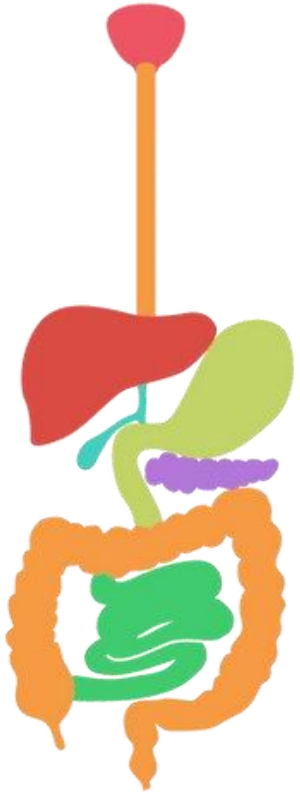
Ashur University
College of Medicine

Grade 2
PHYSIOLOGY OF
GASTROINTESTINAL TRACT
(GIT)

Regulation of GASTROINTESTINAL Function & Motility



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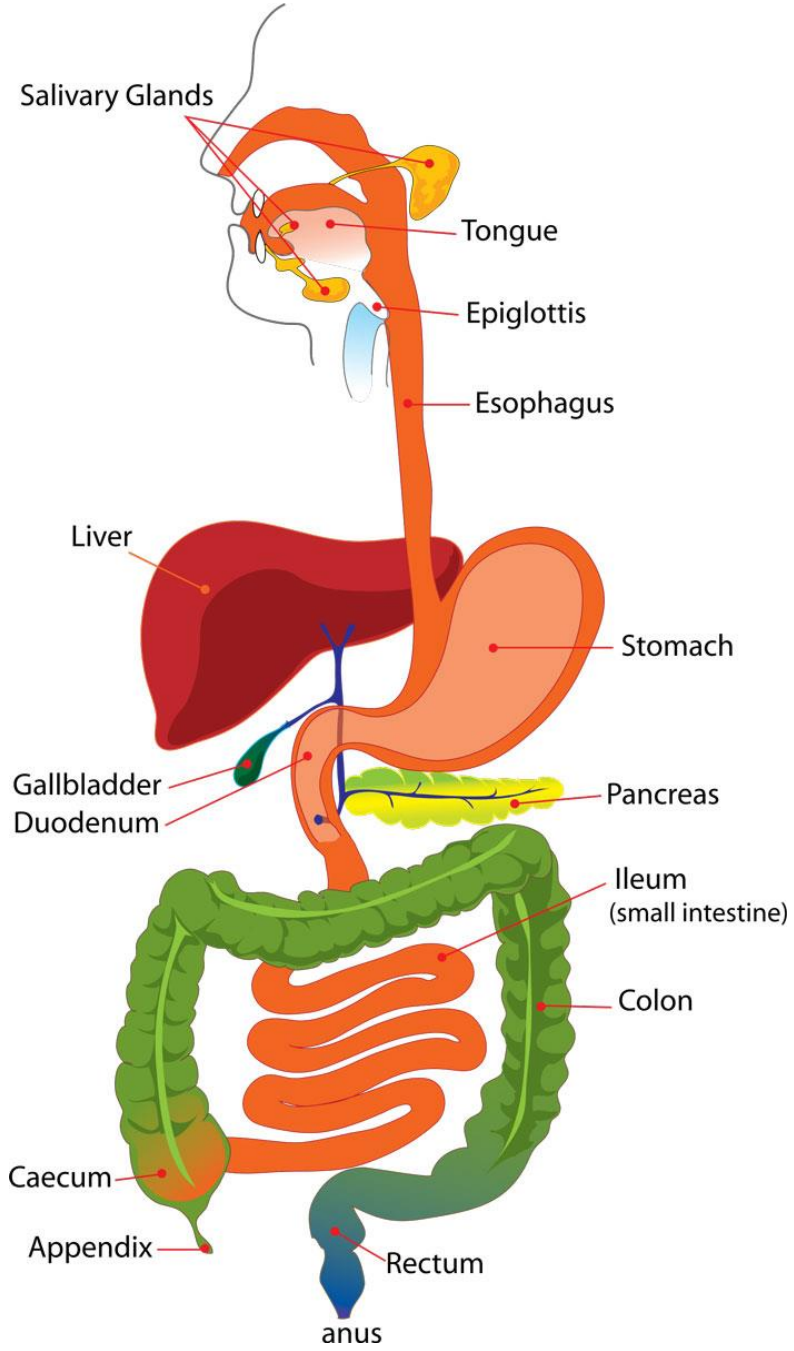
Objectives:

- Outline the mechanisms regulating G.I.T. functions.
- Describe the types of movements of smooth muscles of the gut.
- Define Peristalsis.

Other names of GIT :

Alimentary tract , **Gut** .



GASTROINTESTINAL TRACT (G.I.T) Parts:

1-Oral cavity.

2- Pharynx.

3- Esophagus.

4- Stomach.

5- Small intestine: Duodenum , Jejunum, Ileum.

6- Large intestine: Caecum, Ascending colon, Transverse colon , Descending colon, Sigmoid, Rectum and anal canal.

The accessory organs are:

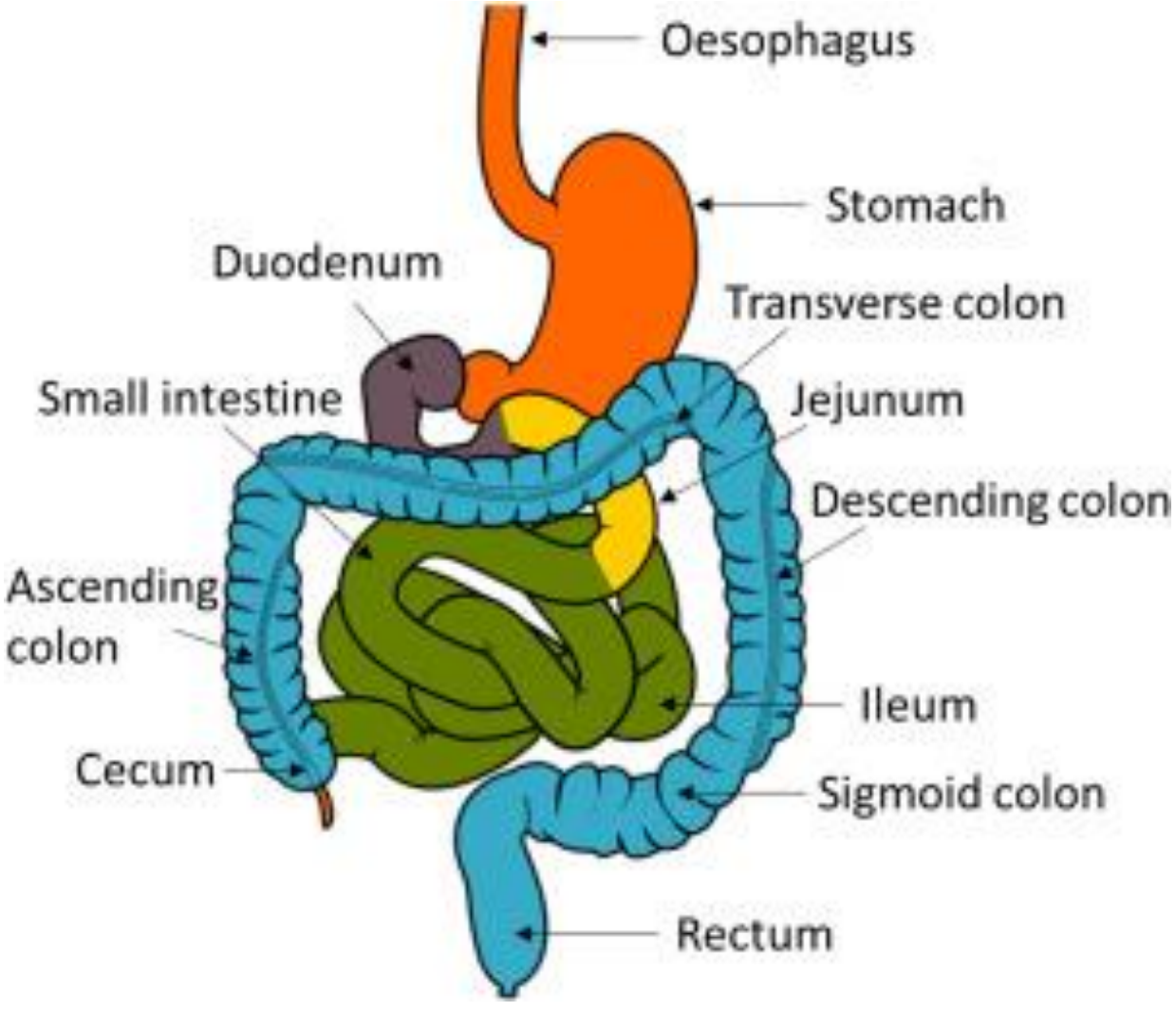
1- Salivary glands.

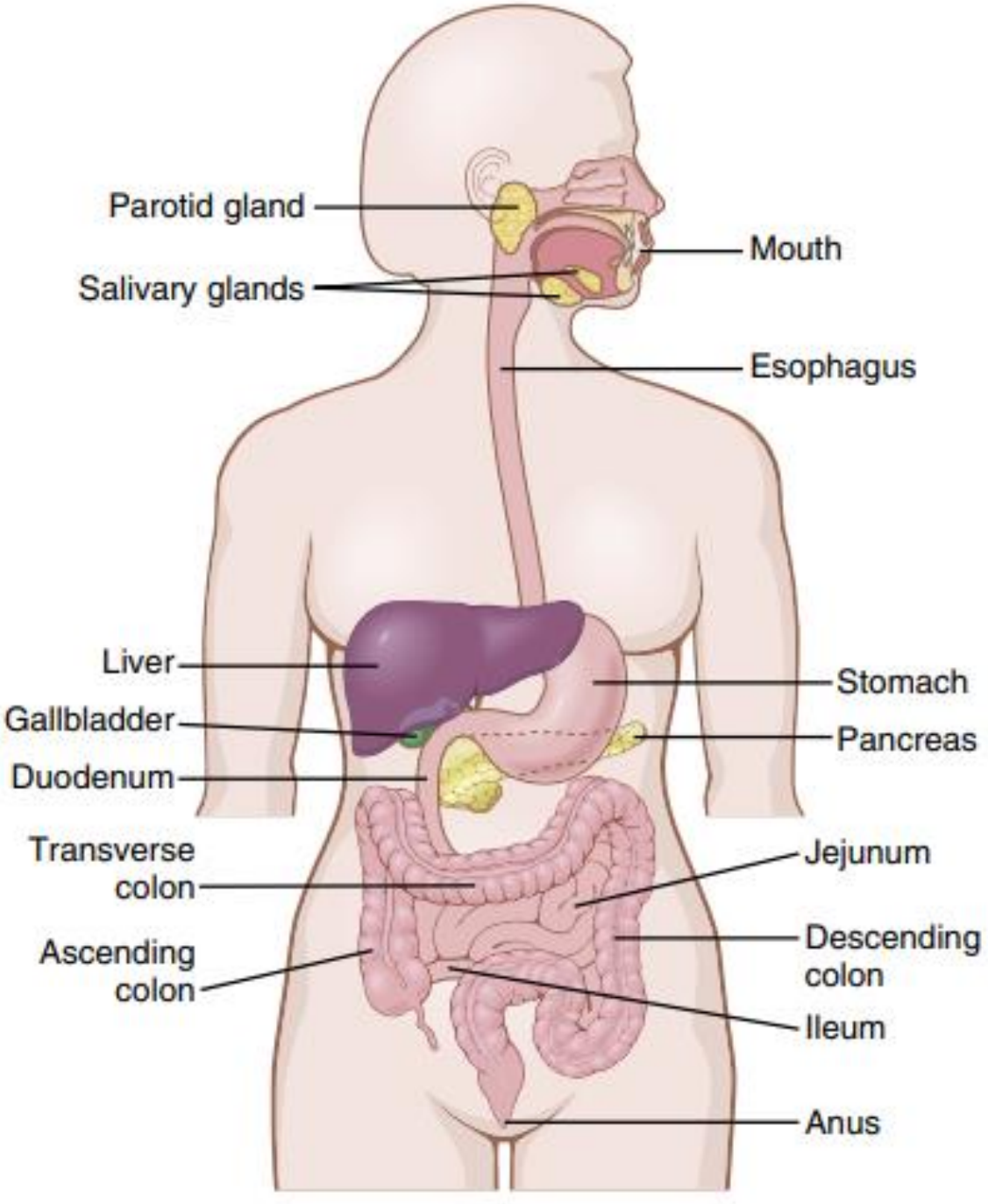
2- Pancreas.

3- Liver.



Parts of GIT


Oesophagus
Stomach
Duodenum
Transverse colon
Small intestine
Jejunum
Descending colon
Ascending colon
Ileum
Cecum
Sigmoid colon
Rectum


Parotid gland
Mouth
Salivary glands
Esophagus
Liver
Stomach
Gallbladder
Pancreas
Duodenum
Transverse colon
Jejunum
Ascending colon
Descending colon
Ileum
Anus

REGULATION OF G.I.T. FUNCTION

- Some of the mechanisms that regulate the gastrointestinal functions depend on:

1- Intrinsic properties of intestinal smooth muscles.

2- Nervous:

A-Extrinsic:

-Parasympathetic

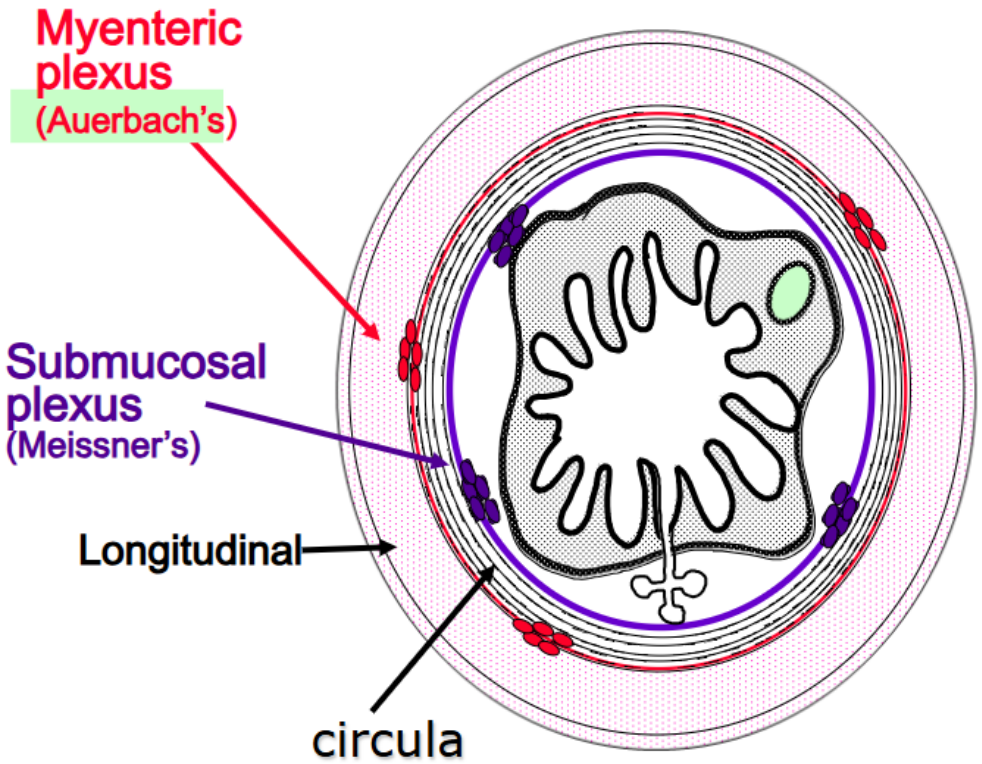
-Sympathetic

B-Intrinsic:

-Auerbach or myenteric plexus

-Meissner's or sub mucosal plexus

3- Hormones.



ELECTRICAL ACTIVITY OF THE G.I. SMOOTH MUSCLES

- The smooth muscle of the G.I. tract is excited by almost continual slow intrinsic electrical activity along the membranes of the muscle fibres. This activity has two basic types of electrical waves.

1. Slow waves.

2. Spikes.

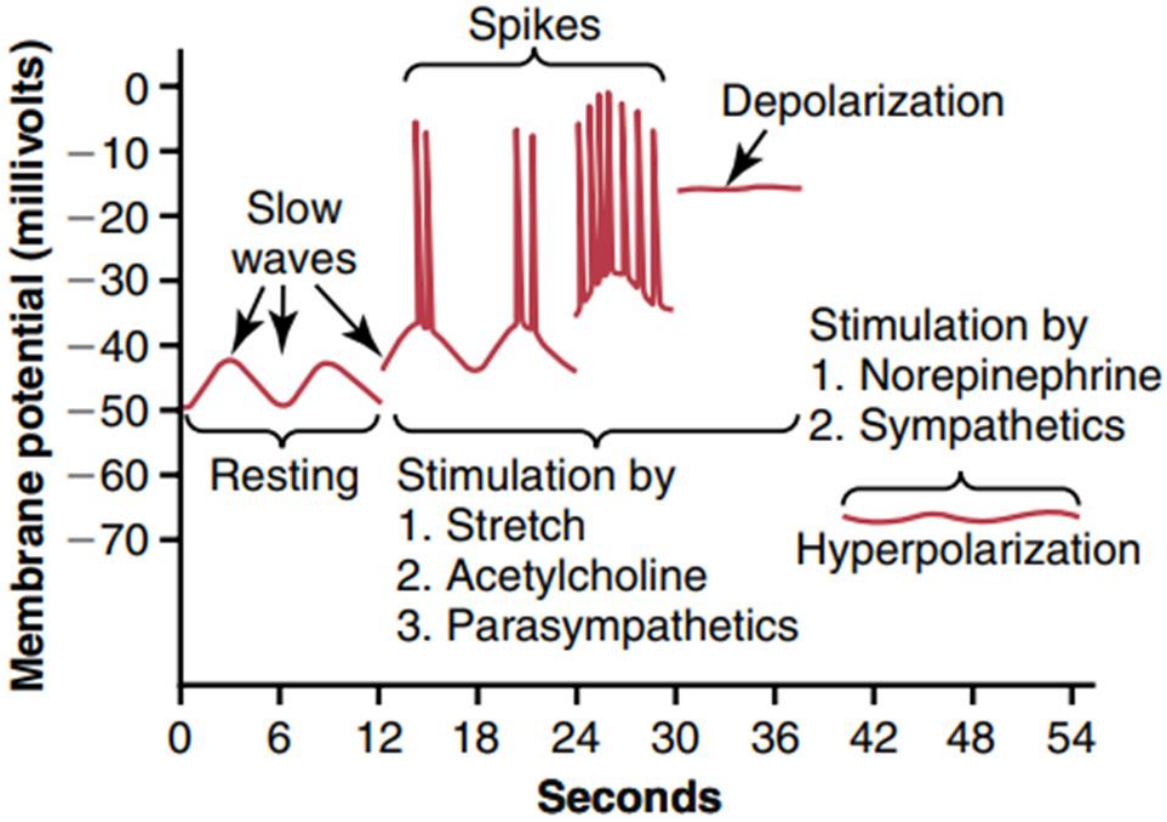
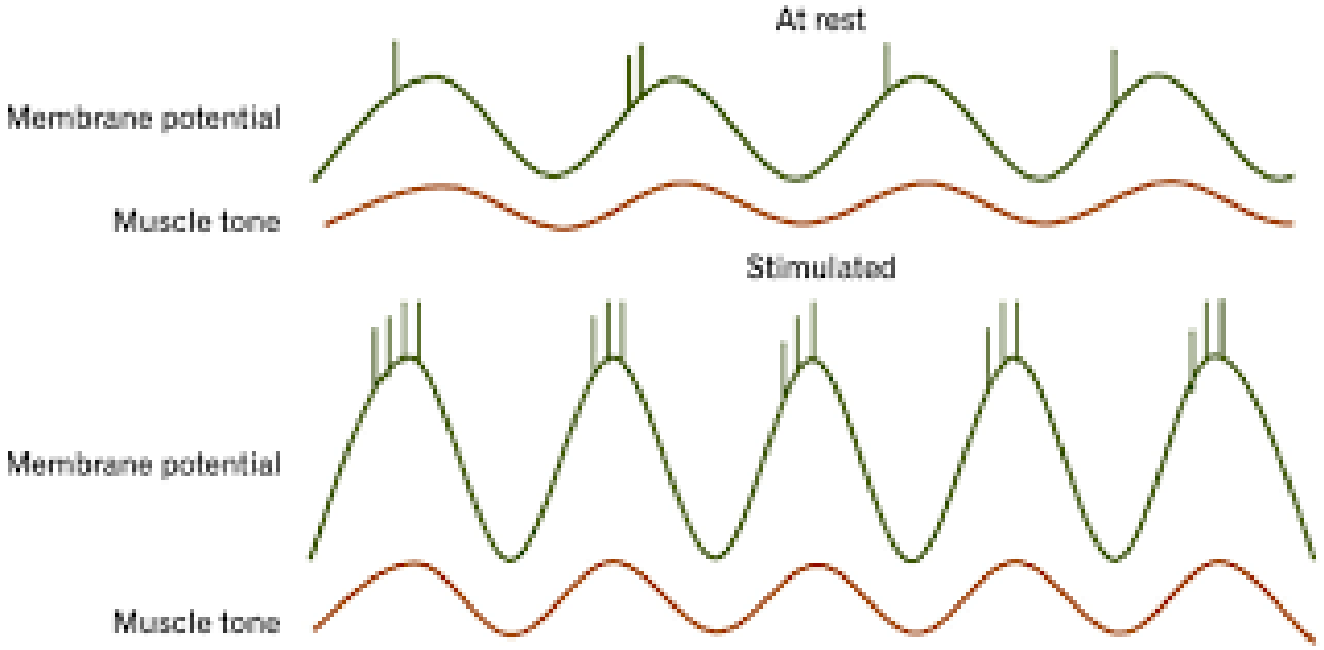
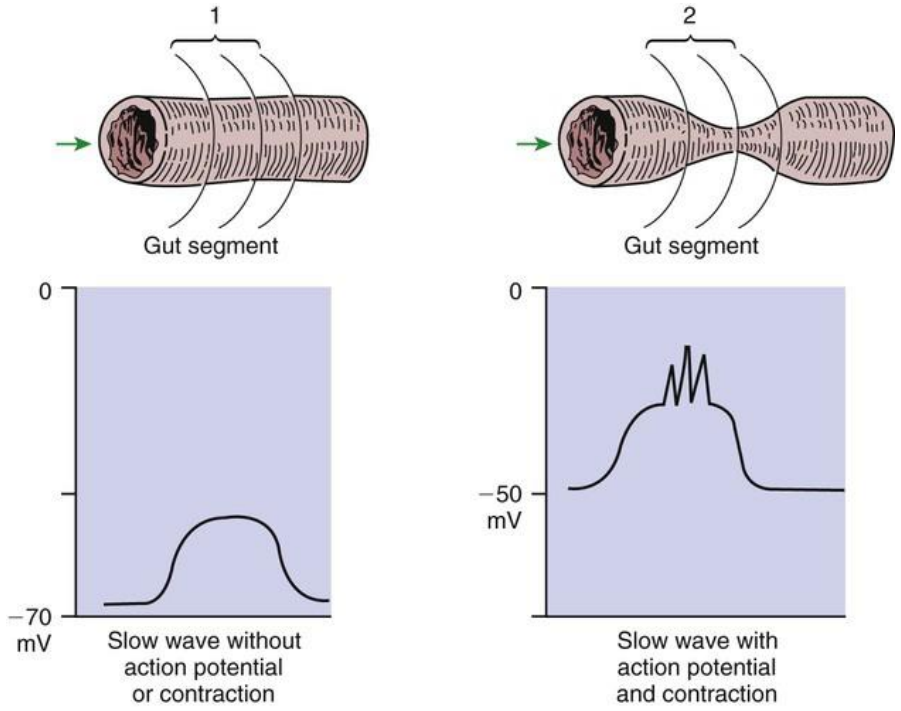


Figure:
Membrane potentials in intestinal smooth muscle. Note the slow waves, the spike potentials, total depolarization, and hyperpolarization, all of which occur under different physiological conditions of the intestine.

SLOW WAVES:

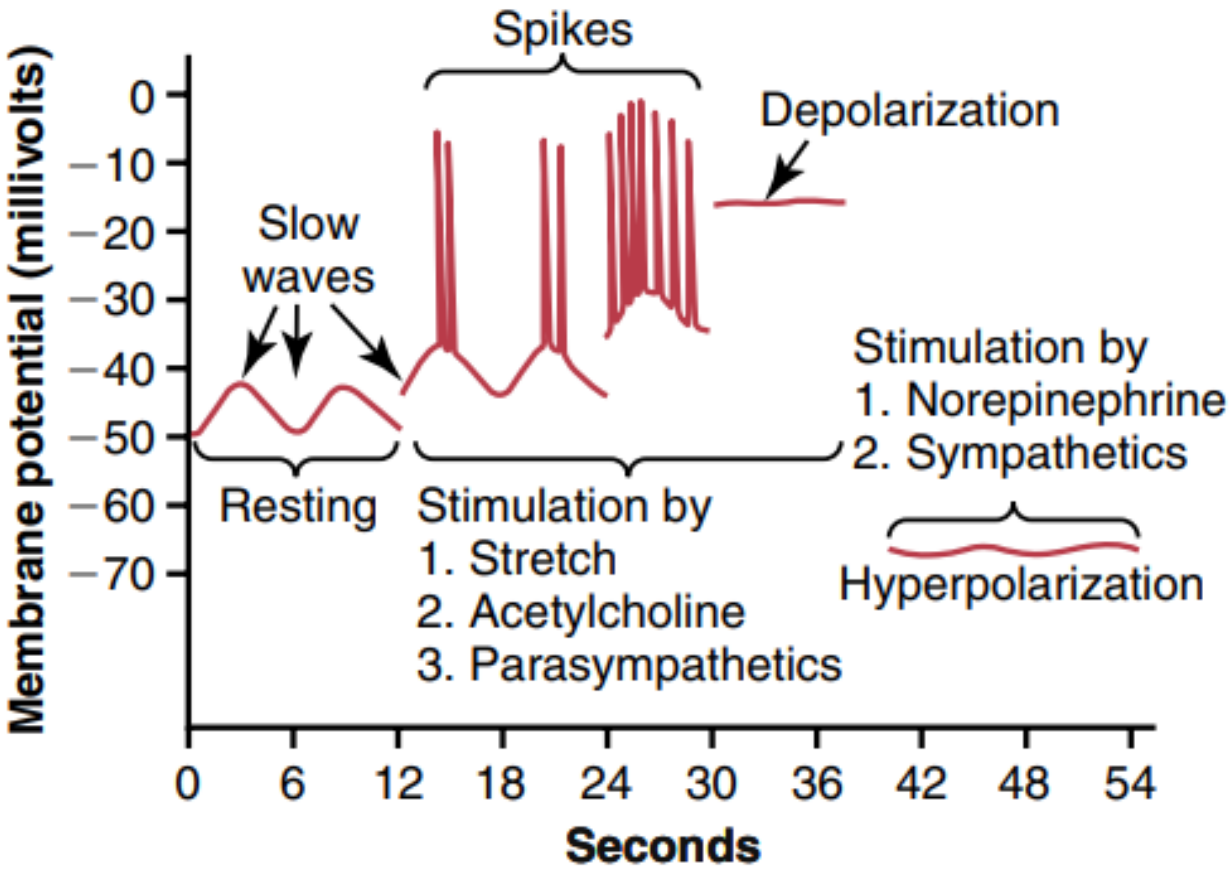
- These waves are slow undulating changes in the resting membrane potential. Their **intensity ranges between 5-15 millivolts**, and their **frequency range between 3-12 per minute** (3 in the body of the stomach and 12 in the duodenum).





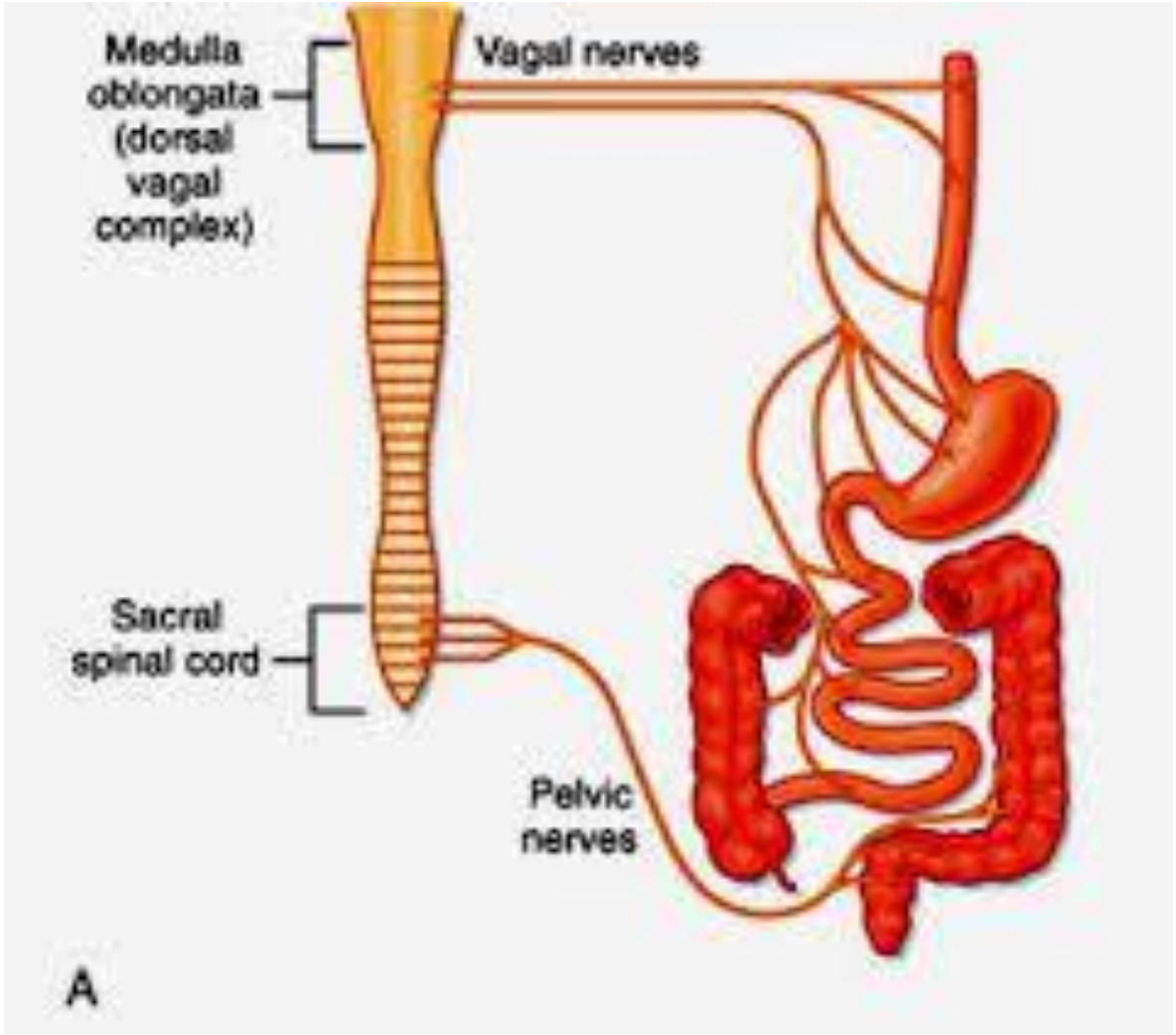
SPIKE POTENTIALS:

- They are true action potentials. They occur automatically when the resting membrane potential of the G.I. smooth muscle becomes more positive than about - 40 mille volt (normal resting membrane potential of the gut is -50 to -60 mille volt).
- **The slow waves do not cause muscle contraction by themselves, but the spike potentials generated at the peak of the slow waves, cause most of the contraction.**
- **(entry of calcium ions into the muscle fibers.)**



AUTONOMIC INNERVATION (extrinsic)
Parasympathetic innervation

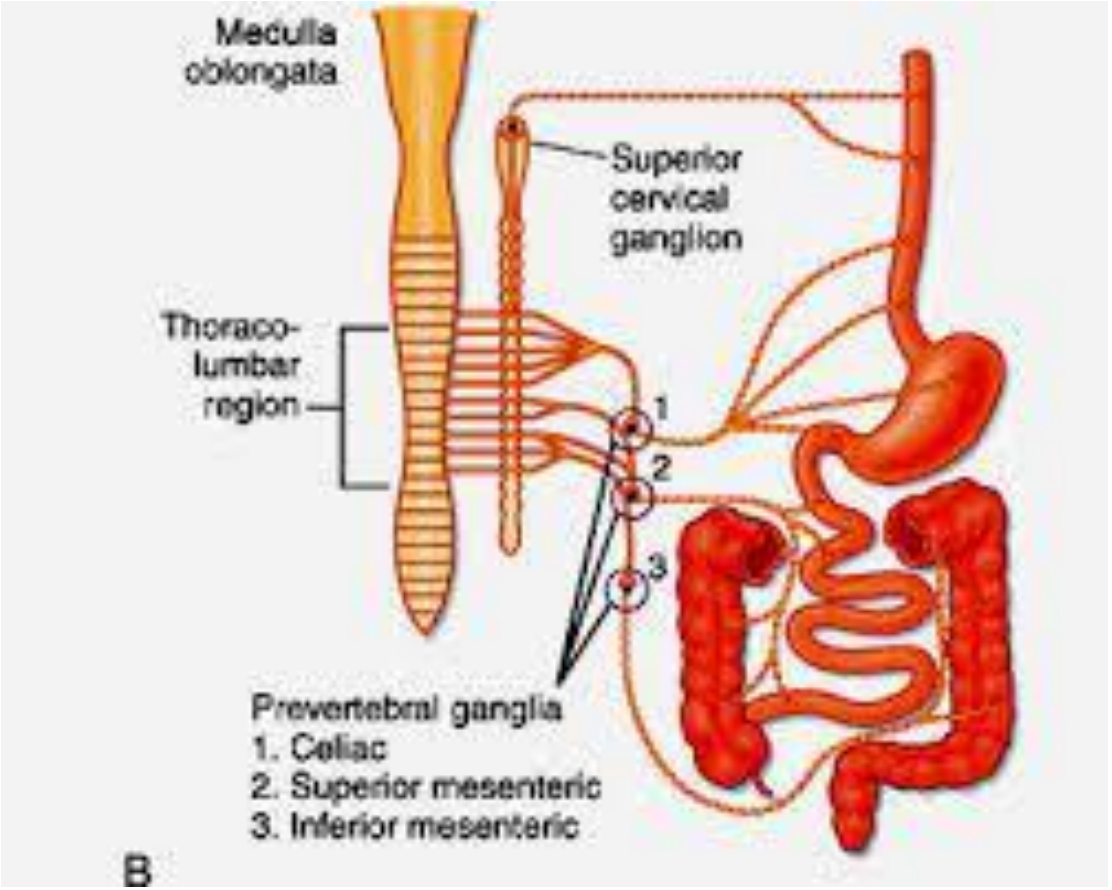
- The **vagus nerve is the main parasympathetic nerve supply to the gut**.
- It provides extensive innervations to the **oesophagus, stomach, pancreas** and **first half of the large intestine**. But to a lesser extent to the small intestine.
- The **pelvic or Nervi erigentes** and comes from 2, 3, 4 th sacral segments of the spinal cord. It supplies the **distal half of the large intestine**.



- The preganglionic parasympathetic nerves will end on ganglion cells in the **enteric plexus (Meissner and Auerbach).**
- The post ganglionic fibers will pass then to the muscles of the muscular coat and to the muscularis mucosae to control contraction of the smooth muscles. Some fibers pass to the secretory cells to control secretion of mucus or different juices.
- **Stimulation of parasympathetic nerves increase the activity of the gastrointestinal tract** i.e. **increases the motility** and **increases the secretion**
- Effects of parasympathetic stimulation:
  - **↑ GI motility**
  - **↑ GI secretions**
  - **↑ Blood flow**
  - **↓ Constriction of GI sphincters** (allows food to move through the tract)

Sympathetic innervation:

- The **thoraco-lumbar** part of the spinal cord.
- The **preganglionic fibers** after leaving the cord will end in the **celiac** and various **mesenteric ganglia**. From there the post ganglionic fibers will pass to all parts of the G.I. tract.
- Some post ganglionic fibers will end on the **myenteric plexus of Auerbach's** to inhibit its activity. In addition to these axons, other postganglionic sympathetic fibers pass to the circular and longitudinal muscle to produce relaxation.



• There are also some fibers going to the blood vessels to cause vasoconstriction. Some fibers pass to the **Meissner plexus** to inhibit its activity.

• Stimulation of the sympathetic nervous system inhibits activity in the G.I. tract causing an opposite effect for that of the parasympathetic stimulation.

This inhibition is carried out by two ways:

1- Direct inhibitory effect of nor-epinephrine on the smooth muscle (except the muscularis mucosae which it excites).

2- By inhibiting the neurons of the enteric nervous plexus.

- **Effects of sympathetic stimulation (opposite to parasympathetic stimulation):**
  - **↓ Motility**
  - **↓ Secretion**
  - **↓ Blood flow**
  - **↑ Sphincter tone**

Figure:

Neural control of the gut wall, showing the following:

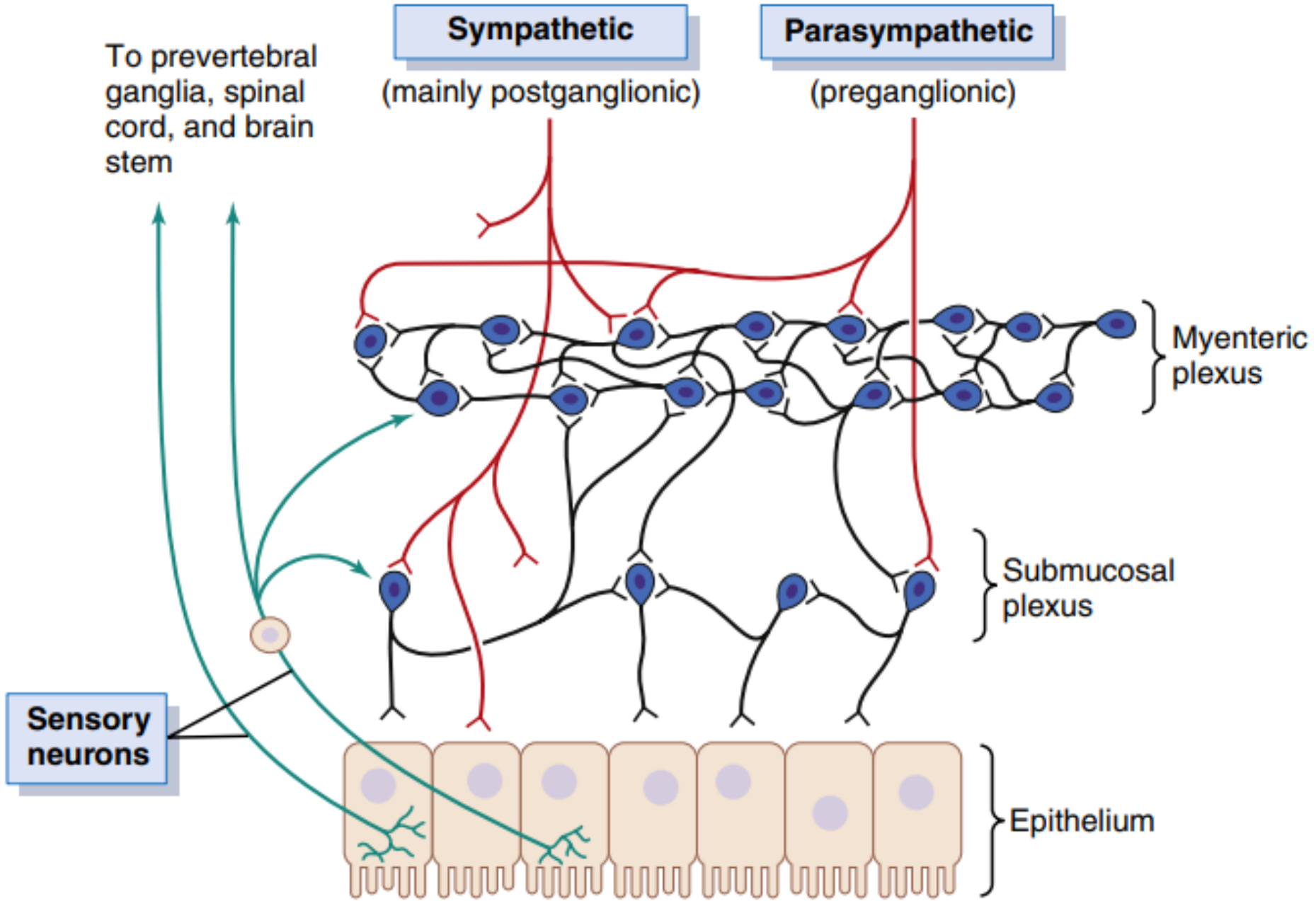
(1) the myenteric and submucosal plexuses

(black fibers);

(1) (2) extrinsic control of these plexuses by the sympathetic and parasympathetic nervous systems (red fibers); and

(2) (3) sensory fibers passing from the luminal epithelium and gut wall to the enteric plexuses, then to the prevertebral ganglia of the spinal cord and directly to the spinal cord and brain stem

(green fibers).

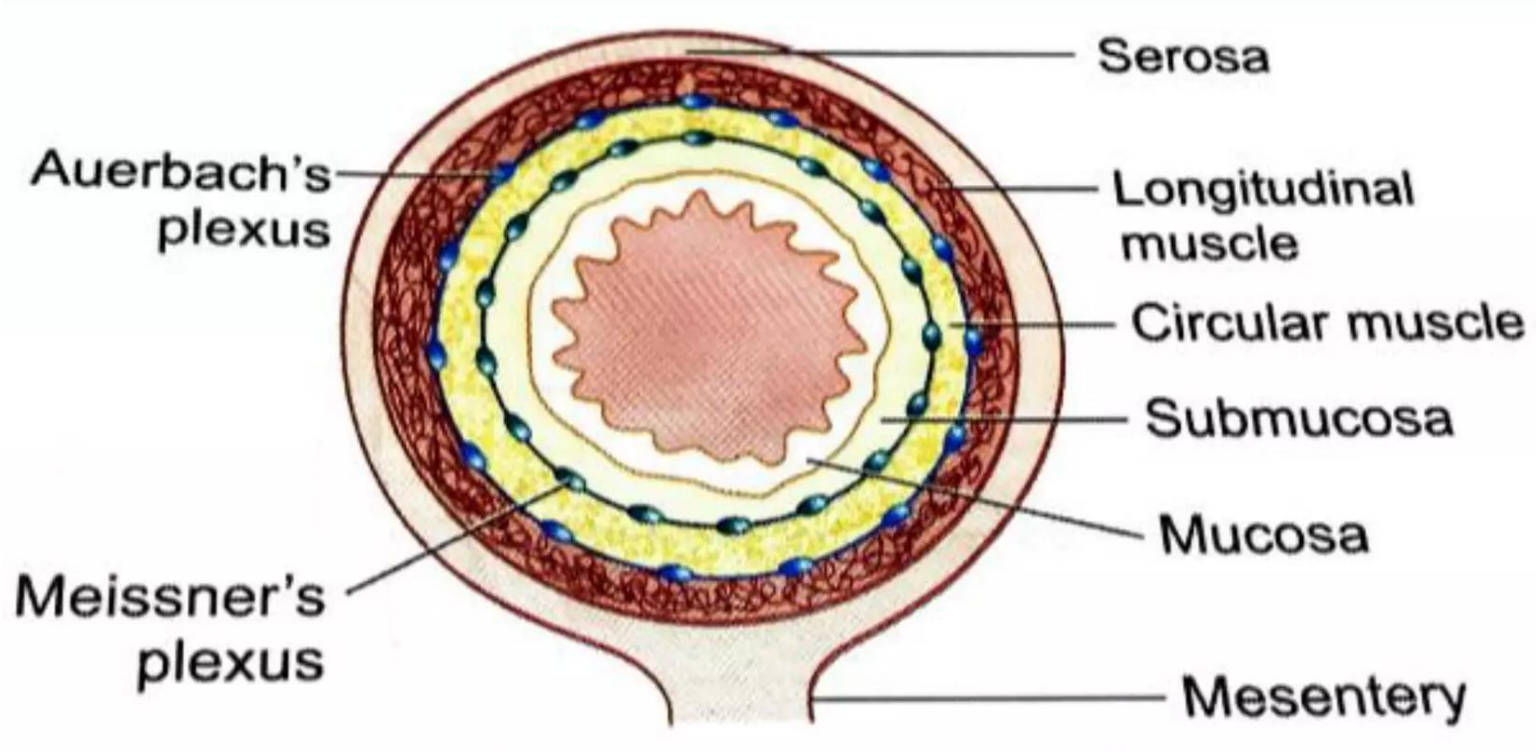


INTRINSIC INNERVATION

- The **whole gut from the oesophagus to the anus is supplied by intrinsic nerves** which consist of two plexuses.

1. Meissner's plexus in the submucosa.

2. Auerbach's or myenteric plexus. In between the circular and longitudinal muscle layer of the muscular coat.

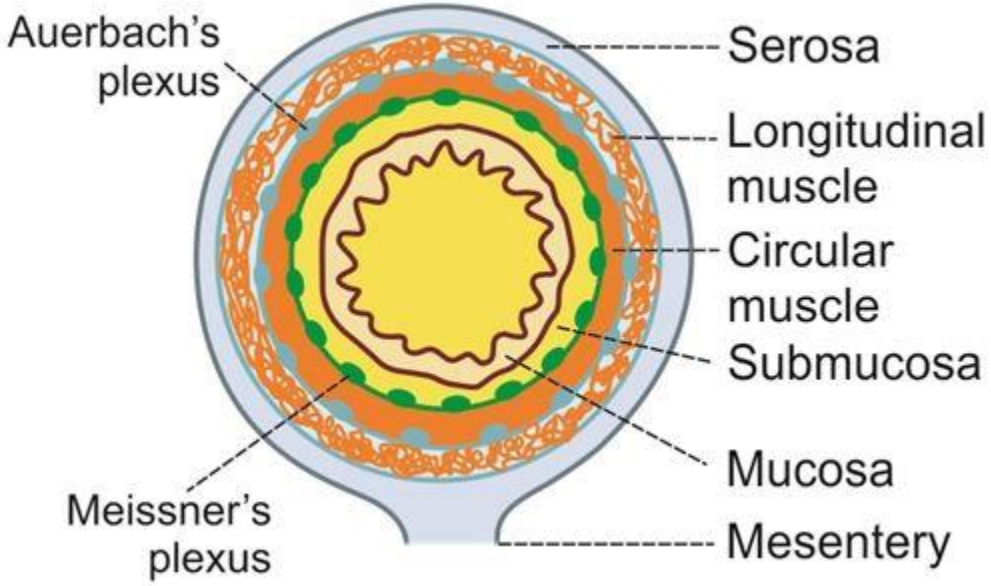


• Together these plexuses are called **ENTERIC PLEXUSES**. These plexuses are composed of groups of ganglionic cells interconnected by a network of fibers. This system control most gastrointestinal functions and particularly movement and secretion.

• **Auerbach's plexuses control mainly the gastrointestinal movement**,

while the

• **Meissner's plexus controls mainly the secretion**, and also has many sensory functions.



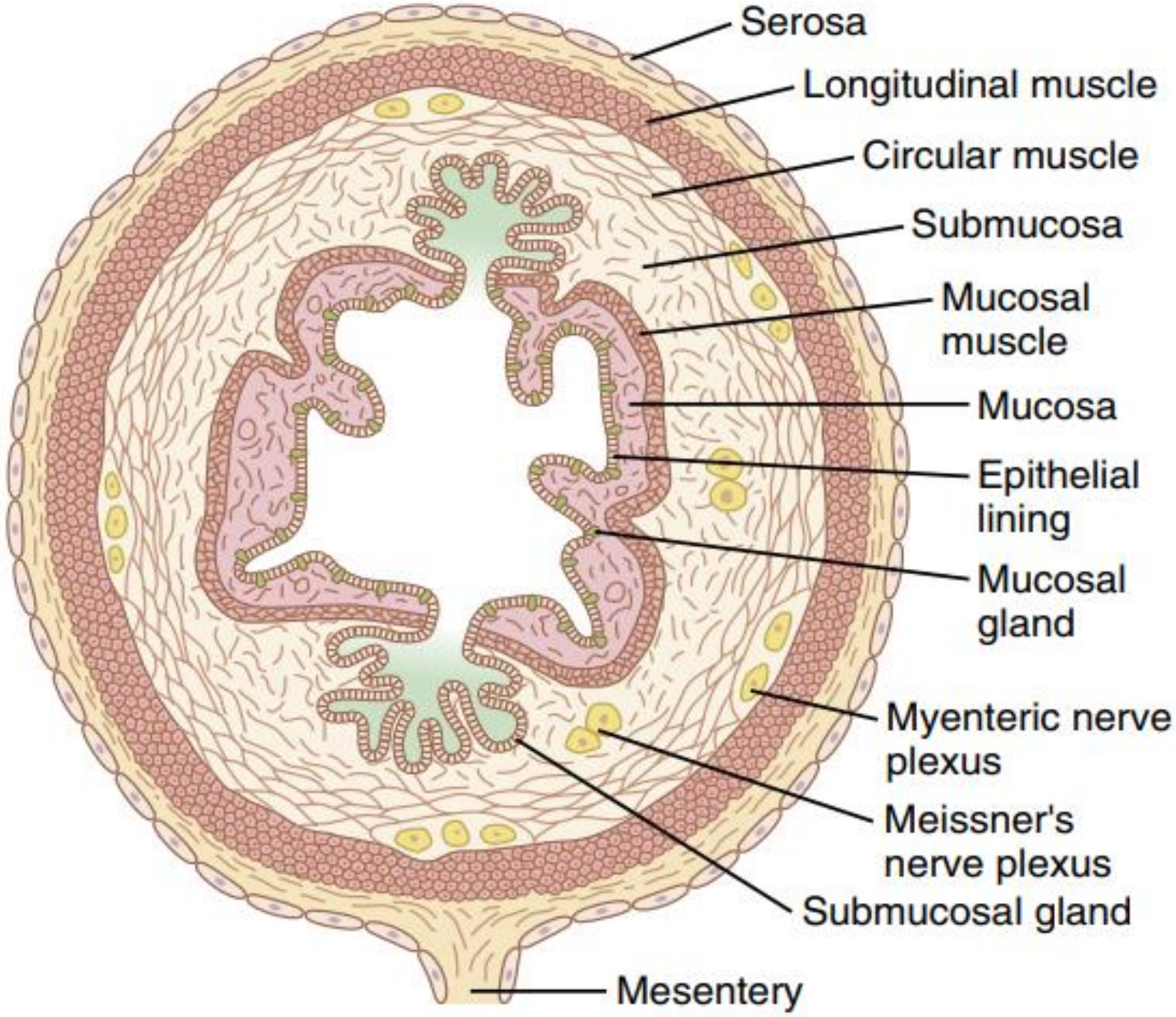


Figure: Typical cross section of the gut.

- **The intrinsic nervous system** is responsible for many neurogenic reflexes that occur locally in the gut, such as reflexes from the mucosal epithelium to **increase the activity of the gut muscles** or to cause localized **secretion of digestive juice** by the gastrointestinal glands.
- There are about 100 million neurons in this system. They contain not only **Ach** and **nor-epinephrine** but **other mediators**.

Mediators are:

- Acetylcholine (Ach)
- Nor-epinephrine.
- Nitric oxide (NO).
- Carbon monoxide (CO).
- Vasoactive intestinal polypeptide (VIP).
- Serotonin.
- Cholecystokinin (CCK)
- Enkephalin.
- Adenosine triphosphate (ATP)
- Gastrin-releasing peptide (GRP)
- Neuropeptide y.
- Peptide yy.
- Neurotensin.
- Somatostatin
- Substance P
- Endothelin -2

HORMONAL CONTROL

There are two major hormones:

1- Gastrin is secreted by the **"G" cells** of the antrum of the **stomach** in response to stimuli associated with ingestion of a meal.

2- Secretin is secreted by the **"S" cells** in the mucosa of the **duodenum** in response to acidic gastric juice emptying into the duodenum from the pylorus of the stomach

Other hormones :

Cholecystokinin (CCK) is secreted by **"I" cells** in the mucosa of the duodenum and jejunum mainly in response to digestive products of fat, fatty acids, and monoglycerides in the intestinal contents.

Motilin is secreted by the stomach and upper duodenum during fasting, and the only known function of this hormone is to increase gastrointestinal motility.

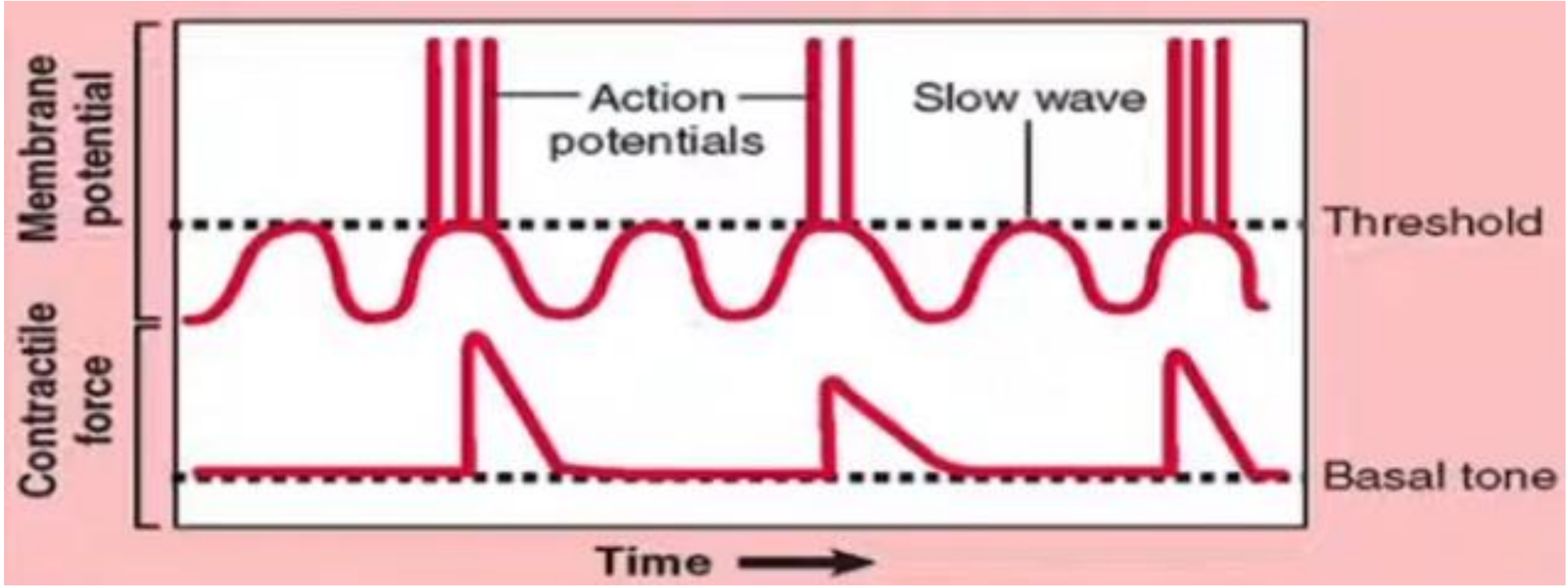
Other hormones :

substance P, Bombesin (Gastrin-Releasing Peptide - GRP),

Somatostatin, Neurotensin, ..etc..

GASTROINTESTINAL MOTILITY

- Smooth muscle of the gut exhibits two types of movements:
- **Tonic contraction.**
- **Rhythmic contraction.**



Tonic contraction: is continuous contraction lasting for minutes or hours and increasing or decreasing in intensity but the contraction is on.

Contractions of the sphincters will determine the amount of resistance offered by the sphincters to the movement of intestinal contents.

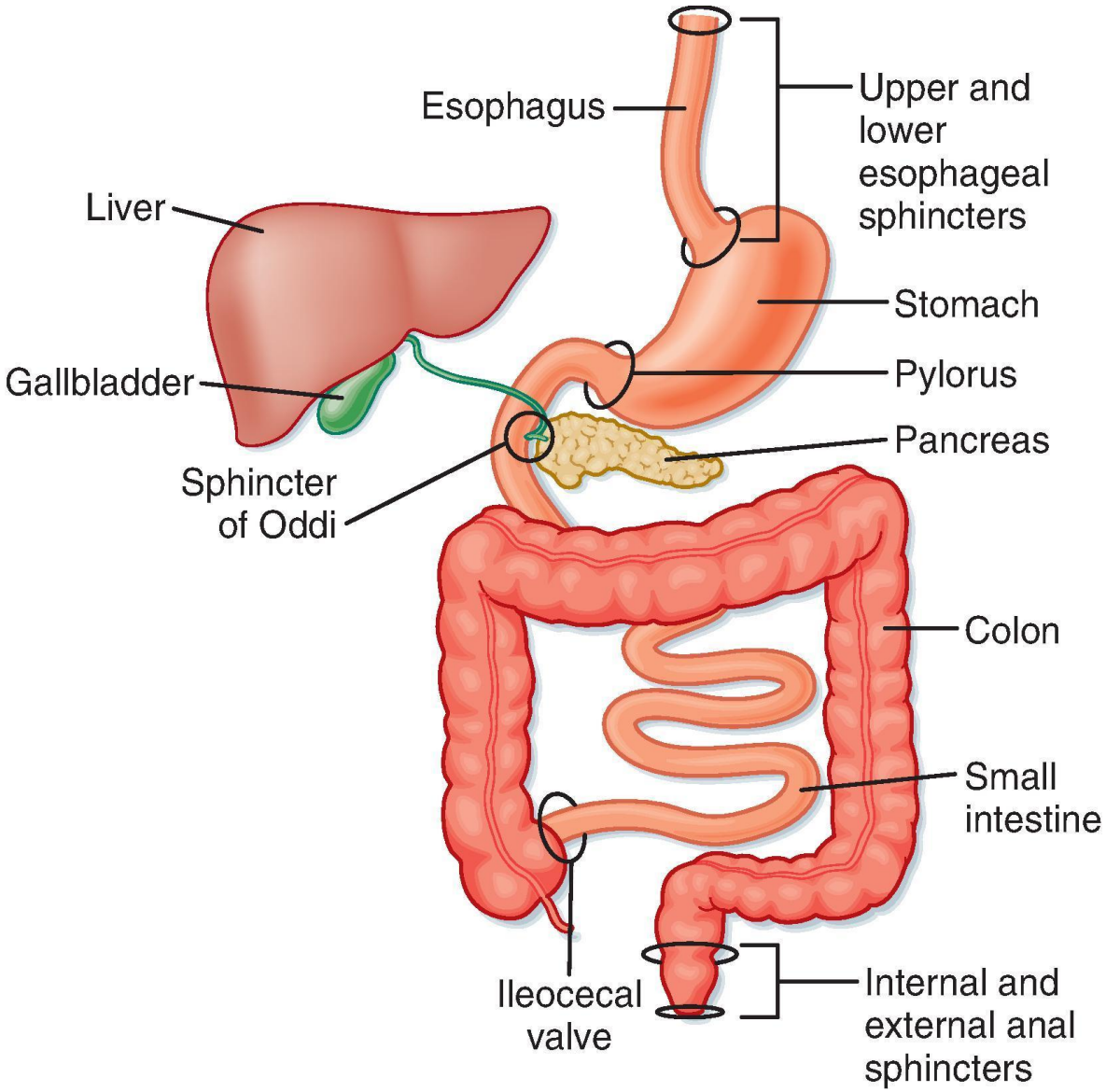
Examples of tonic contractions of sphincters are:

1-Lower esophageal sphincter (LES)

2-Pyloric sphincter (PS)

3-Ileocaecal sphincter (ICS)

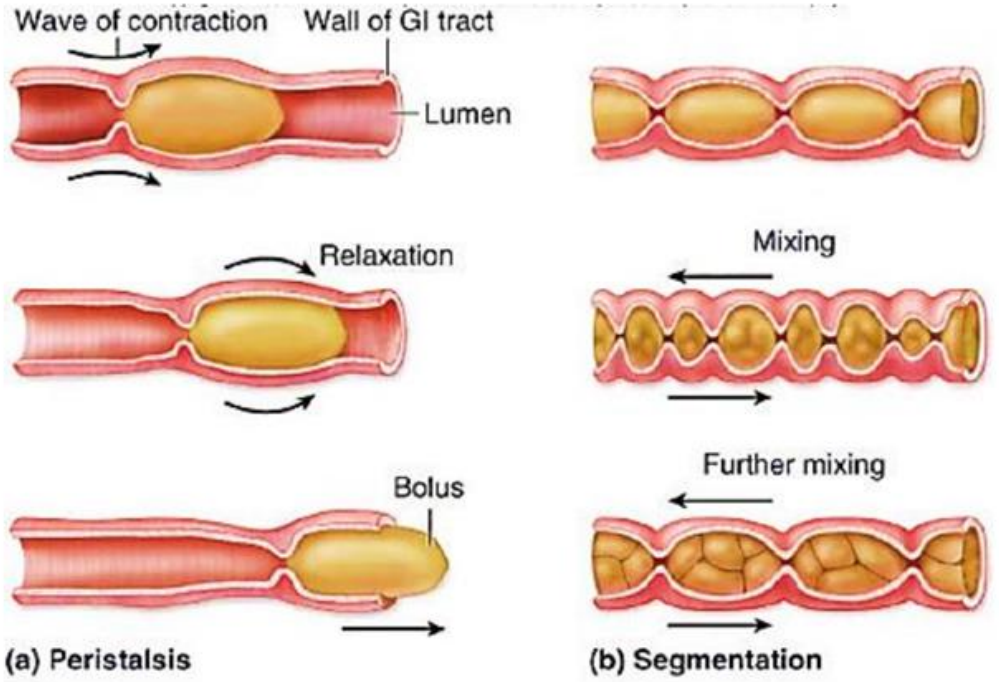
4-Internal anal sphincter (IAS).



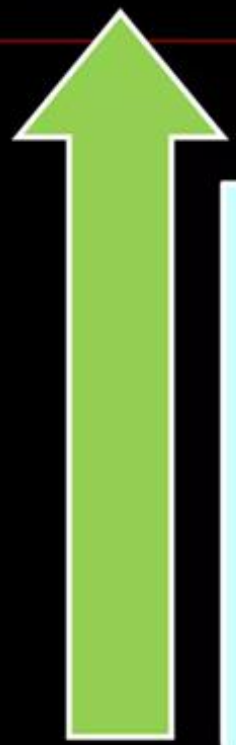
- **Rhythmic contraction:**
- can occur as rapid as 9-12 per minute in the intestine or as slow as 3 per minute in the stomach.
- It is the frequency of the slow wave in these segments that sets the frequency. **Rhythmic contraction is important for:**

1. Mixing the food.

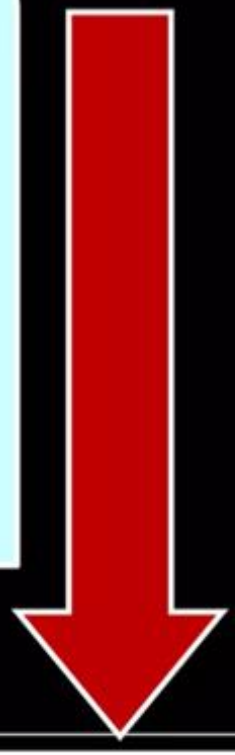
2. Peristaltic propulsion of food.



Factors affecting contractility



Initiate contraction.	Inhibit contraction.
Gastrin,	Enterogastrone,
Histamine,	Epinephrine,
Nicotine,	Norepinephrine,
Barium and K+	Atropine and Ca2+.




Thank
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