FUNGSI SEKRESI, ABSORBSI, EKSKRESI SISTEM PENCERNAAN

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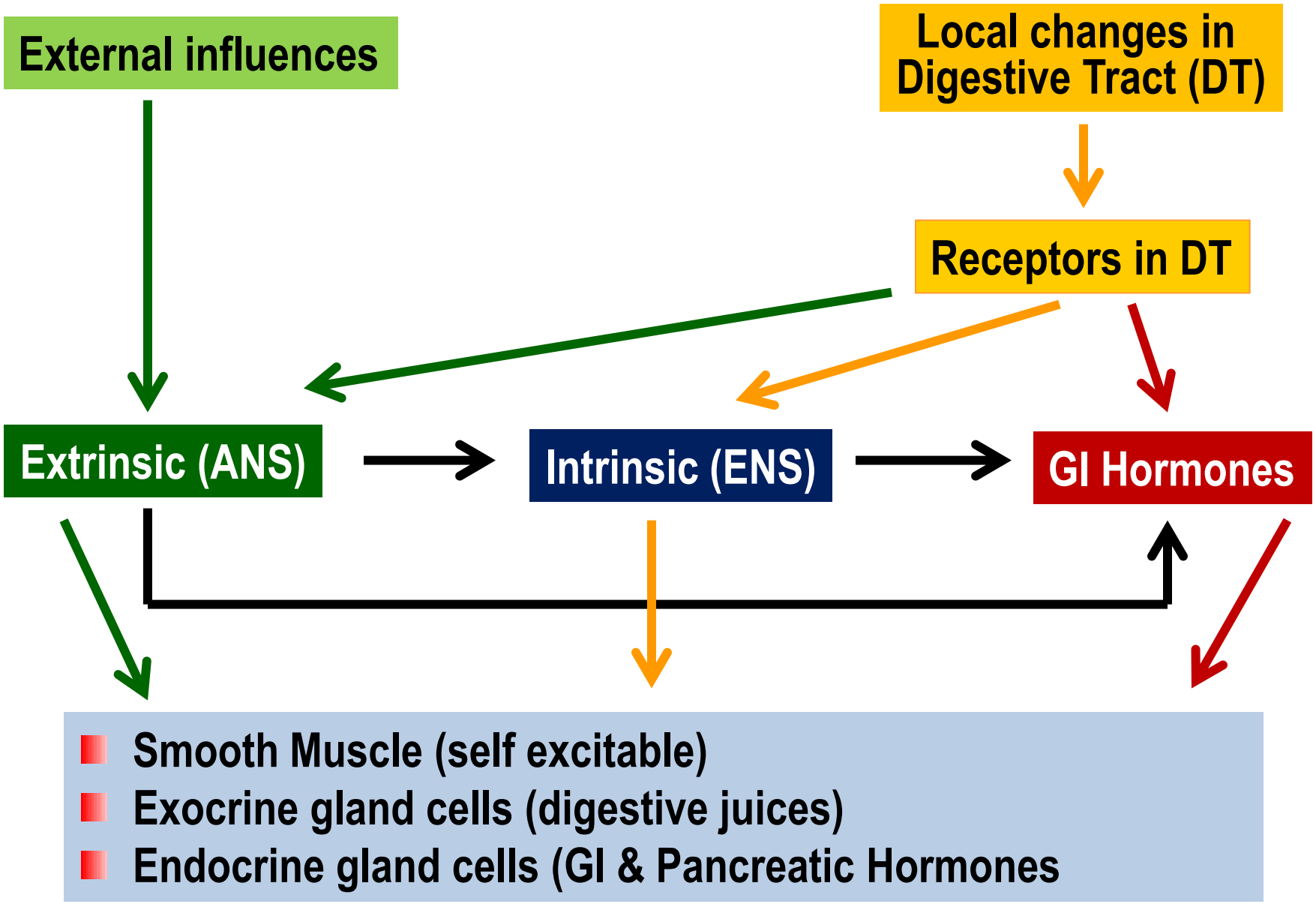
Introduction

- **The primary function of the digestive system is to transfer nutrients, water and electrolytes from the food we eat into the body's internal environment.**
- **Ingested food is essential as:**
  - **an energy source from which the cells can generate ATP to carry out their particular energy-dependent activities**
  - **a source of building supplies for the renewal and addition of body tissues**

……Introduction

- **The digestive system performs 4 basic digestive processes:**
  1. **Motility along gastrointestinal tract**
  2. ***Secretion of digestive juices***
  3. **Digestion of food**
  4. ***Absorption the small absorbable units***
- ***Excretion of the waste materials***
- ***Regulation of digestive function through neural reflexes and hormonal pathways***
- **Protection against any damages**

Pathways Controlling Digestive System



FUNGSI SEKRESI SALURAN PENCERNAAN

Daily Secretion of Digestive Juices

	Daily Volume (ml)	pH
Saliva	1000	6.0 – 7.0
Gastric secretion	1500	1.0 – 3.5
Pancreatic secretion	1000	8.0 – 8.3
Bile	1000	7.8
Small intestine secretion	1800	7.5 – 8.0
Brunner's gland secretion	200	8.0 – 8.9
Large intestine secretion	200	7.5 – 8.0
Total	6700	

General Principles of Digestive Secretion

- **Type of digestive glands:**
  - **Type of secretions:**
    - ◊ digestive enzymes
    - ◊ digestive fluids
    - ◊ mucus
  - **Anatomical type of glands:**
    - ◊ single cell mucous gland/ mucous cells (goblet cells)
    - ◊ crypts of Lieberkuhn: small intestine
    - ◊ tubular glands: in stomach, upper duodenum
    - ◊ complex glands: salivary, pancreas, liver

Basic Mechanism of Stimulation

- **Epithelial stimulation:**
  - tactile stimulation
  - chemical irritation
  - distention of gut wall
- **Nervous stimulation**
  - Enteric nervous system - ENS (intrinsic)
  - Autonomic nervous system – ANS (extrinsic):
    - parasympathetic stimulation
    - sympathetic stimulation
- **Hormonal stimulation: gastrointestinal hormones - GIH**

Secretion in The Mouth

- **Saliva:**
  - > **Saliva glands:**
    - **parotid gland: serous – ptyalin (α-amylase)**
    - **submandibullar/ submaxillar gland: mix**
    - **sublingual: mix**
    - **buccal: mucus**
  - > **Function:**
    - **digestive process**
    - **oral hygiene:**
      - ◊ **stream: flush away fine particles**
        - ◊ **thiocyanate ion, lysozime, antibody, bicarbonate buffers**
- **Lingual lipase**

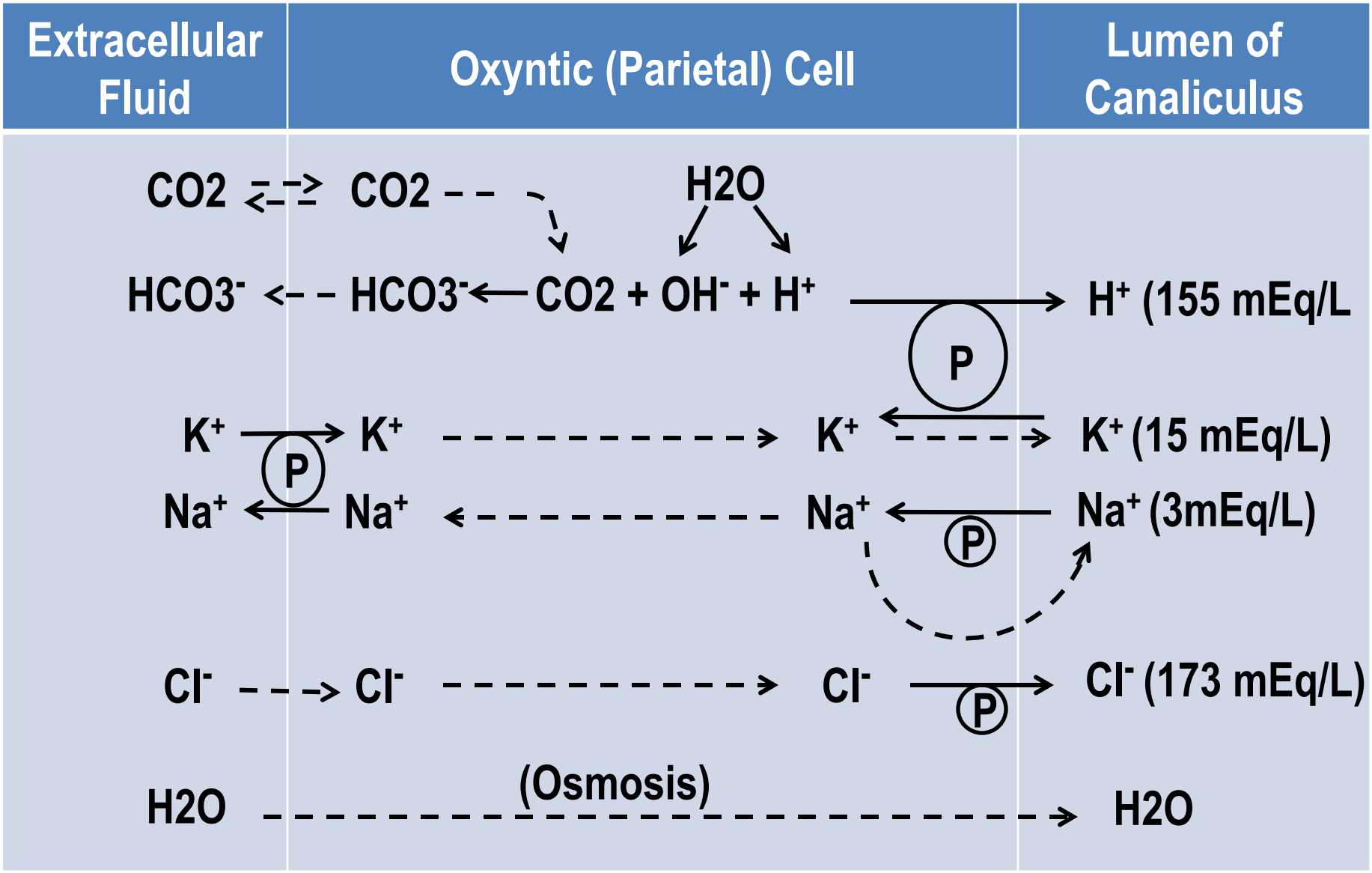
Esophageal Secretion

- **Mucoid (entirely):**
  - ◊ **Function:**
    - **lubrication**
    - **protection**
  - ◊ **Glands:**
    - **simple mucous glands: lubrication**
    - **compound mucous glands: protection**
      - **in the initial portion of esophagus**
      - **near the esophago-gastric junction**

Gastric Secretion

- **Oxyntic glands (gastric glands):**
  at corpus and fundus
  - mucous neck cells: mucus & pepsinogen
  - peptic cells (chief cells): pepsinogen
  - oxyntic cells (parietal cells): HCl & intrinsic factor
- **Pyloric glands:** at antrum
  - mucus, hormone gastrin, pepsinogen
- **Mucus-secreting cells:**
  spread over the surface of the gastric mucosa
  - mucus
- **Enzymes:** lipase, amylase, gelatinase

Postulated Mechanism for Secretion of HCl



Regulation of Gastric Secretion

- **Acetylcholine:**

  excites secretion by all the secretory types in the gastric glands

- **Gastrin and histamine :**

  stimulate strongly the secretion of HCL

- **A few other substances such as circulating amino acids, caffeine, and alcohol**

  also stimulate the gastric secretory cells but the stimulatory effects of these are slightly in comparison with acetylcholine, gastrin, and histamine

Phases of Gastric Secretion

1. Cephalic phase : via vagus
2. Gastric phase :
   - vagal reflexes
   - local enteric reflexes
   - gastrin stimulation
3. Intestinal phase :
   - gastrin that also secreted by duodenal mucosa
   - nervous and hormonal mechanisms: inhibition

Pancreatic Secretions

- **Digestive enzymes:**
  - carbohydrate: ◊ pancreatic amylase
  - fat: ◊ pancreatic lipase
    ◊ cholesterol esterase
    ◊ phospholipase
  - protein :
    ◊ trypsinogen
    ◊ chymotrypsinogen
    ◊ pro-carboxylpolypeptidase
    ◊ elastases & nucleases

} **Activated by Interkinase secreted by duodenal mucosa**

- **Trypsin inhibitor**
- **Bicarbonate ions**

Entering duodenum via sphincter Oddi

Regulation of Pancreatic Secretion

- Acetylcholine
- Gastrin
- Cholecystokinin

} pancreatic digestive enzymes

- Secretin ——→ Na Bicarbonate solution

◊ Gastric acid : Na B solution > enzymes

◊ Fat (soap) : Na B solution = enzymes

◊ Peptones : Na B solution < enzymes

Phases of pancreatic secretion:

- Cephalic phase
- Gastric phase
- Intestinal phase

Secretion of Bile

- **Function:**
  - in fat digestion: emulsifying/ detergent function
  - in fat absorption: micelles
  - excretion of bilirubin and excesses cholesterol
- **Formation: in liver**
  - secreted by hepatocytes
  - along the bile ducts: secretion of Na^+ & HCO_3^-
- **Storage: in gallbladder**
  - re-absorption of water & electrolytes except Ca^{2+}& K^+
- **Entero-hepatic circulation**

Composition of Bile

	Liver Bile	Gallbladder Bile
Water	97.5 gm/dl	92 gm/dl
Bile salts	1.1 gm/dl	6 gm/dl
Bilirubin	0.04 gm/dl	0.3 gm/dl
Cholesterol	0.1 gm/dl	0.3 – 0.9 gm/dl
Fatty acids	0.12 gm/dl	0.3 – 1.2 gm/dl
Lecithin	0.04 gm/dl	0.3 gm/dl
Na^+	145 mEq/L	130 mEq/L
K^+	5 mEq/L	12 mEq/L
Ca^{++}	5 mEq/L	23 mEq/L
Cl^-	100 mEq/L	25 mEq/L
HCO_3^-	28 mEq/L	10 mEq/L

Secretions of Small Intestine

- **Mucus:**
  - by Brunner glands especially at proximal
- **Digestive juices:**
  - extracellular fluids
  - secreted by crypts of Lieberkuhn
  - function: watery vehicles for absorption of substances from the chymes
- **Intestinal enzymes**
  - at brush border
  - peptidases
  - sucrase, maltase, iso-maltase, lactase
  - intestinal lipase

Regulation of Small Intestinal Secretion

- **Local enteric reflex mechanisms**
  - **in response to the presence of chyme in the intestine**
  - **dominant role**
- **Hormonal regulation**

  Some of same hormones that promote secretion in GIT especially secretin and cholecystokinin

Secretions of Large Intestine

- **Mucus:**
  - **function:** ◊ protection (together with $NaHCO_3$)
    ◊ lubrication
    ◊ adherent medium for holding fecal material together
  - **control:** ◊ local
    ◊ parasympathetic
    emotional disturbance: mucus stool
- **Water and electrolyte:**
  - in response to irritation $\rightarrow\rightarrow\rightarrow$ diarrhea
  - none at normal condition

FUNGSI ABSORPSI SALURAN PENCERNAAN

Basic Principles of Gastrointestinal Absorption

- **Basic mechanism: Transport across membrane**

  - **active transport:**
    - **primary**
    - **secondary:**
      - **co - transport**
      - **counter - transport**

  - **passive transport (diffusion):**
    - **simple diffusion**
    - **facilitated diffusion**

  - **osmosis**

…Basic Principles of Gastrointestinal Absorption

- **Cell membrane consists of:**
  - **lipid bilayer**
  - **integral protein molecules:**
    - ◊ **channel**
    - ◊ **carrier**

Absorption in The Stomach

- **“Tight junction”**
- **Only a few:**
  - **fat-soluble material: alcohol**
  - **drug: aspirin**

Absorption in The Small Intestines

Almost all of nutrient, water, and electrolytes

- **Nutrients:**
  - ◊ carbohydrate:
  - ◊ protein:

  } -Active transport (Na co-transport) -Facilitated diffusion

  - ◊ fat: - micelles
    - diffusion
    - chylomicrons
- **Ions:**
  - ◊ positive ions: - active transport
  - ◊ negative ions: - passive transport
- **Water:**
  - osmosis
  - through intercellular spaces

.....Small Intestines

Absorption facilities

- **Absorptive surface:**
  - Valvula of coniventes (Kerckring) : 3 x lipat
  - Villi : 10 x lipat
  - Microvilli (Brush border) : 20 x lipat
- **Transportation in villi:**
  - Vascular system → portal circulation
  - Central lacteal→ lymph → large vein in neck
  - Pinositic vesicles

Large Intestines

- **Absorbing colon**
  - ◊ absorption almost all of water & electrolytes
  - ◊ absorption capacity of colon: 5 – 7 L/day
  - ◊ bacterial action:
    - digesting small amounts of cellulose
    - vit. K, B_{12}, thiamin, riboflavin
    - gases: CO_2, hydrogen, methan
- **Storage colon**

.....Large Intestines

- **Composition of normal feces:**
  - ◊ **three-fourths water and one-forth solid material**
  - ◊ **color: stercobilin dan urobilin**
  - ◊ **odor: by products of bacterial action**
    - **indol, skatol, mercaptan, H_2S**
    - **depending on colonic bacterial flora, and on the type of food eaten**

FUNGSI EKSKRESI SALURAN PENCERNAAN DEFEKASI

General Principles of Gastrointestinal Motility

- **Characteristic of intestinal wall:**
  - **mucosa, muscularis, serosa, peritonium**
  - **smooth muscles:**
    - **> tunica muscularis, 2 muscle layers:**
      - **exterior: longitudinal**
      - **interior: circular**
    - **> muscularis mucosae in the deeper layer of the mucosa**
  - **smooth muscles function as syncytium**

...General Principles of Gastrointestinal Motility

- **Electrical activities in gastrointestinal smooth muscles:**
  - **Slow waves: basic electrical rhythm (BER)**
    - resting membrane potential (-50–-60 mV)
    - because of activities of Na-K pump
  - **Spike potentials:**
    - action potential → muscle contraction
    - on the top of slow waves (> - 40 mVolt)
    - Ca-Na channels

...General Principles of Gastrointestinal Motility

- **Functional types of movements in the GIT:**
  - **Propulsive movements: peristalsis**
    - function of the myenteric plexus
    - peristaltic reflex/ myenteric reflex
    - law of gut: receptive relaxation
  - **Mixing movements:**
    - quite different in difference parts of GIT
    - local constrictive contractions every few centimeters in the gut wall
    - also by peristaltic & sphincter activities (pyloric pump)

...General Principles of Gastrointestinal Motility

- **Basic mechanisms of stimulation**
  - **distention (stretch) of the gut wall**
  - **neural control**
    - ◊ **enteric nervous system**
      - **myenteric plexus (Auerbach)**
      - **submucosal plexus (Meissner)**
    - ◊ **autonomic nervous system**
      - **parasympathetic innervation**
      - **sympathetic innervation**
  - **hormonal control**

Gastrointestinal Reflexes

- Reflexes that occur entirely within the enteric nervous system
- Reflexes from the gut to the prevertebral sympathetic ganglia and then back to the GIT
- Reflexes from the gut to the spinal cord/ brain stem and then back to the GIT:

  - Reflexes from stomach and duodenum to the brain stem and back to the GIT: gastrocolic, duodenocolic, gastroileal, enterogastric
  - pain reflexes that cause general inhibition of GIT
  - defecation reflexes that travel to the spinal cord and back again to produce the powerful colonic, rectal, and abdominal contractions required for defecation (extrinsic)

Defecation

- **Ordinarily, defecation is initiated by defecation reflexes**
- **Defecation reflexes:**
  - **intrinsic reflex: relatively weak**

    mediated by the local enteric nervous system
  - **extrinsic reflex: parasympathetic defecation reflex**

    mediated by parasympathetic nervous system (sacral division)
  - **initiated by distention of the rectal wall**

…Defecation

- When feces enter the rectum → distention of the rectal wall → initiated peristaltic waves
- As the peristaltic waves approach the anus:
  - internal anal sphincter is relaxed (receptive relaxation by myenteric plexus
  - if the external anal sphincter is consciously, voluntarily relaxed at the same time, defecation will occur
- To be effective in causing defecation, usually must be fortified by parasympathetic defecation reflex

THANK YOU