

BASED ON PAST PAPERS

HIGH-YIELD GI NOTES

**Abdalluh Tarawneh M.D-
0790670866**

High-Yield Physiology Notes:

Lecture 1: Introduction & General Control

Interstitial Cells of Cajal

- They are responsible for the **slow action potentials, known as slow waves, in smooth muscle.**
- They are considered the **pacemaker cells of the gastrointestinal tract.**
- They are responsible for generating **the Basic Electrical Rhythm at smooth muscle cells.**
- **They are connected to smooth muscle cells by gap junctions.**
- **They are not neurons.**
- **They are not under the direct control of the** autonomic nervous system.
- **They are controlled by the Enteric Nervous System,** not the other way around.



Control of Gastrointestinal Functions

- The **Parasympathetic** nervous system generally **increases gastrointestinal secretions and motility.**
- The **Sympathetic** nervous system generally **decreases gastrointestinal activity and decreases blood flow by a direct effect on vessels.**
- **Tonic contractions are** set by the release of neurotransmitters.
- **Phasic contractions are controlled by the Basic Electrical Rhythm.**
- **Salivary secretion is increased by conditioned and unconditioned reflexes, not by intrinsic reflexes alone.**

Gastrointestinal Blood Flow

- **Blood flow is controlled by the Enteric Nervous System, hormones, and local factors.**
- Increased blood flow results in increased **water and electrolyte secretion.**
- **Blood flow increases after meals.**
- **It is increased by the release of Vasoactive Intestinal Peptide.**
- **It is decreased by a higher sympathetic tone.**

- **Hormones that affect blood flow include Cholecystokinin, Secretin, and Gastric Inhibitory Peptide. Cholecystokinin does not affect it.**

Lecture 2: Gastrointestinal Movements

Swallowing and Esophageal Motility

- **Swallowing has a voluntary oral phase and an involuntary pharyngeal-esophageal phase.**
- **Primary peristalsis is initiated at the pharynx and moves the bolus down the esophagus.**
- **Secondary peristalsis is initiated in the esophagus itself by the presence of remaining food particles or residue.**
- **A relaxation wave precedes the bolus to open the Lower Esophageal Sphincter.**
- **Closure of the epiglottis is an involuntary reflex.**
- **Esophageal movements are controlled mainly by the Enteric Nervous System.**

Gastric Motility

- **After food ingestion, the tonic contraction of the gastric muscle is decreased to accommodate the food. This is called receptive relaxation.**
- **Gastric motility is regulated by neural and hormonal controls, not by hormones only.**
- **It is increased by parasympathetic stimulation and decreased by the Enterogastric reflex and Cholecystokinin.**
- **The correct chronological order for a food bolus is: Primary Peristaltic Wave, Receptive Relaxation, Pyloric Pump, Segmentation Contractions.**

Intestinal Motility

- **Segmentation contractions mix the chyme.**
- **Peristaltic contractions propel the chyme in an anal-ward direction.**
- **The rhythm of segmentation contractions is set by the Basic Electrical Rhythm of the segment.**
- **Coordinated peristaltic reflexes require an intact myenteric plexus.**
- **An increased velocity of chyme propulsion decreases intestinal absorption.**
- **Tonic contractions are set by the release of neurotransmitters, not by the Interstitial Cells of Cajal.**

Colonic Motility and Defecation

- **Haustral contractions are phasic, non-propulsive contractions that mix content and are present all day.** They are similar to segmentation contractions. **They are not initiated by gastrocolic reflexes.**
- Mass contractions are strong, propulsive contractions that move content long distances. They are facilitated **by gastrocolic and duodenocolic reflexes and can be initiated by mucosal irritation. They do not occur all day.**
- **Defecation reflexes are initiated by distention of the rectum.**
- **The intrinsic reflex is provided by the Enteric Nervous System.**
- **A parasympathetic component fortifies the contractions of the rectal smooth muscle.**
- **Voluntary control is ensured by the relaxation of the external anal sphincter.**
- **Relaxation of the external anal sphincter is a somatic nervous system action, not a parasympathetic one.**

Lectures 3-5: Gastrointestinal Secretions

Salivary Secretion

- **It is regulated by neural reflexes, not by gastrointestinal hormones.**
- **Conditioned reflexes stimulate sympathetic and parasympathetic control.**
- **Functions include keeping the mouth clean, stimulating taste buds, protective action, and facilitating swallowing. It does not facilitate carbohydrate absorption.**
- **Primary saliva is isotonic, similar to plasma.**
- **Final saliva is modified as it passes through the ducts:**
 - **At a low secretion rate, final saliva is hypotonic; it has very low Sodium and Chloride concentrations and high Potassium and Bicarbonate concentrations.**
 - **At a high secretion rate, final saliva is less hypotonic; Sodium and Chloride concentrations increase, and Potassium concentration decreases compared to the low rate.**
 - **The pH is higher at a high rate of secretion due to higher Bicarbonate content.**

Gastric Secretion

- **Parietal cells secrete Hydrochloric Acid and Intrinsic Factor.**

- Chief cells secrete Pepsinogen.
- Enterochromaffin-like cells secrete Histamine. They do not secrete Intrinsic Factor.
- G cells secrete Gastrin.
- Stimuli that increase acid secretion: Gastrin, Histamine, Parasympathetic stimulation via the Vagus nerve, Acetylcholine.
- Stimuli that decrease acid secretion: Somatostatin.
- The Cephalic Phase of gastric secretion is mediated by the Vagus nerve. Vagotomy would eliminate this phase.
- Loss of G cells decreases acid secretion by decreasing Gastrin secretion.
- Paracrine control is achieved by Histamine and Somatostatin, not by Cholecystokinin.

Pancreatic Secretion

- Acinar cells secrete the pancreatic enzymes.
- Duct cells secrete a watery, bicarbonate-rich solution.
- Pancreatic proteolytic enzymes are secreted as inactive enzymes and have optimal activity at an alkaline pH.
- They are not responsible for the final digestion of proteins to amino acids; that is done by intracellular peptidases.
- **Cholecystokinin** stimulates the secretion of enzymes from acinar cells.
- **Secretin** stimulates the secretion of bicarbonate from duct cells.
- Parasympathetic stimulation increases both enzymatic and bicarbonate secretion.
- Pancreatic Polypeptide **inhibits** pancreatic secretion.
- The pancreas **does not contain** enzymes for the digestion of disaccharides.

Bile Secretion

- Bile is stored and concentrated in the gallbladder between meals.
- Its secretion is well correlated with the fat content of a meal.
- The main hormone controlling gallbladder contraction and bile release is Cholecystokinin.
- Cholecystokinin causes contraction of the gallbladder and relaxation of the Sphincter of Oddi.

- **Bile salts** are recycled via **the enterohepatic circulation**.
- **The concentration of constituents is not the same in hepatic bile and gallbladder bile; the gallbladder concentrates bile.**
- **Bilirubin is a waste product; bile salts are important for the formation of micelles.**

Colonic Secretion

- The secretion of the colon **is mainly mucus**.
- It is controlled by **the Enteric Nervous System, not by Interstitial Cells of Cajal or Cholecystokinin**.

Final material :

Lecture 6-8: Digestion and Absorption

Carbohydrate Digestion and Absorption

- Human enzymes can only attack **alpha linkages** of glucose polymers.
- The final digestion of carbohydrates is done by **brush border enzymes** (e.g., lactase, sucrase), not intracellular enzymes.
- The pancreatic enzyme (amylase) is secreted in its **active form**.
- The bulk of carbohydrate digestion is by **pancreatic amylase**, not salivary amylase.
- **Glucose and Galactose** are absorbed via a **Sodium-dependent secondary active transport** mechanism. Inhibiting the Sodium/Potassium pump blocks their absorption.
- **Fructose** is absorbed via **facilitated diffusion**, which is **Sodium-independent**.



Protein Digestion and Absorption

- Proteins can be absorbed as **dipeptides, tripeptides, and even trimers**.
- The final digestion process is carried out by **brush border enzymes** in the small intestine.
- The bulk of protein digestion occurs in the **small intestine**, not the stomach.
- Dipeptides and tripeptides are absorbed via a **Sodium-dependent secondary active transport** mechanism. Inhibiting the Sodium/Potassium pump blocks their absorption.
- Pepsinogen is activated to pepsin by the **low pH** in the stomach, not the high pH in the duodenum.

Fat Digestion and Absorption

- **Emulsification** increases the surface area of fat, exposing it to enzymes.
- Fat digestion takes place at the **shell-core interface of micelles**.
- The products of fat digestion (monoglycerides and free fatty acids) cross the luminal membrane by **simple diffusion**.
- Inside the intestinal epithelial cells, these products are reformed into **triglycerides**.
- Triglycerides are packaged with lipoproteins to form **chylomicrons**.
- Absorbed fat (chylomicrons) is taken away from the villi by the **lymphatic system** (lacteals), **not by blood circulation**.

- A drug that inhibits **lipase** will result in **steatorrhea** (fatty stools).
- Fat digestion occurs in the **intestinal lumen**, not on the brush border.

Vitamin and Mineral Absorption

- **Vitamin B12** absorption requires **Intrinsic Factor**.
- **Iron** absorption is unique; it is **blocked at the mucosal level** when body stores are sufficient and absorbed only when needed. This is called the "mucosal block."
- **Calcium** absorption is enhanced by **Vitamin D** and the protein **calbindin**.
- **Fat-soluble vitamins** (A, D, E, K) are absorbed via simple diffusion. Their absorption is **decreased** in conditions that cause steatorrhea.
- **Vitamin D** absorption occurs via simple diffusion and is **not** dependent on the Sodium/Potassium pump.
- **Bile salts** are absorbed in the ileum via **active transport**.

General Absorption Facts

- The **ileum** has the highest reabsorption of **fluids**.
- The **duodenum** has the highest absorption of **food nutrients**.
- **Pancreatic insufficiency** impairs the digestion of triglycerides, starch, and proteins, but does not affect the absorption of sucrose, which is digested by the brush border enzyme sucrase.

Energy Metabolism and Regulation of Food Intake

Starvation and Body Fuel Use

- During starvation, the **first** body stores to be depleted are **carbohydrates**.
- The **last** body stores to be depleted are **proteins**.
- The rate of **protein depletion** between weeks 1-6 of starvation is **slower** than the rate of fat depletion.
- The **metabolic rate decreases** during starvation to conserve energy.
- The highest rate of **fat depletion** occurs between weeks 2-6 of starvation.

Respiratory Quotient

- The **Respiratory Quotient** is the ratio of **Carbon Dioxide produced to Oxygen consumed**.

- It is **highest** when **glucose** is the primary fuel.
- It is **lowest** when **fats** are the primary fuel, such as in the **third week of starvation** or in diabetic patients during a crisis.
- **Brain tissue** has a very high Respiratory Quotient because it primarily uses glucose.

Metabolic Rate

- **Metabolic Rate** represents the heat produced by the body per square meter of surface area per hour.
- It reflects the metabolic activities per unit of time.
- It is measured via **indirect calorimetry** using **Oxygen consumption**.
- It is **increased** by: **sympathetic stimulation, fever, cold weather**.
- It is **decreased** in: **sleep, hypothyroidism, malnutrition, starvation**.

Regulation of Food Intake (Leptin, Hormones, and Centers)

- **Leptin** is a hormone secreted by **adipocytes** (fat cells).
- Its expression is controlled by the **OB gene**.
- It acts on **hypothalamic centers** to **inhibit feeding** (suppress appetite).
- Its secretion increases with **increased fat stores**.
- A **defect in the OB gene** that produces non-functional leptin **causes obesity**.
- **Low leptin levels** are found in starvation and thin people.
- **Insulin release** also inhibits feeding behavior.
- **Feeding centers are stimulated** by: **low glucose levels, an increased metabolic rate, and cold weather** (which increases the need for energy stores).
- **Feeding centers are inhibited** by: **increased leptin, increased insulin, stomach distension, and cholecystokinin**.
- **Obesity** can be caused by: a defect in the OB gene, over-nutrition during childhood, neurogenic abnormalities, and hypothyroidism. It is **not** caused by overproduction of normal leptin.

Lab: Intestinal Motility

- **Slow waves** are the basic electrical rhythm set by the Interstitial Cells of Cajal. Their **frequency does not change** with neurotransmitters.

HIGH-YIELD GI NOTES

- **Contractions** (phasic) are the mechanical responses that can be initiated by slow waves. Their **frequency and strength can be changed** by neurotransmitters.
- **Norepinephrine** (sympathetic effect) **stops contractions** but **does not change** the slow wave frequency. The result is slow waves without contractions.
- **Acetylcholine** (parasympathetic effect) **increases the strength of tonic contractions** and can increase phasic contractions.
- In a lab recording, the rhythmic waves represent **mechanical contractions**, not the slow waves themselves.