Sheet# 1

Lecture 1

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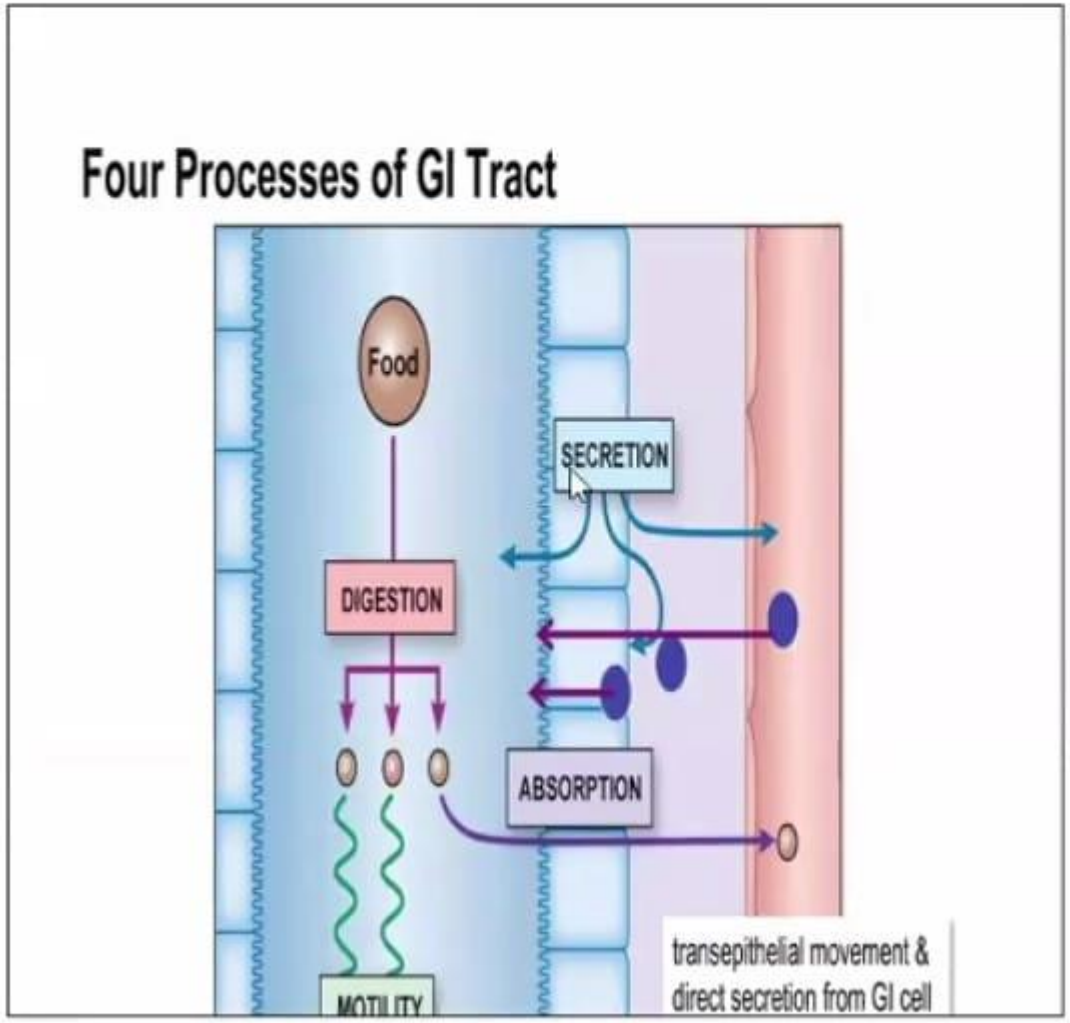
Functional Anatomy and General Principles of Regulation in the Gastrointestinal Tract

Functions of the Gastrointestinal System

- Secretion: Total about 7L into lumen.
- Motility
  - Mixing
  - propulsion
- Digestion: Breakdown of ingested food
  - Mechanical
  - Chemical
- Absorption: passage of nutrients into the blood



- From physiological point view the motility and secretion are tightly tied in order to achieve optimal digestion and absorption , by achieving optimal digestion and absorption we are getting the primary role of Digestive system (digestion and absorption) , then we are facilitate food assimilation which is the primary role of digestive system
- What are the products of secretion ??

  1-endocrine (enzymes , hormones)

  2-exocrine (H_2O,HCL,HCO_3^-,Pancreatic secretion , biliary secretion)

>digestion : the process by which food particles are converted into smaller particles that can be absorbed :

- mechanical or physical (chewing , segmentation movement (mixing) peristaltic movement)

-chemical (enzymes)

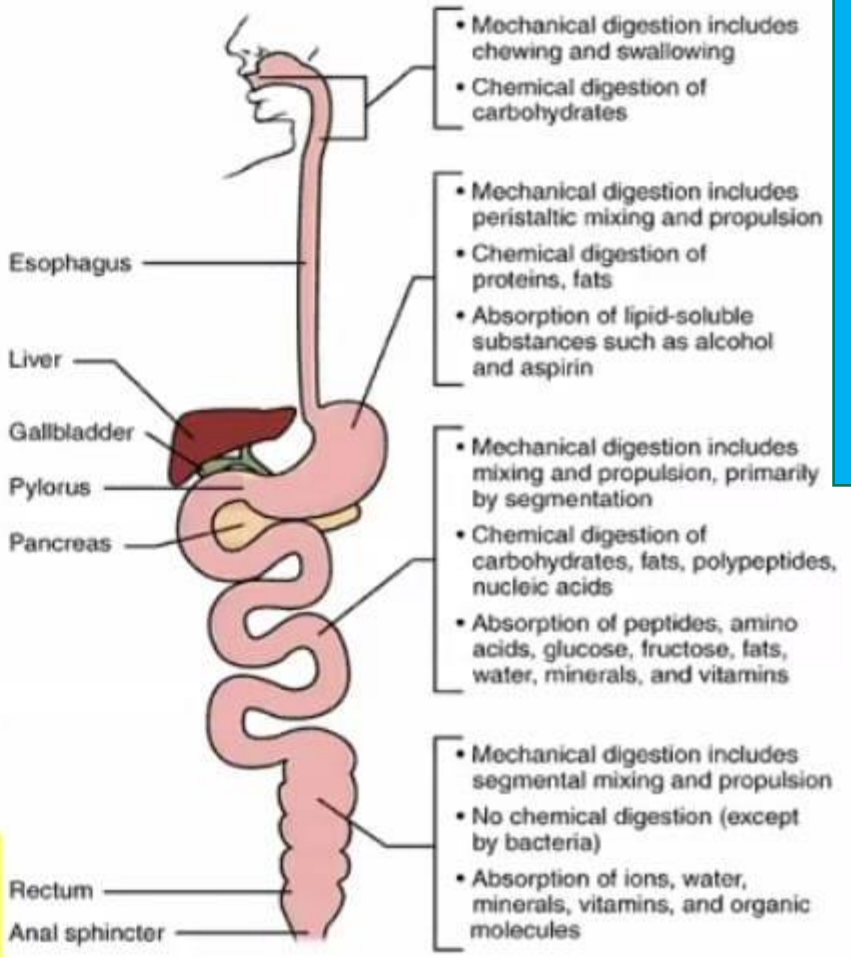
>motility : electrical motor activity of muscles (smooth or skeletal{in external sphincter of anus , upper third of esophagus , oral cavity})

>absorption : the process how to obtain the necessary fuel

The gastrointestinal organs functions

The GI tract or alimentary canal	The accessory glands and organs
Ingestion of food. Propulsion of food and wastes from the mouth to the anus Secretion of mucus, water and enzymes Mechanical digestion of food particles Chemical digestion of food particles. Absorption of digested food. Elimination of waste products by defecation.	The Liver, gall bladder and exocrine pancreas all secrete enzymes for the digestion of chyme.

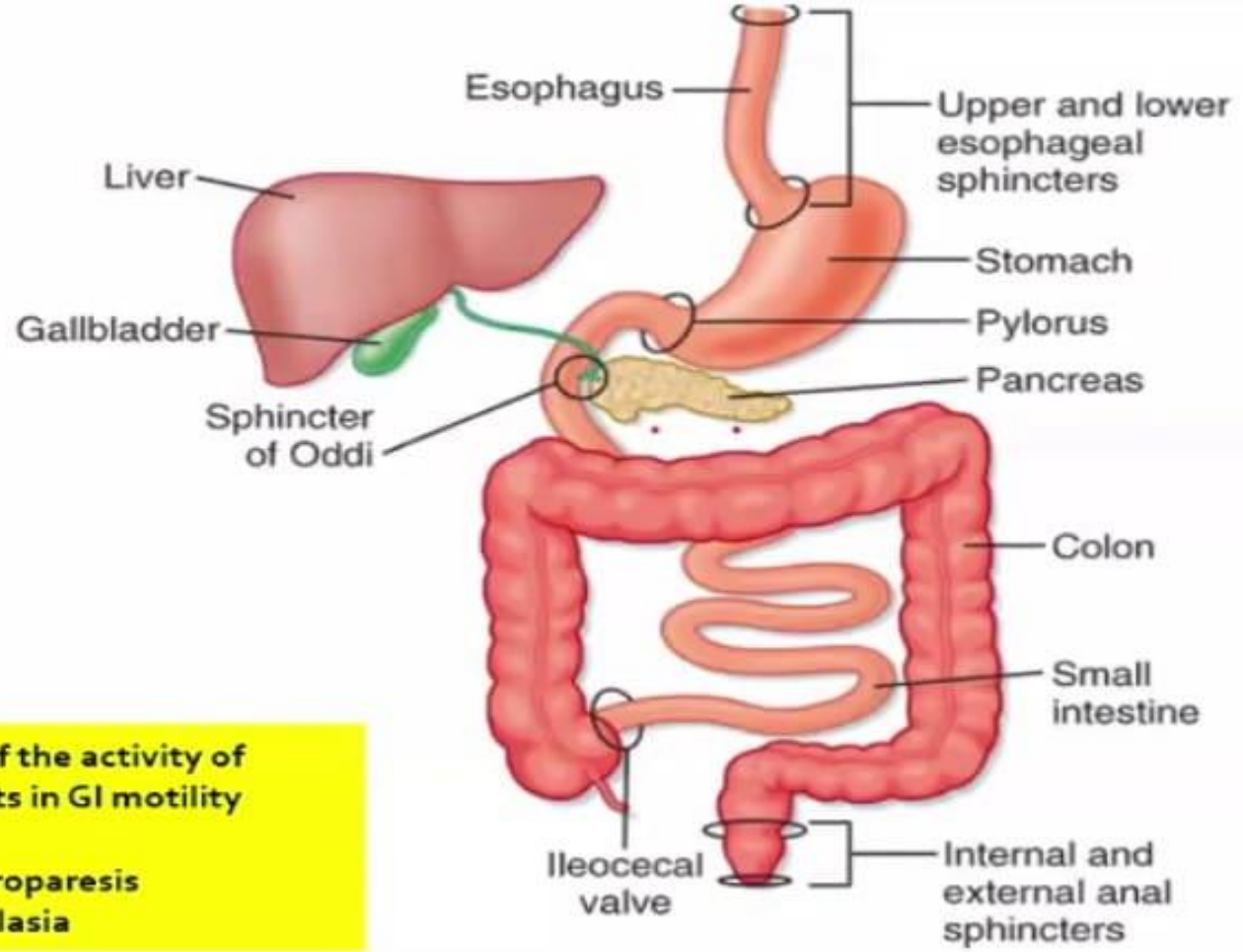
The GI tract is a muscular tube of about *5 m* long when one is alive



>There is no secretion in oral cavity .
The salivary secretion from accessory gland.

>Its length 5 m when one is alive, can be 10 m postmortem . the muscle tone is completely remove

The gastrointestinal organs functions



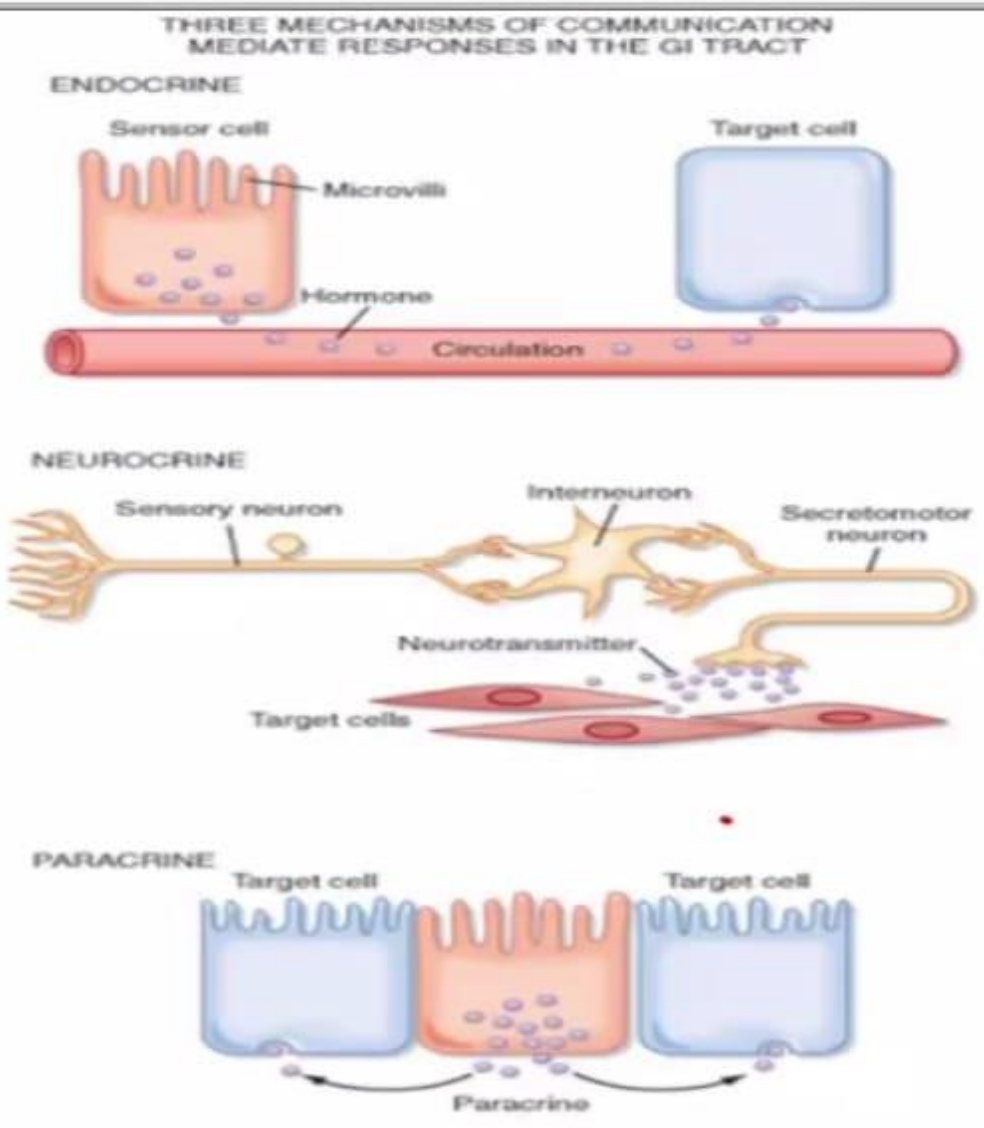
Dysregulation of the activity of sphincters results in GI motility disorders like:

- **Gastroparesis**
- **Achalasia**

- Importance of sphincter > one way direction (to anus) , it is valve for holding the lumenal contents for an adequate time , before these content is removed to the second segment (optimum mixing and digestion and absorption)

- Sphincter >>Smooth muscles regulated by neural and hormonal mechanism

Neural and Hormonal Regulators of Gastrointestinal Function



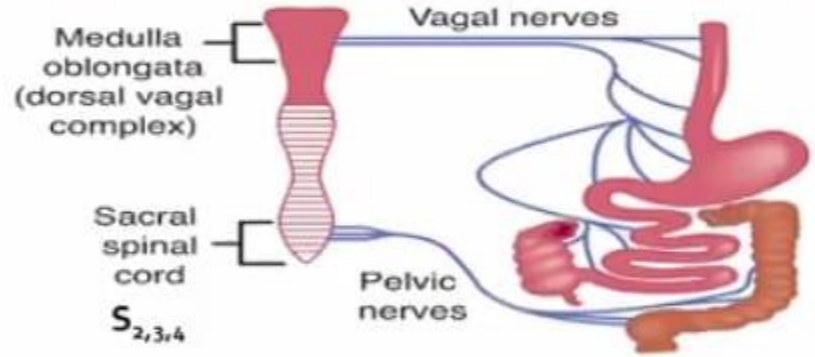
- Neurocrine >>why neurocrine ?????
- Innervation of GIS : interacting component (intrinsic , extrinsic (motor {sympathetic and parasympathetic}))
- intrinsic : ENS in GI wall

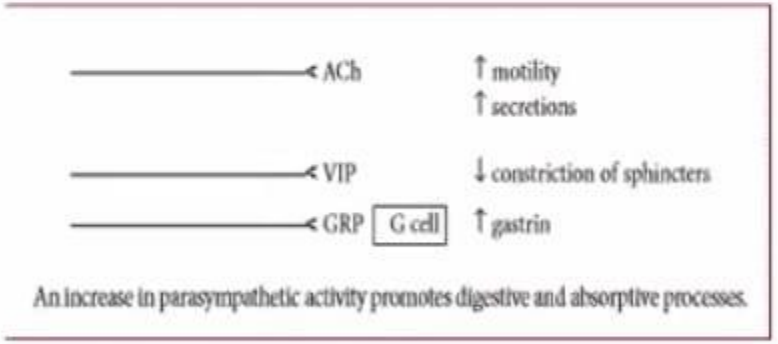
Extrinsic Nervous System

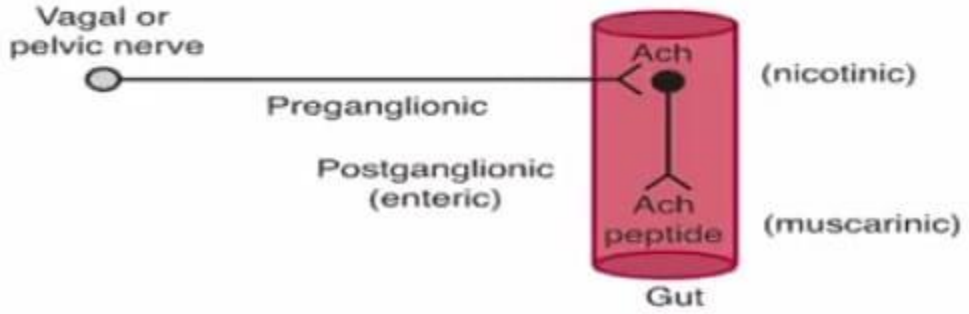
Extrinsic neural innervation to the gut is via the two major subdivisions of the ANS, namely, parasympathetic and sympathetic innervation

Parasympathetic

Neurons of the autonomic parasympathetic division project from the medulla oblongata and sacral regions of the spinal cord





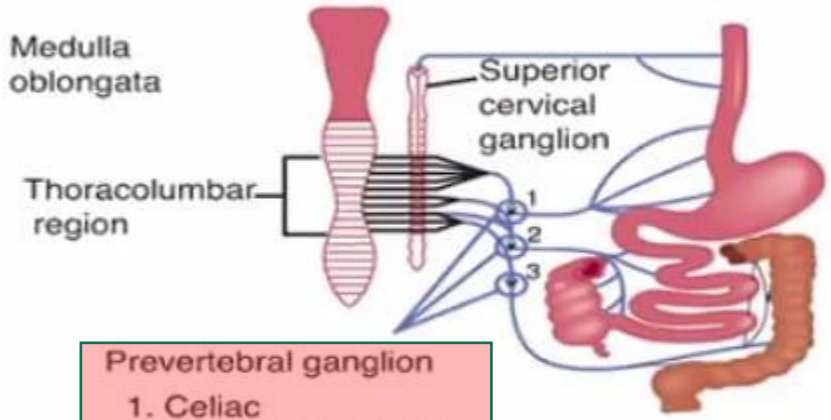


- Vagal nerve >>primary part
- Pelvic nerve >>dorsal part
- The synapse in para between pre and post(Enteric NS) in target tissue , in this synapse Ach is produced so the receptors in the synaptic region is nicotinic (stimulation)
- Peptide neurotransmitter produced by post >> neurocrine (VIP{ vasointestinal peptide} , GRP{gastrin releasing peptide} , neuropeptide Y)>>mostly enhance the function of GIS (stimulation)

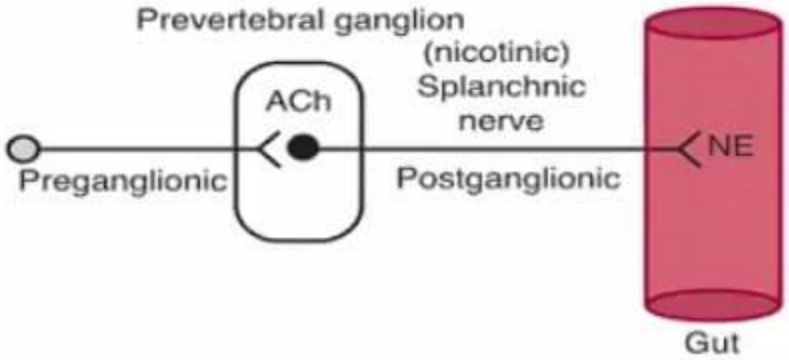
Extrinsic Nervous System

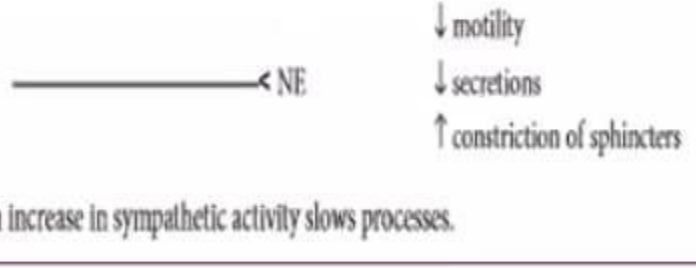
Sympathetic

Neurons of the autonomic sympathetic division project to the gut from thoracic and first lumbar segments of the spinal cord



Prevertebral ganglion
1. Celiac
2. Superior mesenteric
3. Inferior mesenteric





NE(norepinephrine) : inhibitory neurotransmitter

- Sympathetic effect on the GIS

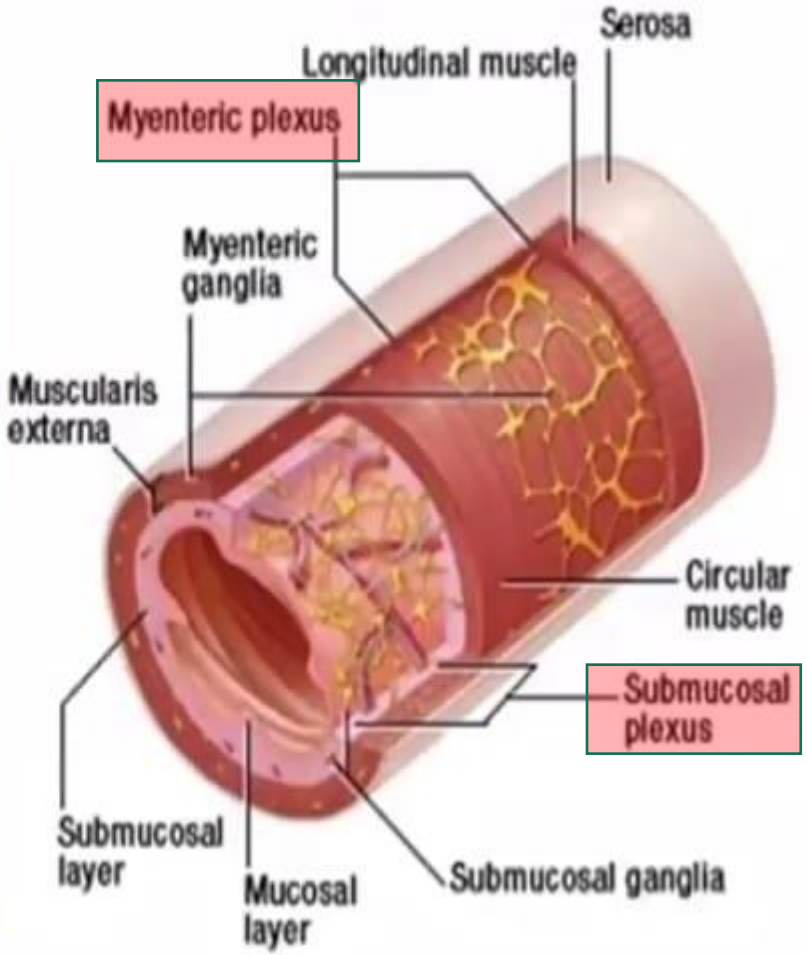
  1- directly : all component of GIT by secretion of NE

  2-frequently , on ENS (inhibitory)

Intrinsic Neural Innervation

Enteric nervous system (little brain in the gut) is made up of two major plexuses:

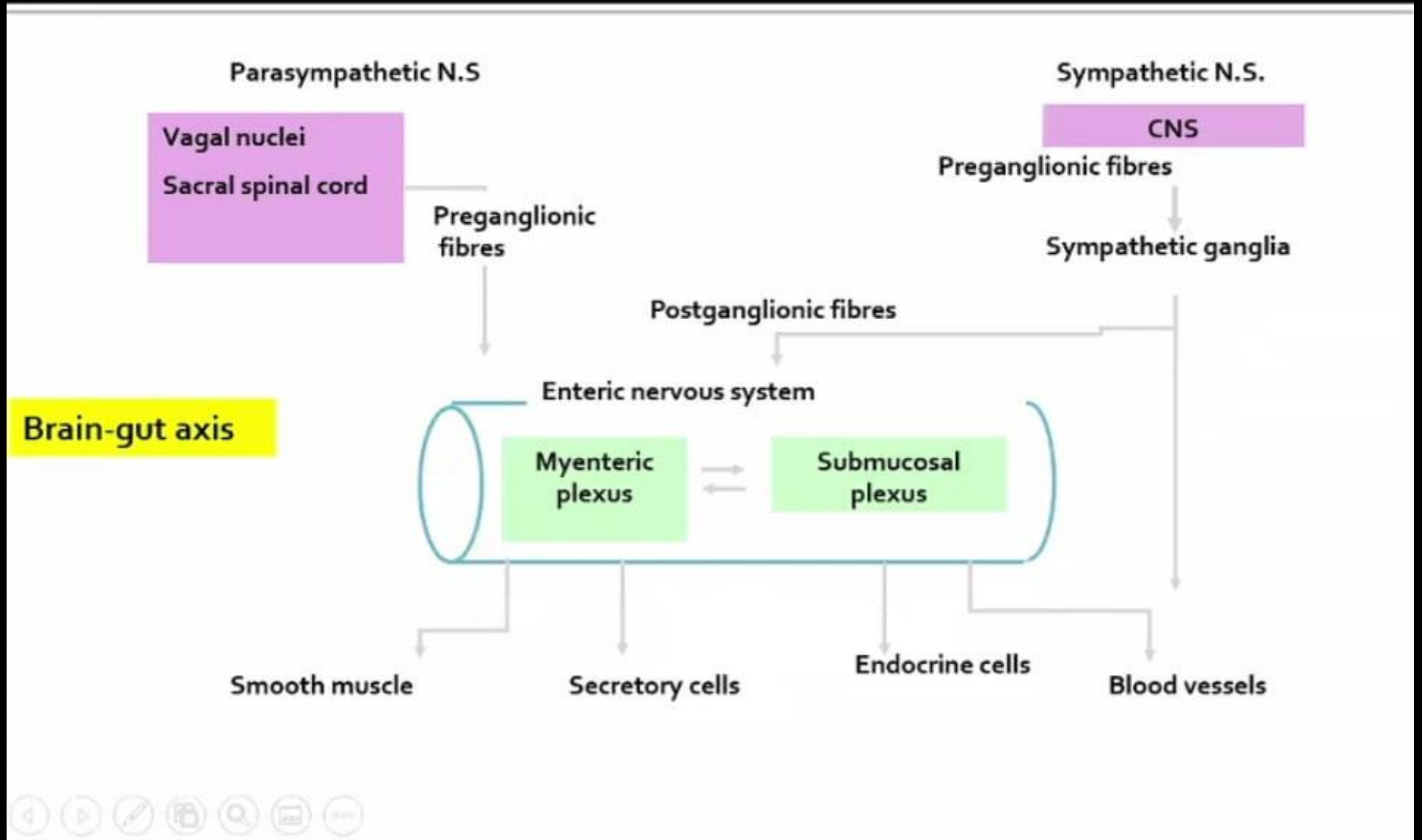
- Submucosal plexus is located within the GI submucosa and mostly regulates GI Secretion.
- Myenteric plexus is located between the circular and longitudinal muscle layers of the GI muscularis propria and mostly regulates GI motility.



- There are many neurons in ENS as in the spinal cord
- Plexus : collection of neurons with axons
- ENS : complete set of nerve (sensory , inter , efferent) neuron that make reflex pathway so , can act autonomically from extrinsic innervation (independence of extrinsic innervation) , but there connection and interaction between ENS and extrinsic
- Excitation for my myenteric plexus mostly will increase the rate of gut contraction (increase the intensity and the tone of gut wall) , because it mostly regulates GI motility
- Myenteric plexus maybe inhibit the GIT by secretion of VIP that is very important in emptying by inhibited the intestinal muscles sphincter

- Other inhibitory transmitter that inhibit the muscles, produced by Myenteric plexus and is most important (from quantitative point view) >>>???

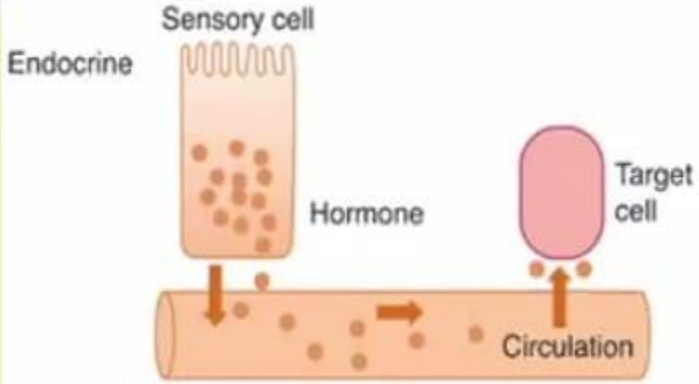
Enteric Nervous System



- There is connection between myenteric and submucosal
- And there is connection between ENS and extrinsic (brain –gut axis) , (CNS effect on GIS vice versa), these connection allow to CNS to exert control over gi function and on another hand these connection allow the ENS to make modulation for central behaviour and allows to inform CNS about the status in GIS organs
- If there is any defect in this connection can affect on the body like obesity

Endocrine regulation of GI function

- The hormone-secreting cells are called entero-endocrine cells (EECs).
  - Open
  - Closed (enterochromaffin-like (ECL))
- Based on structural and to a lesser extent functional similarity, there are two families of GI hormones:



Brain-gut peptides

Peptide hormone

Gastrin-CCK family

- Gastrin
- Cholecystokinin (CCK)

Secretin family

- Secretin
- Glucagon
- Glucose-dependent insulinotropic peptide (GIP)
- VIP

Many other peptide hormones have recently been identified, which are released by GI endocrine cells and influence gut functions:
Ghrelin, leptin, AngII, GLP1(incretin)

- Endocrine regulation : process whereby the sensory cells in GIT response to the stimulus by secreting hormones
- Sensory cells(EECs) : scattered throughout the mucosa of stomach and small intestine and it is not concentrated is specialized gland (sense any changes in lumenal contents in GIS)

1-Open>>direct contact with lumen

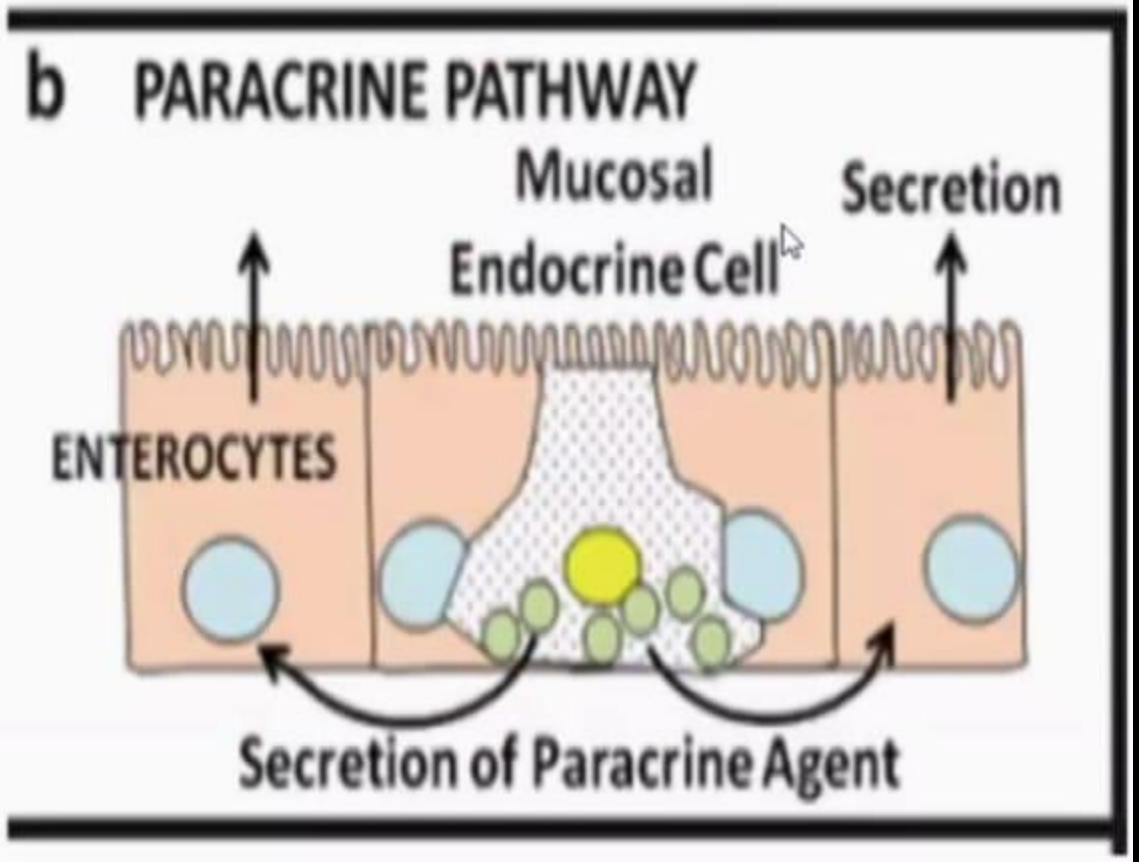
2-closed>> no connection between lumen and apical membrane

Type of hormones (amino acids , peptides ….)

- All endocrine hormones are peptide hormones in GIS
- GIP >>>stimulate insulin secretion
- Ghrelin secreted by stomach wall to stimulate appetite
- Leptin secreted by GIT or fat cells inhibit the appetite
- Ang11>>increase the blood pressure by (vasoconstriction) and regulate the function of GIT (absorption of glucose)by inhibit the Na dependent glucose cotransporter 1(SGLT1) that absorb glucose from intestine to blood
- Most of peptides hormones of GIS secreted from GIS itself , but there is one hormone secreted from outside of GIS and regulate GIS functions>>???

Paracrine regulation of GI function

- Specialized entero-endocrine cells, called enterochromaffin-like (ECL) cells in the stomach secrete histamine that regulates gastric acid secretion.
- Some other paracrine actors – NO, PGs, adenosine.



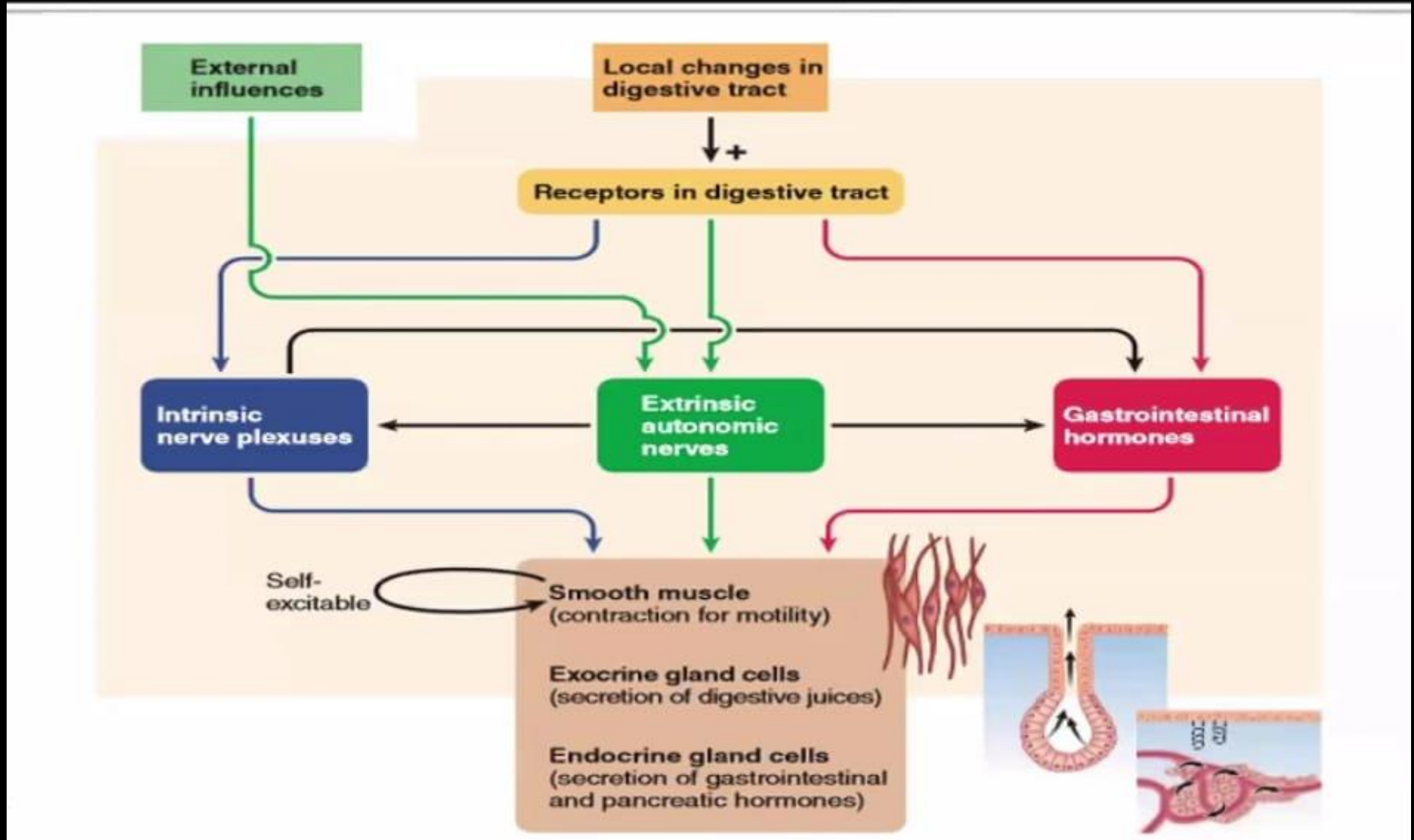
ECL cells is type of EECs but with local effect

The Endocrine Control of the GI System

More fat digestion and absorption

Hormone	Stimuli for Secretion	Site of Secretion	Actions
Gastrin Endocrine	Protein Distention Nerve *(Acid inhibits release)*	G cells of the antrum, duodenum, and jejunum	Stimulates Gastric acid secretion Mucosal growth
Cholecystokinin Paracrine, endocrine	Protein Fat the most effective Acid	I cells of the duodenum, jejunum, and ileum	Stimulates Pancreatic enzyme secretion Pancreatic bicarbonate secretion Gallbladder contraction Growth of exocrine pancreas Inhibits Gastric emptying
Secretin Paracrine, endocrine	Acid the most effective Fat	S cells of the duodenum, jejunum, and ileum	Stimulates Pepsin secretion Pancreatic bicarbonate secretion Biliary bicarbonate secretion Growth of exocrine pancreas Inhibits Gastric acid secretion
Insulinotropic peptide (GIP)			
Gastric inhibitory peptide	Protein Fat Carbohydrate	K cells of the duodenum and jejunum	Stimulates Insulin release Inhibits Gastric acid secretion
Motilin	Fat Acid Nerve	M cells of the duodenum and jejunum	Stimulates Gastric motility Intestinal motility

Summary of mechanisms controlling digestive system activities




Remember
WHY
YOU
STARTED