Lecture series
Gastrointestinal tract

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INNERVATION OF GIT

1. **Intrinsic innervation**
   - 1. Myenteric/Auerbach plexus or Local
   - 2. Submucosal/Meissner's plexus

2. **Extrinsic innervation**
   - 1. Parasympathetic or
   - 2. Sympathetic
   - Higher centre
Enteric Nervous System

- Lies in the wall of the gut, beginning in the esophagus and extending all the way to the anus
- controlling gastrointestinal movements and secretion.

- (1) an outer plexus lying between the longitudinal and circular muscle layers, called the myenteric plexus or Auerbach’s plexus,
- controls mainly the gastrointestinal movements

- (2) an inner plexus, called the submucosal plexus or Meissner’s plexus, that lies in the submucosa.
- controls mainly gastrointestinal secretion and local blood flow
Enteric Nervous System

- The **myenteric plexus** consists mostly of a **linear chain of many interconnecting neurons** that extends the **entire length of the GIT**

- When this plexus is stimulated, its principal effects are
- (1) increased **tonic contraction, or “tone,”** of the gut wall,
- (2) increased **intensity of the rhythmical contractions,**
- (3) slightly increased **rate of the rhythmical contraction,**
- (4) increased **velocity of conduction** of excitatory waves along the gut wall, causing **more rapid movement of the gut peristaltic waves.**

- **Inhibitory** transmitter - vasoactive intestinal polypeptide (**VIP**) - pyloric **sphincter, sphincter** of the ileocecal valve
Enteric Nervous System

- The submucosal plexus is mainly concerned with controlling function within the inner wall

- Local intestinal secretion, local absorption, and local contraction of the submucosal muscle

- Neurotransmitters:
  - (1) Ach (7) substance P
  - (2) NE (8) VIP
  - (3) ATP (9) somatostatin
  - (4) 5 – HT (10) bombesin
  - (5) dopamine (11) metenkephalin
  - (6) cholecystokinin (12) leuenkephalin
Higher centre innervation

- the **extrinsic sympathetic and parasympathetic** fibers that **connect to both** the myenteric and submucosal plexuses.

- the **enteric nervous system** can function on its own, **independently of these extrinsic nerves**, 

- **stimulation by the parasympathetic and sympathetic** systems can greatly **enhance or inhibit gastrointestinal functions**

- **sensory nerve endings** that originate in the **gastrointestinal epithelium or gut wall** and send **afferent fibers to both plexuses** of the enteric system, 

- as well as (1) to the **prevertebral ganglia** of the sympathetic nervous system, (2) to the **spinal cord**, and (3) in the vagus nerves all the way to the **brain stem**.

- These sensory nerves can elicit **local reflexes** within the gut wall
- **Parasympathetic**

- the *cranial* parasympathetic nerve fibers - mouth and pharyngeal regions of the alimentary tract, esophagus, stomach, and pancreas and somewhat less to the intestines down through the first half of the large intestine.

- The *sacral* parasympathetics originate in the 2\textsuperscript{nd}, 3\textsuperscript{rd} & 4\textsuperscript{th} sacral segments of the spinal cord and pass through the pelvic nerves to the distal half of the large intestine and all the way to the anus.

- The sigmoidal, rectal, and anal regions are considerably better supplied with parasympathetic fibers than are the other intestinal areas - defecation reflexes
- Sympathetic Innervation - spinal cord between segments T-5 and L-2.

- Pre ganglionic - sympathetic chains - celiac ganglion and various mesenteric ganglia – post ganglionic

- Innervate essentially all of the gastrointestinal tract – inhibitory

- (1) to a slight extent by direct effect of secreted NE to inhibit intestinal tract smooth muscle

- (2) to a major extent by an inhibitory effect of NE on the neurons of the entire enteric nervous system
Afferent Sensory Nerve Fibers

- sensory nerves can be stimulated by

(1) *irritation* of the gut mucosa,

(2) excessive *distention* of the gut,

(3) presence of specific *chemical substances* in the gut.
Higher centre innervation

- the extrinsic sympathetic and parasympathetic fibers that connect to both the myenteric and submucosal plexuses.

- the enteric nervous system can function on its own, independently of these extrinsic nerves,

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Autonomic Control

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Sympathetic Innervation

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- sensory nerves can be stimulated by

(1) **irritation** of the gut mucosa,

(2) excessive **distention** of the gut,

(3) presence of specific **chemical substances** in the gut.
1. Reflexes that are integrated entirely within the gut wall enteric nervous system – secretion, peristalsis, mixing contractions, local inhibitory effects

2. Reflexes from the gut to the prevertebral sympathetic ganglia and then back to the GIT

- signals from the stomach to cause evacuation of the colon (the gastrocolic reflex),
- signals from the colon and small intestine to inhibit stomach motility and stomach secretion (the enterogastric reflexes),
- reflexes from the colon to inhibit emptying of ileal contents into the colon (the colonoileal reflex).
3. Reflexes from the gut to the spinal cord or brain stem and then back to the GIT.

- (1) reflexes from the stomach and duodenum to the brain stem and back to the stomach — by way of the vagus nerves — to control gastric motor and secretory activity;

- (2) pain reflexes that cause general inhibition of the entire GIT;

- (3) defecation reflexes that travel from the colon and rectum to the spinal cord and back again to produce the powerful colonic, rectal, and abdominal contractions required for defecation
**GIT Hormones**

- **GASTRIN** is secreted by the “G” cells of the antrum of the stomach in response to stimuli associated with ingestion of a meal.
- G-cell is neural in origin, also called APUD cells, as it is amine precursor uptake and decarboxylation.
- It occurs in 3 forms - G34, G17, G14.
- G-17 (MW-2000) is the principal form.
- It is also found in pituitary gland, hypothalamus, medulla, vagal & sciatic nerves.
- Gastrin is secreted as progastrin which get activated to gastrin by HCL.

**Function:**

1. Stimulate gastric acid & pepsin secretion
2. Stimulate growth of mucosa of GIT
3. Stimulate gastric motility
4. Stimulate insulin & glucagon secretion
2. **cholecystokinin** 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.

- This hormone strongly *contracts the gallbladder*, expelling bile into the small intestine where the bile in turn plays important roles in emulsifying fatty substances, allowing them to be digested and absorbed.

- Cholecystokinin also *inhibits stomach contraction moderately* – give adequate time for digestion of the fats in the upper intestinal tract.
3. **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.

- Secretin has a **mild effect on motility** of the GIT and acts to promote **pancreatic secretion of bicarbonate** which in turn helps to **neutralize** the acid in the small intestine.

4. **Gastric inhibitory peptide** is secreted by the mucosa of the upper **small intestine**, mainly in response to fatty acids and amino acids but to a lesser extent in response to carbohydrate.

- It has a mild effect in **decreasing motor activity of the stomach** and therefore **slows emptying of gastric contents** into the duodenum when the upper small intestine is already **overloaded** with food products.
Higher centre innervation

- the **extrinsic sympathetic and parasympathetic** fibers that **connect to both** the myenteric and submucosal plexuses.

- the **enteric nervous system** can function on its own, **independently of these extrinsic nerves,**

- **stimulation by the parasympathetic and sympathetic** systems can **greatly enhance or inhibit gastrointestinal functions**

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- These sensory nerves can elicit **local reflexes** within the gut wall
To prevertebral ganglia, spinal cord, and brain stem

Sympathetic (mainly postganglionic)

Parasympathetic (preganglionic)

Myenteric plexus

Submucosal plexus

Epithelium

Sensory neurons
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- It has a mild effect in **decreasing motor activity of the stomach** and therefore **slows emptying of gastric contents** into the **duodenum** when the upper small intestine is already **overloaded with food products**.
- **Motilin** is secreted by the **upper duodenum** during fasting, and the only known function of this hormone is to *increase* gastrointestinal motility.

- Motilin is released *cyclically* and stimulates waves of gastrointestinal motility called *interdigestive myoelectric complexes*;

- that move through the **stomach** and **small intestine** every 90 minutes in a fasted person.
MIGRATING MOTOR COMPLEX

- Electrical and motor activity in gut smooth muscles during interdigestive stage
- Duration: 90-100 min in each cycle
- Rate of movement is 5cm/min from oral to aboral site
- Phase 1 - Quiescent period with no activity
- Phase 2 - Period of irregular activity
- Phase 3 - Period of regular activity
- Initiated by motilin
- Gastic secretion, bile flow, pancreatic secretion increases MMC
- Food abolish MMC by inhibiting motilin
Phase I - No spike potentials, no contractions

Phase II - Irregular spike potentials and contractions

Phase III - Regular spike potentials and contractions

Phases of MMC

Stomach

Propagation rate (5 cm/m)

Distal ileum

~90 min

Resumption of MMCs
References

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• Medical Physiology, Updated second edition (walter F. Boron, MD, phd)
• Berne & levy, physiology, sixth edition, updated edition
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