

Gastrointestinal physiology

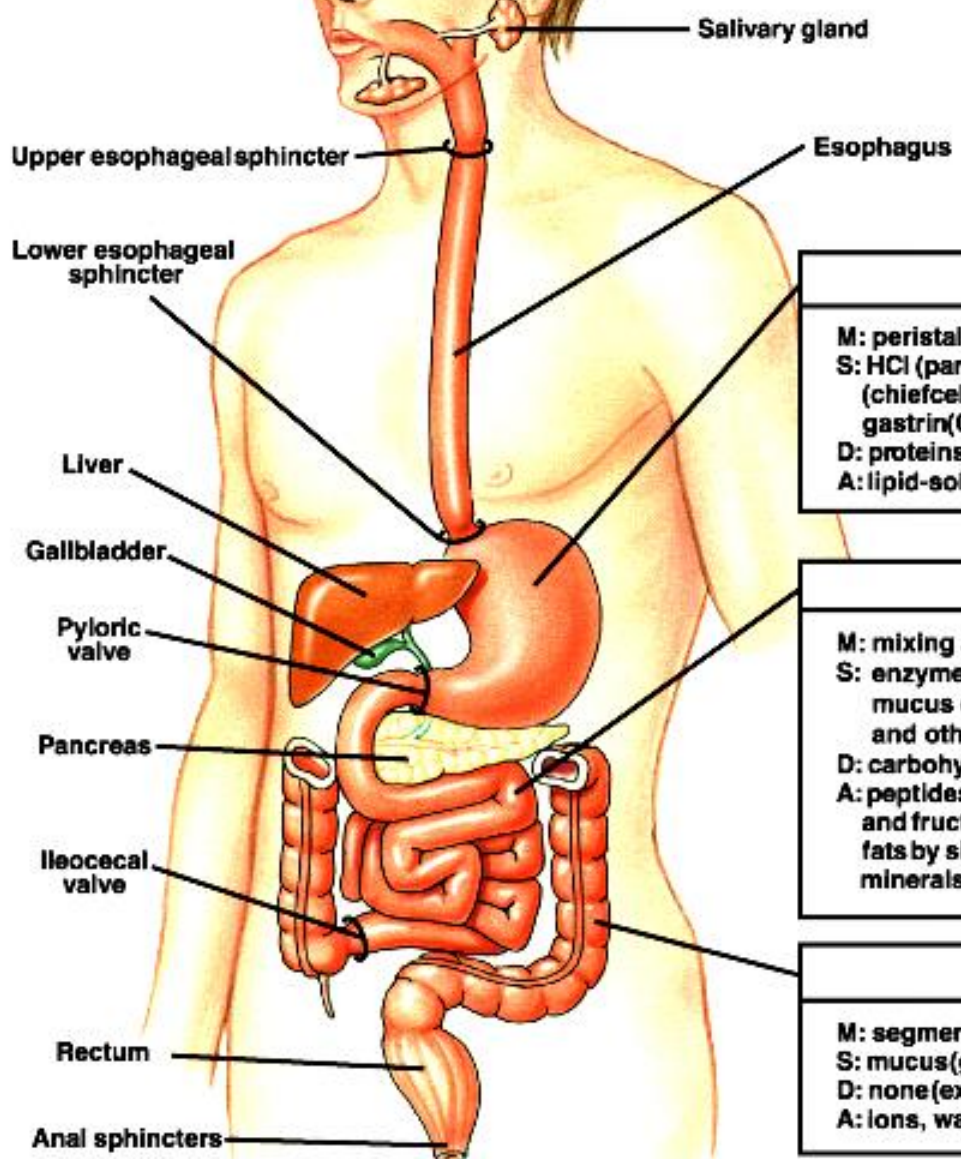
Textbook of Medical Physiology,

GUYTON and HALL,

12th Ed: pp753-803, pp: 843-863. **11th ed:** pp771-818, pp865-888. **10th Ed,** pp 718-770, pp 803-821.

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**

Esophagus Stomach Small intestine Large intestine

Superficial

Deep

Myenteric plexus (plexus of Auerbach)

Submucosal plexus (plexus of Meissner)

Gland in submucosa

Duct of gland outside tract (such as salivary gland or pancreas)

Lymphatic nodule

Measentery

Longitudinal muscle
Circular muscle

Mucularis mucosae
Lamina propria
Epithelium

MUCOSA

SUBMUCOSA

MUSCULARIS

SEROSA (ADVENTITIA IN ESOPHAGUS)

Villus

Lumen

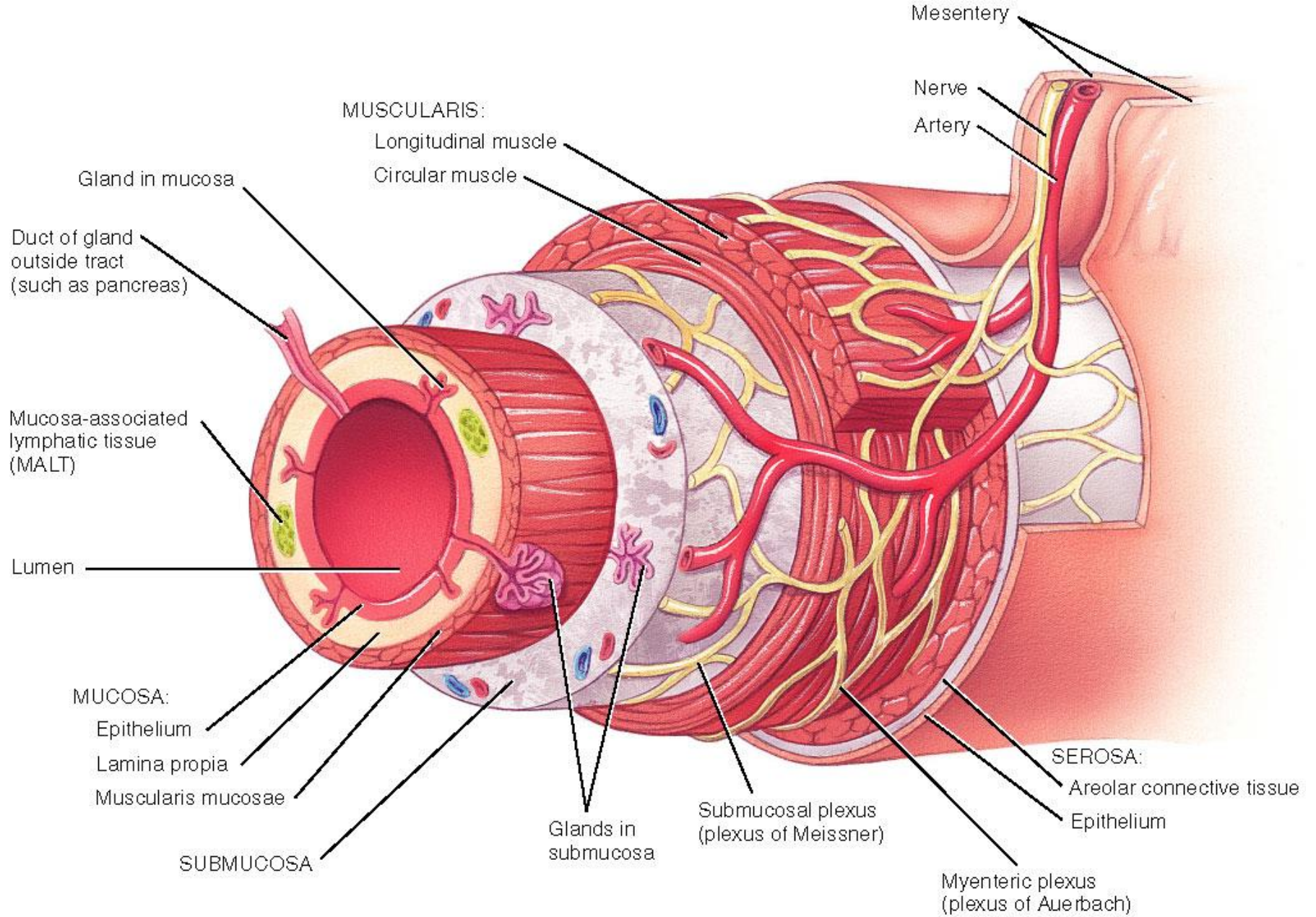
Blood vessel

Sectional views of layers of the GI tract

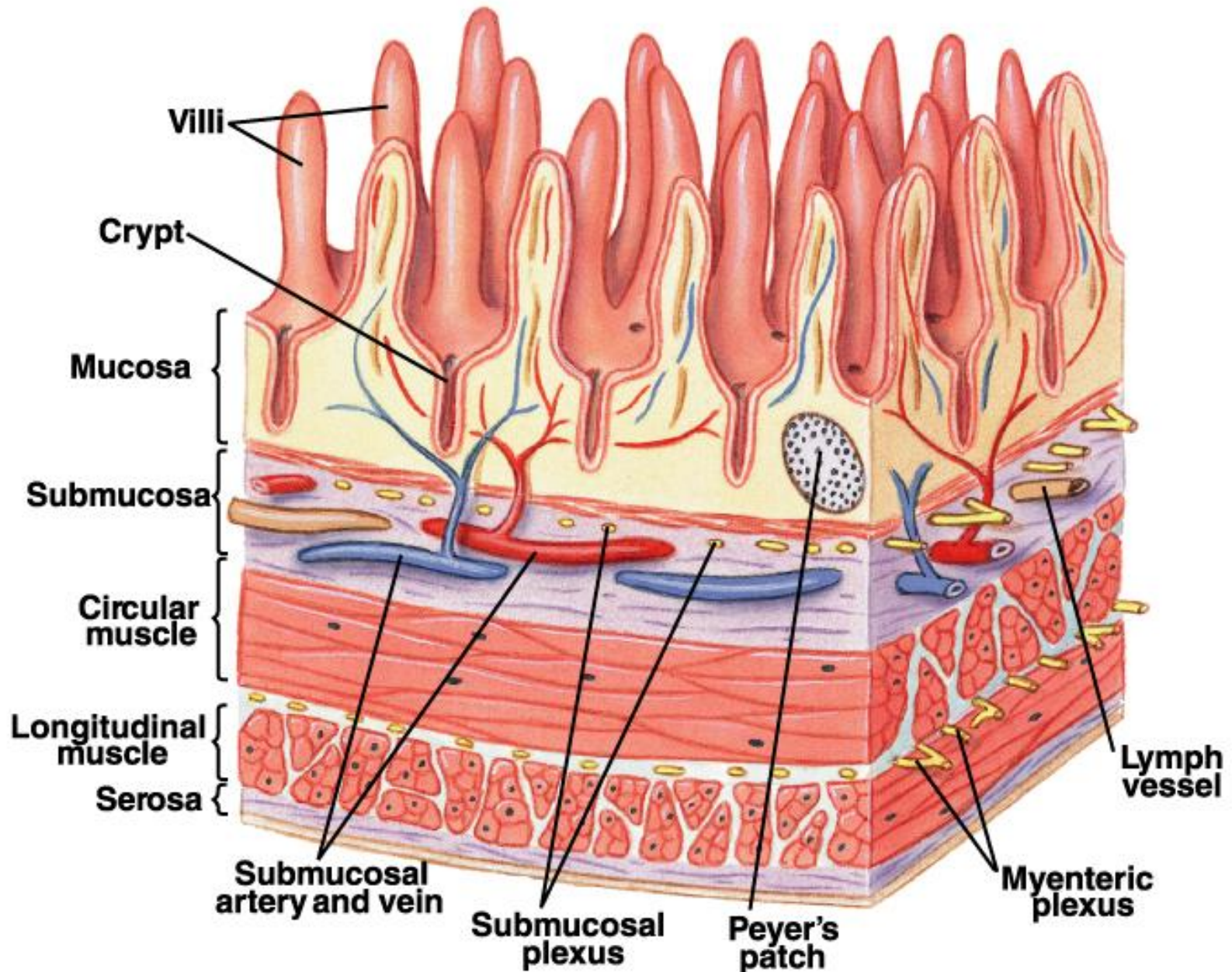
Composite of Various Sections of the Gastrointestinal Tract. Fig# 24.2

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.**

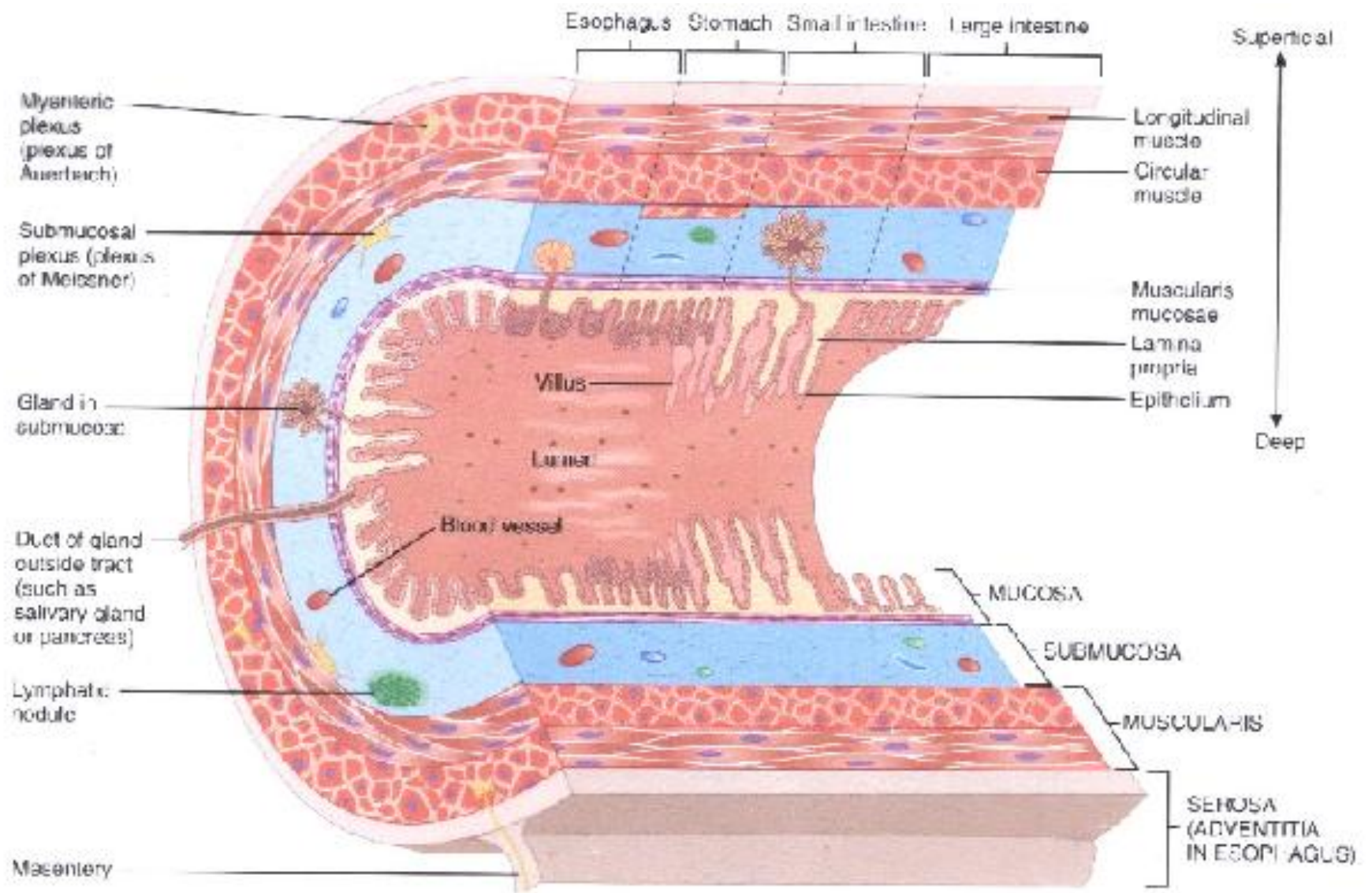


Intestinal surface area is enhanced by finger-like villi.

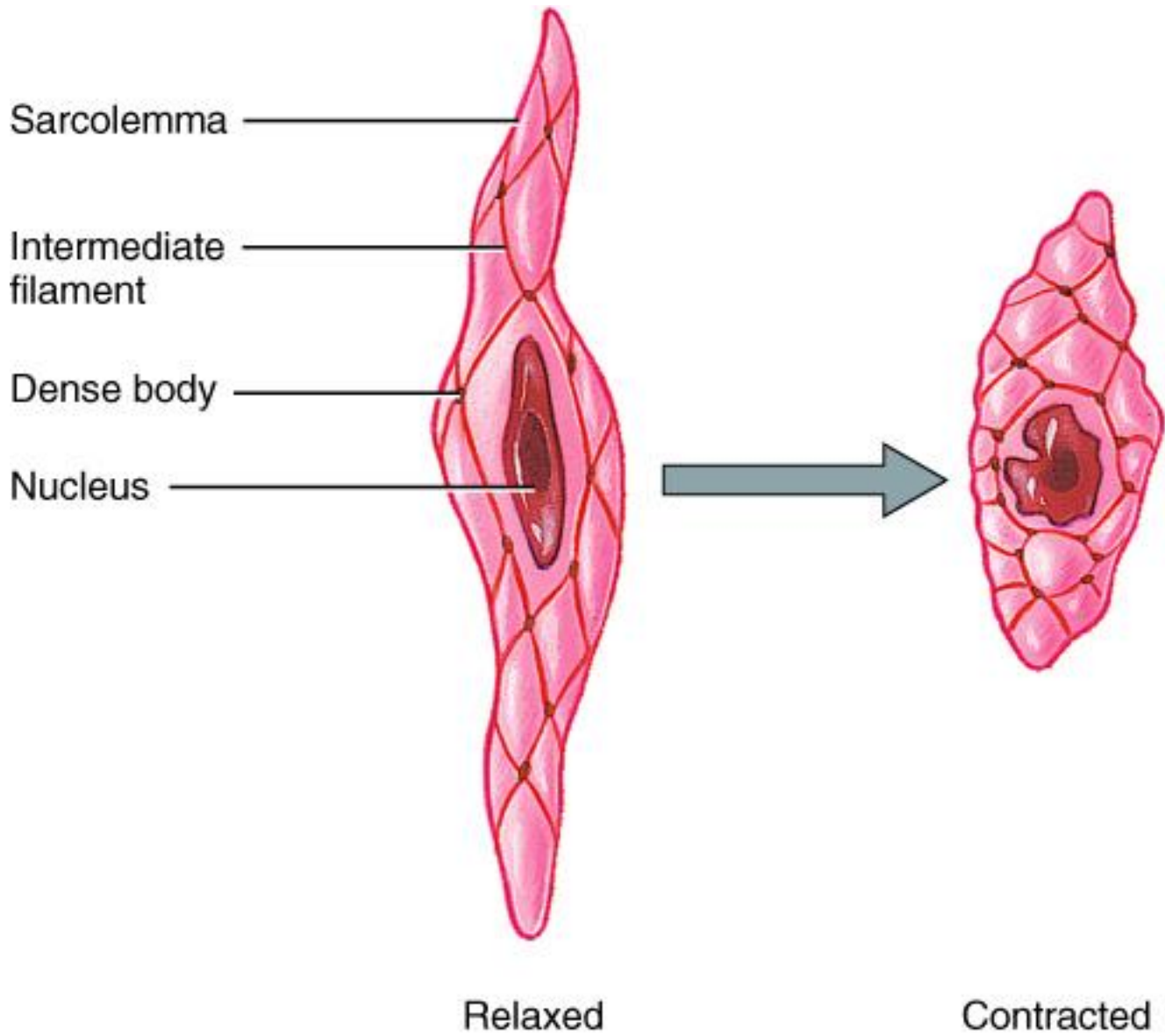


Functional structures in the gastrointestinal tract

Smooth muscle cells (SMCs)

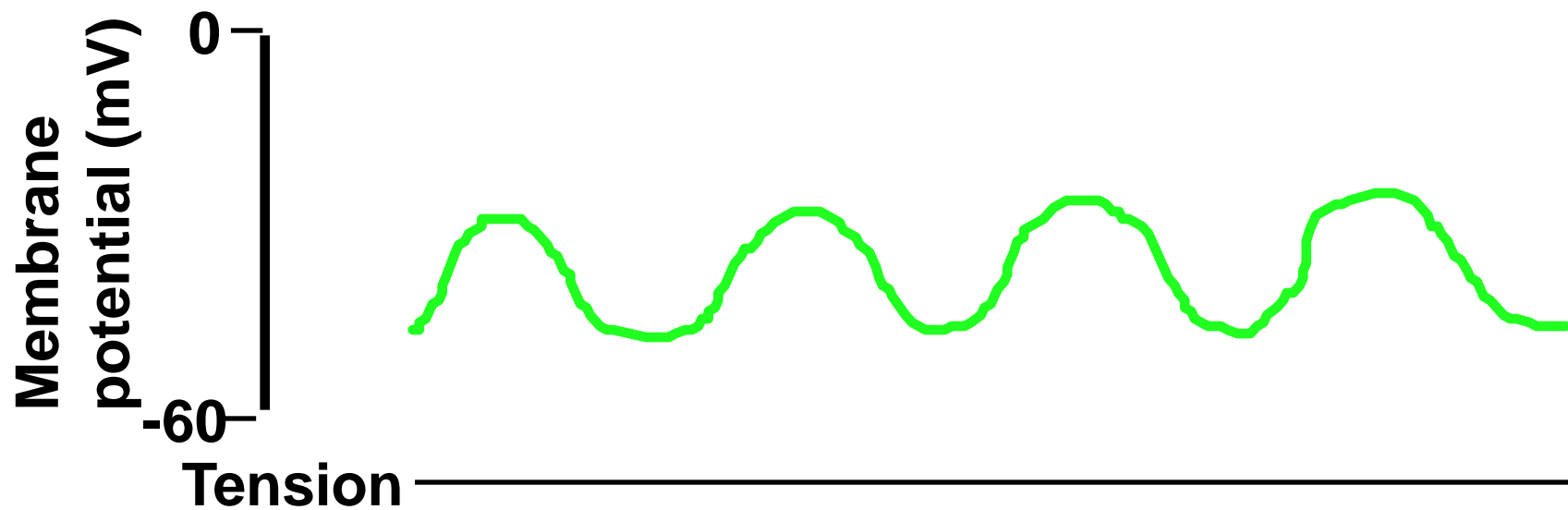


Sectional views of layers of the GI tract

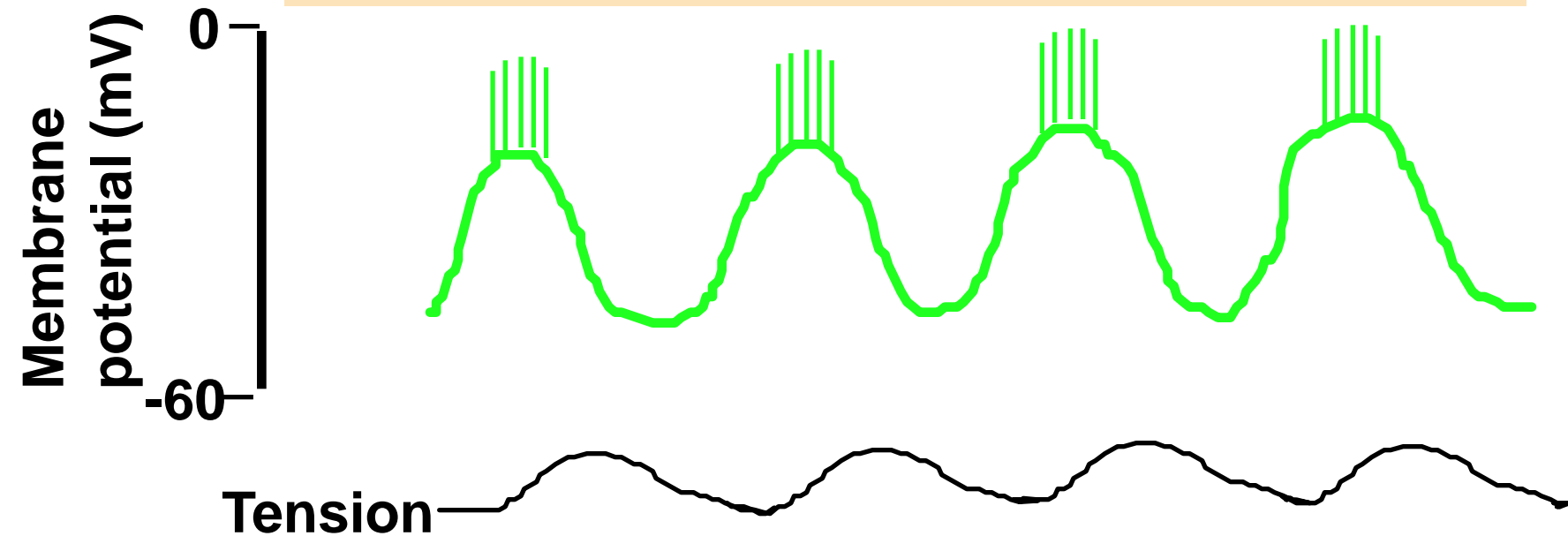


Smooth Muscle cells Characteristics

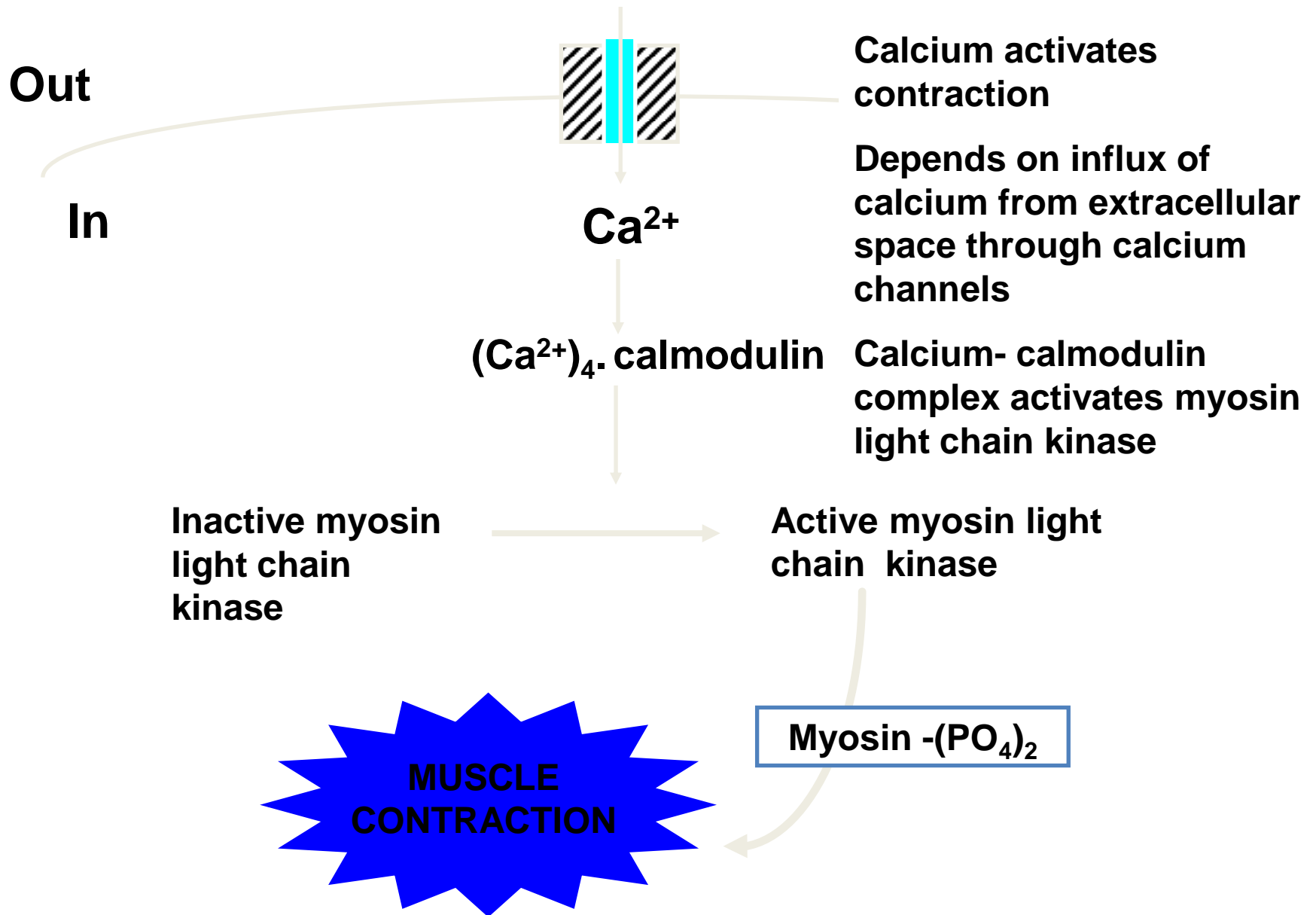
- **Electrical activity**
 - Slow waves (basic electrical rhythm)



Acetylcholine



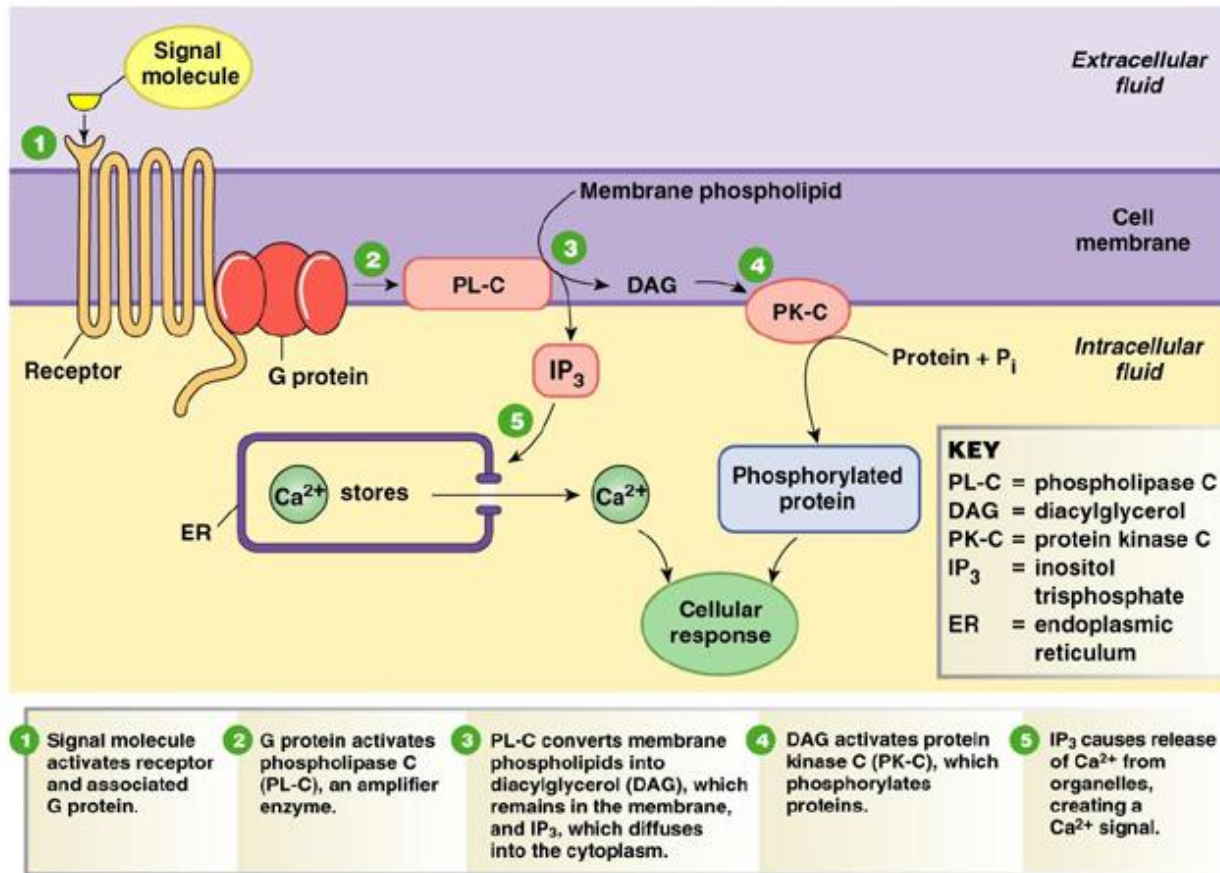
Contraction of GI smooth muscle



Smooth Muscle cells Characteristics

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

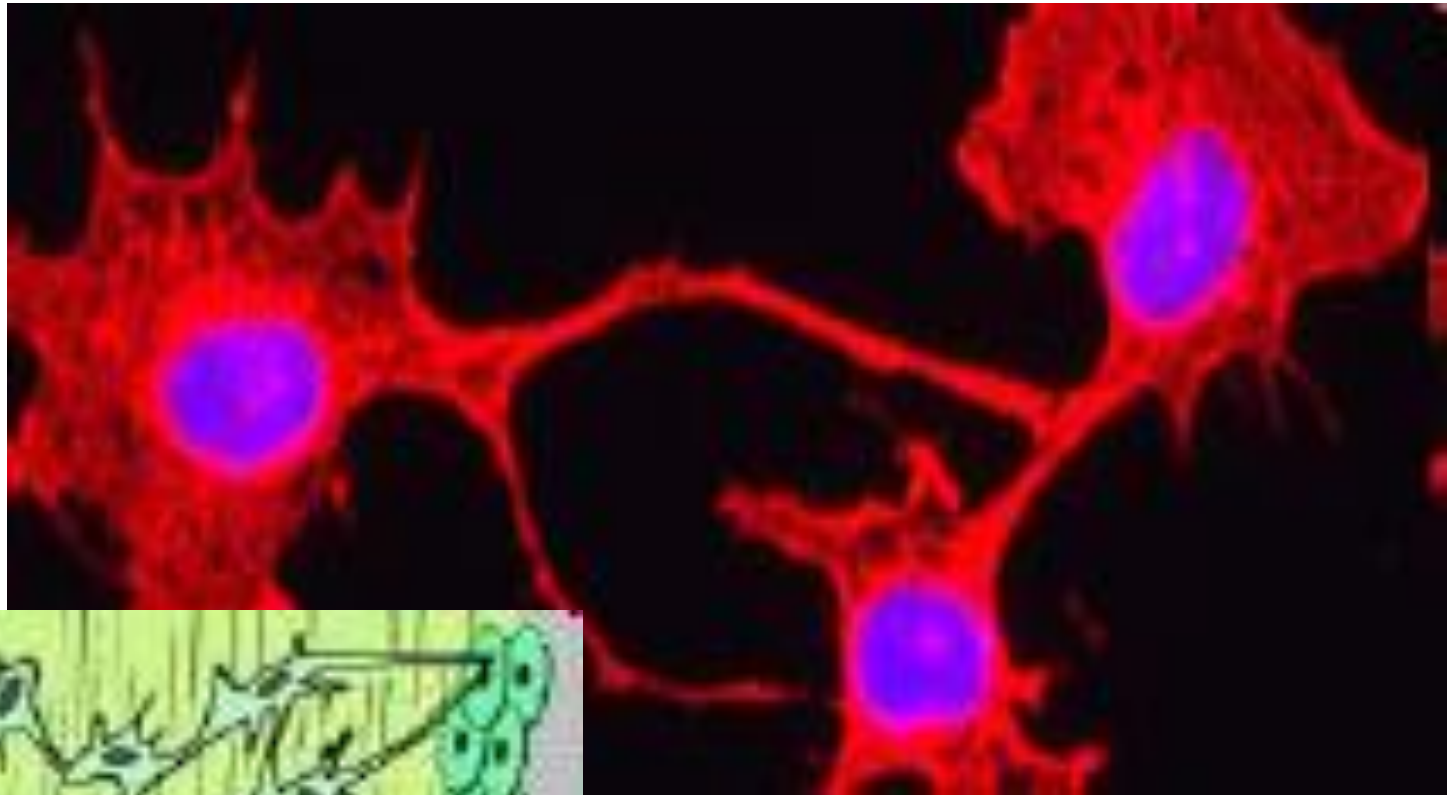
Chemical control of SMCs



Control of smooth muscle cells activity

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

Interstitial Cells of Cajal (ICCs)



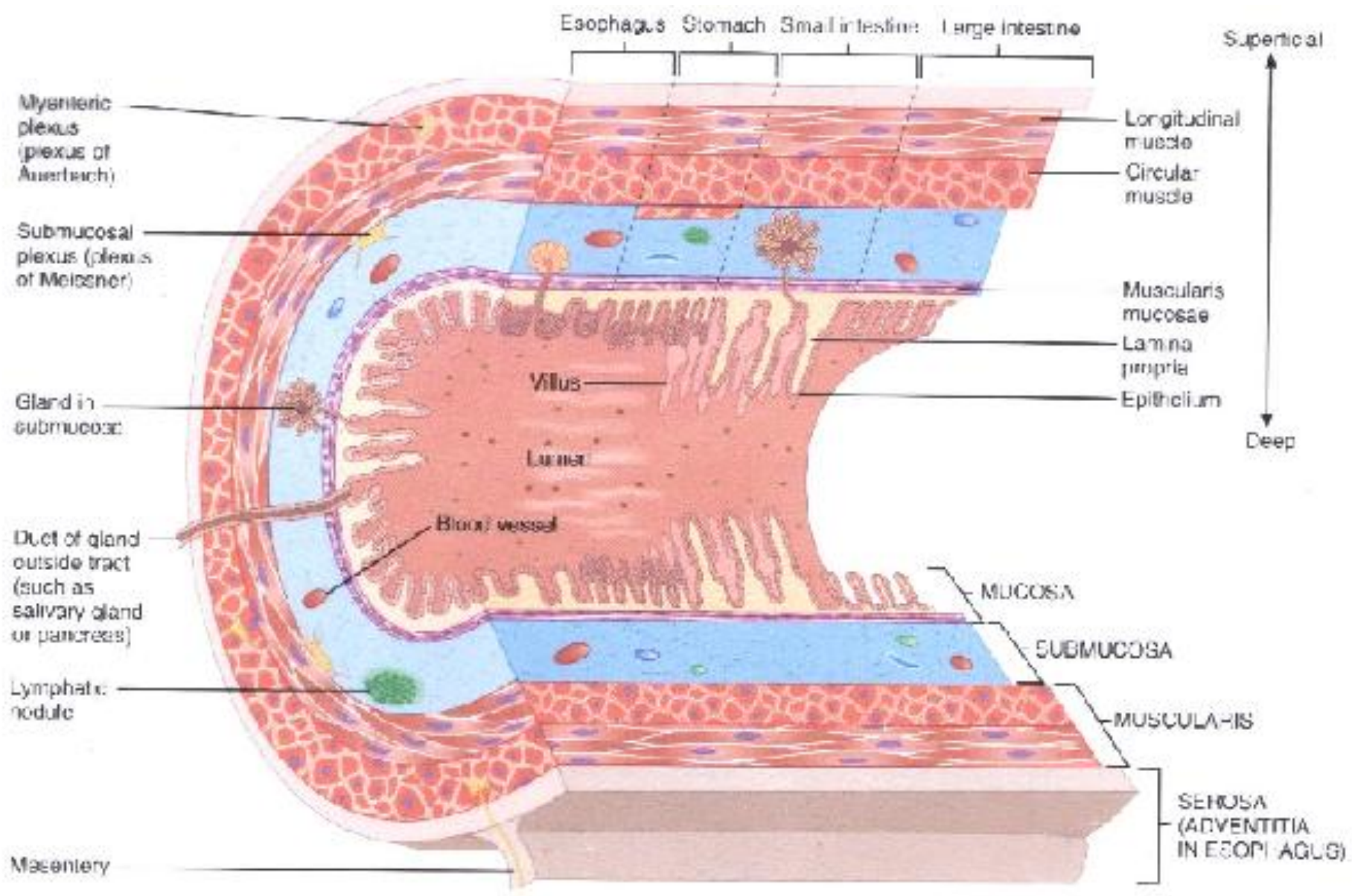
Characteristics of ICCs

- **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

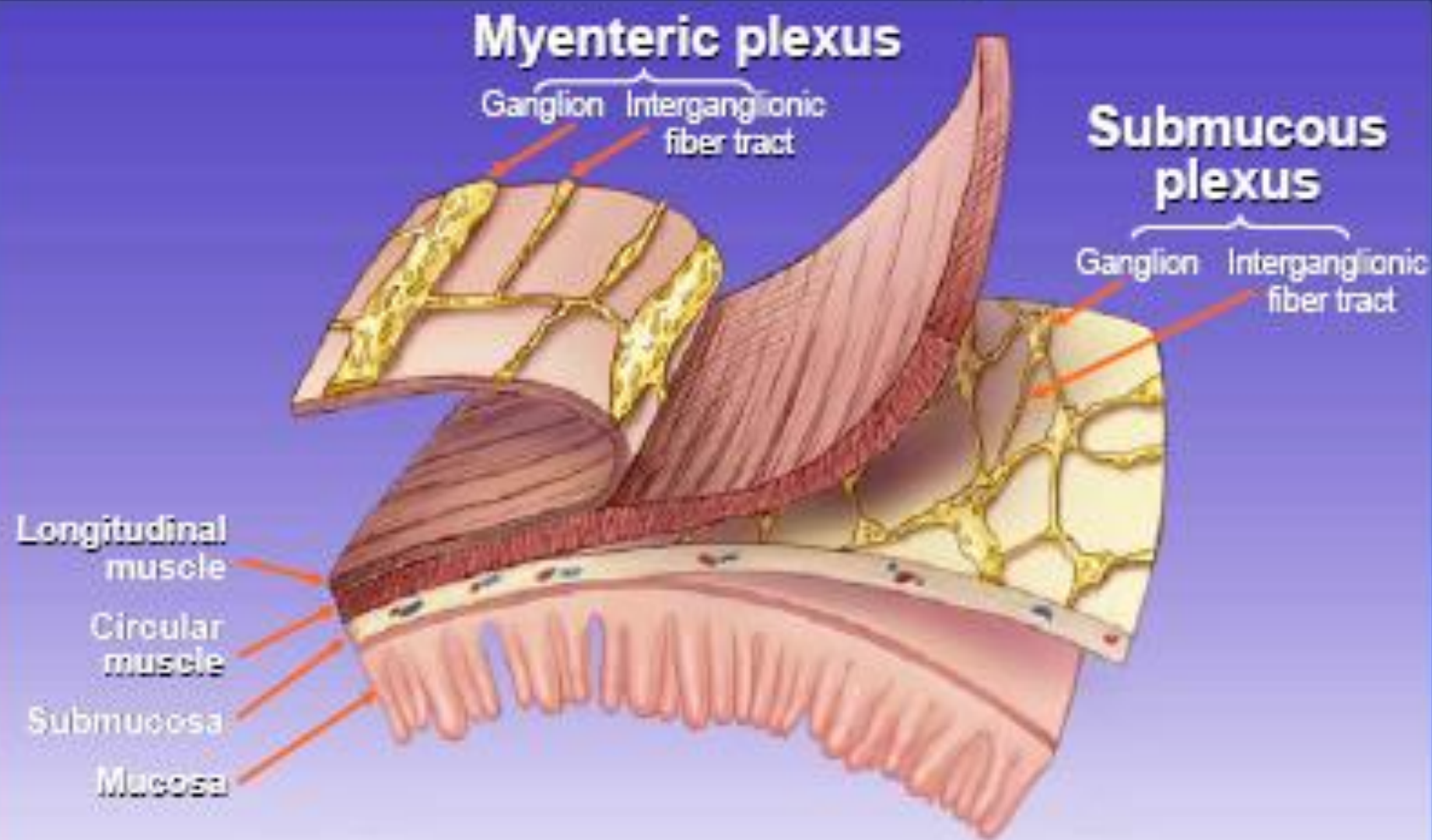
Mucous secretion and serous secretion

- Solitary cells
- Pits
- Compound glands
- Secretory organs



Sectional views of layers of the GI tract

Enteric Nervous System

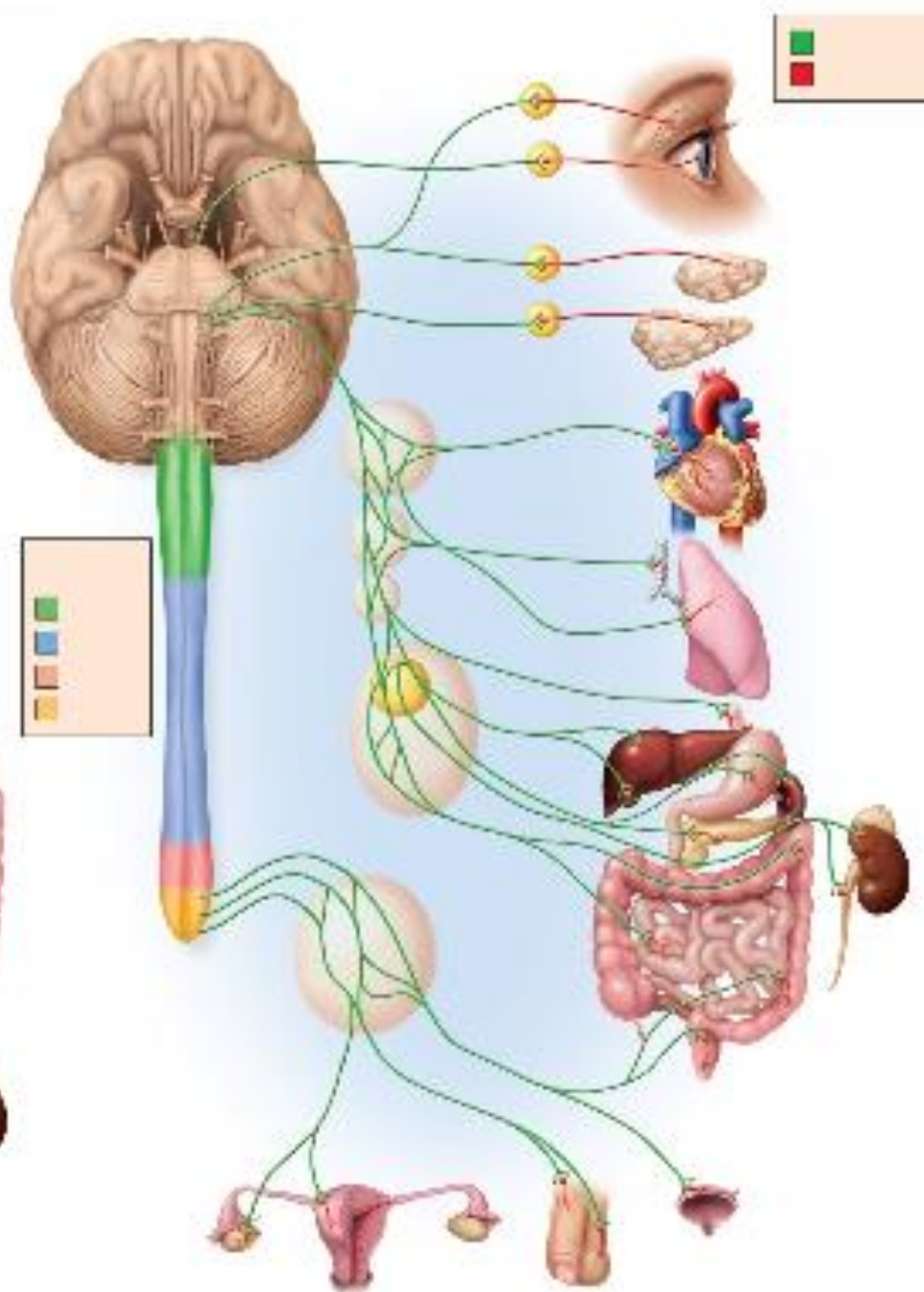
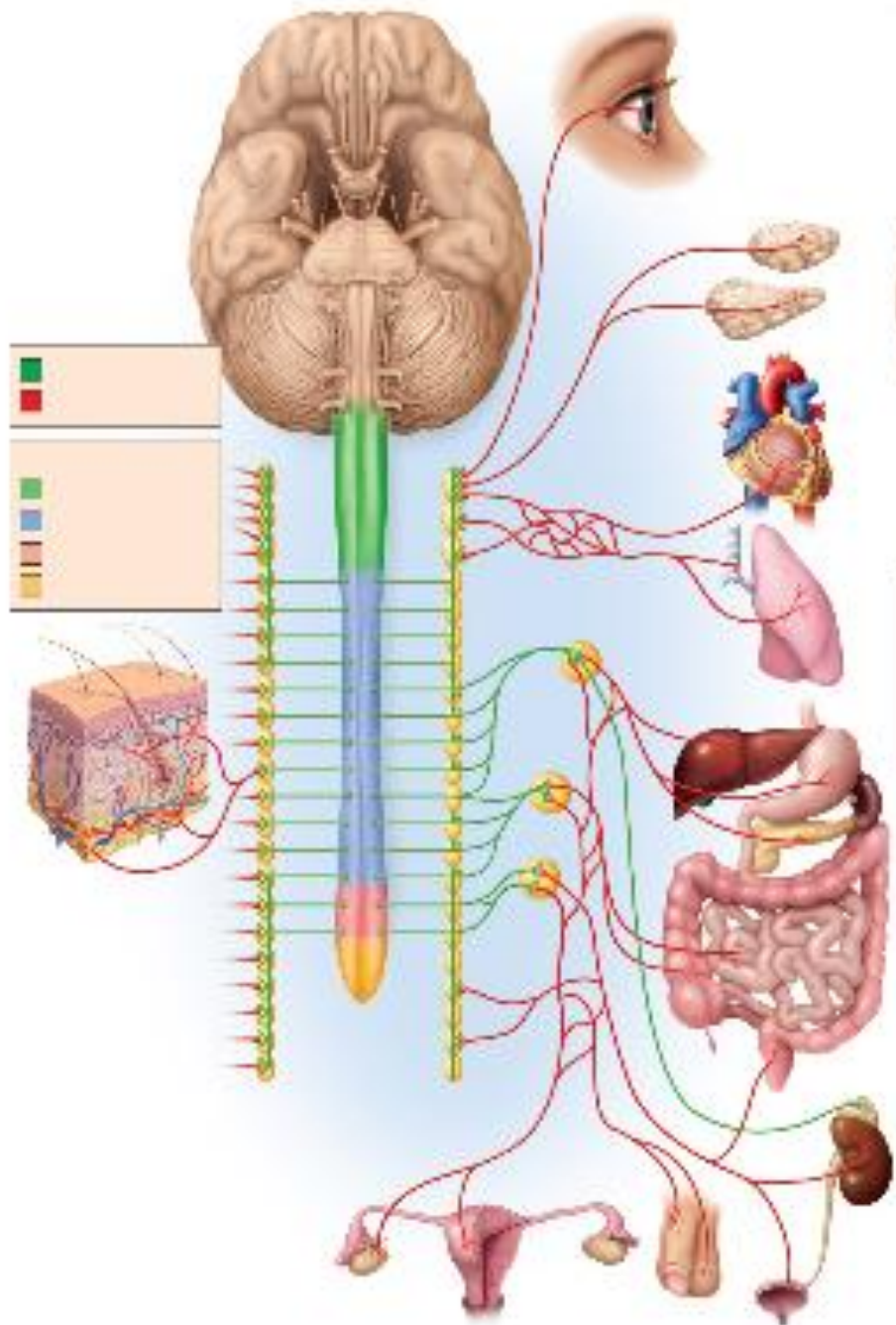


Characteristics of ENS

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

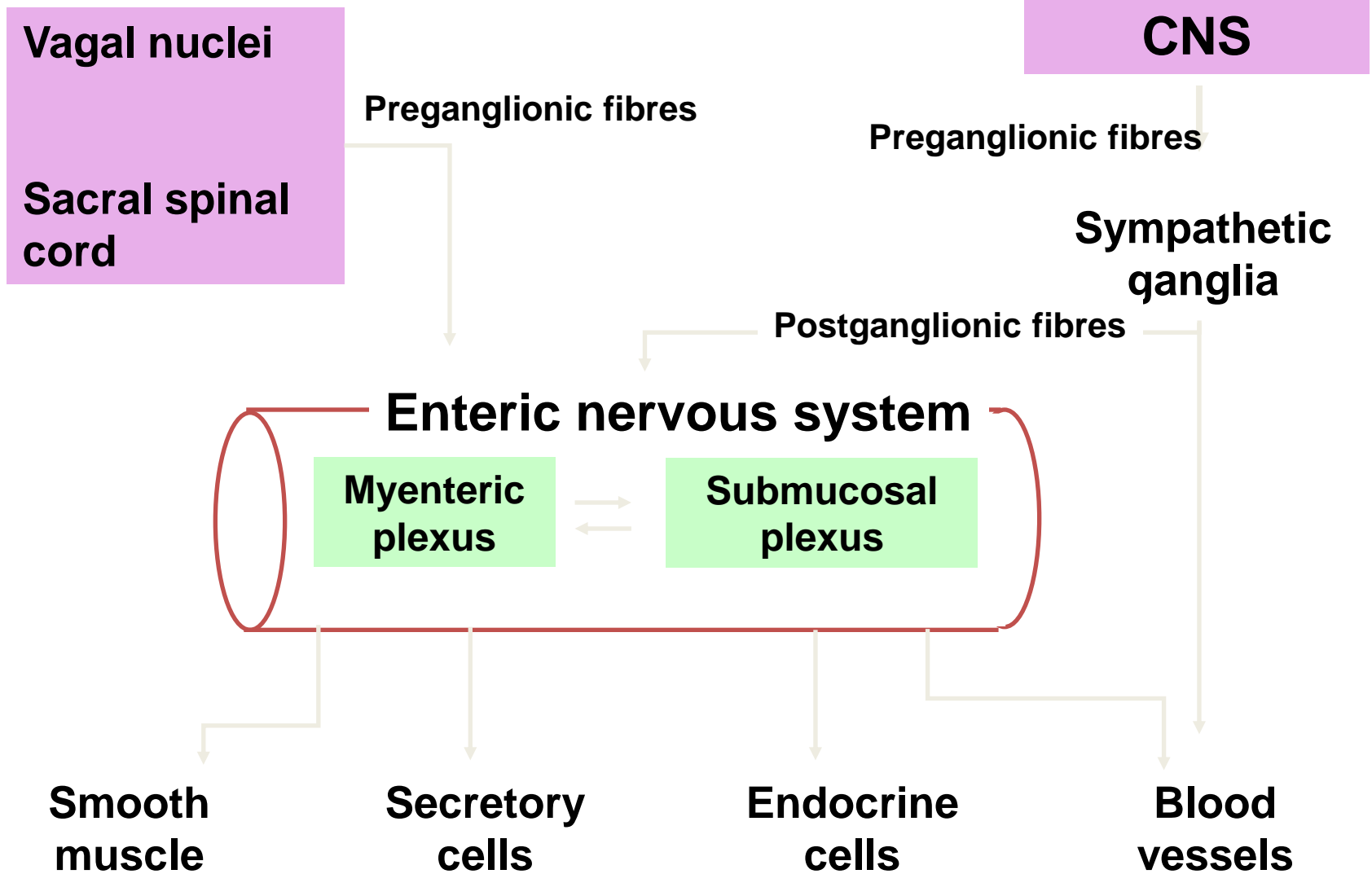
Autonomic Nervous System (ANS)

- **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

