Gastrointestinal Secretions Summary

General Principles

- Functions: Digest food, lubricate, and protect mucosa.
- Components:
  - Organic materials (enzymes).
  - Water and electrolytes from blood vessels.
- Gland types: Goblet cells, crypts of Lieberkühn, complex glands, and external glands (e.g., salivary glands, pancreas, liver).

Regulation of GI Secretion

System	Action
ENS (Enteric Nervous System)	Responds to food → increases secretions.
Parasympathetic	Stimulates secretions.
Sympathetic	Slightly increases organic secretion but reduces water/electrolyte secretion.
Hormones	Food triggers hormone release → stimulates secretory glands.

Salivary Glands

- Secretion: Water, electrolytes, enzymes (amylase), mucins.
- Cells:
  - Acinar cells: Create primary secretion.
  - Duct cells: Modify saliva to be hypotonic (absorb $Na+$, Cl^-; secrete $K+$, HCO_3^-).
- Types of Saliva:

The final saliva is a hypotonic solution because there is a higher absorption rate of Nat and $Cl-$ than secretion of $K+$ and $HCO3-$ by tubular cells.

Gland	% of Saliva	Type
Parotid	25%	Serous
Submandibular	70%	Mixed
Sublingual	5%	Mucous

- Functions: Digestion, lubrication, antibacterial action, taste, speech aid, and acid neutralization.

Esophageal Secretion

- Mainly mucus for lubrication and protection.
- Alkaline mucus near the gastroesophageal junction protects against reflux.

Gastric Secretions

Cell Type	Secretion	Function
Mucus cells	Mucus	Protection and lubrication.
Parietal (Oxyntic) cells	HCl, Intrinsic Factor	Acid production, Vitamin B12 absorption.
Chief (Peptic) cells	Pepsinogen	Protein digestion.
G cells	Gastrin	Stimulate HCl, pepsinogen, mucosal growth.

- HCl: Converts pepsinogen to pepsin, defense, connective tissue digestion.
- Intrinsic Factor: Essential for vitamin B12 absorption.
- Regulation: Neural (Ach, GRP), hormonal (gastrin), and paracrine (histamine, somatostatin).

Phases of Gastric Secretion

1. Cephalic: Smell, sight, thought.
2. Gastric: Food in stomach.
3. Intestinal: Early stimulation, later inhibition.

Intestinal Secretion

- Crypts of Lieberkühn: Secrete water, electrolytes, mucus.
- Duodenal glands: Serous secretion.
- Regulation: Ach, VIP, Secretin.

Colonic Secretion

- Mainly mucus, little serous secretion rich in $K+$ and HCO_3^-.

Pancreatic Secretions

Component	Source	Function
Enzymes	Acinar cells	Digest carbs, fats, proteins.
Water + Bicarbonate	Duct cells	Neutralize acid, optimal pH for enzymes.

- Proteolytic Enzymes: Trypsin, Chymotrypsin, Carboxypeptidase (activated in duodenum).
- Lipolytic Enzymes: Lipase, Phospholipase, Cholesterol esterase.
- Amylase: Carbohydrate digestion.

- Regulation:
  - Neural: Vagal stimulation.
  - Hormonal:
    - Secretin → Bicarbonate.
    - CCK → Enzymes.
    - Pancreatic polypeptide → Inhibits secretion.

Phases of Pancreatic Secretion

1. Cephalic
2. Gastric
3. Intestinal (most important) Intestinal phase:

- Excitatory: Distension of the upper portion of the duodenum can slightly stimulate gastric secretions. This effect is probably by the release of gastrin.

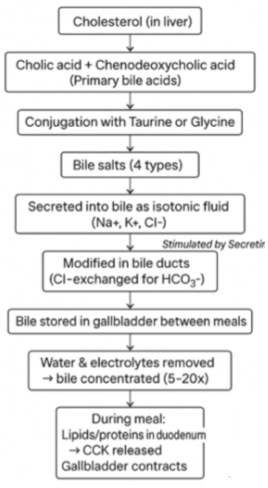
- Inhibitory: the presence of chyme in intestine usually inhibits gastric secretions. The presence of food and acids in duodenum initiates neural reflexes (enterogastric reflex) and causes the release of hormones (GIP, CCK, secretin, enterogastrone).These hormones inhibit acid secretions.

Liver and Bile Secretions

- Functions of Liver: Nutrient metabolism, detoxification, protein synthesis, storage, immunity.
- Bile Composition: Bile salts, electrolytes, cholesterol, phospholipids, bilirubin.
- Bile Salts:
  - Made from cholesterol (cholic acid, chenodeoxycholic acid).
  - Conjugated with taurine/glycine.
- Gallbladder Role: Concentrates and stores bile.
- Enterohepatic circulation: Recycles bile salts.
- Bilirubin Metabolism:
  - Hemoglobin → Heme → Biliverdin → Bilirubin.
  - Excreted in bile → Converted to urobilinogen in intestines.

Hemoglobin catabolism → Heme + Globin
Heme decomposition → Iron + Biliverdin
Biliverdin conversion → Bilirubin (conjugated with glucuronide, sulfate, or other substances) → Secreted in bile
In the intestine → Bilirubin → Urobilinogen (via bacterial action)
Urobilinogen fate → Reabsorbed → Secreted in urine as urobilin
OR → Secreted in feces as stercobilin

Bile synthesis and secretion:



. Summary of Endocrine cells and Hormones in the GI.

Substance	Source	Stimulus for Secretion	Main Action
Gastrin	G cells (Pyloric glands, stomach)	- Stomach distension- Proteins in food- Vagal stimulation (via GRP)	- ↑ HCl secretion (parietal cells)- ↑ Pepsinogen secretion (chief cells)- Trophic effect on gastric mucosa
Pepsinogen	Chief cells (Stomach)	- Vagal stimulation (Ach)- Gastrin- HCl (indirectly via reflex)	- Inactive form → activated to Pepsin in acidic environment- Breaks down proteins
Intrinsic Factor	Parietal cells (Stomach)	- Same as HCl secretion triggers	- Essential for Vitamin B12 absorption in the ileum
GRP (Gastrin-Releasing Peptide)	Enteric neurons (Vagal nerve endings)	- Vagal stimulation during cephalic phase	- Stimulates G cells to secrete Gastrin
Histamine	Enterochromaffin-like (ECL) cells (Stomach)	- Vagal stimulation (indirect)- Local stimuli	- Stimulates HCl secretion (binds to H2 receptors on parietal cells)
Somatostatin (SS)	paracrine cells (Stomach and duodenum)	- Acid in stomach- Inhibitory signals	- Inhibits HCl secretion (parietal cells)- Inhibits Gastrin, Histamine secretion
VIP (Vasoactive Intestinal Peptide)	Enteric neurons	- Local reflexes- Intestinal distension	- Stimulates intestinal secretions (water, electrolytes)- Relaxes smooth muscle
Secretin	(Duodenum)	- Acidic chyme in duodenum (↓ pH)	- Stimulates bicarbonate secretion (pancreas, bile ducts)- Inhibits gastric acid secretion
CCK (Cholecystokinin)	(Duodenum and jejunum)	- Presence of fatty acids and amino acids	- Stimulates pancreatic enzyme secretion- Contracts gallbladder- Relaxes sphincter of Oddi Acts directly through CCK-A receptors on acinar cells to increase enzymatic secretion. CCK also acts indirectly through vagovagal reflex to stimulate enzyme secretions

⊕ CCK-B receptor on oxyntic cells to secrete HCl

- Pancreatic polypeptide: inhibits the release of enzymes by its inhibitory effects:
  - On the release of Ach from enteric nervous system.
  - On vagal output of the CNS.