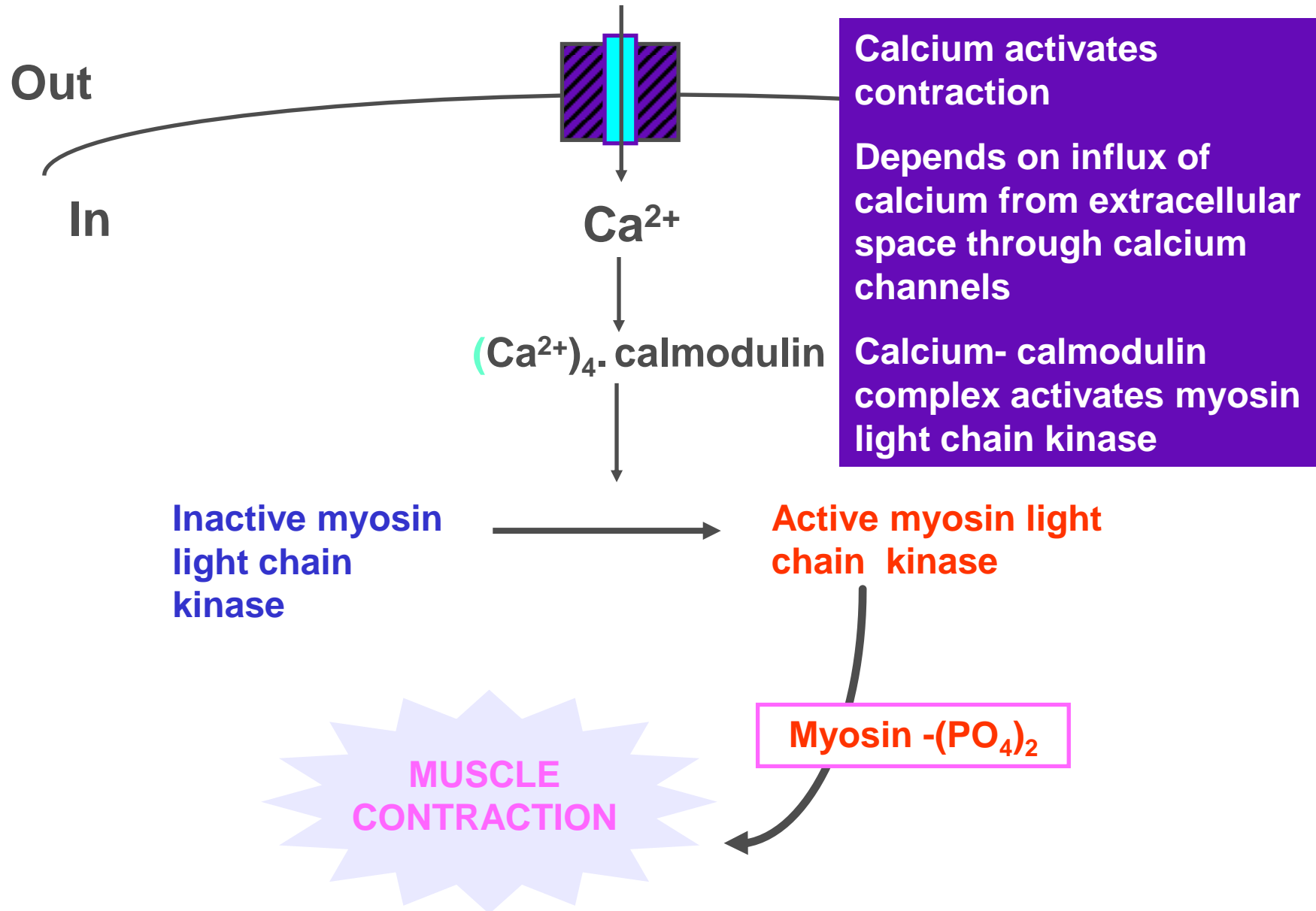
Smooth Muscle cells

Characteristics

- **Electrical activity**
 - Slow waves (basic electrical rhythm)



Contraction of GI smooth muscle

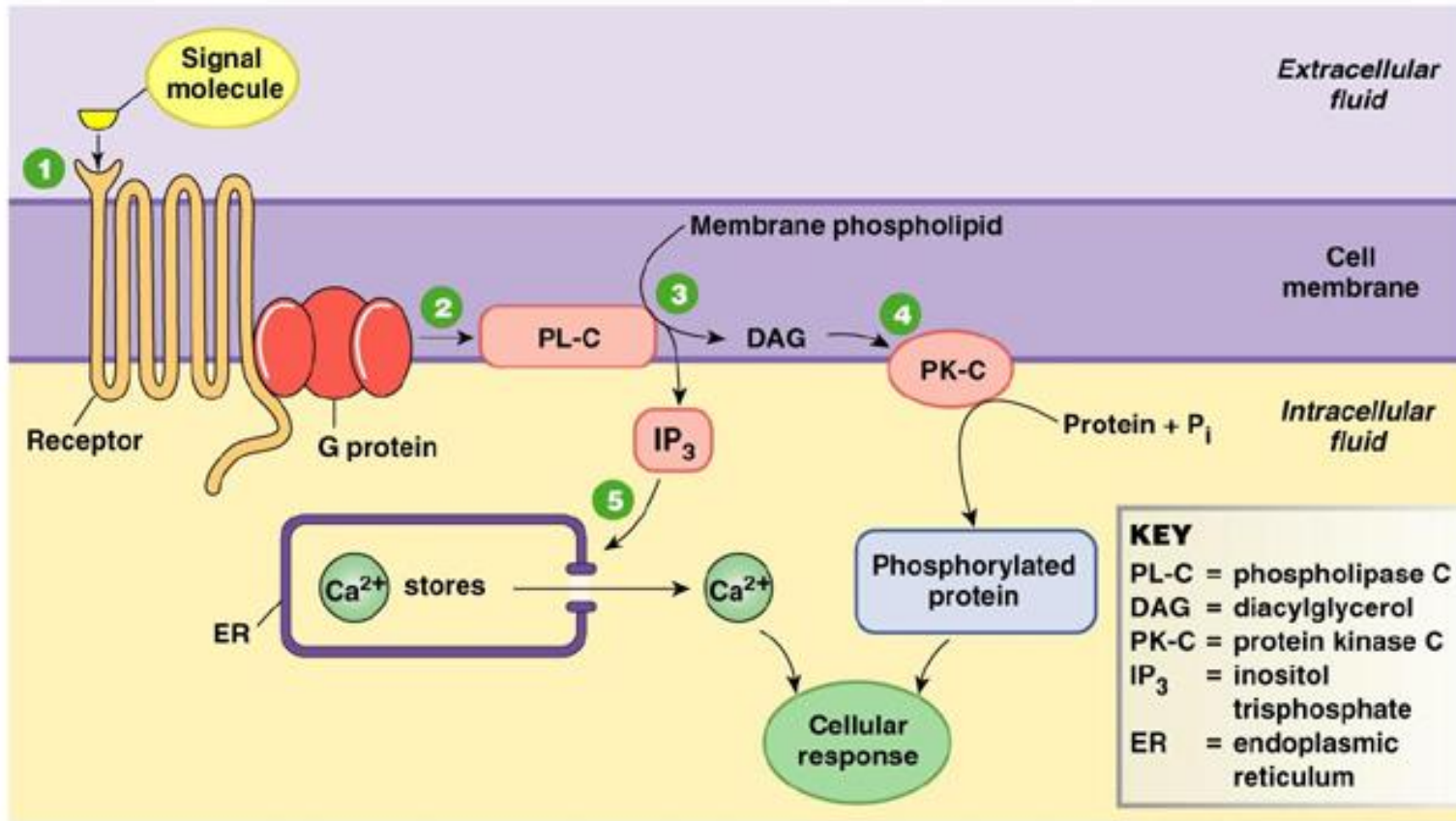


Smooth Muscle cells

Characteristics

- **Gap junctions:**
 - **Communication between cells**
 - **Functional syncytium**

Chemical control of SMCs

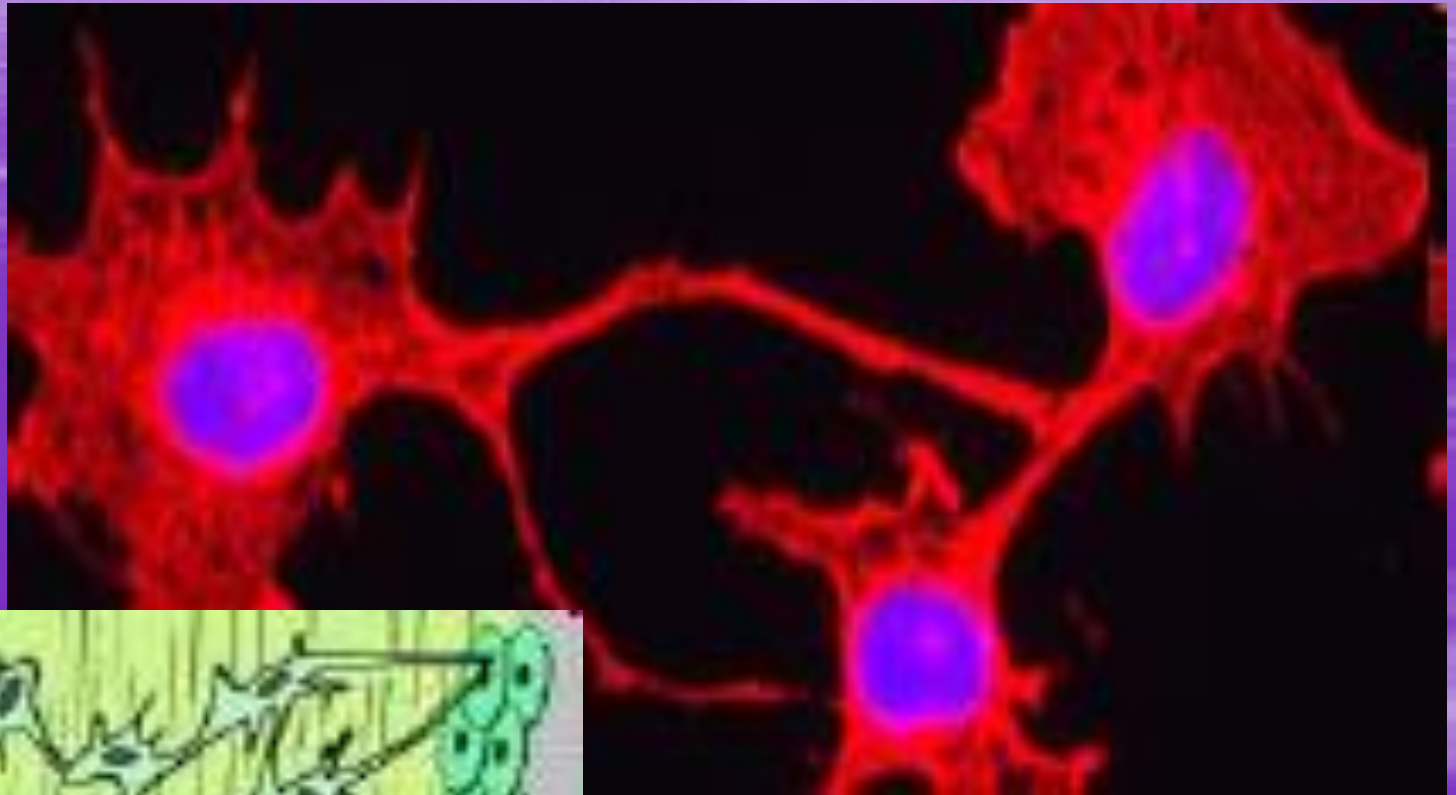


- 1 Signal molecule activates receptor and associated G protein.
- 2 G protein activates phospholipase C (PL-C), an amplifier enzyme.
- 3 PL-C converts membrane phospholipids into diacylglycerol (DAG), which remains in the membrane, and IP₃, which diffuses into the cytoplasm.
- 4 DAG activates protein kinase C (PK-C), which phosphorylates proteins.
- 5 IP₃ causes release of Ca²⁺ from organelles, creating a Ca²⁺ signal.

Control of smooth muscle cells activity

- **Electrical control:**
 - Rhythm or phasic contractions
- **Chemical control:**
 - tonic contractions

Interstitial Cells of Cajal (ICCs)



Characteristics of ICCs

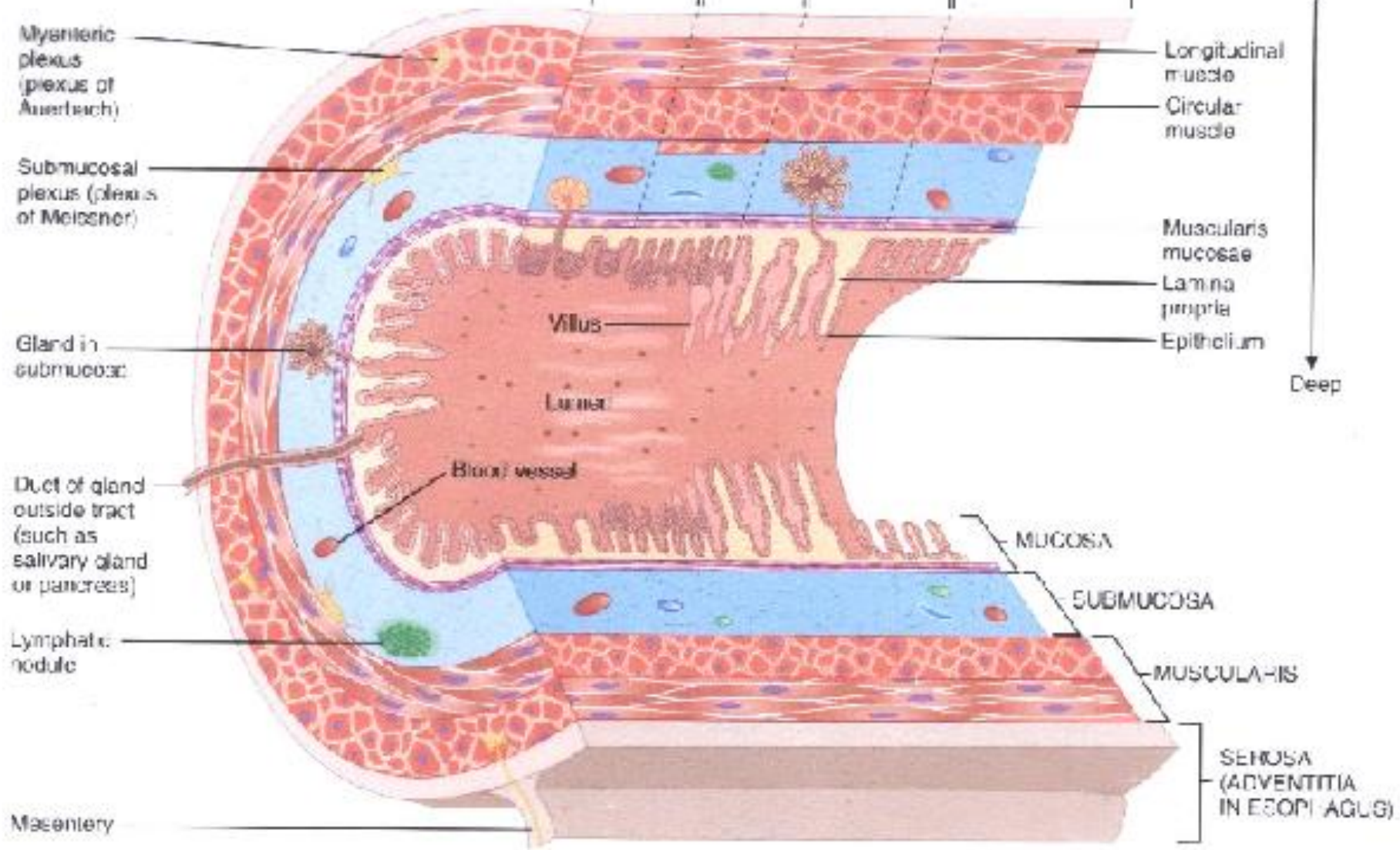
- **Communications:**
 - ICCs-ICCs gap junctions
 - ICCs-smooth muscle cells gap junctions
 - inputs from ENS
- **Generation of action potentials:**
 - pacemaker cells of the GI tract

Secretory Cells

Mucous secretion and serous secretion

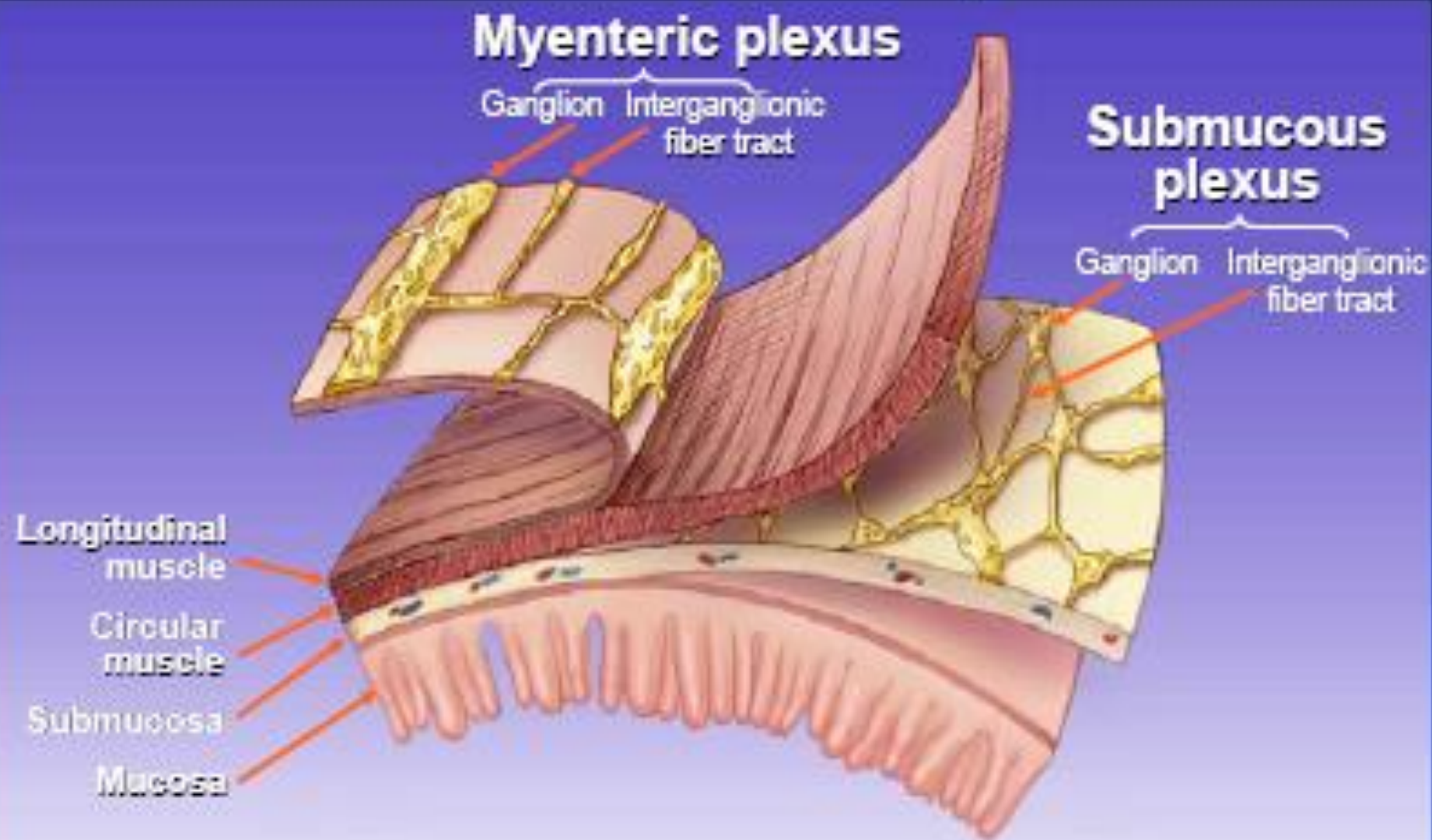
- Solitary cells
- Pits
- Compound glands
- Secretory organs

Esophagus Stomach Small intestine Large intestine



Sectional views of layers of the GI tract

Enteric Nervous System

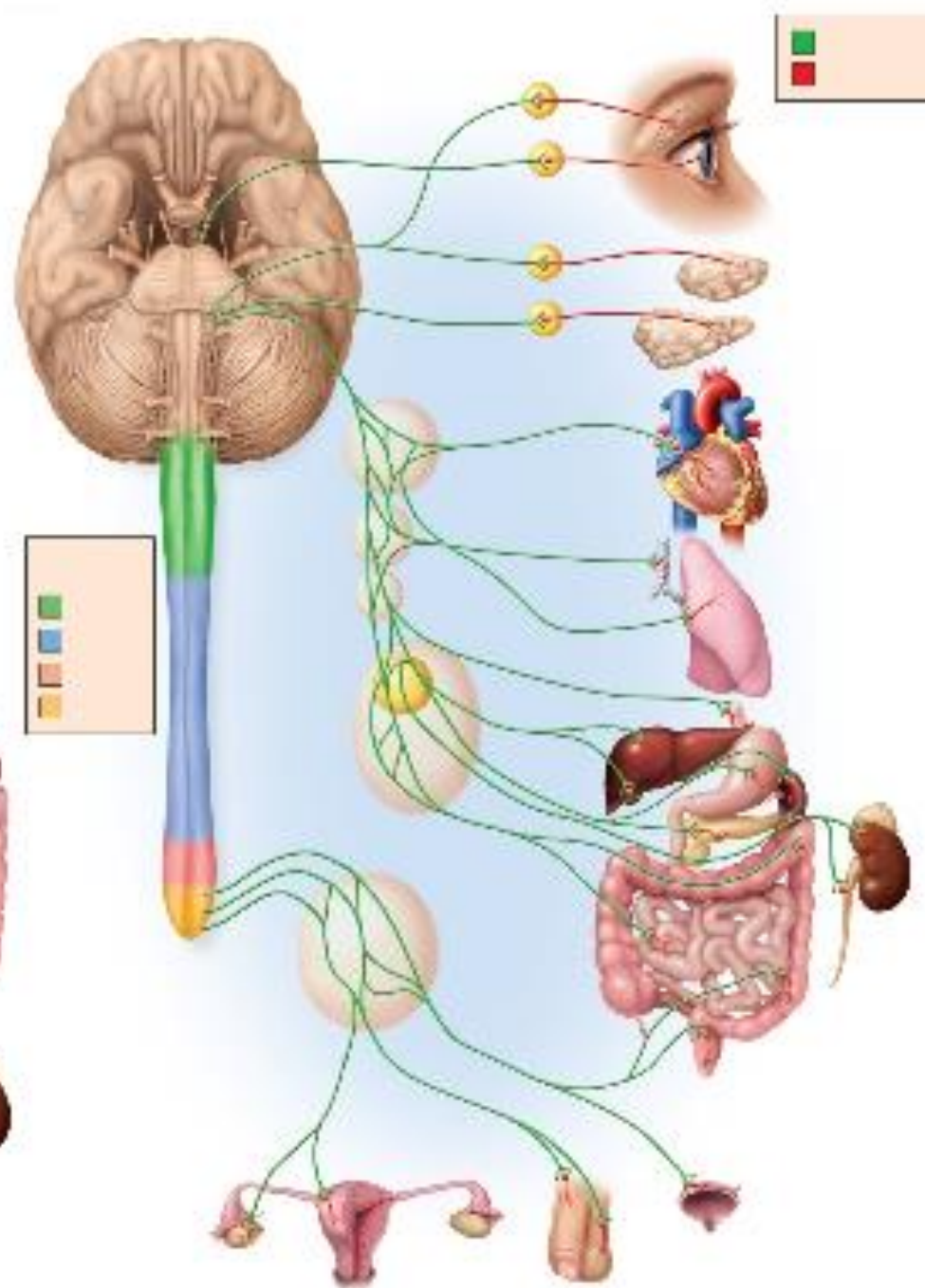
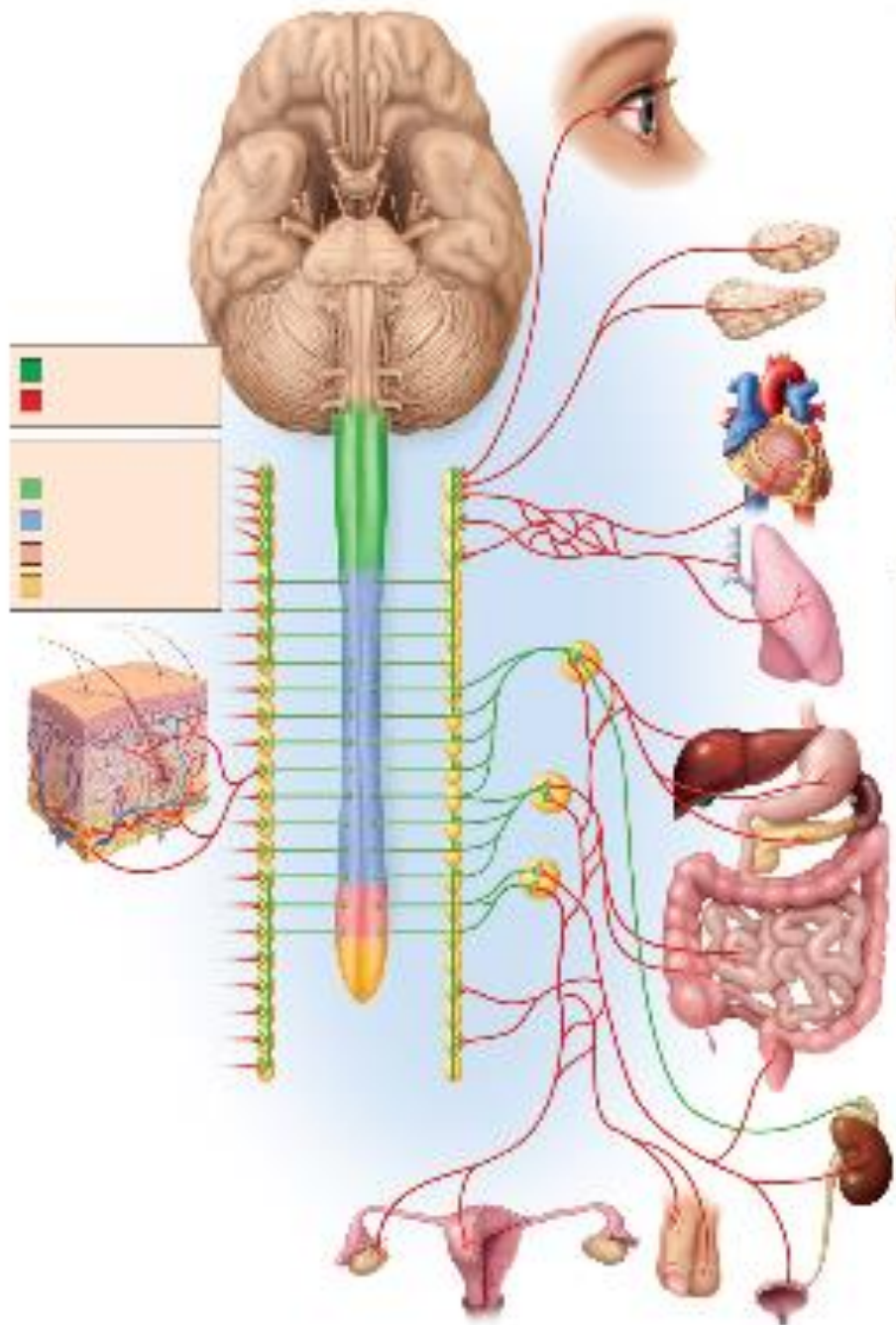


Characteristics of ENS

- Enteric Neurons:
 - Excitatory
 - Inhibitory
- Neurotransmitters
 - Ach, SP (Substance P), VIP (Vasoactive intestinal peptide), CGRP (Calcitonin gene related peptide), GRP (Gastrin releasing peptide)...etc

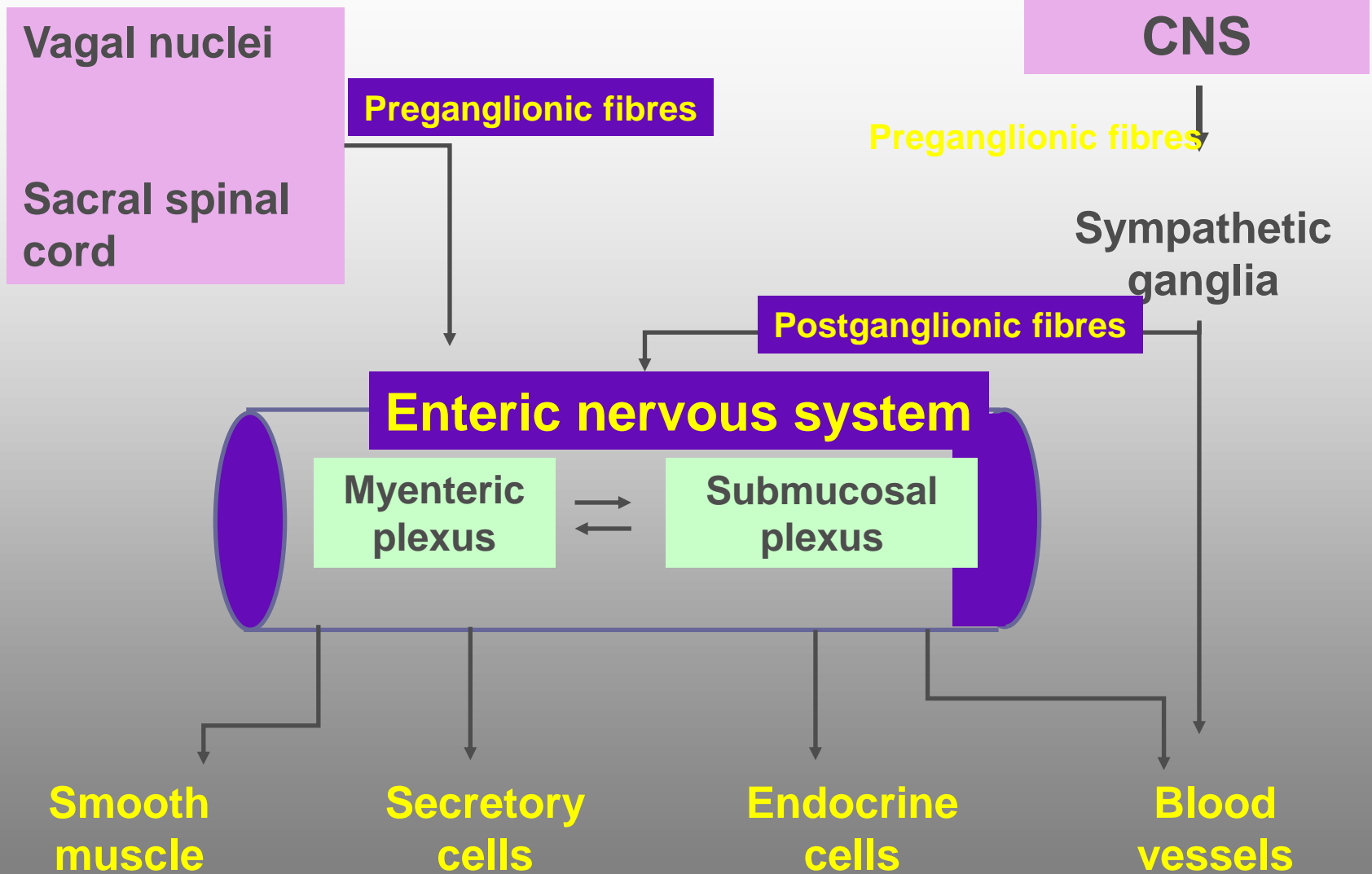
Autonomic Nervous System (ANS)

- Sympathetic
- Parasympathetic



Parasympathetic N.S

Sympathetic N.S.



Enteric Endocrine System

- **Gastrin**
- **Cholecystokinin (CCK)**
- **Secretin**
- **GIP (Gastric Inhibitory peptide) or (Glucose dependent Insulinotropic Polypeptide)**

Enteric Endocrine System

Glucagon-like peptide-1 (GLP-1), Motilin, Ghrelin, Amylin, Enterostatin, Neuropeptide Y (NPY), polypeptide YY, Pancreatic polypeptide which is closely related to polypeptide YY and NPY

Somatostatin,, Neurotensin, Thyrotropin releasing hormone (TRH), Adrenocorticotrophic hormone ACTH.

Functions of Hormones

- **Control of motility**
- **Control of secretion**
- **Control of blood flow**
- **Regulation of food intake**
- **Regulation of metabolic activities in the body**

Blood Flow of the GI

- Related to GI activities:
 - Controlled by:
 - **Hormones** (Secretin, CCK)
 - **ENS** (VIP, SP, CGRP)
 - **Vasodilators:**
 - Kinins (Kallidin, Bradykinin)
 - **Decreased O₂ concentration**
 - **ANS**
 - (Sympathetic and parasympathetic)

Summary of Pathways Controlling Digestive-System Activities

