PHYSIOLOGY OF DIGESTION

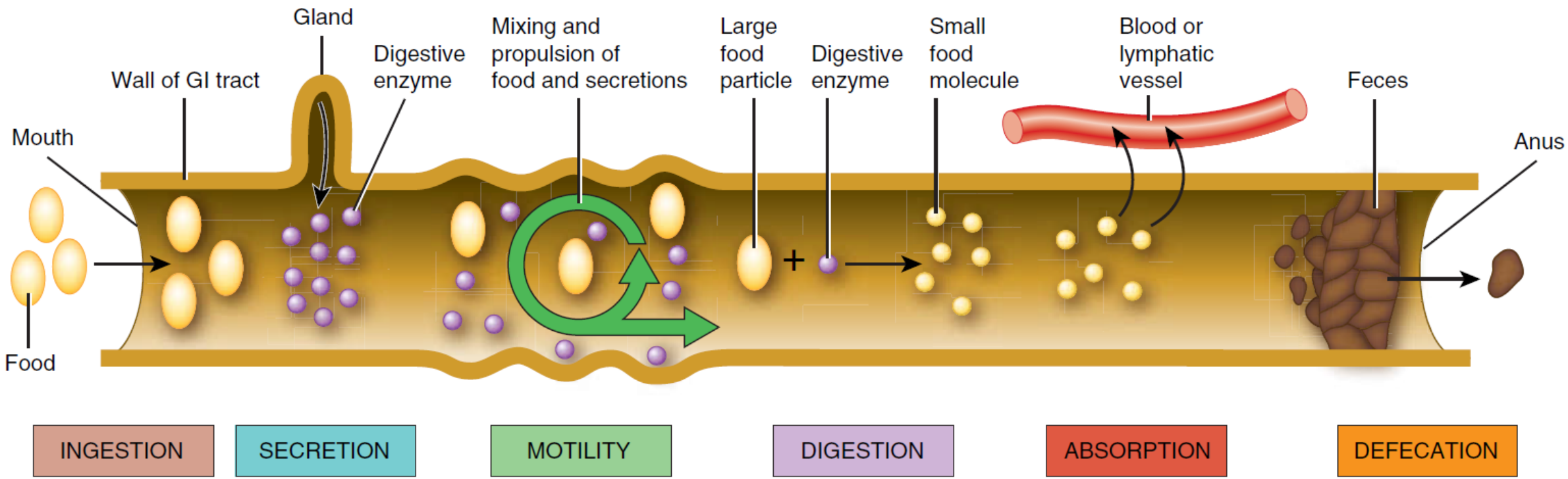
HORMONAL CONTROL OF DIGESTIVE CONTROL

SEMESTER – IV
ZOO CC409
UNIT-1

RAJEEV RANJAN
ASSISTANT PROFESSOR
DEPARTMENT OF ZOOLOGY
PATNA WOMEN'S COLLEGE

INTRODUCTION

- The gastrointestinal tract is basically a muscular tube that contains and processes food as it moves from the **mouth** to the **anus**.
- The food material is complex and composed of carbohydrate, proteins, fats and other substances. These complex materials are hydrolysed into simpler materials, with the help of enzymes for absorption by the intestinal wall. Overall, the digestive system performs **six** basic processes:
- **Ingestion:** This process involves taking foods and liquids into the mouth (eating).
- **Secretion:** Each day, cells within the walls of the GI tract and accessory digestive organs secrete a total of about 7 liters of water, acid, buffers, and enzymes into the lumen (interior space) of the tract.
- **Motility:** Alternating contractions and relaxations of smooth muscle in the walls of the GI tract mix food and secretions and move them toward the anus. This capability of the GI tract to mix and move material along its length is called **motility.**
- **Digestion: Digestion** is the process of breaking down ingested food into small molecules that can be used by body cells.
- **Absorption:** The movement of the products of digestion from the lumen of the GI tract into blood or lymph is called **absorption.**
- **Defecation:** Wastes, indigestible substances, bacteria, cells sloughed from the lining of the GI tract, and digested materials that were not absorbed in their journey through the digestive tract leave the body through the anus in a process called **defecation.**



The digestive system performs six basic processes: ingestion, secretion, motility, digestion, absorption, and defecation.

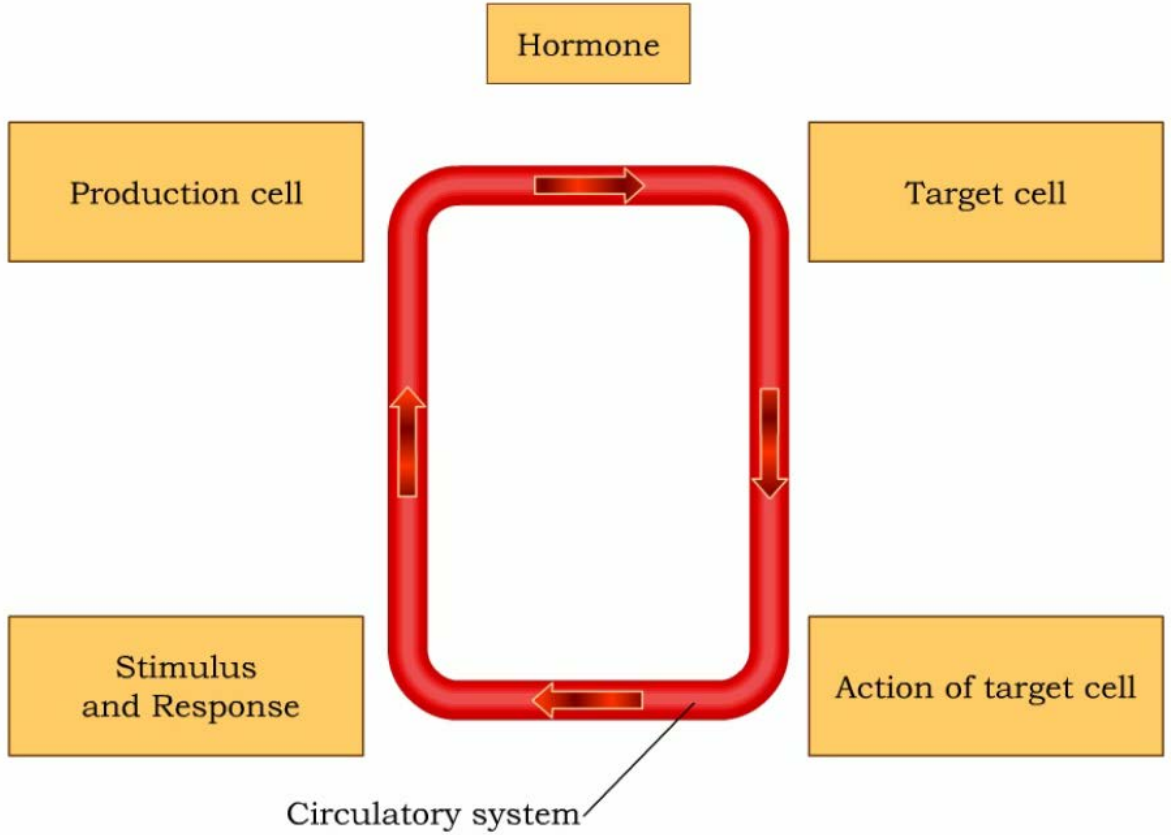
Physiology of Digestion

- **Digestion** is the process of breaking down ingested food into small molecules that can be used by body cells. Digestion of food occurs in three phases and all these phases takes place in coordination with each other. Three components of physiology of digestion are:
  - Mechanical digestion
  - Chemical digestion
  - Hormonal control of digestive activities

- In **mechanical digestion** the teeth cut and grind food before it is swallowed, and then smooth muscles of the stomach and small intestine churn the food to further assist the process. As a result, food molecules become dissolved and thoroughly mixed with digestive enzymes.
- In **chemical digestion** the large carbohydrate, lipid, protein, and nucleic acid molecules in food are split into smaller molecules by hydrolysis. Digestive enzymes produced by the salivary glands, tongue, stomach, pancreas, and small intestine catalyse these catabolic reactions.
- Physiology of digestion is under strict action of **hormones** and different **enzymes**.

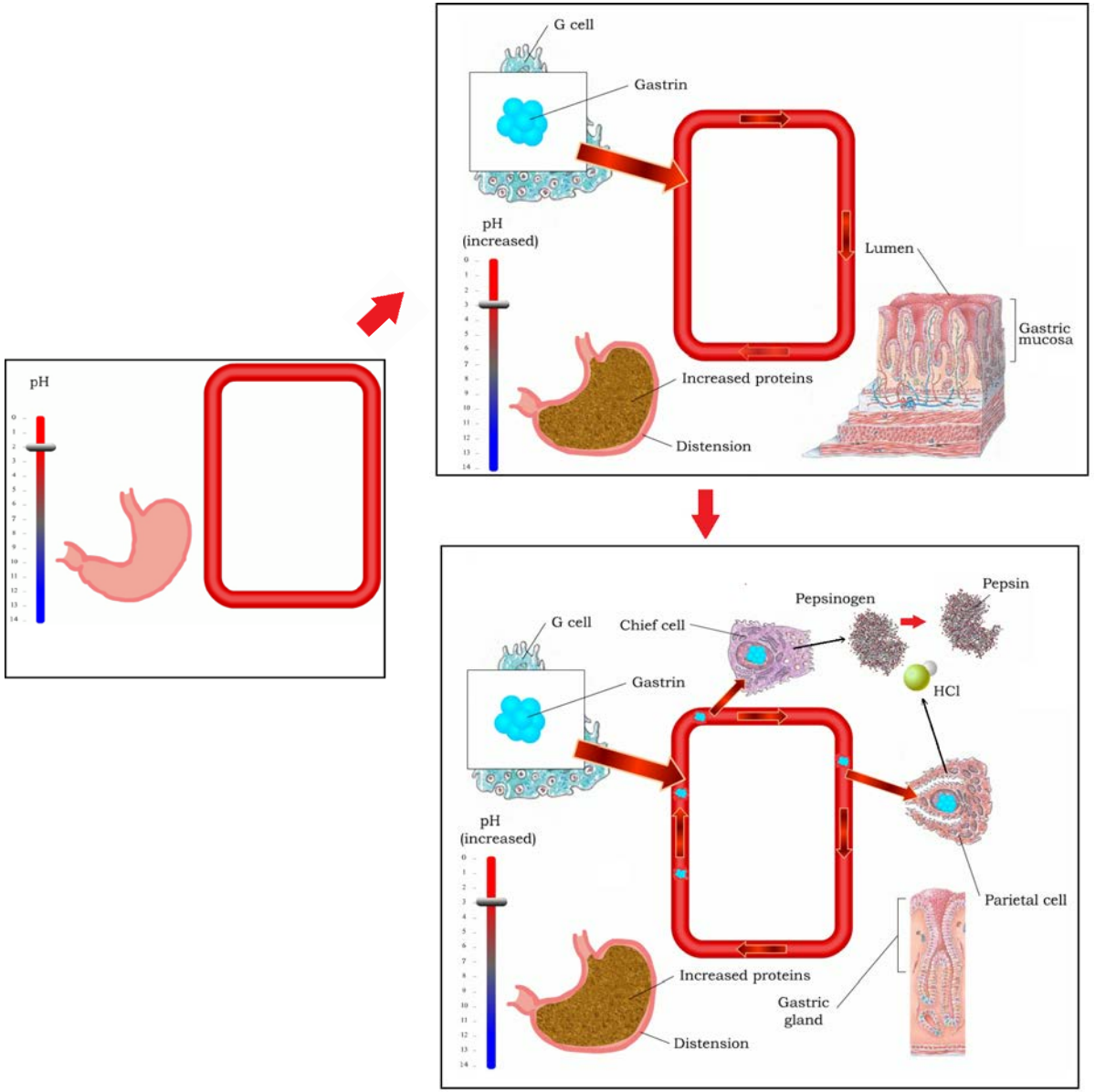
Hormonal Control Of Digestive Activities

- The endocrine system maintains many body conditions within normal limits with feedback loops. Each endocrine feedback loops maintains homeostasis using the following components:
- **Stimulus** - a change in a body condition.
- **Production cell** - an endocrine cell that produces a hormone after being affected by stimulus.
- **Hormone** - the signaling chemical
- **Target cell** -a cell receptive to the hormone.
- **Action** - what the cell does when affected by the hormone.
- **Response** - the overall change in controlled body condition as a result of the feedback loop.



Gastrin - Protein Digestion

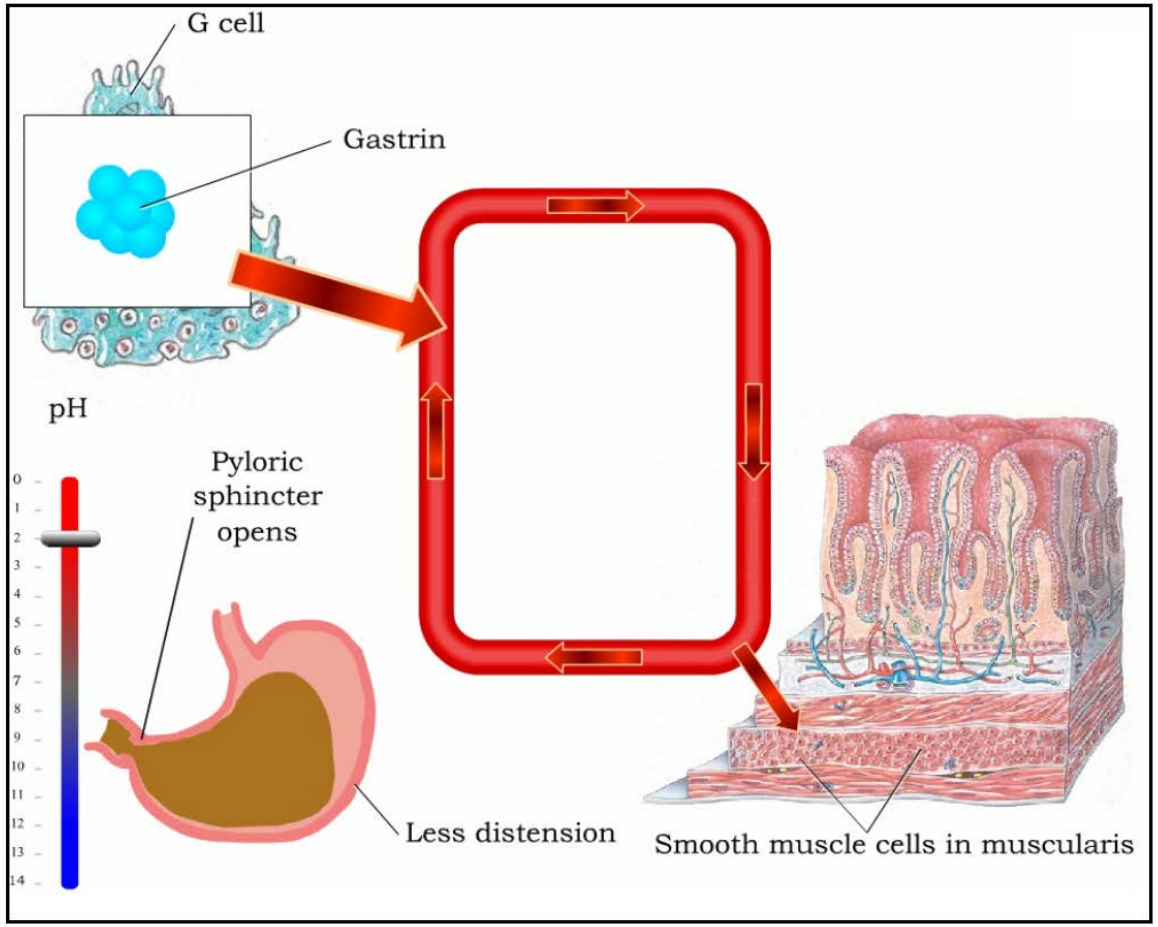
- The gastric phase of digestion begins as the stomach fills with food(especially proteins).
- Receptors sense distension and the increased gastric pH.
- Stimulated receptors prompt **G cells** in mucosa of stomach to secrete gastrin.



- Gastrin binds to parietal and chief cells in gastric mucosa.
- Stimulated parietal cell produce more HCl.
- Chief cell produce more pepsinogen, the precursor to pepsin.
- Increased pepsin and gastric acid increase the stomachs ability to digest proteins.
- Gastrin also binds to the smooth muscle cells in the stomach causing; increased gastric motility, Opening of pyloric sphincter, Increased gastric emptying.

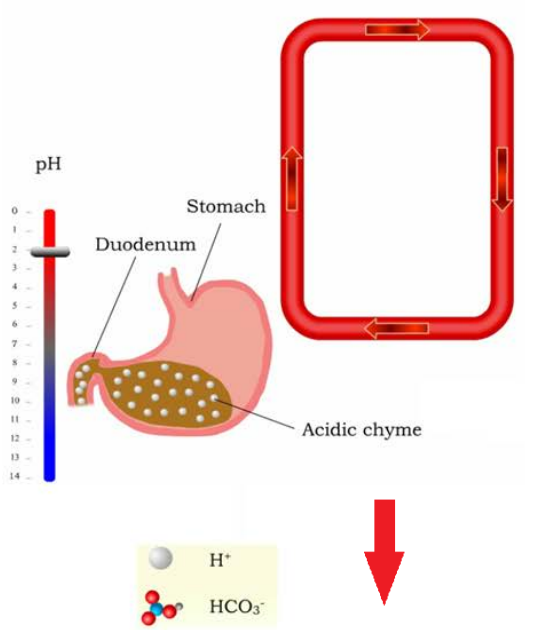
Gastrin (Gastric Emptying)

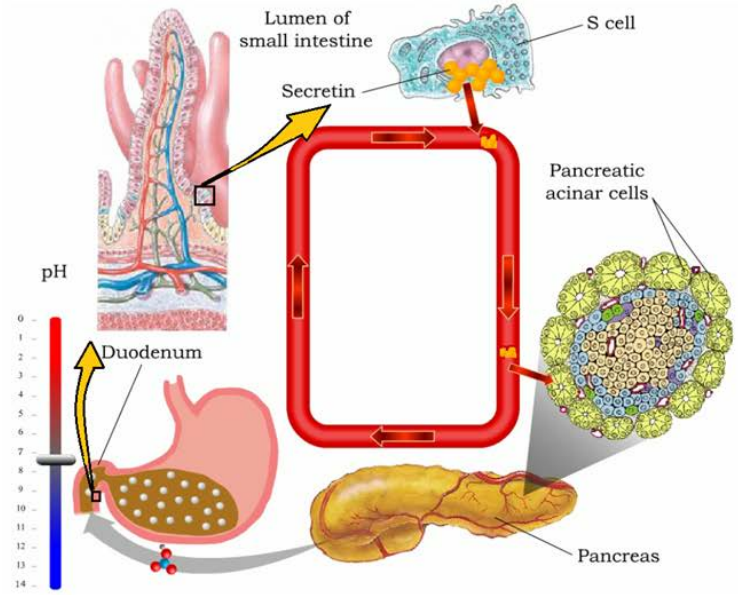
- Gastrin also binds to the smooth muscle cells in the stomach causing:
  - increased gastric motility
  - Opening of pyloric sphincter
  - Increased gastric emptying.



Secretin (buffering gastric acid)

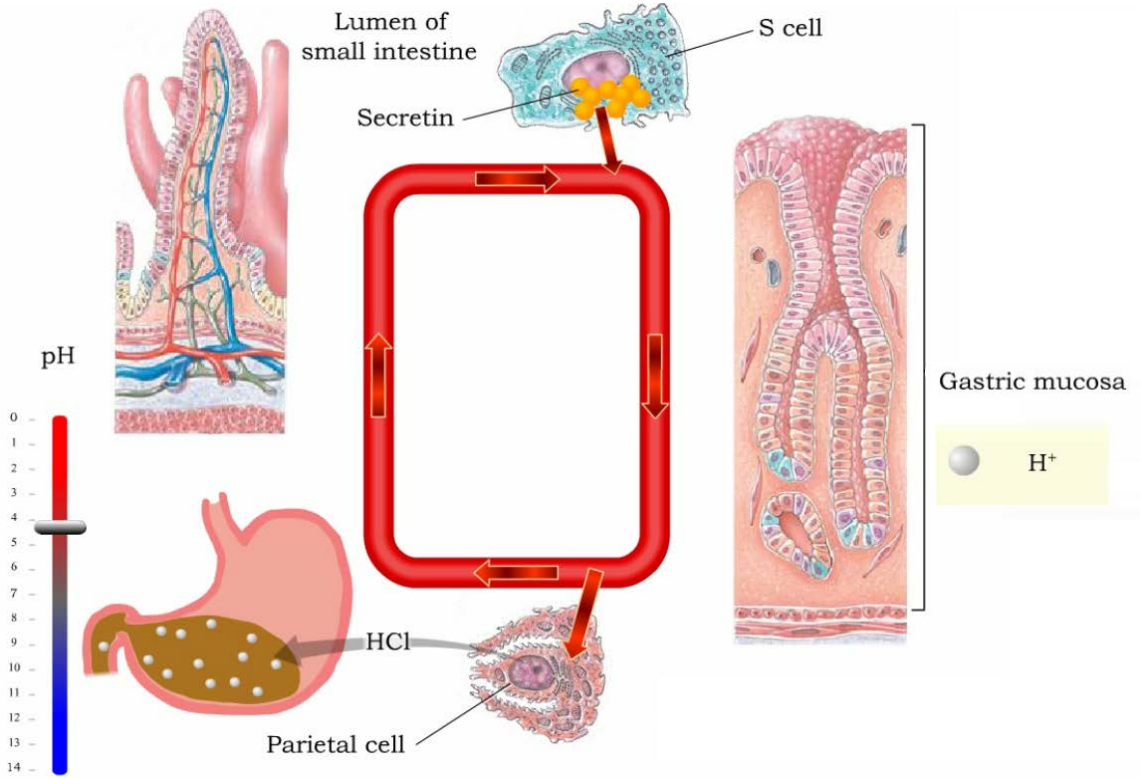
- The intestinal phase of digestion begins as chyme enter the duodenum.
- The chymes acidity can damage intestinal mucosa.
- **S cells** in intestinal mucosa are stimulated to produce secretin.
- Secretin targets pancreatic **acinar cells**.
- Secretin stimulates the pancreas to produce and deliver more bicarbonate to the small intestine.
- Bicarbonate buffers acidity of chyme and protects intestinal tissue.





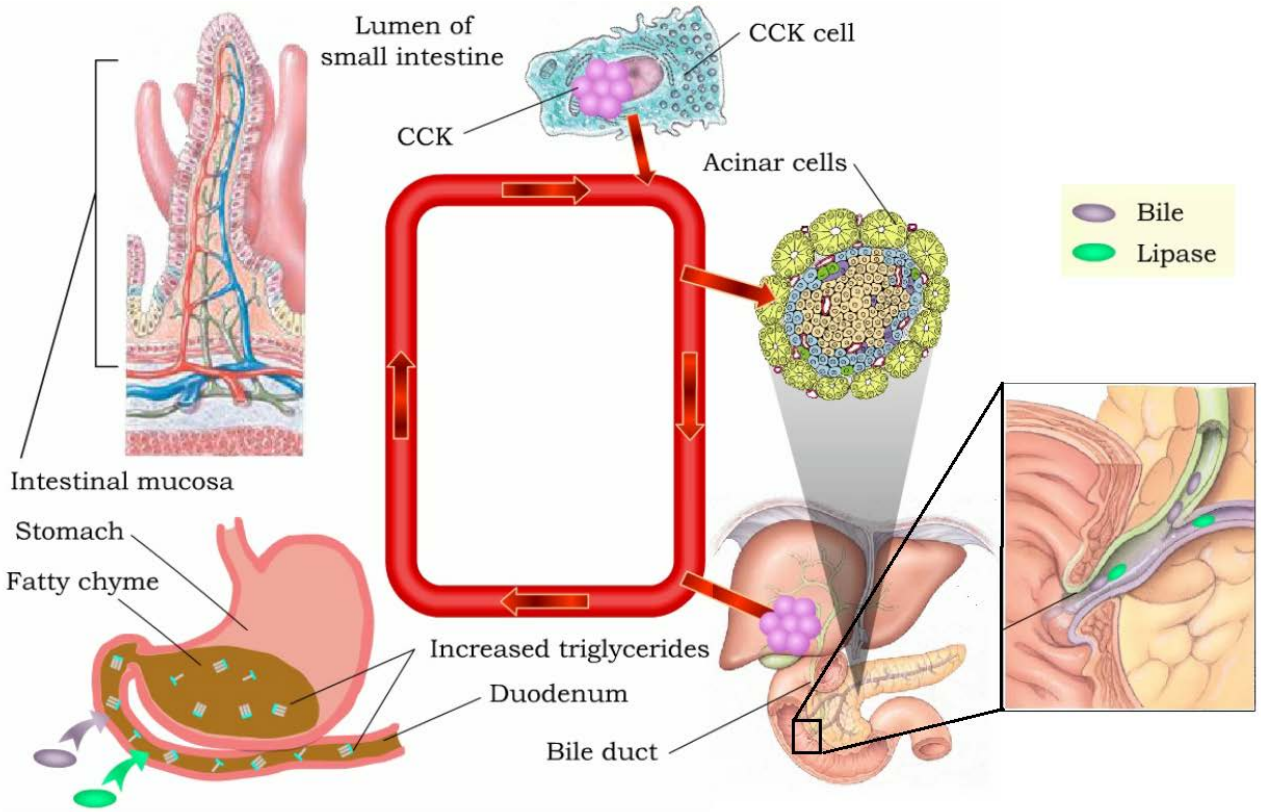
Secretin (Inhibiting gastric acid secretion)

- As chyme approaches the small intestine , secretin also targets acid producing parietal cells in the gastric mucosa.
- Increased secretin inhibits gastric acid secretion.
- With less gastric acid produced, the chyme going into the intestine is less acidic.



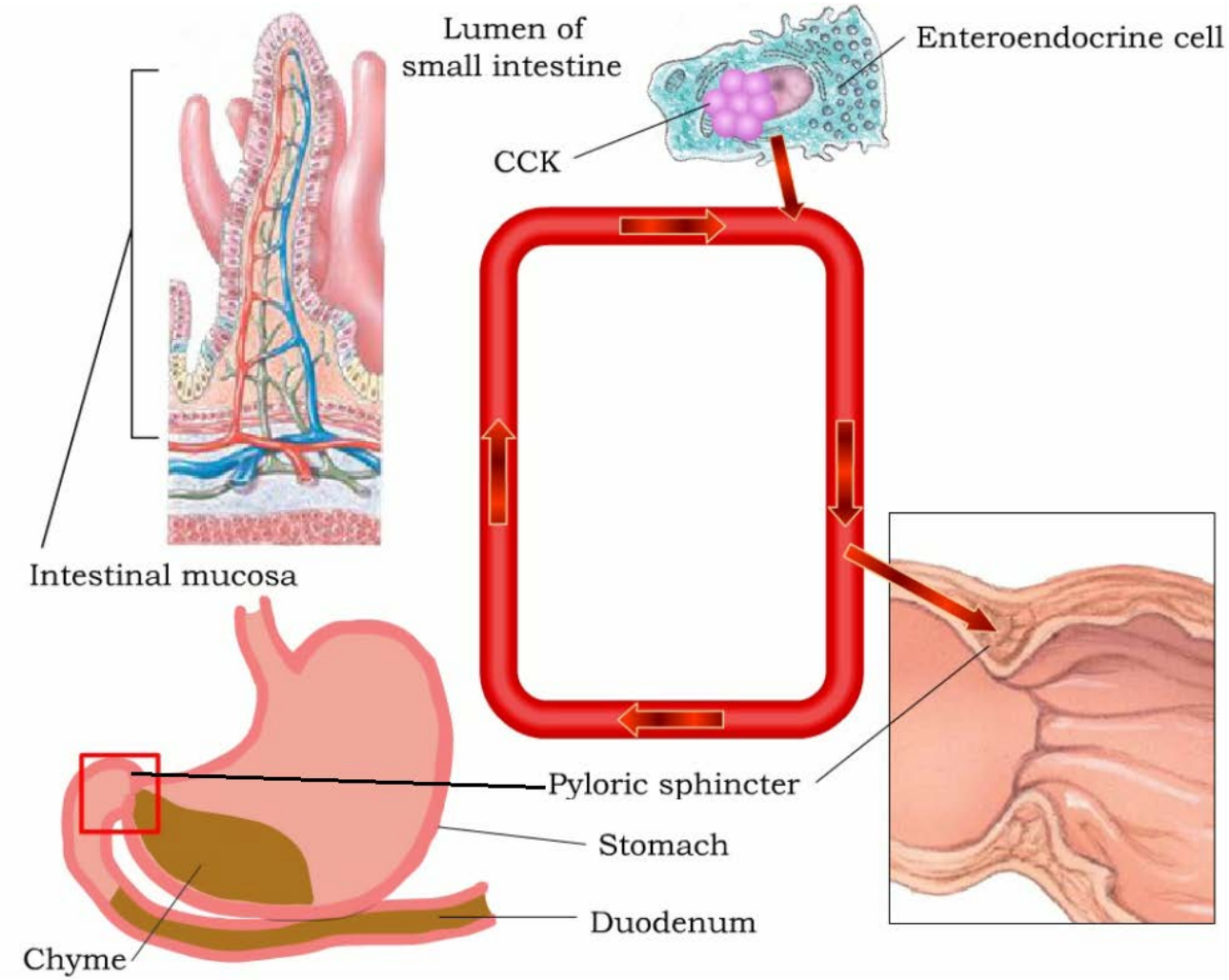
Cholecystokinin (fat digestion)

- The hormone CCK also regulates the intestinal phase of digestion.
- If fatty chyme enters the duodenum, **enteroendocrine** cells of the intestinal mucosa are stimulated to produce **cholecystokinin(CCK).**
- CCK targets pancreatic acinar cells and the billiary system.
- Delivery of pancreatic lipases and bile is increased to the small intestine.
- CCK promotes the digestion of fats in the chyme.



Cholecystokinin (Gastric Emptying)

- CCK also regulates gastric emptying.
- Distended duodenum & fatty acids or undigested proteins in the chyme promotes the secretion of CCK.
- CCK triggers the closing of the pyloric sphincter, thereby inhibiting gastric emptying.
- High protein & high fat meals stimulate the secretion of CCK & consequently take longer to digest & empty.



Some Important Gastrointestinal Hormones, source of secretion and their activities

Gastrointestinal hormones

Hormone	Source of secretion	Actions
Gastrin	G cells in stomach TG cells in GI tract Islets in fetal pancreas Anterior pituitary Brain	Stimulates gastric secretion and motility Promotes growth of gastric mucosa Stimulates release of pancreatic hormones Stimulates secretion of pancreatic juice Stimulates secretion of pancreatic hormones
Secretin	S cells of small intestine	Stimulates secretion of watery and alkaline pancreatic secretion Inhibits gastric secretion and motility Constricts pyloric sphincter Increases potency of cholecystokinin action
Cholecystokinin	I cells of small intestine	Contracts gallbladder Stimulates pancreatic secretion with enzymes Accelerates secretin activity Increases enterokinase secretion Inhibits gastric motility Increases intestinal motility Augments contraction of pyloric sphincter Suppresses hunger Induces drug tolerance to opioids
Gastric inhibitory peptide (GIP)	K cells in duodenum and jejunum Antrum of stomach	Stimulates insulin secretion Inhibits gastric secretion and motility
Vasoactive intestinal polypeptide (VIP)	Stomach Small and large intestines	Dilates splanchnic (peripheral) blood vessels Inhibits Hcl secretion in gastric juice Stimulates secretion of succus entericus Relaxes smooth muscles of intestine Augments acetylcholine action on salivary glands Stimulates insulin secretion
Glucagon	α-cells in pancreas A cells in stomach L cells in intestine	Increases blood sugar level
Glicentin	L cells in duodenum and jejunum	Increases blood sugar level
Glucagon-like polypeptide-1 (GLP-1)	α-cells in pancreas Brain	Stimulates insulin secretion Inhibits gastric motility
GLP-2	L cells in ileum and colon	Suppresses appetite

Hormone	Source of secretion	Actions
Somatostatin	Hypothalamus D cells in pancreas D cells in stomach and small intestine	Inhibits secretion of growth hormone Inhibits gastric secretion and motility Inhibits secretion of pancreatic juice Inhibits secretion of GI hormones
Pancreatic polypeptide	PP cells in pancreas Small intestine	Increases secretion of glucagons Decreases pancreatic secretion
Peptide YY	L cells of ileum and colon	Inhibits gastric secretion and motility Reduces secretion of pancreatic juice Inhibits intestinal motility and bowel passage Suppresses appetite and food intake
Neuropeptide Y	Ileum and colon Brain and autonomic nervous system (ANS)	Increases blood flow in enteric blood vessels
Motilin	Mo cells in stomach and intestine Enterochromoffin cells in intestine	Accelerates gastric emptying Increases movements of small intestine Increases peristalsis in colon
Substance P	Brain Small intestine	Increases movements of small intestine
Ghrelin	Stomach Hypothalamus Pituitary Kidney Placenta	Promotes growth hormone (GH) release Induces appetite and food intake Stimulates gastric emptying