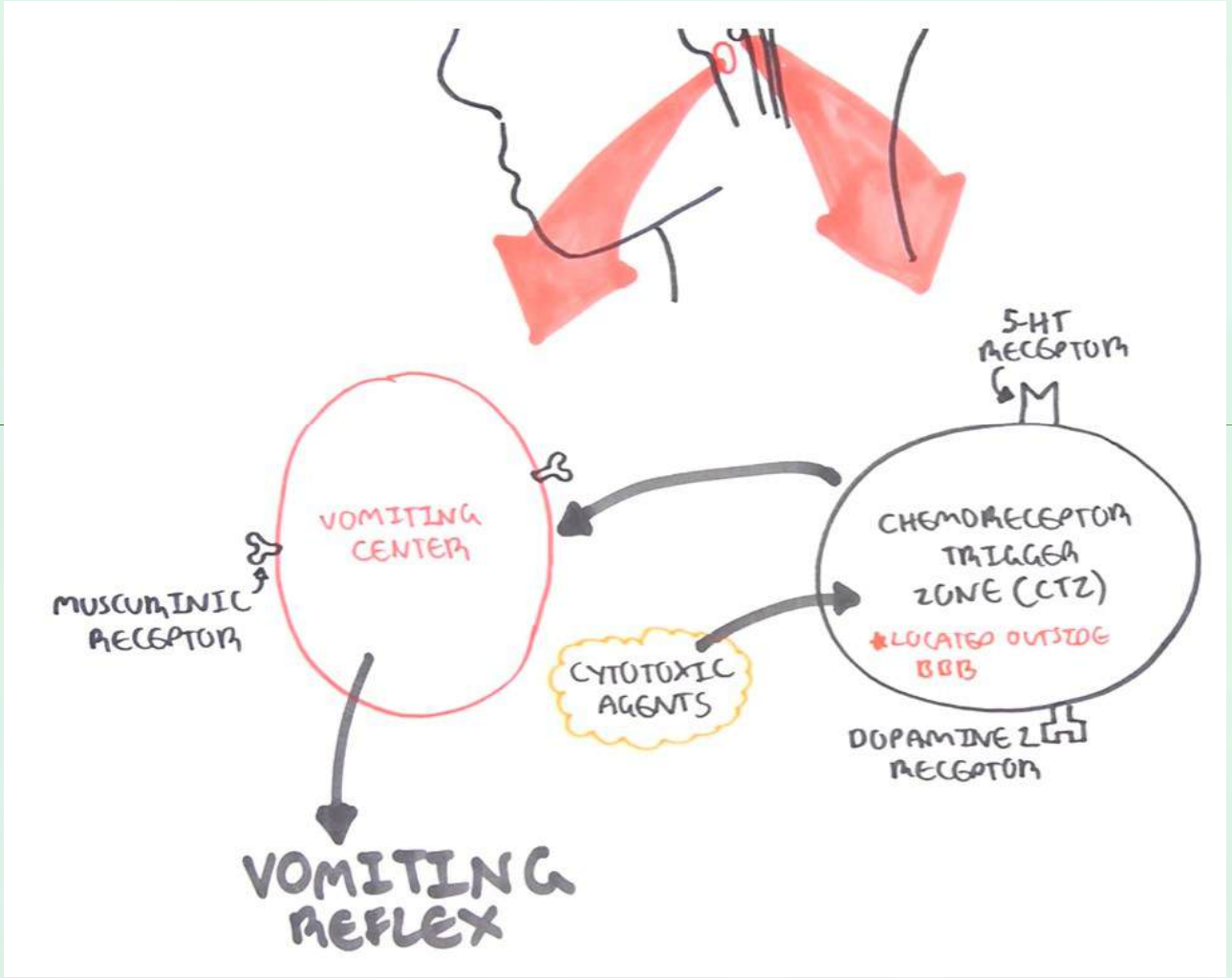
Vomiting (Emesis)

A comprehensive overview of the physiology, triggers, and neuromuscular coordination of the vomiting reflex — for medical students.

MEDICAL PHYSIOLOGY

EMESIS

Definition



Vomiting (emesis) is a **coordinated reflex process** resulting in the forceful expulsion of gastric — and sometimes intestinal — contents through the mouth.

- It is controlled by the **vomiting center** in the **medulla oblongata**, which integrates signals from multiple sources throughout the body.

CHAPTER 1

Control Centers in the Brain

Vomiting Center

Located in the **medulla oblongata**. Acts as the central integrator — coordinates motor responses and receives input from multiple pathways.

Chemoreceptor Trigger Zone (CTZ)

Located in the **area postrema**, outside the blood-brain barrier. Detects toxins, drugs, and metabolic disturbances via circulating chemicals.

Key Receptors in the CTZ

Dopamine (D2)

CTZ activation; targeted by metoclopramide

Serotonin (5-HT3)

GI irritation & chemotherapy-induced emesis

Histamine (H1)

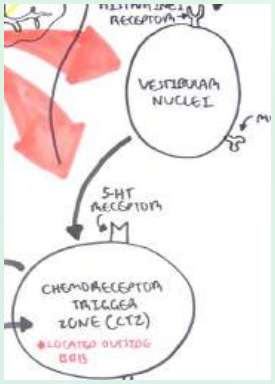
Vestibular input; motion sickness

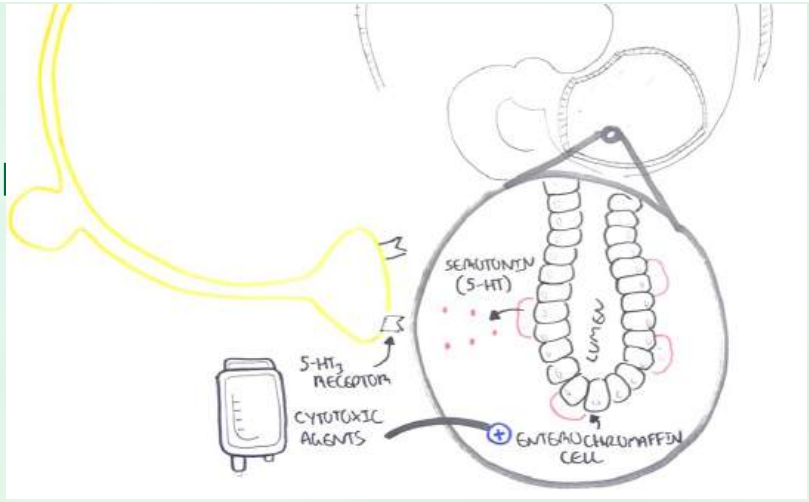
Acetylcholine (M1)

Vestibular and GI pathways

CHAPTER 2

Afferent Pathways — Triggers of Vomiti



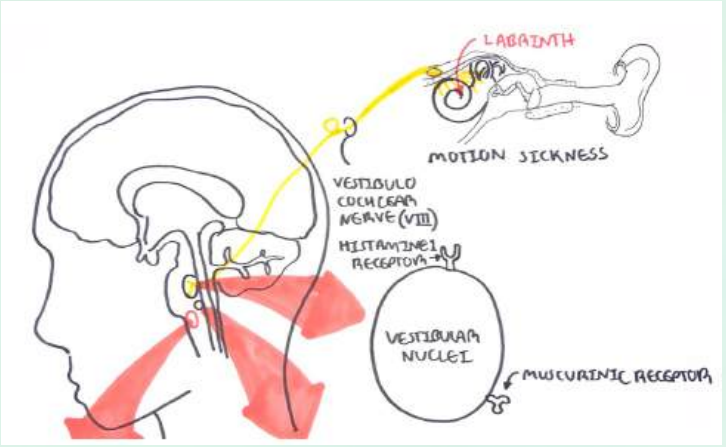


Signals to Vomiting Center

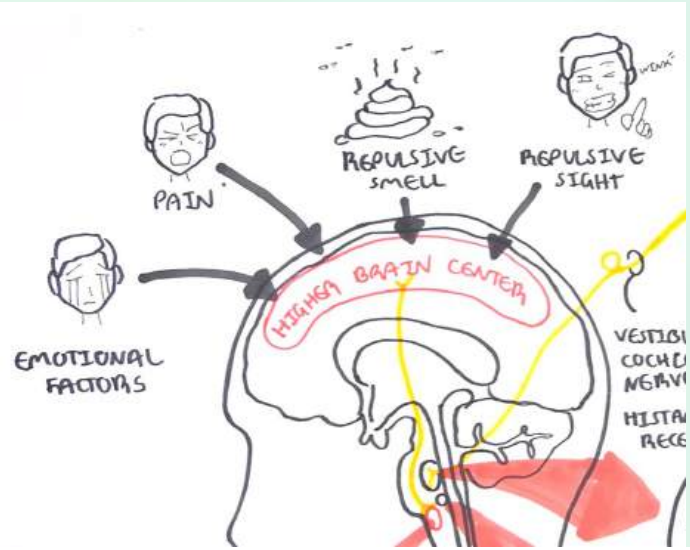
GI Tract — Vagus; 5-HT from enterochromaffin cells

Bloodborne (CTZ) — Drugs, toxins, metabolic causes

Sensory Triggers



Peripheral vs Central



Vestibular — Motion sickness via H1 and M1

Higher Centers — Emotions, pain, unpleasant stimuli

Other Modulators

All four pathways converge on the vomiting center in the medulla, which then coordinates the efferent response.

Physiology of Vomiting - Vomiting reflex (NEW)

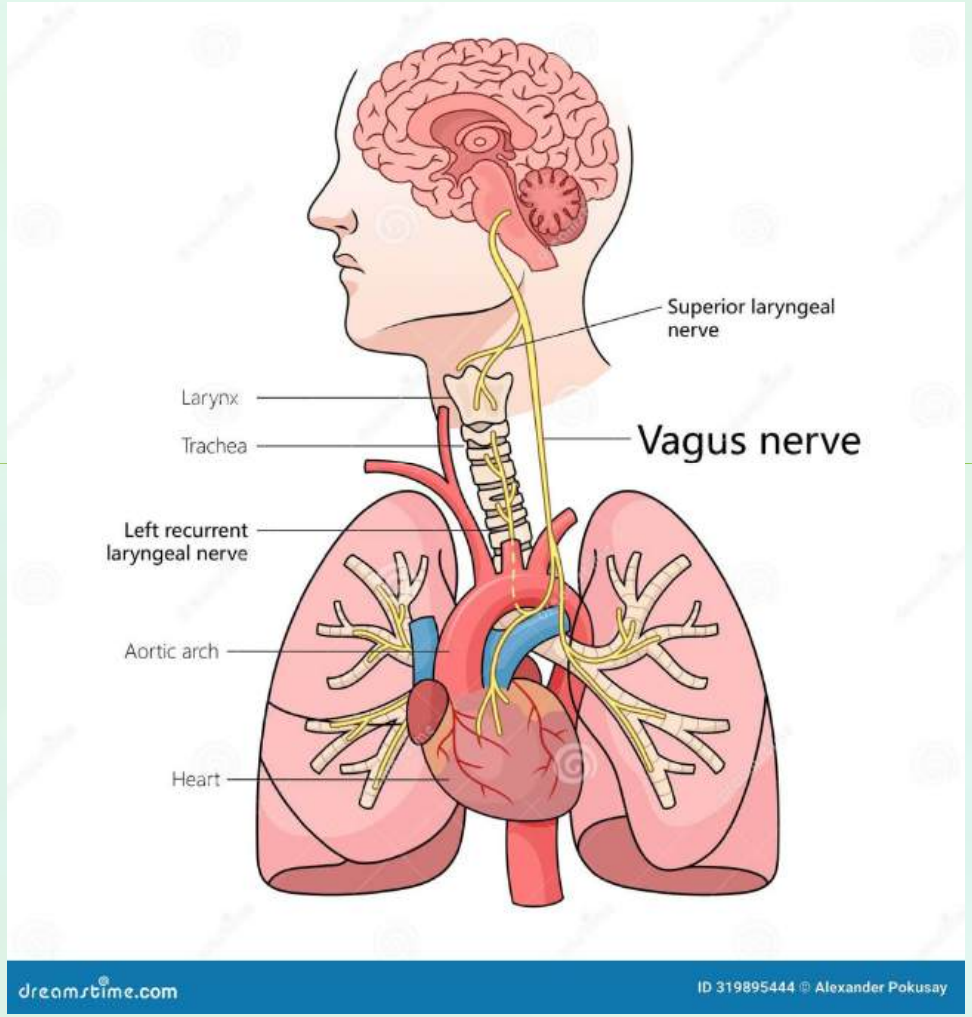
GI Tract & Bloodborne Triggers

🍽 □ Gastrointestinal Tract

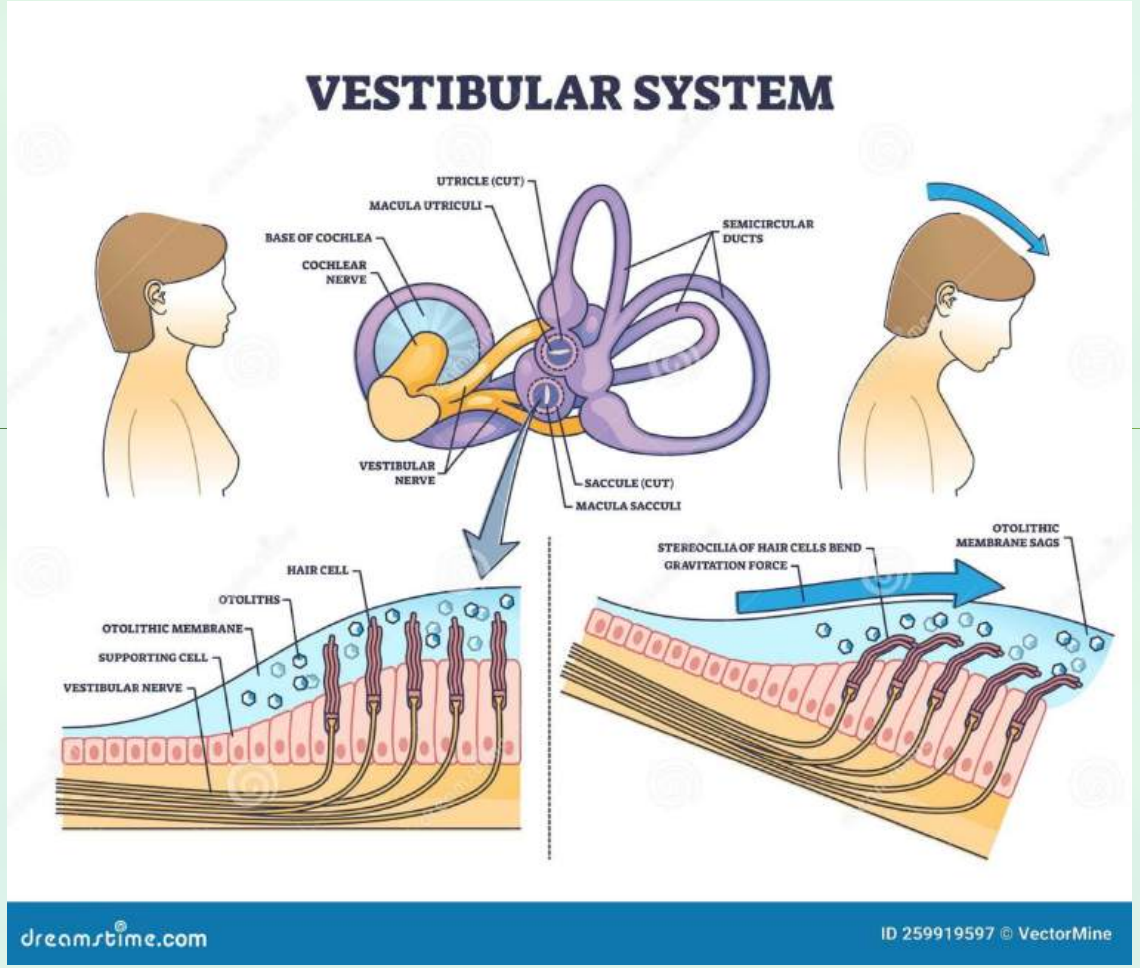
- Irritation from infection, toxins, or distension
- Mediated via the vagus nerve
- Serotonin released from enterochromaffin cells

💉 Bloodborne Stimuli (CTZ)

- Drugs — e.g. chemotherapy, opioids
- Toxins and metabolic disorders
- Uremia, diabetic ketoacidosis



Vestibular & Higher Brain Triggers



Vestibular System

- Motion sickness
- Mediated via Histamine (H1) and Acetylcholine (M1)

Higher Brain Centers

- Emotions: fear, stress, anxiety
- Pain
- Unpleasant sights or smells

CHAPTER 3

Efferent Pathways — Execution of Vomiting

Once activated, the vomiting center sends efferent signals through three main nerves:

Vagus Nerve

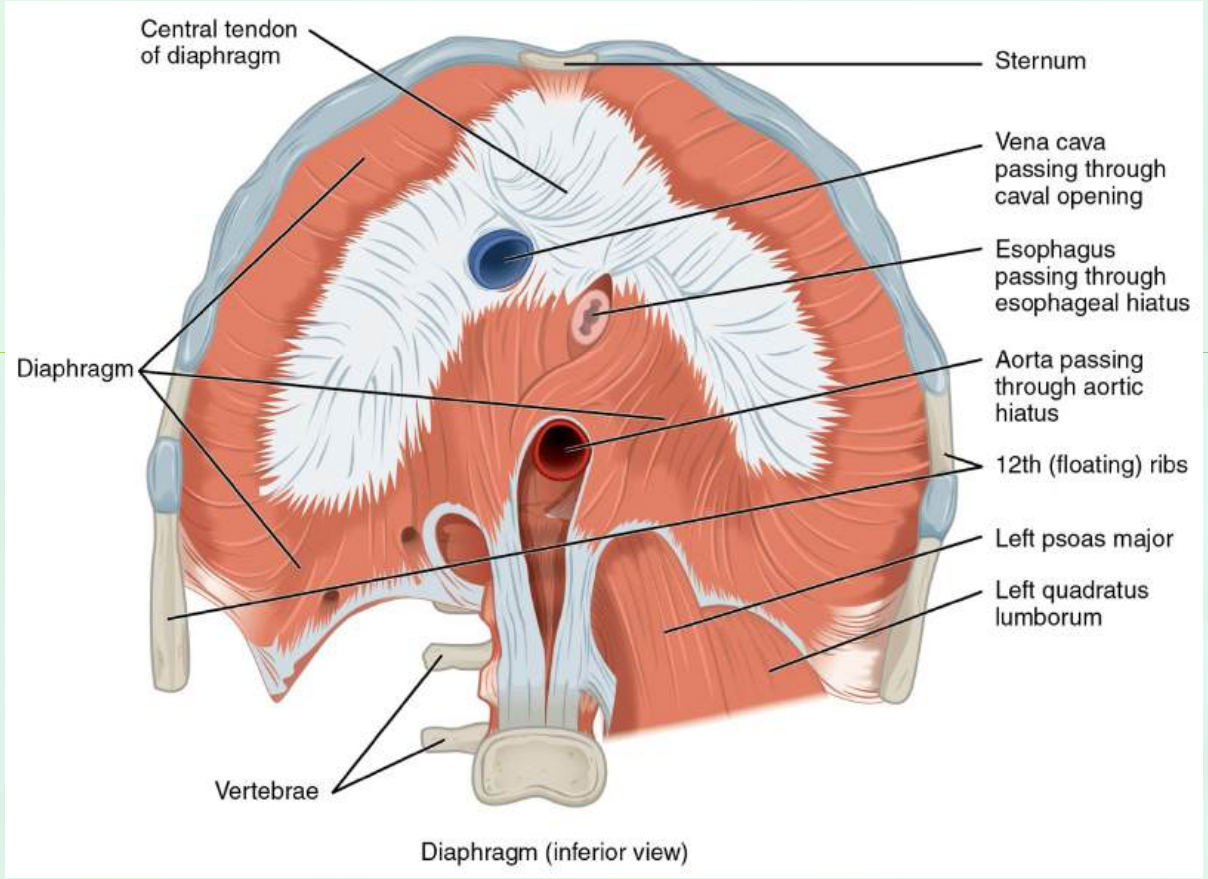
Controls esophagus and stomach

Phrenic Nerve

Controls the diaphragm

Spinal Nerves

Control abdominal muscles



Diaphragm (inferior view)

CHAPTER 4

Three Phases of Vomiting

Nausea **Retching** **Expulsion**

Each phase is a distinct physiological event — understanding the sequence is essential for clinical assessment and management.

Phase 1 — Nausea

Nausea is a **subjective sensation** of the urge to vomit. It is associated with:

Salivation

Increased saliva production

Sweating & Pallor

Autonomic nervous system activation

↓ Gastric Motility

Slowing of normal GI movement

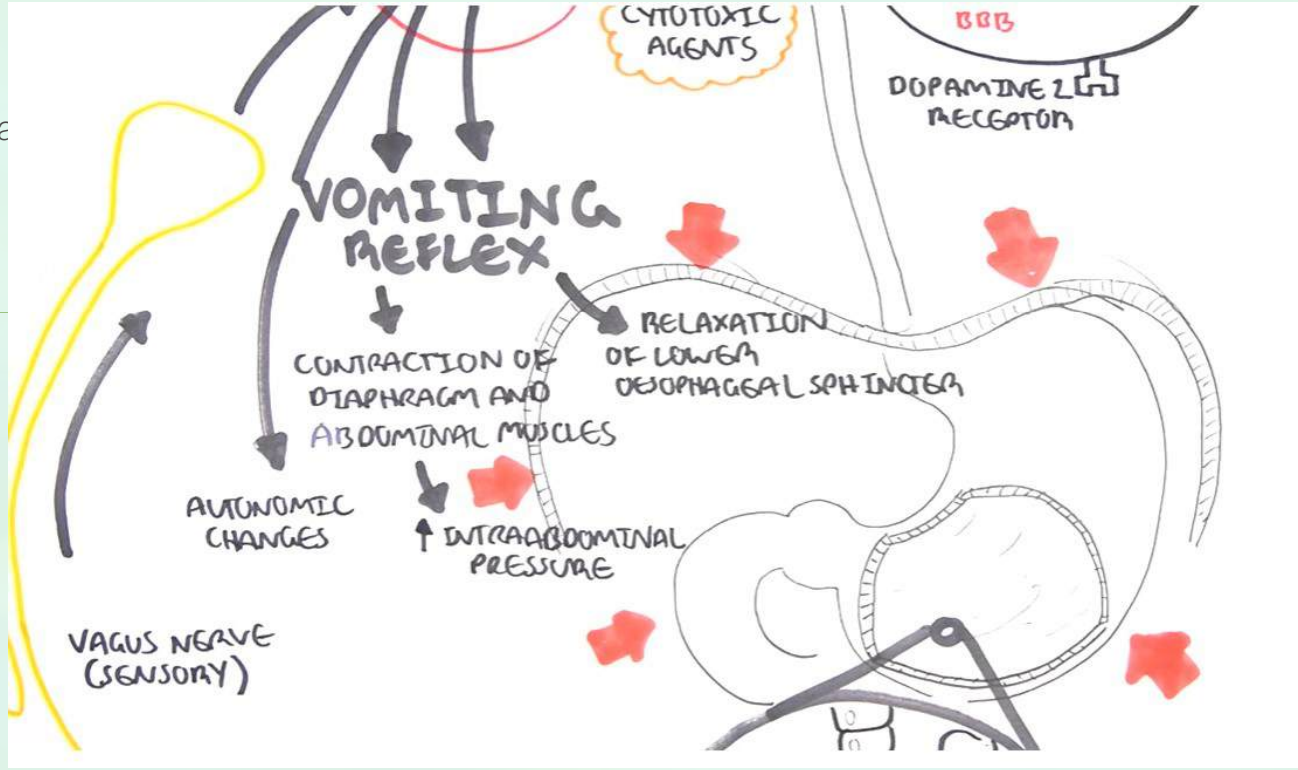
Phase 2 & 3 — Retching & Expulsion

Retching (Dry Heaving)

- Rhythmic contractions of respiratory and abdomina muscles
- No expulsion yet
- Stomach contents begin moving upward

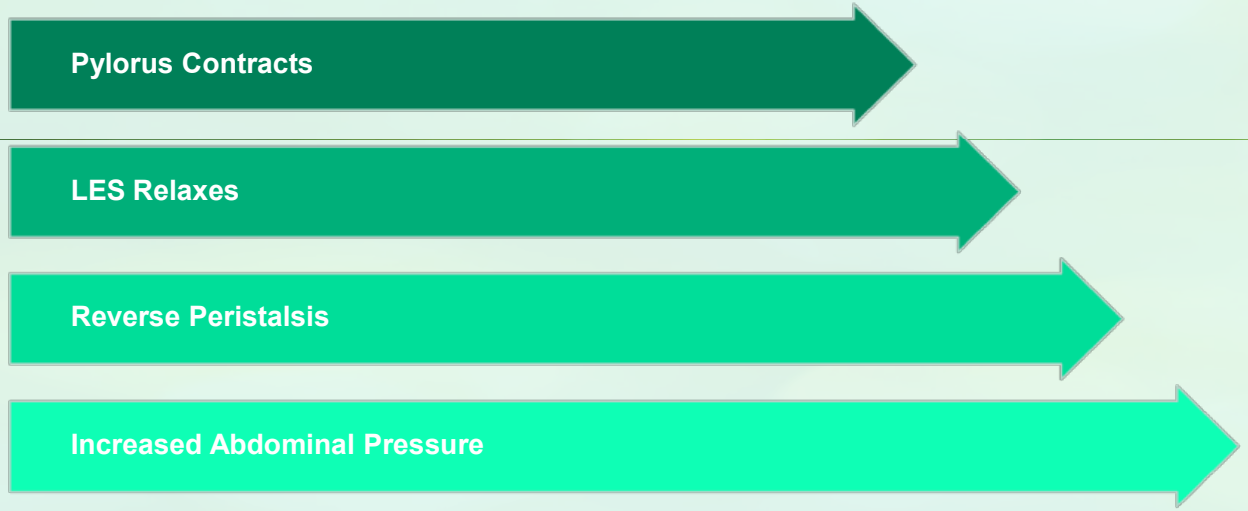
Expulsion — Coordinated Sequence

1. Deep inspiration
2. Closure of glottis (prevents aspiration)
3. Elevation of soft palate (protects nasal cavity)
4. Contraction of diaphragm + abdominal muscles
5. Relaxation of lower esophageal sphincter



CHAPTER 5

Physiological Mechanism



Key Mechanical Events

- Reverse peristalsis — intestinal contents move back into stomach
- Lower esophageal sphincter relaxes
- Pylorus contracts
- Intra-abdominal pressure increases

These events create a **pressure gradient** that pushes gastric contents upward and out.

CHAPTER 6

Neurotransmitters & Antiemetic Targets

Serotonin (5-HT3)

Triggered by GI irritation and chemotherapy → **Ondansetron** blocks this receptor

Dopamine (D2)

CTZ activation → **Metoclopramide, Haloperidol** block D2

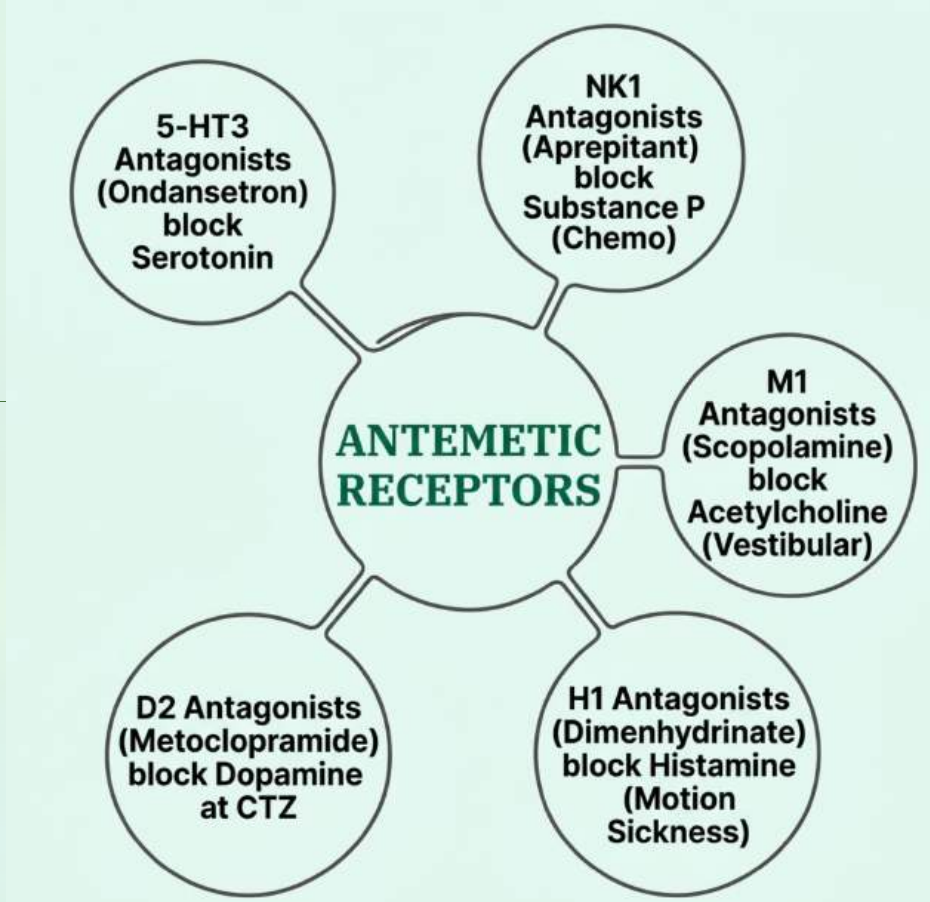
Histamine (H1)

Motion sickness, vestibular input → **Dimenhydrinate, Promethazine**

Acetylcholine (M1)

Vestibular pathway → **Scopolamine** (anticholinergic)

Antiemetic Drug Targets — Summary



Each antiemetic drug class targets a specific receptor involved in the vomiting reflex. Choosing the right drug depends on identifying the dominant trigger pathway.

- Combination therapy is common in chemotherapy-induced nausea and vomiting (CINV) to block multiple pathways simultaneously.

Protective Role of Vomiting

Vomiting is fundamentally a defense mechanism:

Removes Harmful Substances

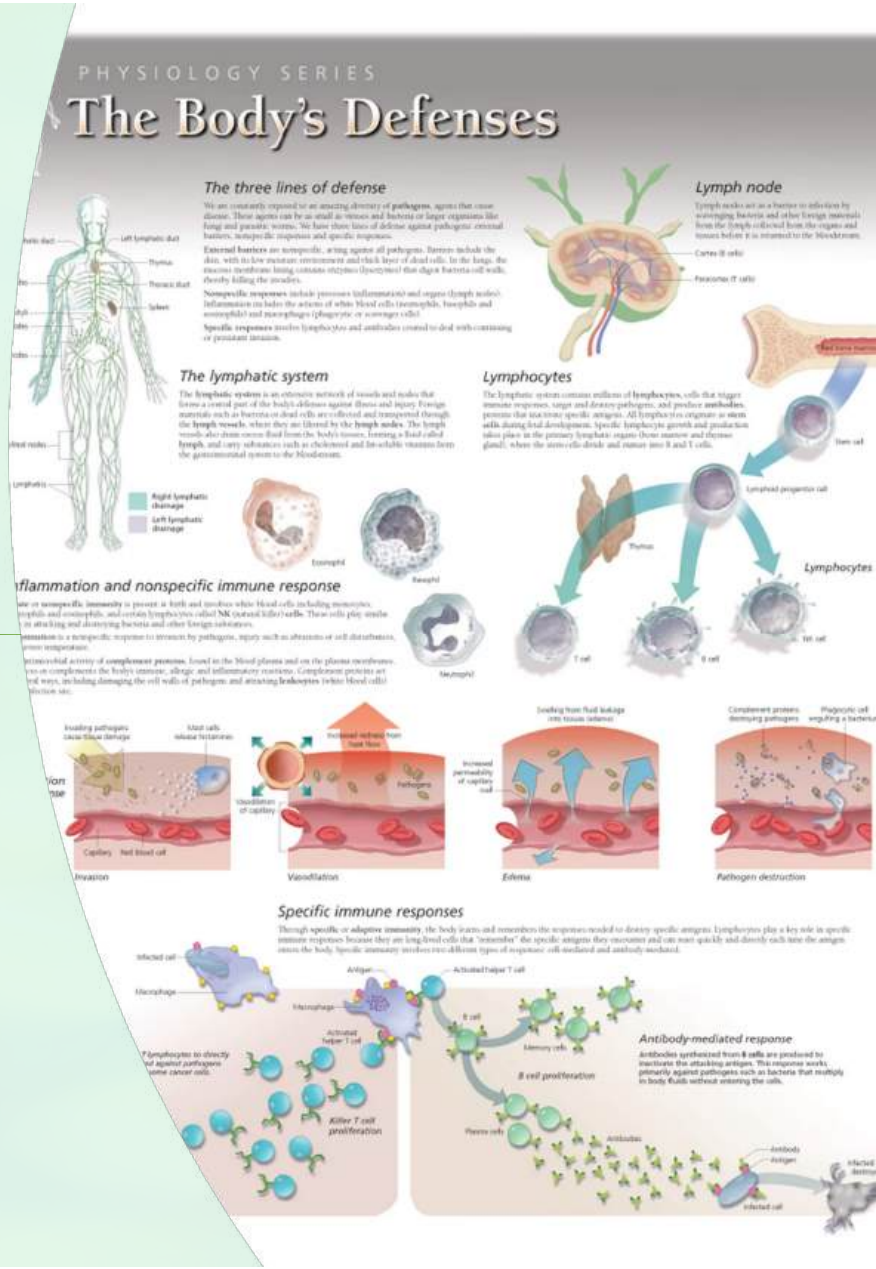
Expels ingested toxins or pathogens before full absorption

Prevents Toxin Absorption

Limits systemic damage from poisons or spoiled food

Danger Alert

Signals the organism to avoid the triggering substance

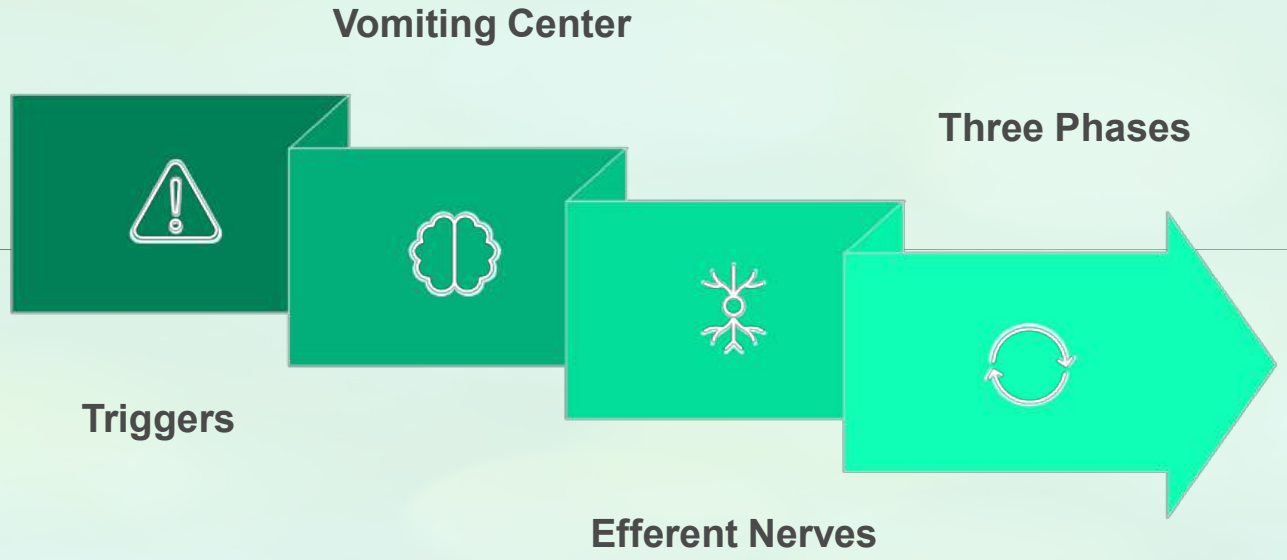


CHAPTER 8

Complications of Vomiting

- **Dehydration**
  Fluid loss from repeated emesis
- **Electrolyte Imbalance**
  Hypokalemia and metabolic alkalosis (loss of HCl)
- **Aspiration**
  Life-threatening — gastric contents enter airways
- **Esophageal Damage**
  Mallory-Weiss tears from forceful retching

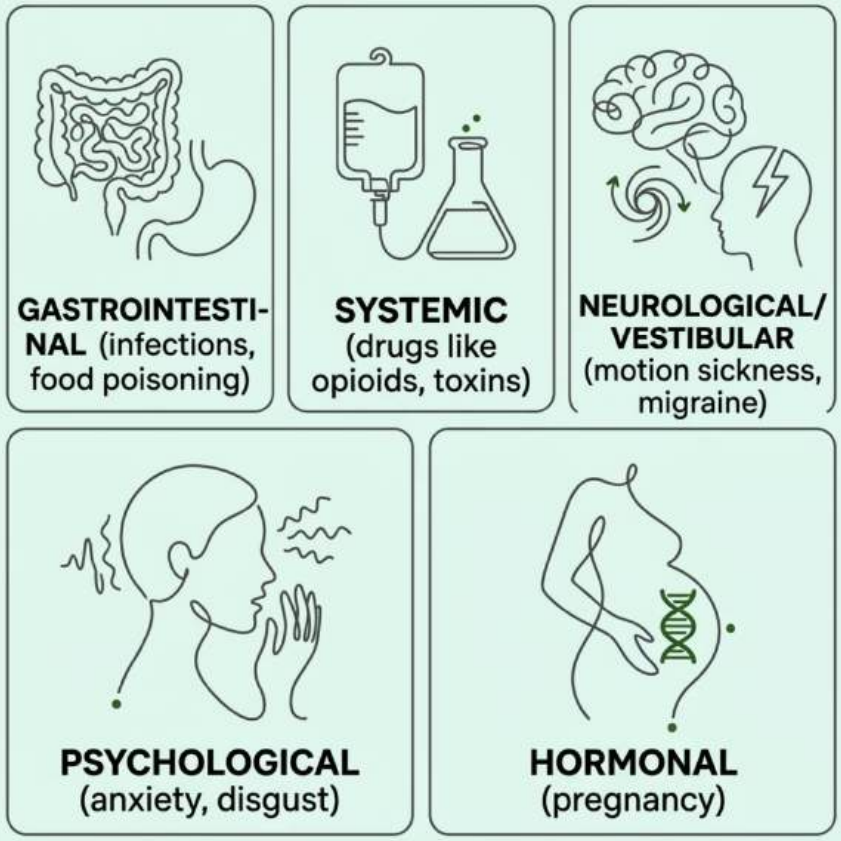
Full Pathway — Integrated Overview



This integrated view connects all components — from trigger to expulsion — showing how the brainstem orchestrates the entire reflex.

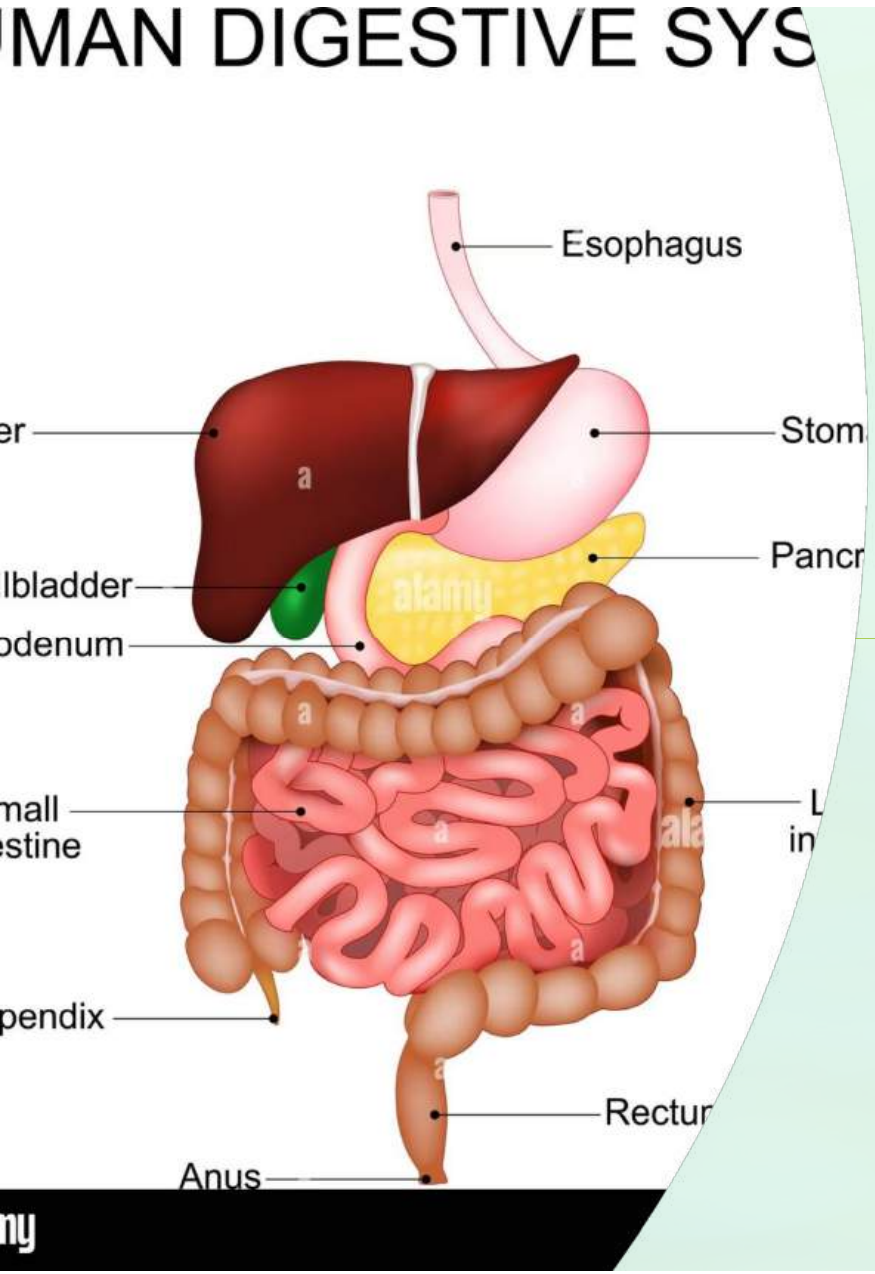
CHAPTER 7

Common Triggers — Overview



Vomiting triggers span nearly every organ system. Recognizing the category of trigger guides both diagnosis and antiemetic selection.

Pregnancy-related emesis is mediated by hCG and typically peaks in the first trimester.



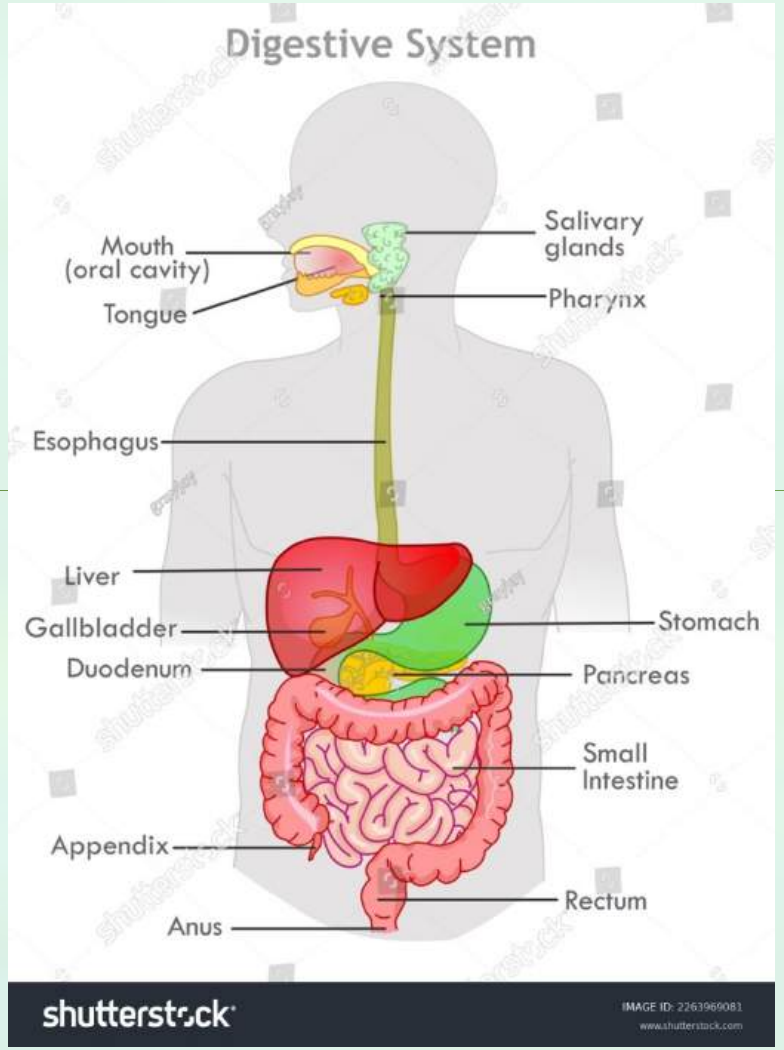
Gastrointestinal Bleeding

A comprehensive medical-school–level overview of GI bleeding: definitions, clinical forms, classification, etiology, and pathophysiology — without therapeutic management.

MEDICAL EDUCATION

GI MEDICINE

What Is GI Bleeding?



Definition

Gastrointestinal bleeding (GIB) refers to any **hemorrhage originating from the GI tract**, extending from the oral cavity to the anus.

It is **not a disease itself**, but a clinical manifestation of underlying pathology.

Two Broad Types

- **Overt** – visible bleeding (hematemesis, melena, hematochezia)
- **Occult** – not visible; detected via fecal occult blood test (FOBT)

CHAPTER 1

Clinical Forms of GI Bleeding

Hematemesis

Vomiting of blood — bright red or "coffee-ground" appearance

Melena

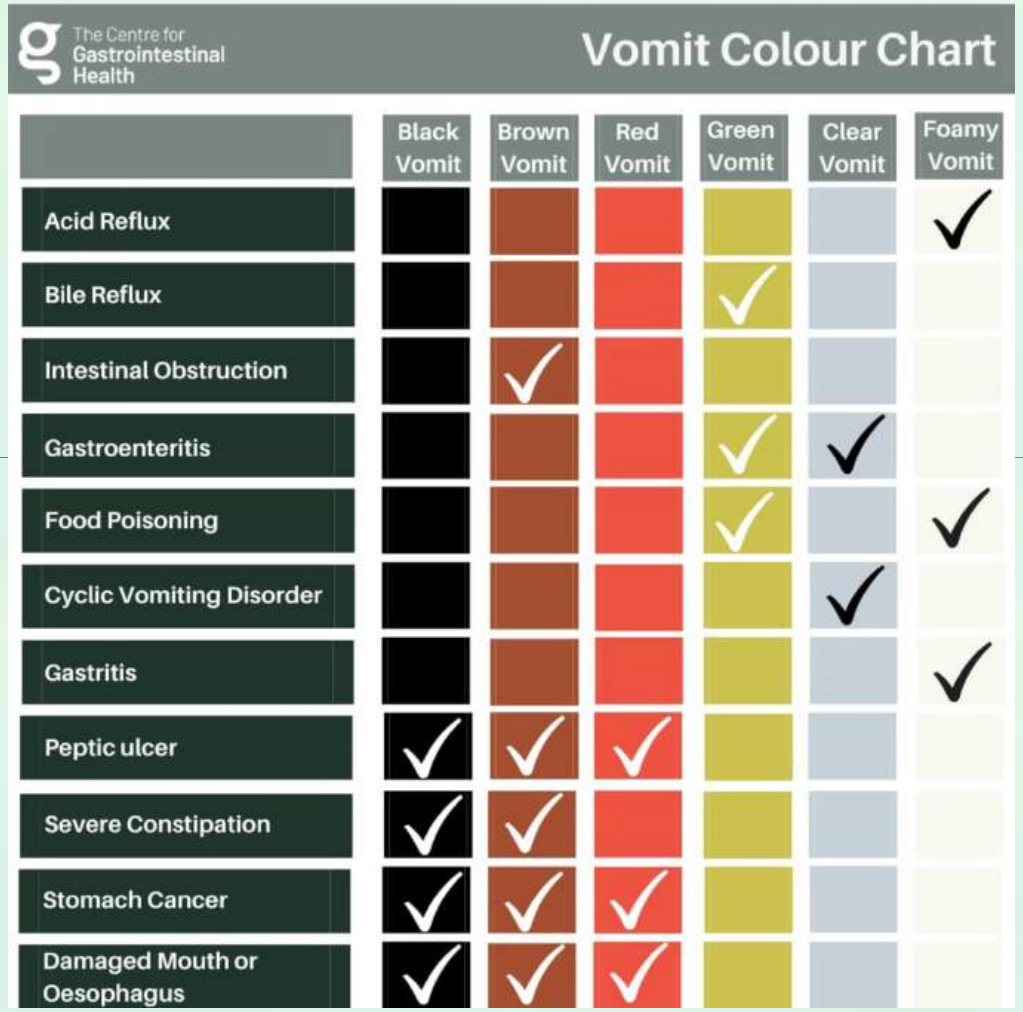
Black, tarry, foul-smelling stool from digested blood

Hematochezia

Passage of fresh red blood per rectum

Recognizing these three forms is the first step in localizing the bleeding source and guiding diagnostic strategy.

Hematemesis: In Depth



Definition

Vomiting of blood originating almost always from the **upper GI tract** (esophagus, stomach, duodenum).

Appearance & Mechanism

- **Bright red** → active, brisk bleeding
- **Coffee-ground** → oxidized hemoglobin; slower or recently ceased bleeding

Coffee-ground vomiting indicates slower/ceased bleeding — not necessarily less dangerous.

Melena: In Depth

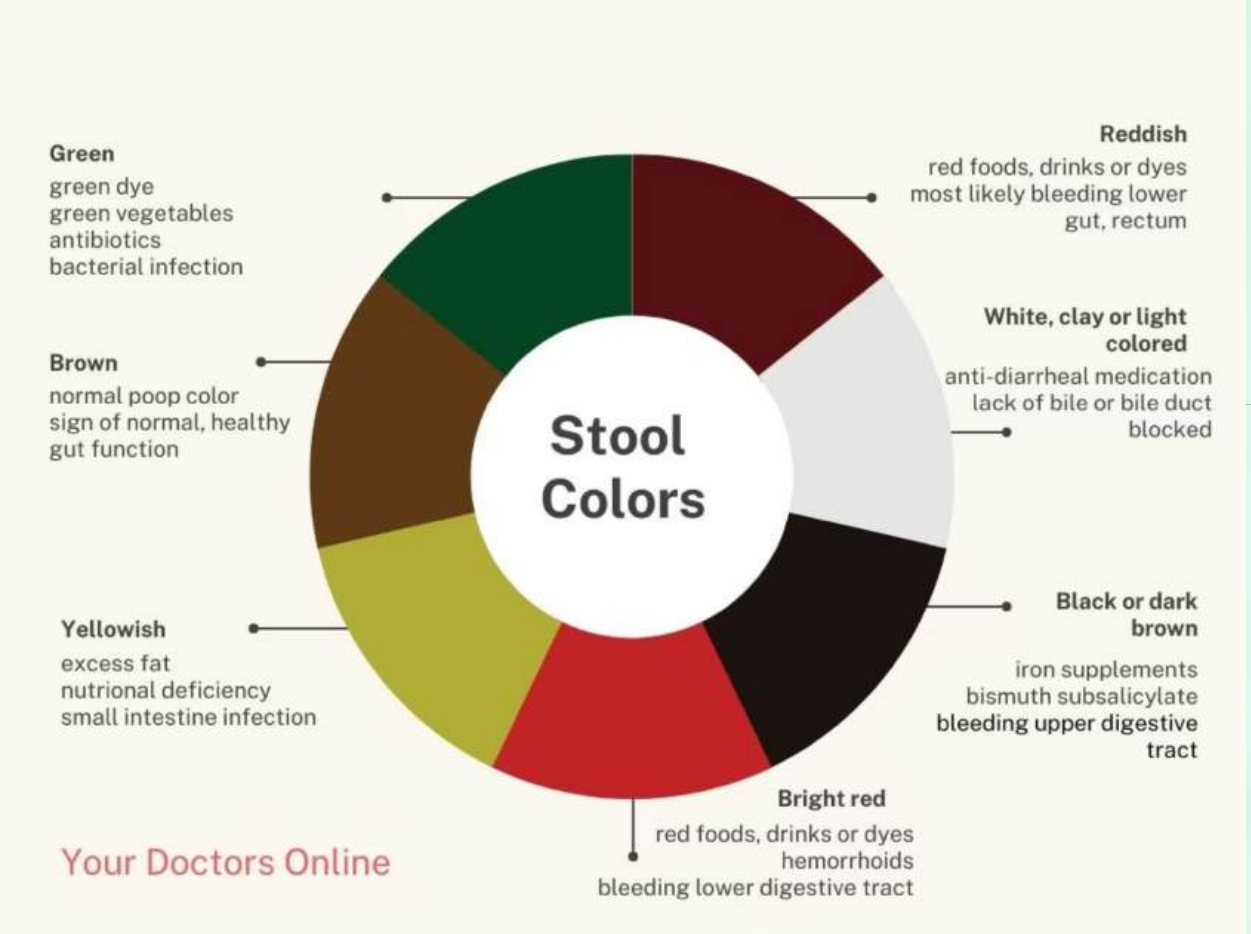
Definition

Black, tarry, foul-smelling stool resulting from **digestion of blood** by intestinal enzymes and bacteria.

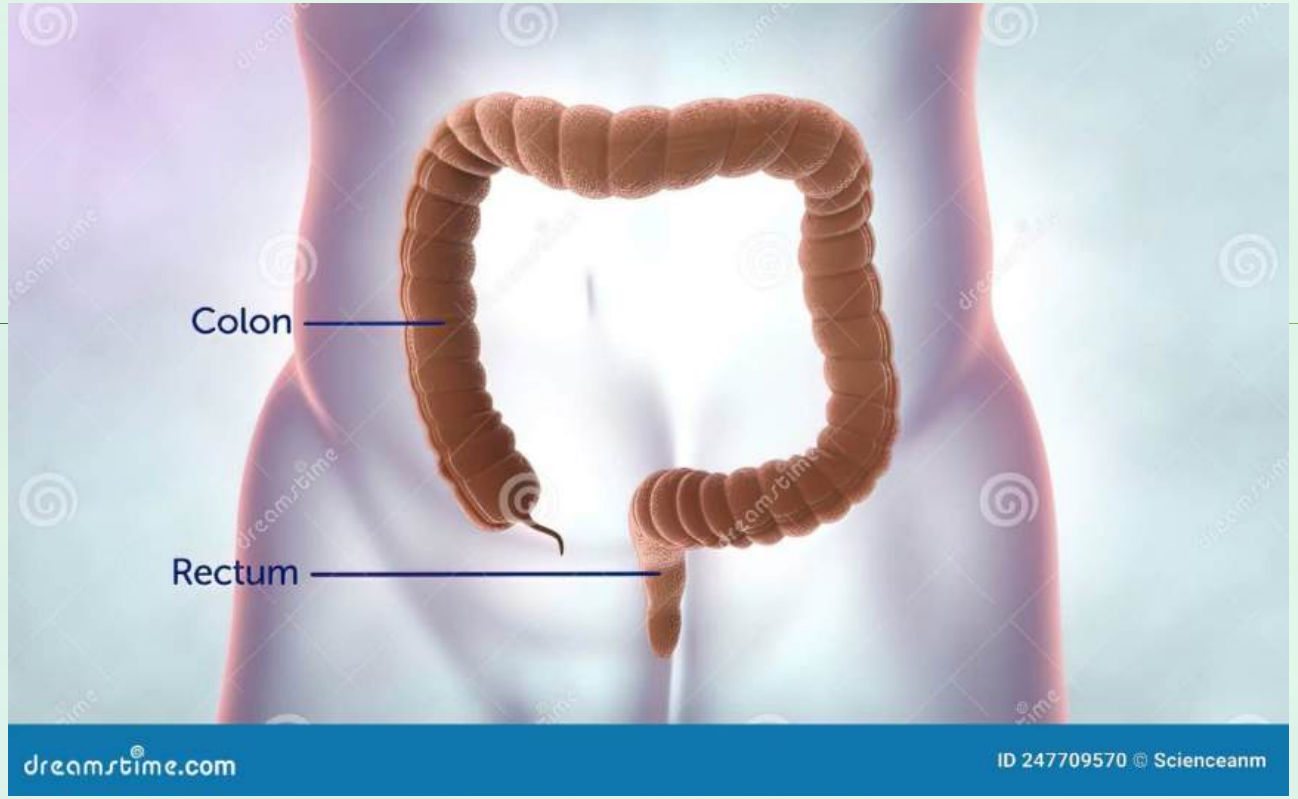
Key Facts

- Source: Upper GI in **>90%** of cases
- Can also arise from small bowel or right colon if **transit is slow**
- Requires approximately **50–200 mL** of blood in the GI tract

> Melena ≠ always upper GI, but strongly suggests it.



Hematochezia: In Depth



Definition

Passage of **fresh red blood per rectum**, typically indicating a lower GI source.

Sources

- Typically: **colon, rectum, anus**
- Exception: **Massive upper GI bleeding** with rapid transit may also present as hematochezia

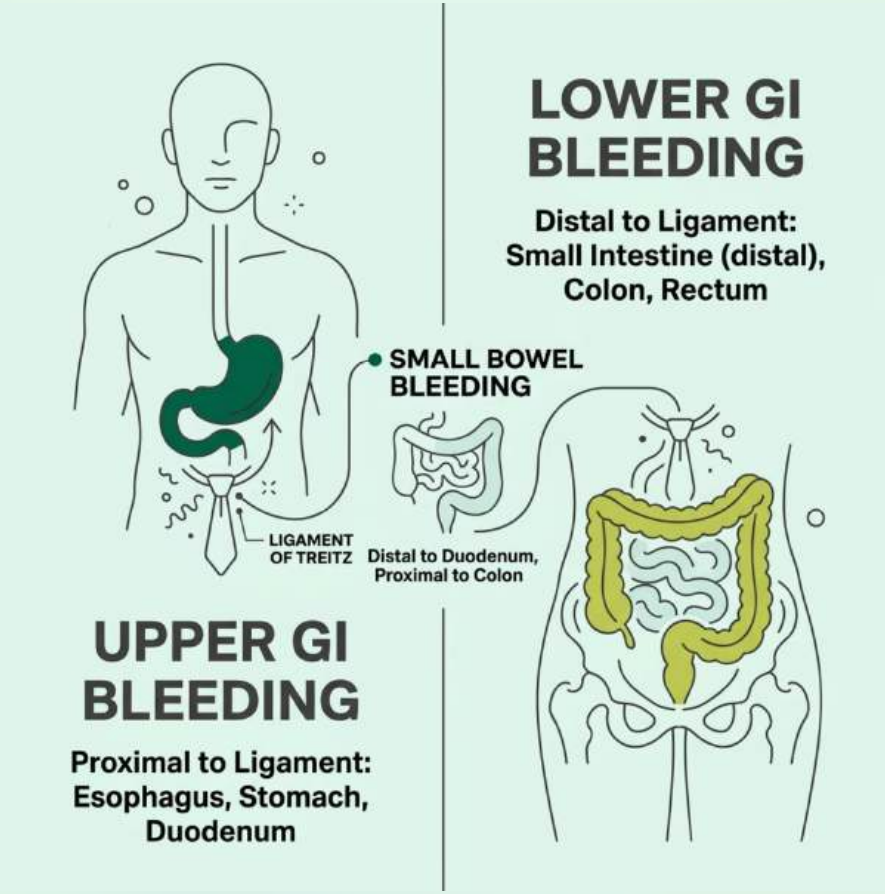
Hematochezia from an upper GI source implies massive, life-threatening hemorrhage.

Comparing the Three Clinical Forms

Feature	Hematemesis	Melena	Hematochezia
Appearance	Vomited blood (red or coffee-ground)	Black, tarry stool	Bright red blood per rectum
Usual source	Upper GI	Upper GI (mostly)	Lower GI
Blood digested?	No	Yes	No
Severity implication	Often acute	Subacute/recent	Variable (can be massive)

CHAPTER 2

Classification of GI Bleeding



Anatomical Classification

The Ligament of Treitz is the anatomical landmark dividing upper from lower GI bleeding.

- UGIB: Esophagus, stomach, duodenum
- LGIB: Distal small intestine, colon, rectum
- Small bowel bleeding: Intermediate; hardest to diagnose

Clinical Classification

Acute vs. Chronic

Acute: sudden onset, hemodynamic impact. Chronic: slow, insidious, often occult.

Overt vs. Occult

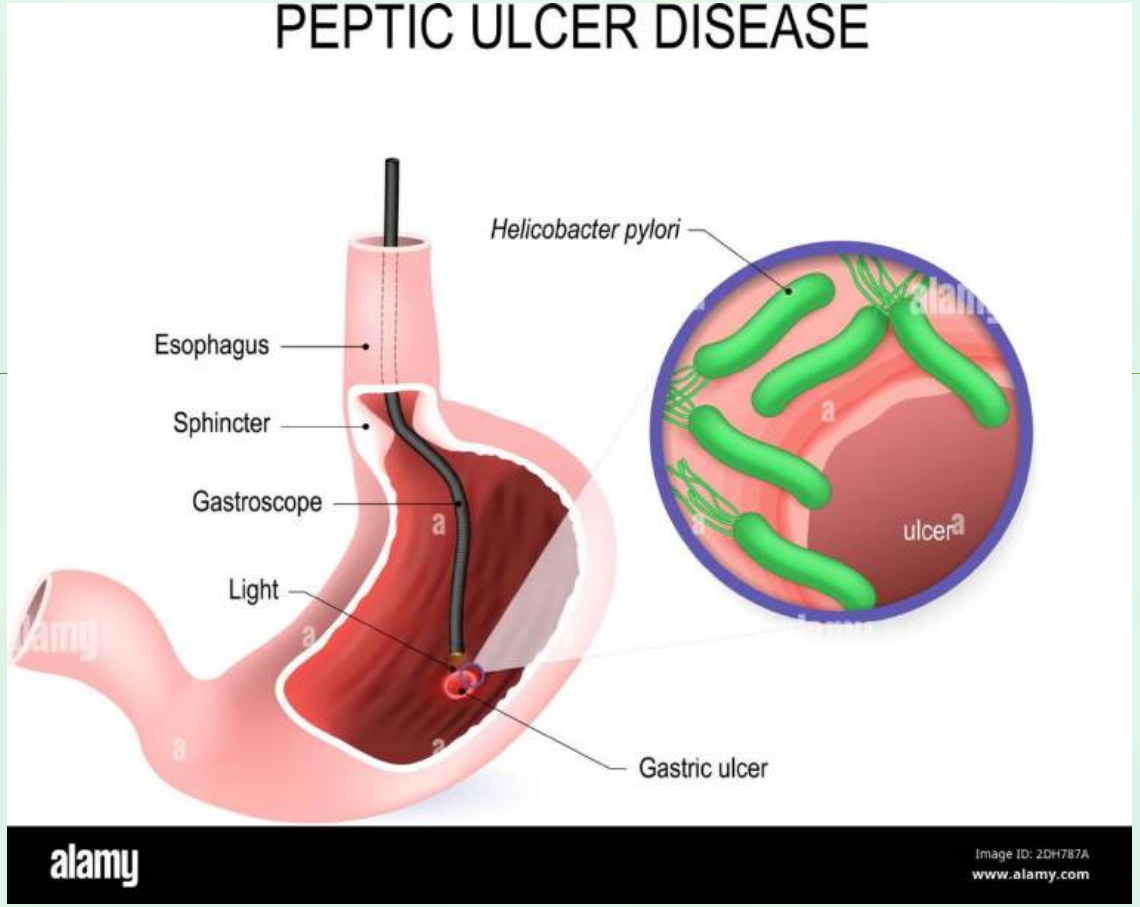
Overt: visible bleeding. Occult: detected only by FOBT or iron-deficiency anemia workup.

Severity

Mild – stable vitals. Moderate – some instability. Severe – hemodynamic instability, shock.

CHAPTER 3

Etiology: Upper GI Bleeding



Most Common Causes

- **Peptic Ulcer Disease (PUD)**

  Most frequent cause of UGIB overall

- **Esophageal Varices**

  Due to portal hypertension (cirrhosis)

- **Mallory–Weiss Tear**

  Post-vomiting mucosal tear at GEJ

- **Gastritis / Esophagitis / Duodenitis**

  Mucosal inflammation and erosion

Etiology: Upper GI Bleeding (cont.)

Malignancies

Gastric and esophageal cancers can erode vessels, causing significant hemorrhage.

Angiodysplasia

Abnormal, fragile mucosal vessels prone to bleeding; more common in elderly.

Dieulafoy Lesion

Large submucosal artery eroding through mucosa; rare but causes massive bleeding.

Etiology: Lower GI Bleeding

Common Causes

Diverticulosis

Most common cause of LGIB in adults

Colorectal Cancer

Chronic occult or overt bleeding

Polyps

Benign lesions that may bleed

IBD

Crohn's disease & ulcerative colitis

Additional Causes

Infectious Colitis

Bacterial or viral mucosal injury

Ischemic Colitis

Vascular insufficiency to colon wall

Hemorrhoids / Anal Fissures

Most common anorectal cause

Angiodysplasia

Vascular malformations in colon

Systemic Risk Factors & Medications

Liver Disease / Cirrhosis

Portal hypertension → esophageal and gastric varices; coagulopathy from impaired clotting factor synthesis.

Coagulopathies

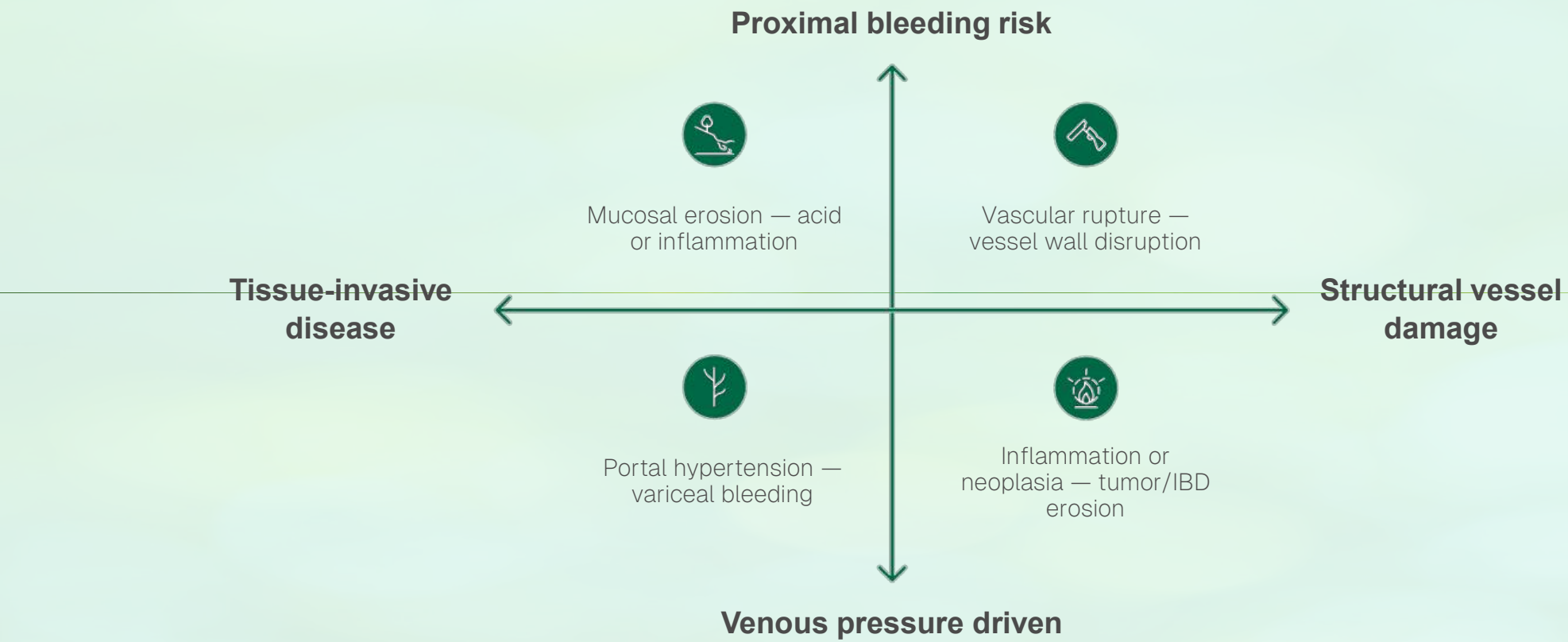
Inherited or acquired clotting disorders increase bleeding risk throughout the GI tract.

Medications

NSAIDs (mucosal damage), anticoagulants (warfarin, DOACs), antiplatelets (aspirin, clopidogrel).

CHAPTER 4

Pathophysiology of GI Bleeding



The clinical presentation depends on the **location**, **rate of bleeding**, and **intestinal transit time** — which together determine whether hematemesis, melena, or hematochezia occurs.

Clinical Presentation

General Symptoms

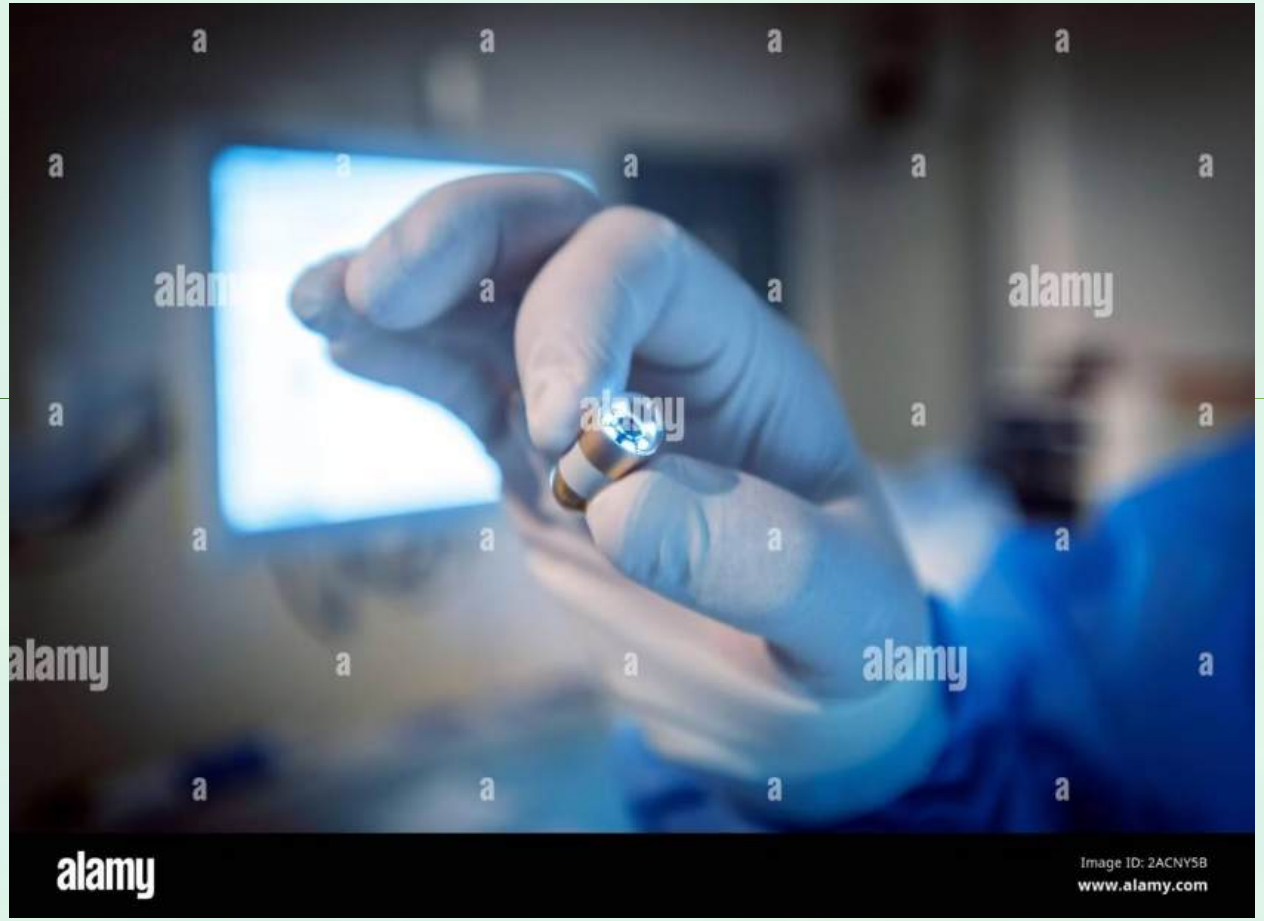
- Hematemesis, melena, or hematochezia
- Weakness and dizziness
- Syncope
- Abdominal pain (sometimes)

Signs of Severe Bleeding

- Hypotension
- Tachycardia
- Shock
- Pallor

Severe GIB is a **medical emergency** requiring immediate evaluation and resuscitation.

Small Bowel Bleeding



The Diagnostic Challenge

Small bowel bleeding lies **between UGIB and LGIB** — beyond the reach of standard endoscopy and above the colon.

Why It's Difficult

- Standard EGD and colonoscopy cannot visualize it
- Presentation may be occult or intermittent

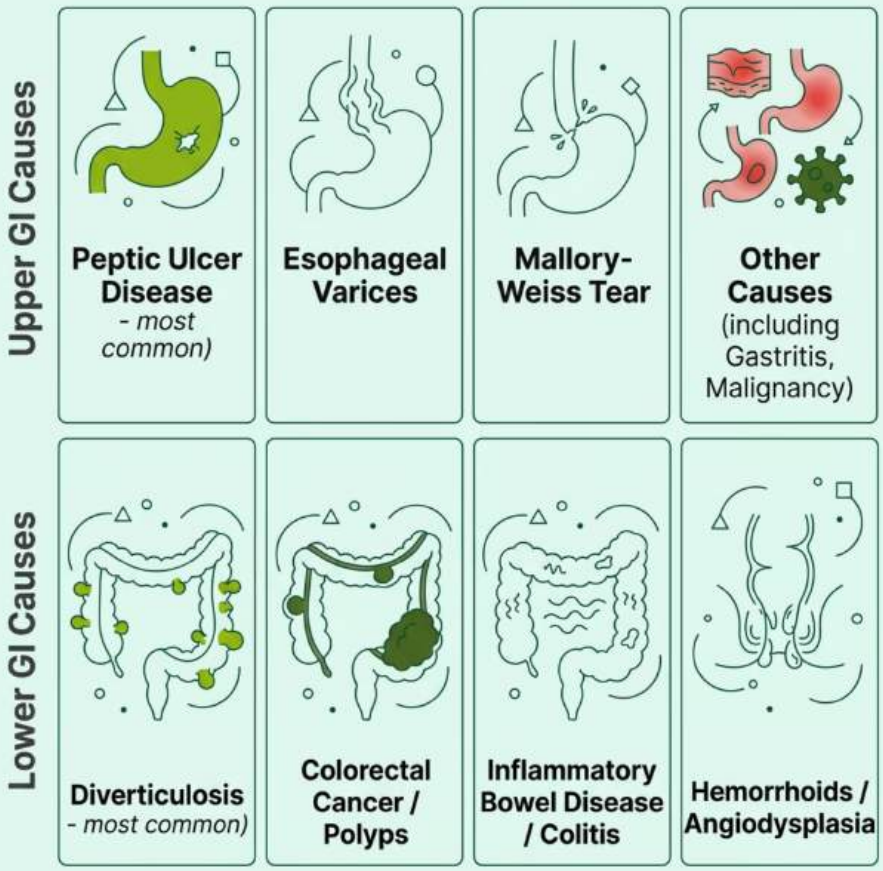
Diagnostic Tools

- **Capsule endoscopy** — first-line for small bowel
- **Device-assisted enteroscopy** (push or balloon)
- **CT angiography** — for active bleeding

Diagnostic Approach Overview

Initial priority is always hemodynamic stabilization — diagnosis comes second. Endoscopy is both diagnostic and potentially therapeutic.

Etiology at a Glance



Key Takeaway

Peptic ulcer disease is the single most common cause of upper GI bleeding.

Diverticulosis is the most common cause of lower GI bleeding in adults.

Always consider medications (NSAIDs, anticoagulants) and liver disease as contributing risk factors in any GIB patient.

Key Clinical Pearls

1 **Melena ≠ always upper GI**

But it strongly suggests it (>90% of cases are upper GI origin).

2 **Hematochezia can be upper GI**

Only if bleeding is massive with rapid intestinal transit — a dangerous sign.

3 **Coffee-ground = slower bleeding**

Oxidized hemoglobin indicates bleeding has slowed or stopped — not necessarily benign.

4 **Hemodynamic status first**

Always assess and stabilize vitals before pursuing diagnosis.

Summary

Definition

GIB = hemorrhage anywhere from oral cavity to anus; overt or occult

Clinical Forms

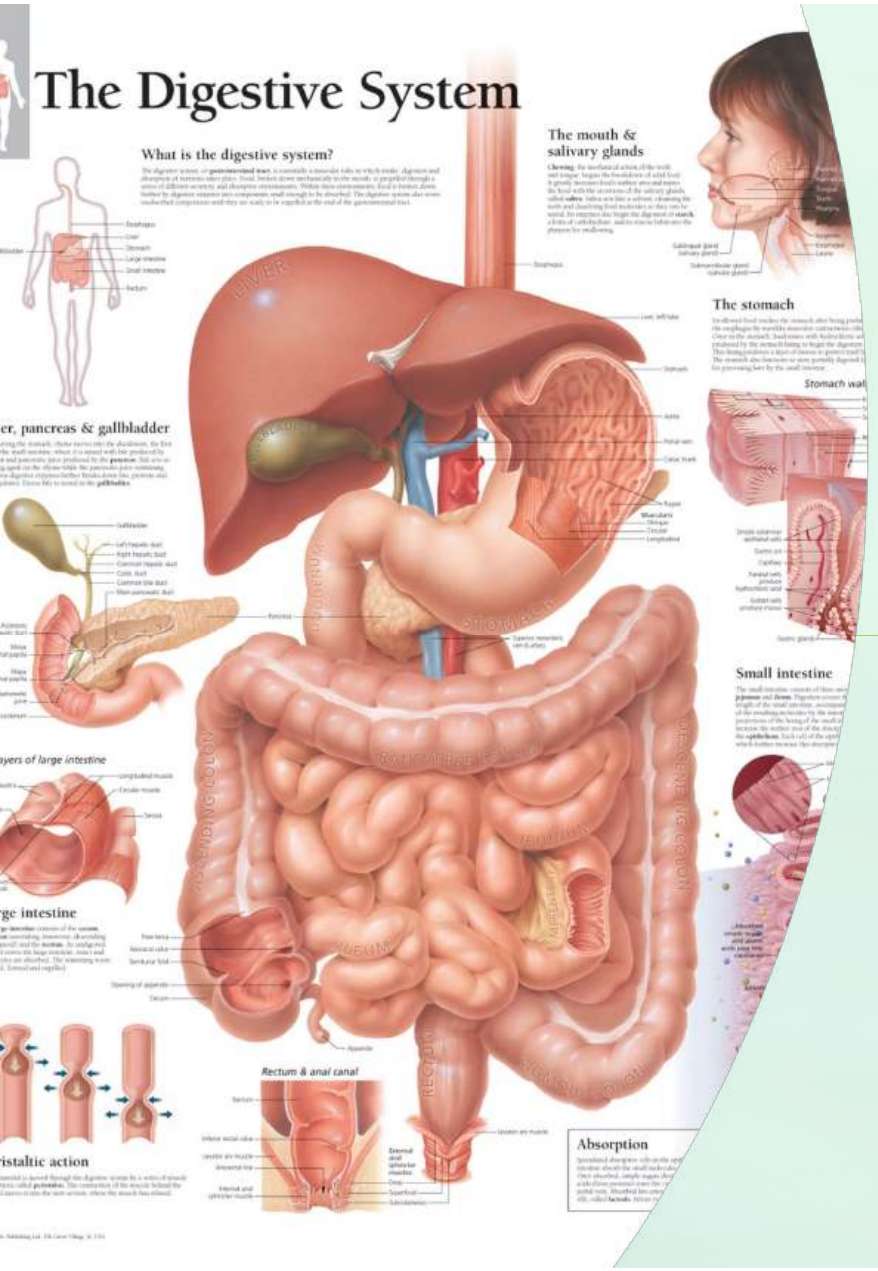
Hematemesis (upper), Melena (upper, mostly), Hematochezia (lower, usually)

Classification

Anatomical (UGIB/LGIB/small bowel) + Clinical (acute/chronic, overt/occult, severity)

Top Causes

UGIB: PUD, varices. LGIB: diverticulosis, colorectal cancer. Risk factors: NSAIDs, anticoagulants, cirrhosis



Maldigestion & Malabsorption

A medical-school level synthesis of causes, mechanisms, consequences, and symptoms — structured for clinical understanding.

GASTROENTEROLOGY

MEDICAL SCHOOL

Definitions & Conceptual Distinction

Maldigestion

Impaired **intraluminal breakdown** of nutrients — defective hydrolysis of macromolecules before absorption can occur.

Malabsorption

Impaired **transport of nutrients** across the intestinal mucosa into blood or lymph after digestion.

In clinical practice these processes overlap — the term **malabsorption syndrome** frequently includes both. *(NCBI, NBK553106)*

Normal Physiology: Three Sequential Phases

Luminal Phase

Mucosal Phase

Postabsorptive Phase

Failure in **any phase** leads to malabsorption syndrome. Understanding which phase is disrupted guides diagnosis and treatment. *(MSD Manuals)*

Causes: Maldigestion (Luminal Defects)

Pancreatic Insufficiency

Chronic pancreatitis, cystic fibrosis → ↓ lipase → fat maldigestion

Bile Deficiency

Cholestasis, liver disease → ↓ micelle formation → fat malabsorption

Gastric Dysfunction

Hypochlorhydria → impaired protein digestion in the stomach

[Exocrine functions of the pancreas | Deranged Physiology]

TABLE 1.

Digestive Enzymes Secreted by the Pancreas

Enzyme	Target
Amylolytic enzymes	
Amylase	alpha-1,4-glycosidic bonds in starch
Lipolytic enzymes	
Lipase	Triglyceride, producing fatty acids and 2-monoglycerides
Phospholipase A2	Phosphotidylcholine, producing a free fatty acid and lysophospho dylcholine
Carboxylesterase	Cholesterol esters, lipid-soluble vitamin esters, and glycerides (tri-, di-, or monoglycerides)
Proteolytic enzymes	
Trypsin	Interior peptide bonds involving basic amino acids
Chymotrypsin	Interior peptide bonds involving aromatic amino acids
Carboxypeptidase A and B	External peptide bonds involving aromatic and neutral aliphatic amino acids (A) and basic amino acids (B) at the carboxy-terminal e
Elastase	Interior peptide bonds involving neutral aliphatic amino acids
Nucleases	
Deoxyribonuclease (DNAse)	Endonuclease that splits phosphodiester linkages adjacent to pyrimidine nucleotide
Ribonuclease (RNAse)	Catalyzes the breakdown of RNA

Adapted from Henderson.[1]

Causes: Malabsorption (Mucosal & Transport Defects)

Mucosal Damage

Celiac disease, Crohn's, Giardia, Whipple → villous atrophy → ↓ absorptive surface

Enzyme Deficiency

Lactase deficiency → carbohydrate malabsorption

Short Bowel Syndrome

Post-resection → reduced absorptive surface area

Lymphatic Obstruction

Lymphangiectasia, lymphoma → impaired fat transport via lymphatics

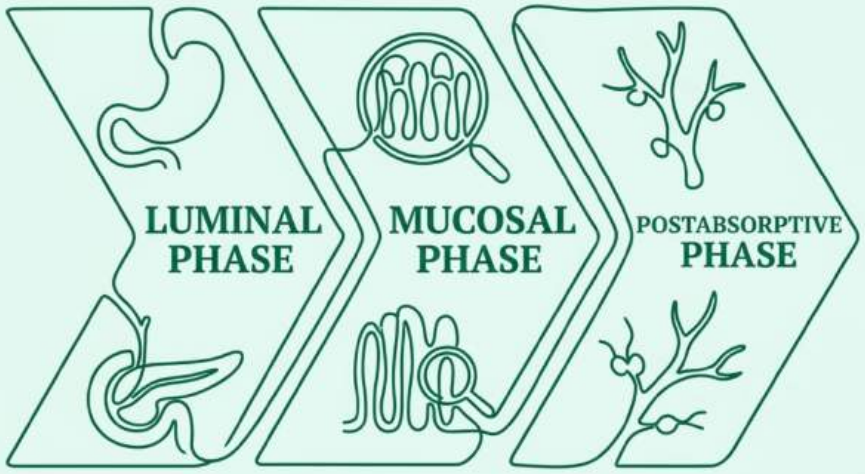
SIBO

Bacteria consume nutrients + deconjugate bile salts → malabsorption

Motility Disorders

Rapid transit → insufficient contact time for absorption

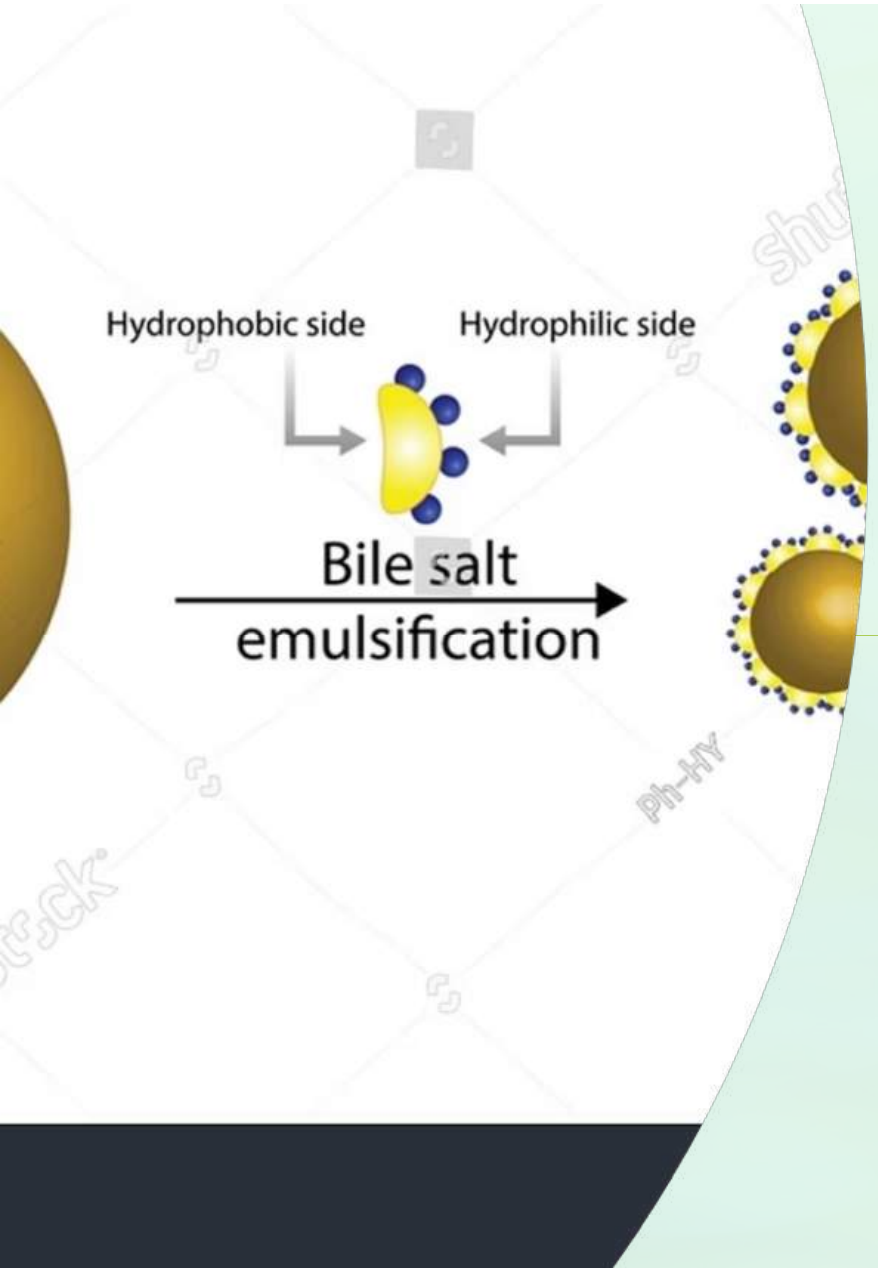
Etiology Classification by Phase



Phase-Based Diagnosis

Identifying the affected phase is the cornerstone of clinical workup. Each phase has distinct diagnostic tests and treatment strategies.

Phase	Example
Luminal	Pancreatic insufficiency
Mucosal	Celiac disease
Postabsorptive	Lymphatic obstruction



Mechanism: Fat Malabsorption & Steatorrhea

1

Trigger

↓ Lipase or ↓ Bile salts

2

Defect

↓ Micelle formation → unabsorbed fats in lumen

3

Consequence

Steatorrhea + fat-soluble vitamin binding (A, D, E, K)

Source: MSD Manuals — Overview of Malabsorption

Mechanism: Carbohydrate Malabsorption

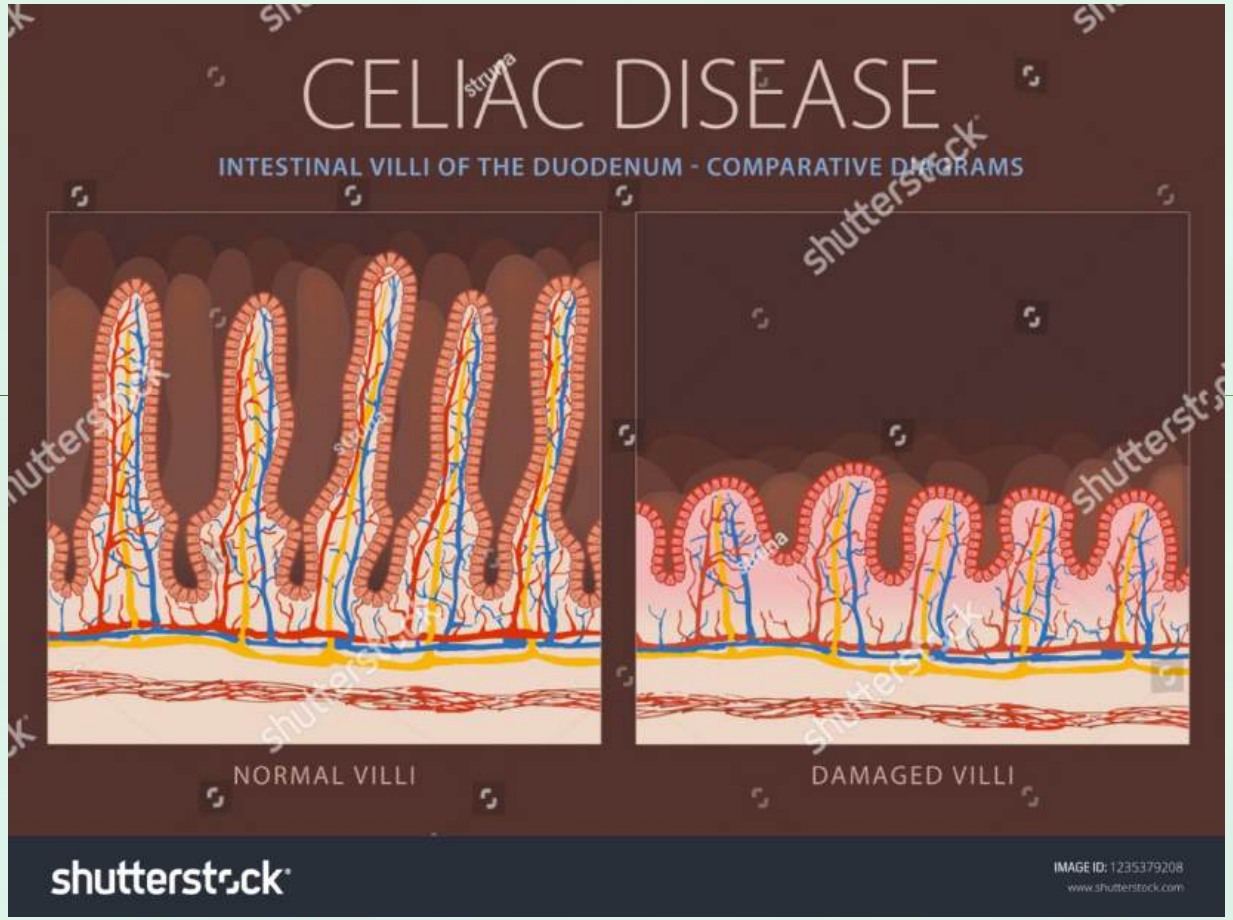
Undigested carbs → **Bacterial fermentation** → **Gas & osmotic diarrhea**

Key Clues

- Gas and bloating after meals
- Osmotic diarrhea (unabsorbed solutes retain water)
- Positive hydrogen breath test

Lactase deficiency is the most common enzyme deficiency worldwide.

Mechanism: Protein Malabsorption



Pathophysiology

↓ Proteases or mucosal damage → ↓ amino acid uptake into enterocytes

Hypoproteinemia

↓ Serum albumin → reduced oncotic pressure

Edema

Fluid shifts into interstitial space → peripheral edema

Diarrhea Mechanisms

Osmotic Diarrhea

Unabsorbed nutrients retain water in the intestinal lumen, increasing osmotic load and stool volume.

Secretory Diarrhea

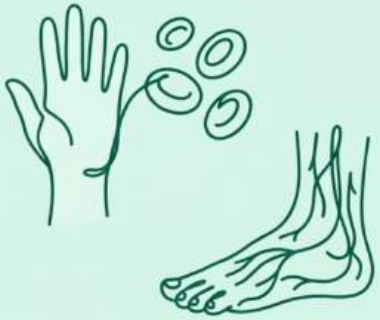
Unabsorbed bile acids stimulate colonic secretion of water and electrolytes.

Rapid Transit

Reduced contact time worsens both osmotic and secretory mechanisms, amplifying fluid loss.

Systemic Nutritional Failure

MACRONUTRIENT DEFICIENCY: ENERGY DEFICIT, WEIGHT LOSS, MUSCLE WASTING, CACHEXIA.



MICRONUTRIENT DEFICIENCY: ORGAN-SPECIFIC DYSFUNCTION (IRON, VIT D, VIT K, VIT B12 DEFICIENCY).

Micronutrient Deficiencies

Nutrient	Consequence
Iron	Anemia
Vitamin D	Osteomalacia
Vitamin K	Coagulopathy
Vitamin B12	Neuropathy

GI Clinical Consequences

Chronic Diarrhea

Most common presenting symptom; often the first clinical sign

Steatorrhea

Pale, greasy, bulky, floating stools — hallmark of fat malabsorption

Bloating & Flatulence

Gas production from bacterial fermentation of unabsorbed carbohydrates

Systemic Clinical Consequences

Growth Failure

Stunted growth and delayed development in children with chronic malabsorption.

Neurological

Vitamin B12 deficiency → peripheral neuropathy, subacute combined degeneration.

Immune Dysfunction

Protein-energy malnutrition impairs immune response; increased infection susceptibility.

Electrolyte Imbalance

Chronic diarrhea → hypokalemia, hyponatremia, metabolic acidosis.

Severe, untreated malabsorption → multisystem disease. *(NCBI, NBK553106)*

Early Symptoms (Gastrointestinal)

Chronic diarrhea

Persistent, often watery or fatty stools

Abdominal distension

Bloating and visible distension after meals

Flatulence & Nausea

Gas, belching, and nausea from fermentation

Steatorrhea

Greasy, pale, floating, foul-smelling stools

Late Symptoms (Malnutrition-Related)

1

Weight Loss

Despite adequate oral intake — energy not absorbed

2

Fatigue & Anemia

Iron, B12, folate deficiency → pallor, weakness

3

Edema

Hypoalbuminemia → peripheral fluid accumulation

4

Bone Pain

Vitamin D deficiency → osteomalacia, fracture risk

5

Hair & Skin Changes

Micronutrient deficiencies → alopecia, dermatitis

Classic Clinical Triad

Steatorrhea + Weight Loss + Diarrhea

This triad is the **key clinical hallmark** of malabsorption syndrome and should prompt systematic workup for underlying etiology.

Fat Clues

Floating greasy stool + fat-soluble vitamin deficiency

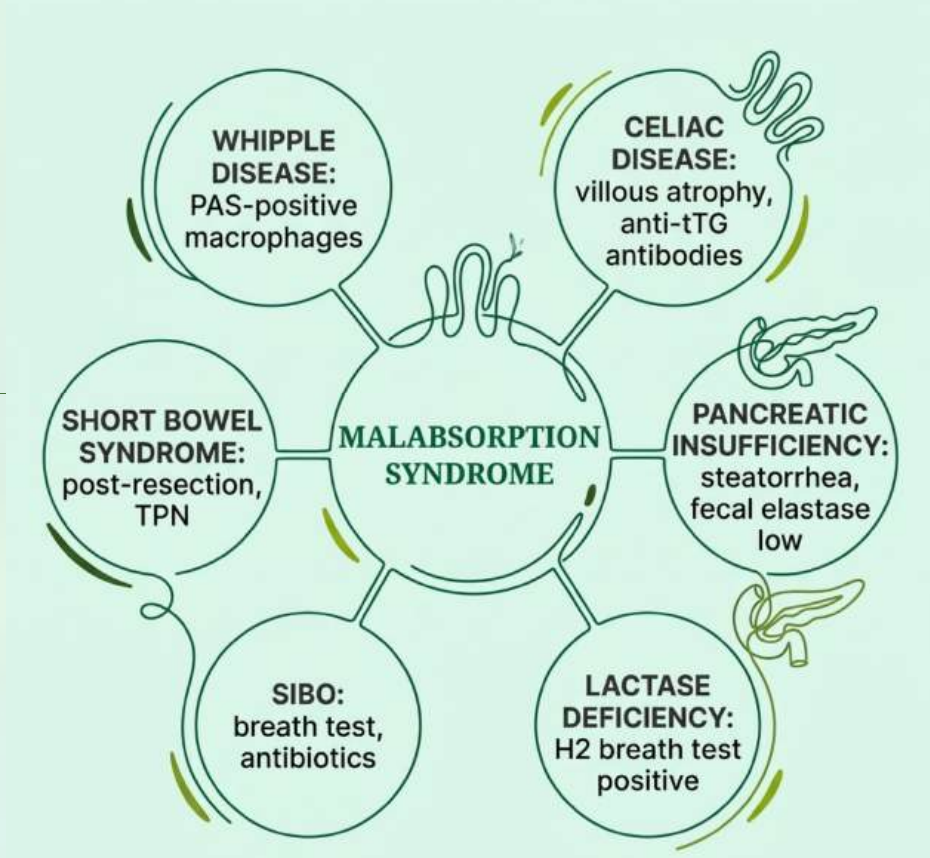
Carb Clues

Gas + bloating after meals + positive H_2 breath test

Protein Clues

Peripheral edema + ↓ albumin on labs

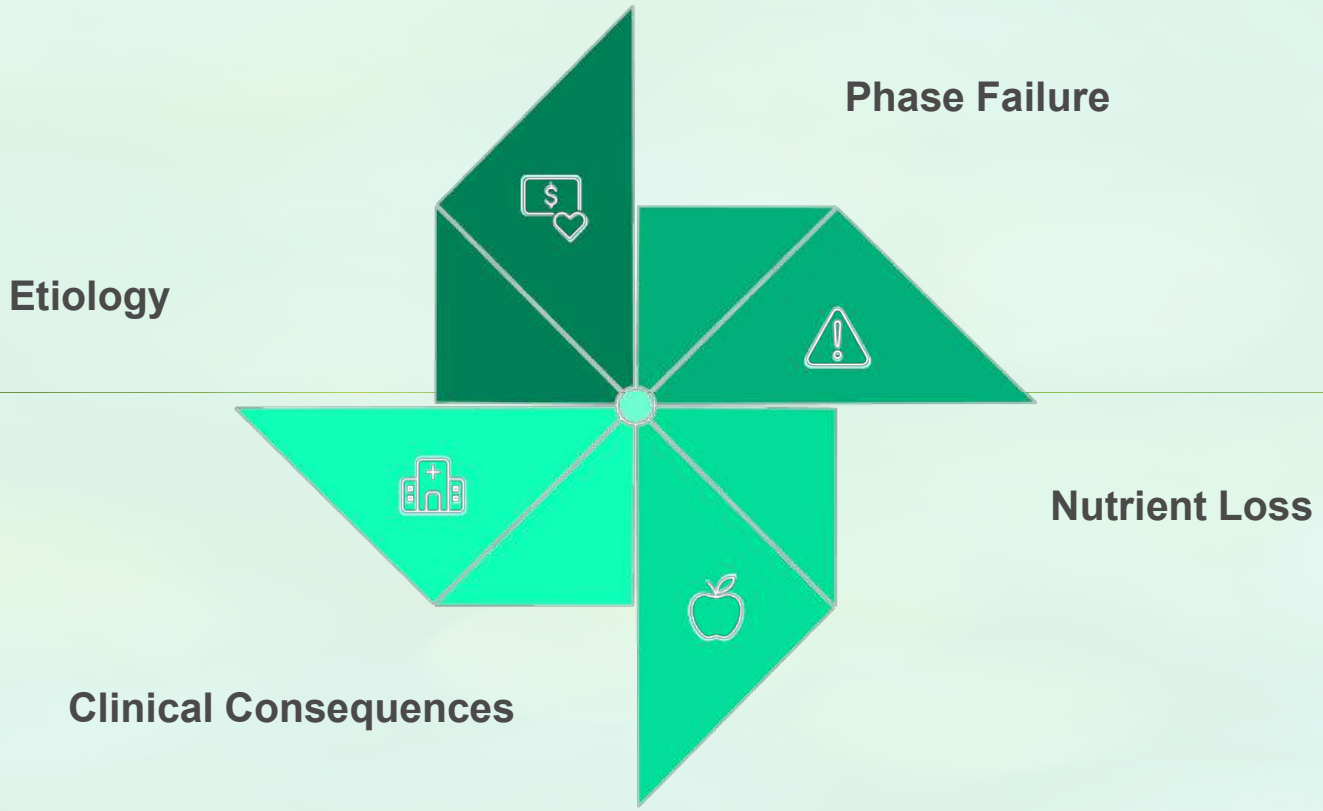
High-Yield Clinical Correlations



Exam-Focused Associations

Disease	Key Test
Celiac	Anti-tTG IgA, biopsy
Pancreatic insuff.	Fecal elastase
Lactase deficiency	H_2 breath test
SIBO	Glucose breath test
Whipple disease	PAS+ macrophages

Pathophysiology Summary Diagram



The cascade from etiology to clinical consequence follows a predictable pattern — identifying the disrupted phase guides targeted investigation and management.

Key Takeaways

01

Maldigestion = Breakdown Problem

Defective intraluminal hydrolysis of macromolecules (luminal phase)

02

Malabsorption = Uptake/Transport Problem

Defective mucosal or postabsorptive nutrient transport

03

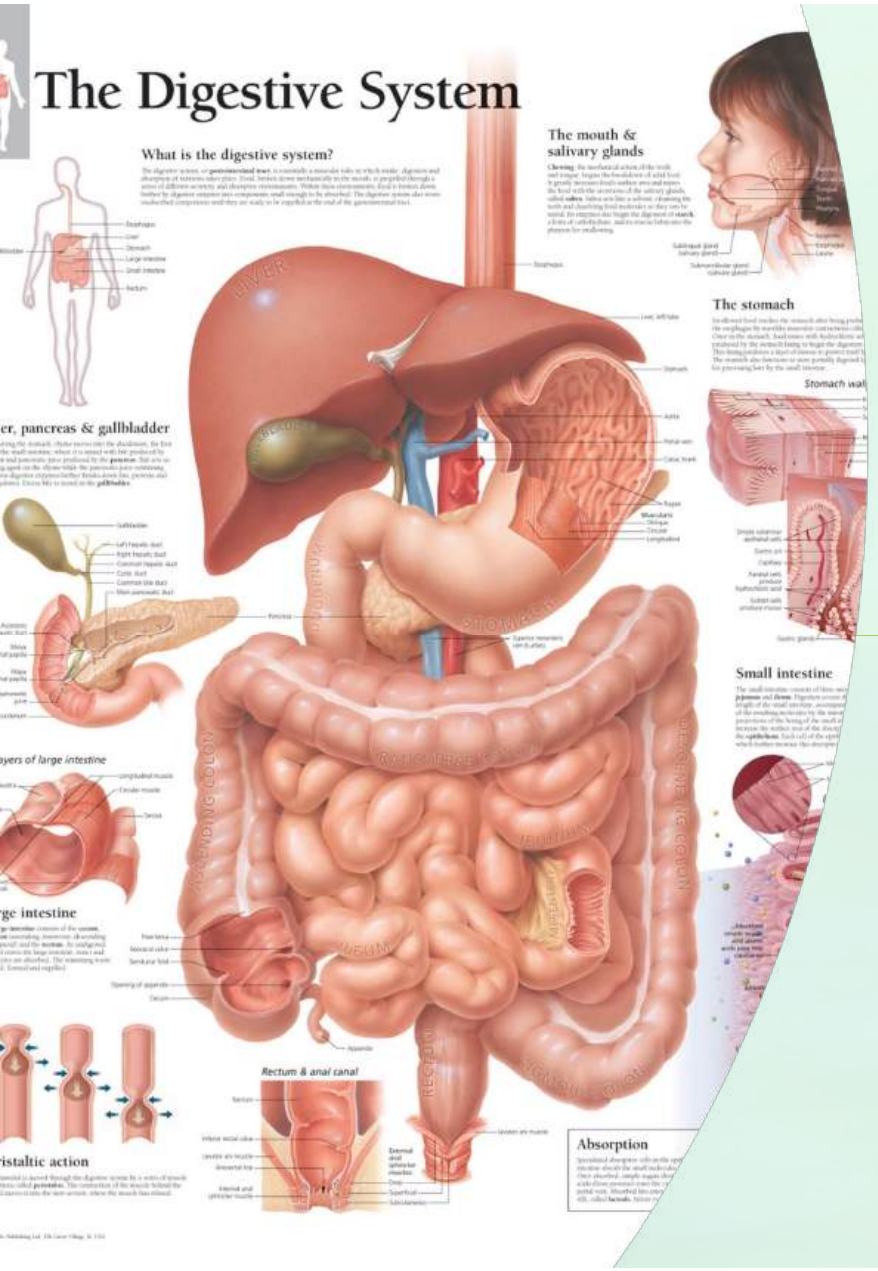
Most Diseases Involve Both

Mechanisms overlap; the small intestine is the central organ of pathology

04

Clinical Spectrum

Ranges from mild GI symptoms to severe multisystem disease



Diarrhea

A Comprehensive Overview for Medical Students Pathological Physiology · Etiology · Classification · Mechanisms · Symptoms

PATHOLOGICAL PHYSIOLOGY

MEDICAL SCHOOL

What Is Diarrhea?

Clinical Definition

- ≥3 loose or watery stools per day
- Increased stool frequency and/or decreased consistency compared to normal bowel habits
- Research setting: stool weight >200–300 g/day

Diarrhea reflects an imbalance between intestinal secretion and absorption of water and electrolytes.

Key Pathophysiological Concept

Diarrhea results from one or more of the following fundamental mechanisms:

↓ Intestinal Absorption

Reduced uptake of water and electrolytes from the gut lumen

↑ Secretion

Active secretion of water and electrolytes into the intestinal lumen

↑ Intestinal Motility

Accelerated transit reduces contact time for absorption

Etiology: Infectious Causes

Most common in acute diarrhea — typically self-limited

Viral

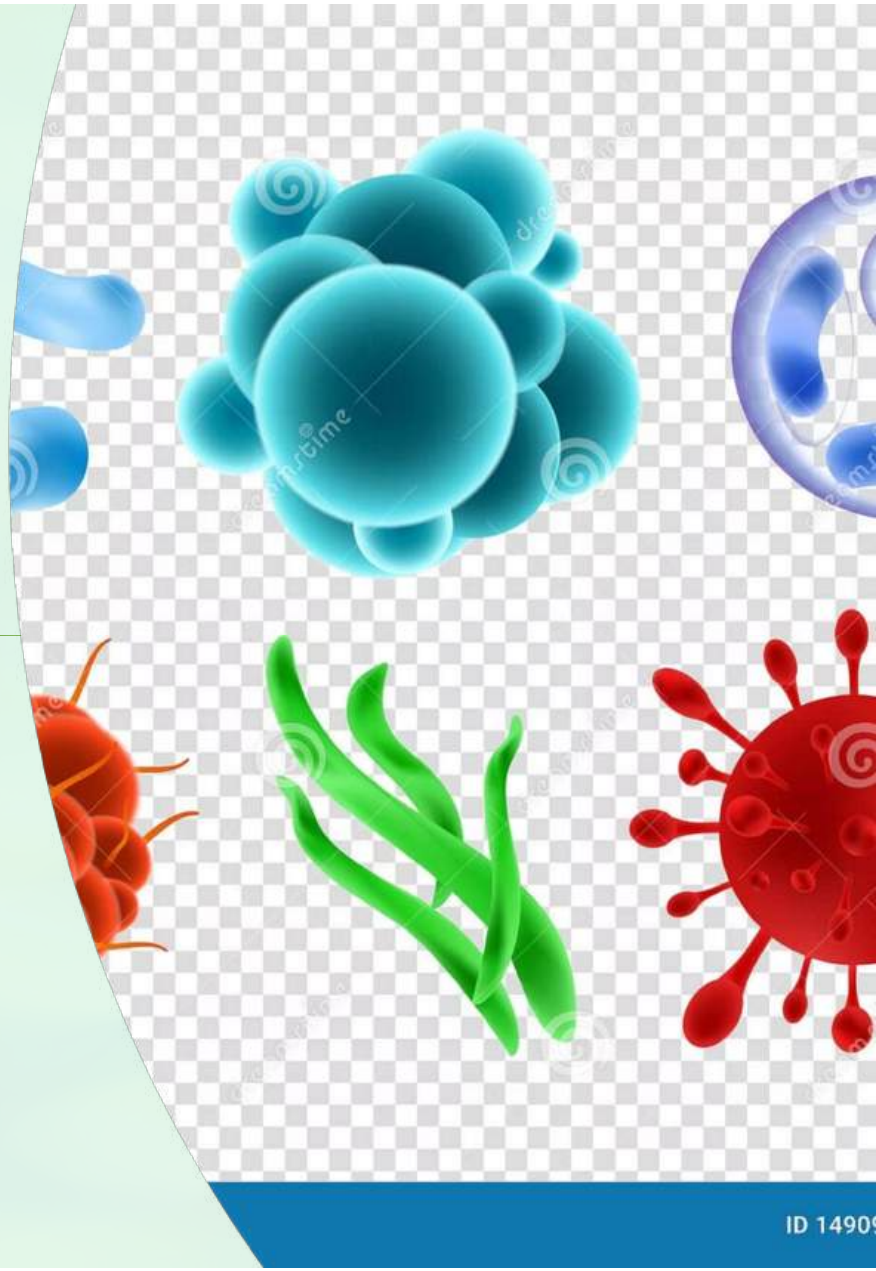
- Norovirus
- Rotavirus

Bacterial

- E. coli, Salmonella
- Shigella
- Vibrio cholerae

Parasitic

- Giardia
- Entamoeba histolytica



Etiology: Non-Infectious Causes

Inflammatory
IBD, Microscopic colitis

Malabsorption
Celiac disease, Chronic pancreatitis

Functional
Irritable bowel syndrome (IBS)

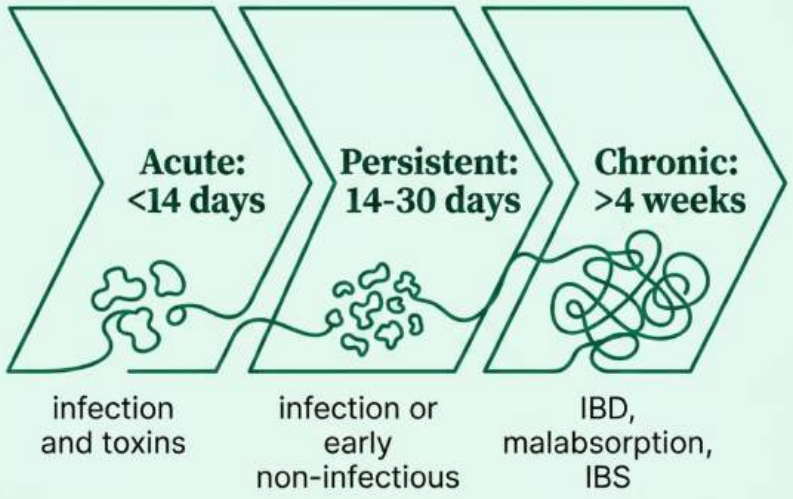
Endocrine/Metabolic
Hyperthyroidism, Diabetes mellitus

Drug-Induced
Antibiotics (→ C. difficile), Laxatives, Chemotherapy

Osmotic Agents
Lactose intolerance, Sorbitol ingestion

Classification by Duration

Duration-based classification is the **first step** in clinical evaluation and guides the diagnostic workup.



Acute <14 days

Infection, toxins — usually self-limited

Persistent 14–30 days

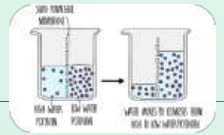
Infection ± early non-infectious etiology

Chronic >4 weeks

IBD, malabsorption syndromes, IBS

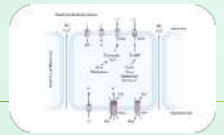
Classification by Pathophysiology

Understanding the mechanism is essential for targeted diagnosis and treatment.



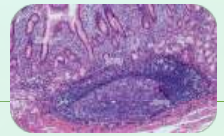
Osmotic

Non-absorbed solutes retain water in the lumen *Example: Lactose intolerance*



Secretory

Active secretion of electrolytes and water *Example: Cholera toxin*



Inflammatory (Exudative)

Mucosal injury → blood, pus, mucus *Example: IBD, invasive bacteria*

Motility-Related

Rapid transit reduces absorption time *Example: IBS*

Major Causes of Diarrheal Illnesses:

Secretory Diarrhea

Infectious:

1. Rotavirus
2. Caliciviruses
3. Enteric adenoviruses
4. Astroviruses

Infectious: endotoxin mediated

1. Vibrio cholera
2. Escherichia coli
3. Bacillus cereus
4. Clostridium perfringens

Neoplastic:

1. Tumor elaboration of peptide, serotonin or prostaglandins
2. Villous adenoma in distal colon (nonhormone mediated)

Excess in laxative usage

Osmotic Diarrhea

1. Disaccharides (lactase) deficiency
2. Lactulose therapy (for hepatic encephalopathy, constipation)
3. Perscribed gut lavage for diagnostic procedures
4. Antacids ($MgSO_4$ and other magnesium salts)
5. Primary bile acids malabsorption

Pathophysiology of diarrhea | PPT

Major Causes of Diarrheal Illnesses:	
Exudative Diseases	**Infectious: bacterial damage to mucosal epithelium** 1. Shigella 2. Salmonella 3. Campylobacter 4. Entamoeba hystolytica **Idiopathic inflammatory bowel disease**
Malabsorption	1. Defective intraluminal digestion 2. Primary mucosal cell abnormalities 3. Reduced small intestine surface area 4. Lymphatic obstruction 5. Infectious: Giardia lamblia infection

Pathophysiology of diarrhea | PPT

Major Causes of Diarrheal Illnesses:

Deranged Motility

Decreased intestinal transit time

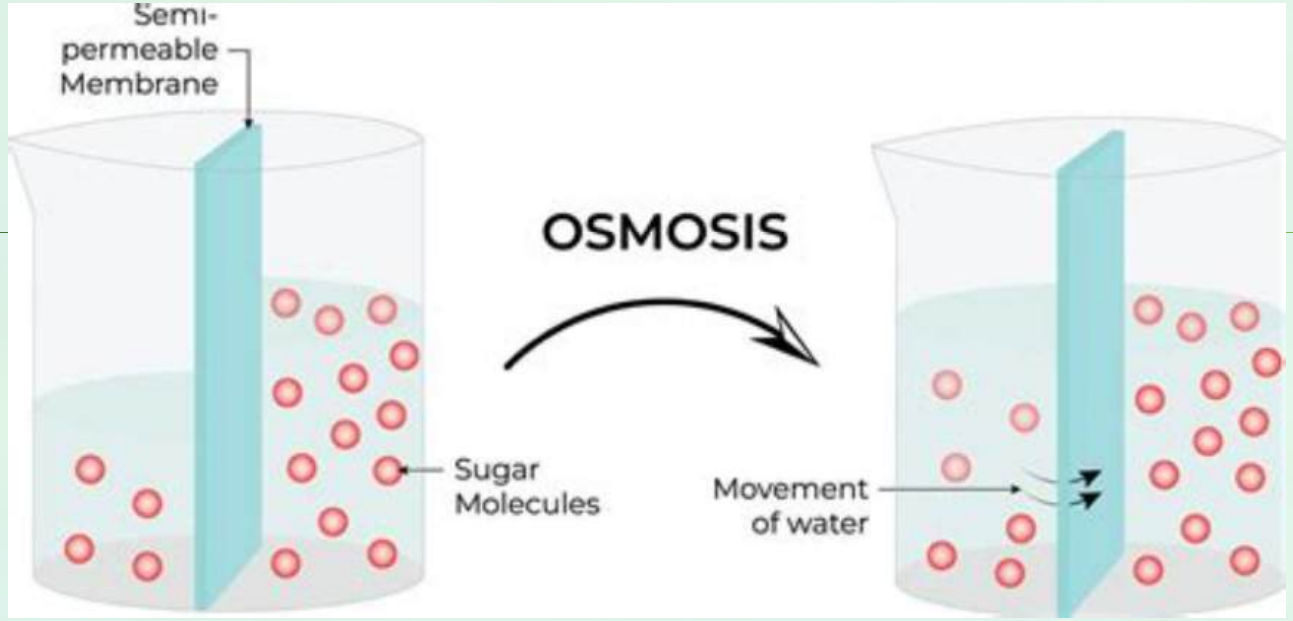
1. Surgical reduction of gut length
2. Neural dysfunction – IBS
3. Hyperthyroidism
4. Diabetic neuropathy
5. Carcinoid syndrome

Decreased motility (increased intestinal transit time)

1. Small intestine diverticula
2. Surgical creation of 'blind' intestinal loops
3. Bacterial overgrowth in small intestine

Pathophysiology of diarrhea | PPT

Osmotic Diarrhea — Deep Dive



Mechanism

Non-absorbable solutes accumulate in the intestinal lumen, creating an osmotic gradient that draws water into the gut.

- **Stops with fasting** — key distinguishing feature
- Stool osmotic gap **>125 mOsm/kg**
- Normal stool pH or acidic (fermentation)

Classic examples: Lactose intolerance, Sorbitol, Mg^{2+}-containing laxatives

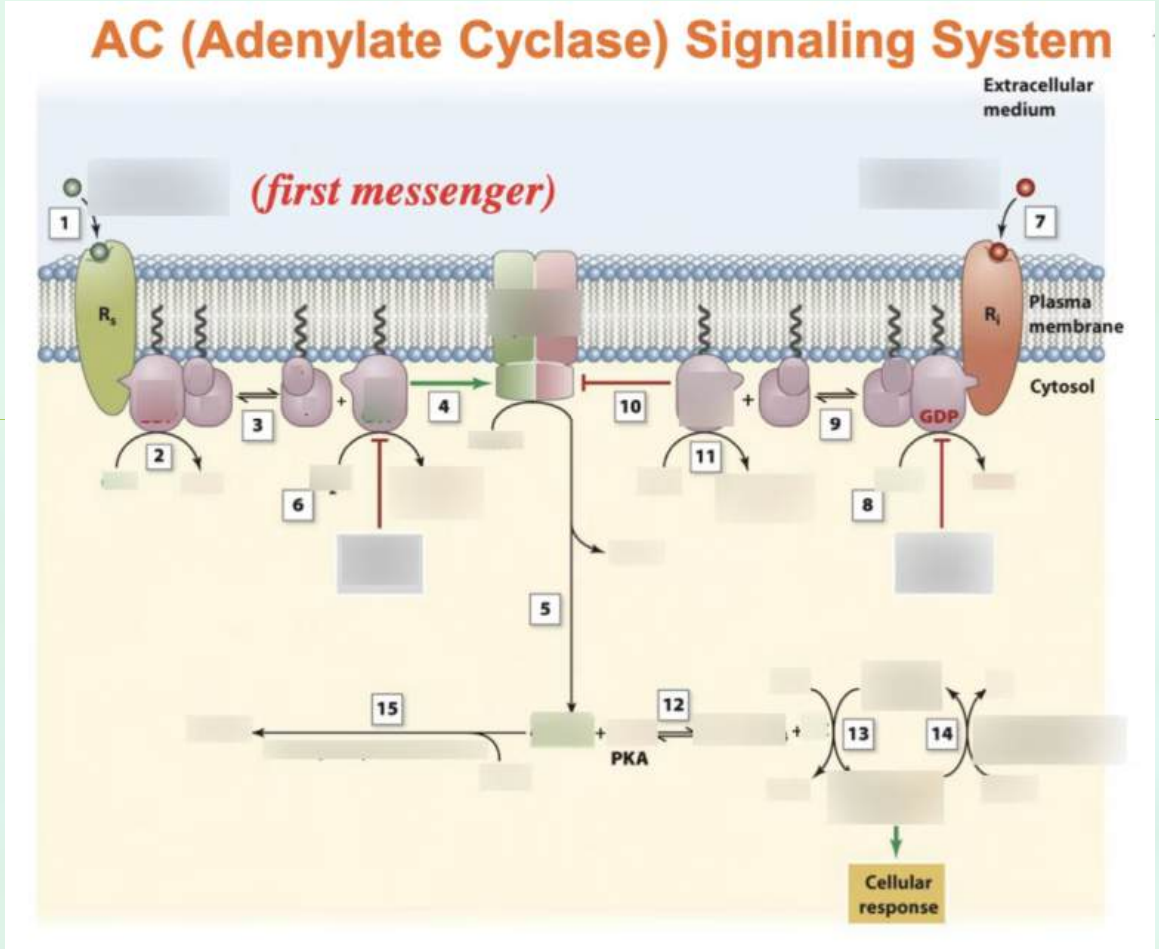
Secretory Diarrhea — Deep Dive

Mechanism

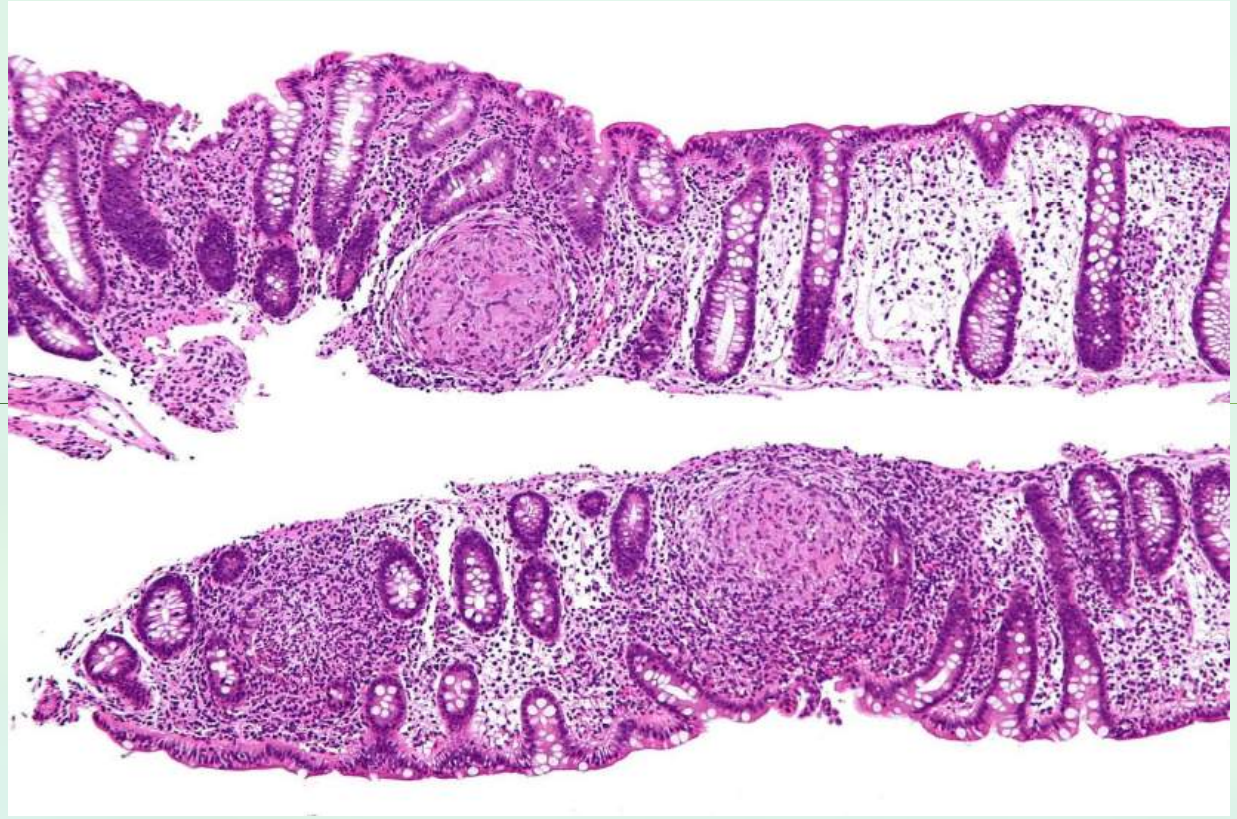
Abnormal activation of secretory pathways leads to massive electrolyte and water efflux into the lumen, overwhelming absorptive capacity.

- Persists with fasting — key distinguishing feature
- Large-volume, watery stools
- Stool osmotic gap <50 mOsm/kg

Classic example: Cholera toxin activates adenylyl cyclase → ↑ cAMP → Cl^- secretion



Inflammatory (Exudative) Diarrhea



Mechanism

Mucosal damage disrupts the epithelial barrier, leading to exudation of blood, pus, and mucus into the lumen.

- Positive fecal leukocytes / calprotectin
- Blood and mucus in stool
- Associated with fever and systemic signs

IBD (Crohn's, UC)

Invasive bacteria (Shigella, Salmonella)

Microscopic colitis

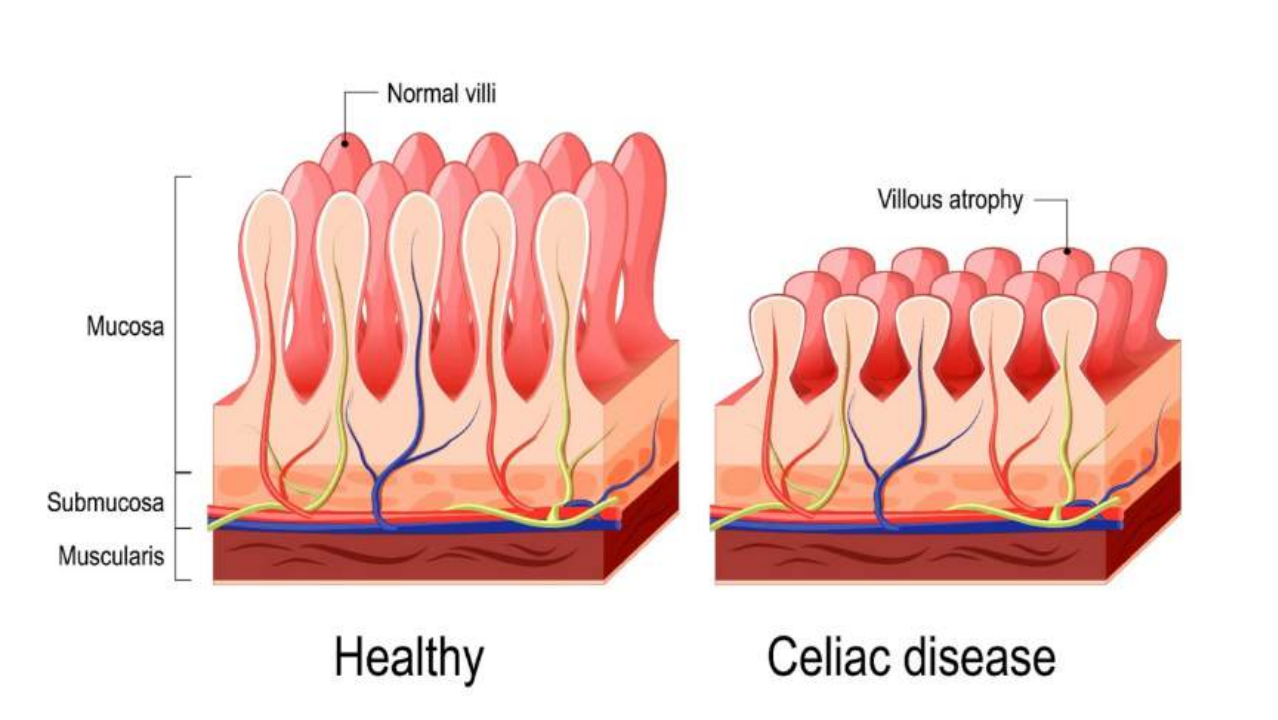
Malabsorptive (Fatty) Diarrhea

Mechanism

Impaired digestion or absorption of fats results in steatorrhea — fatty, foul-smelling, floating stools.

- Sudan stain positive for fat
- 72-hour fecal fat >7 g/day
- Associated with weight loss and nutritional deficiencies

Key causes: Celiac disease (mucosal damage), Chronic pancreatitis (enzyme deficiency), Bile acid deficiency



Classification by Stool Characteristics

Stool appearance provides immediate clinical clues to the underlying mechanism.

Watery

Secretory or osmotic mechanism
Large volume, no blood

Fatty (Steatorrhea)

Malabsorptive mechanism
Greasy, foul-smelling, floating

Inflammatory

Mucosal damage Blood, mucus, pus present

Small Bowel vs. Large Bowel Diarrhea

Localizing the source is critical for differential diagnosis.

Feature	Small Bowel	Large Bowel
Volume per stool	Large	Small
Frequency	Moderate	High
Blood in stool	Rare	Common
Pain location	Periumbilical	Lower abdomen
Tenesmus	No	Yes

Gastrointestinal Symptoms

Frequent loose stools

The cardinal symptom — ≥3/day by definition

Urgency & Tenesmus

Especially prominent in colonic (large bowel) disease

Abdominal cramps & Bloating

Caused by increased peristalsis and gas production

Systemic Symptoms & Complications

Systemic Signs

□ Fever

Suggests infection or inflammation

Nausea & Vomiting

Common in infectious etiology

Fatigue

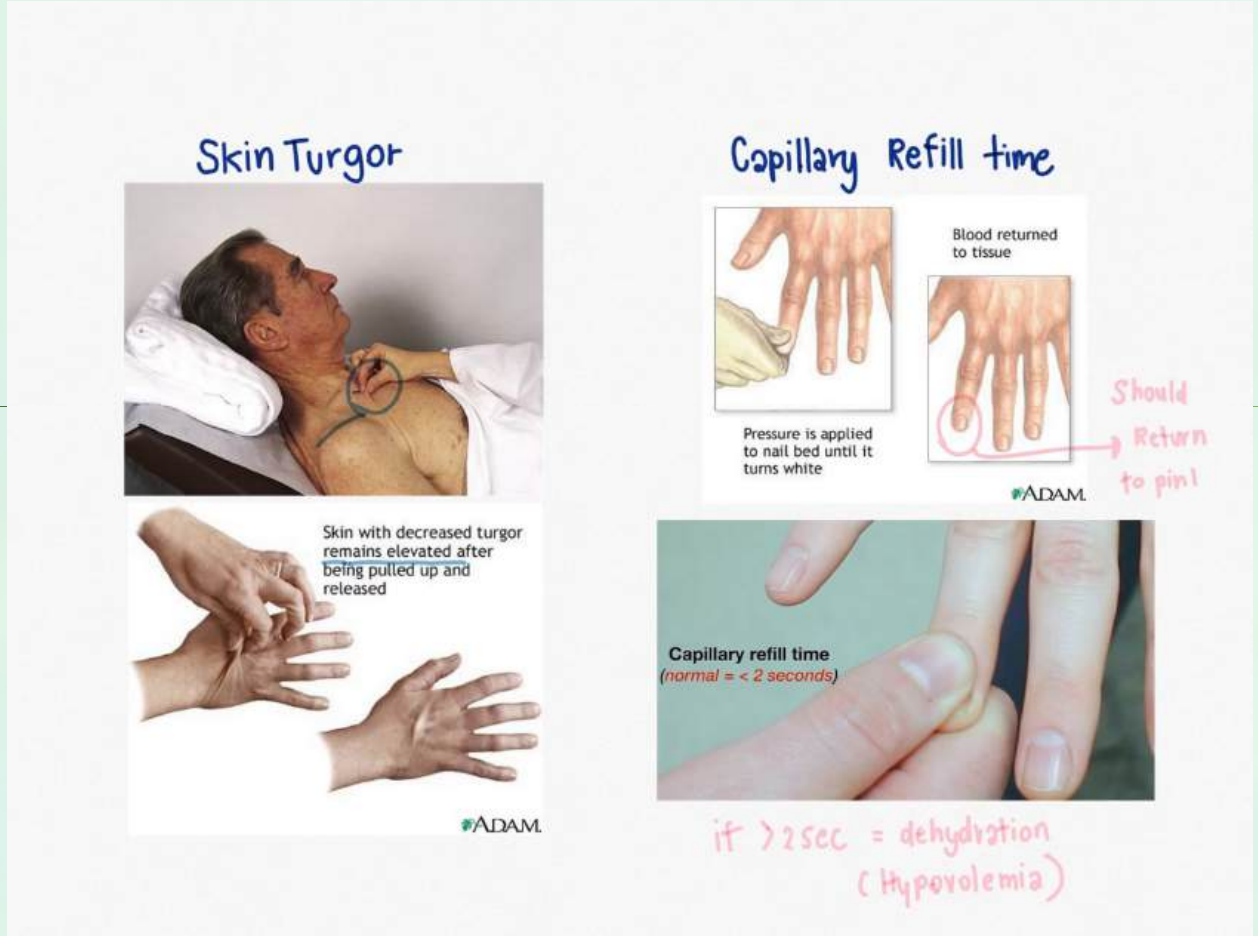
Systemic inflammatory response

⚠ Most Important Complication

DEHYDRATION

- Thirst, dry mucosa
- Hypotension, tachycardia
- Electrolyte imbalance (Na^+, K^+, HCO_3^-)
- Weight loss in chronic cases

Dehydration Assessment



Clinical Signs by Severity

Severe (>10%)

Shock, sunken eyes, no urine output

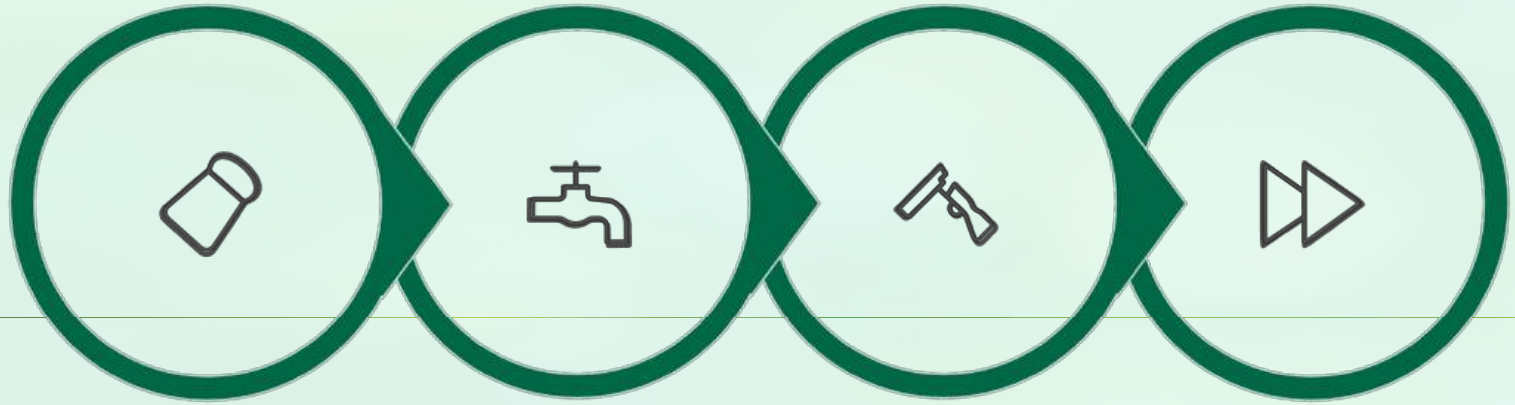
Moderate (5–10%)

Reduced skin turgor, dry mucosa, oliguria

Mild (<5%)

Thirst, slightly dry mouth

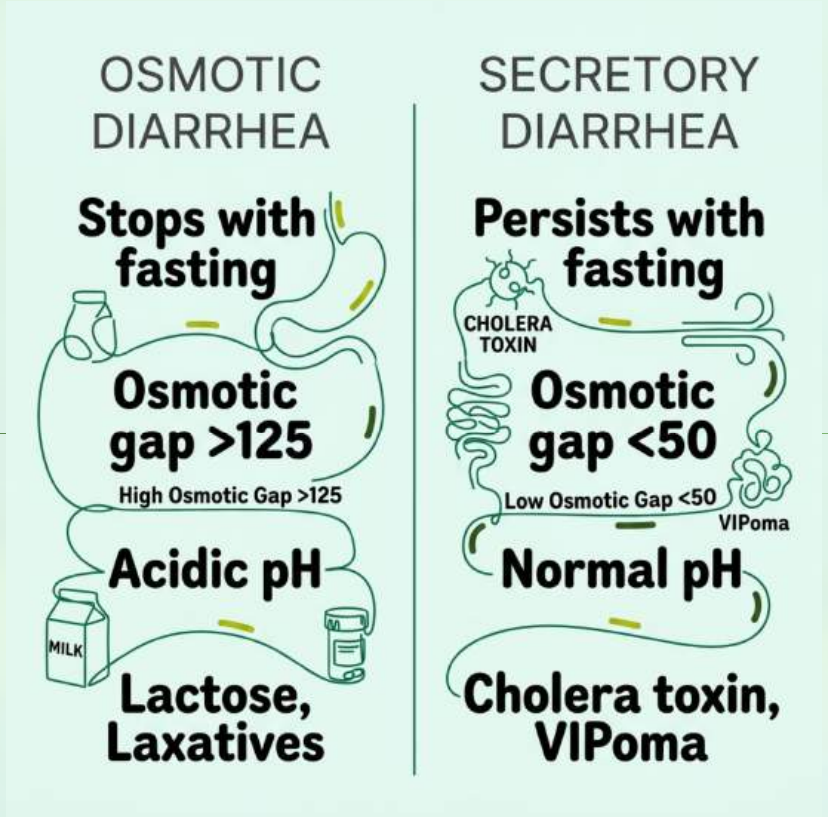
Pathophysiology Summary



Osmotic **Secretory** **Inflammatory** **Motility**

All four mechanisms ultimately result in the same outcome: excess water in the intestinal lumen exceeding the colon's absorptive capacity, producing loose or watery stools.

Distinguishing Osmotic vs. Secretory



The Fasting Test

The single most useful bedside maneuver to differentiate osmotic from secretory diarrhea:

Stool osmotic gap = 290 – 2×(stool Na^+ + stool K^+)

Stops with fasting

→ Osmotic

Persists with fasting

→ Secretory

Drug-Induced Diarrhea

Drugs causing diarrhea

1) **Laxatives**
2) **Antacids containing magnesium**
3) **Antineoplastic drugs**
4) **Antibiotics**
    a) Clindamycin
    b) Tetracyclines
    c) Sulfonamides
    d) Any broad-spectrum antibiotic
5) **Antihypertensives**
    a) Methyldopa
    b) Angiotensin-converting enzyme inhibitors
    c) Angiotensin receptor blockers
    d) α-adrenergic receptor blockers

Key Offending Agents

Antibiotics

Disrupt gut flora → *C. difficile* overgrowth (pseudomembranous colitis)

Laxatives

Osmotic or stimulant mechanisms; overuse causes secretory diarrhea

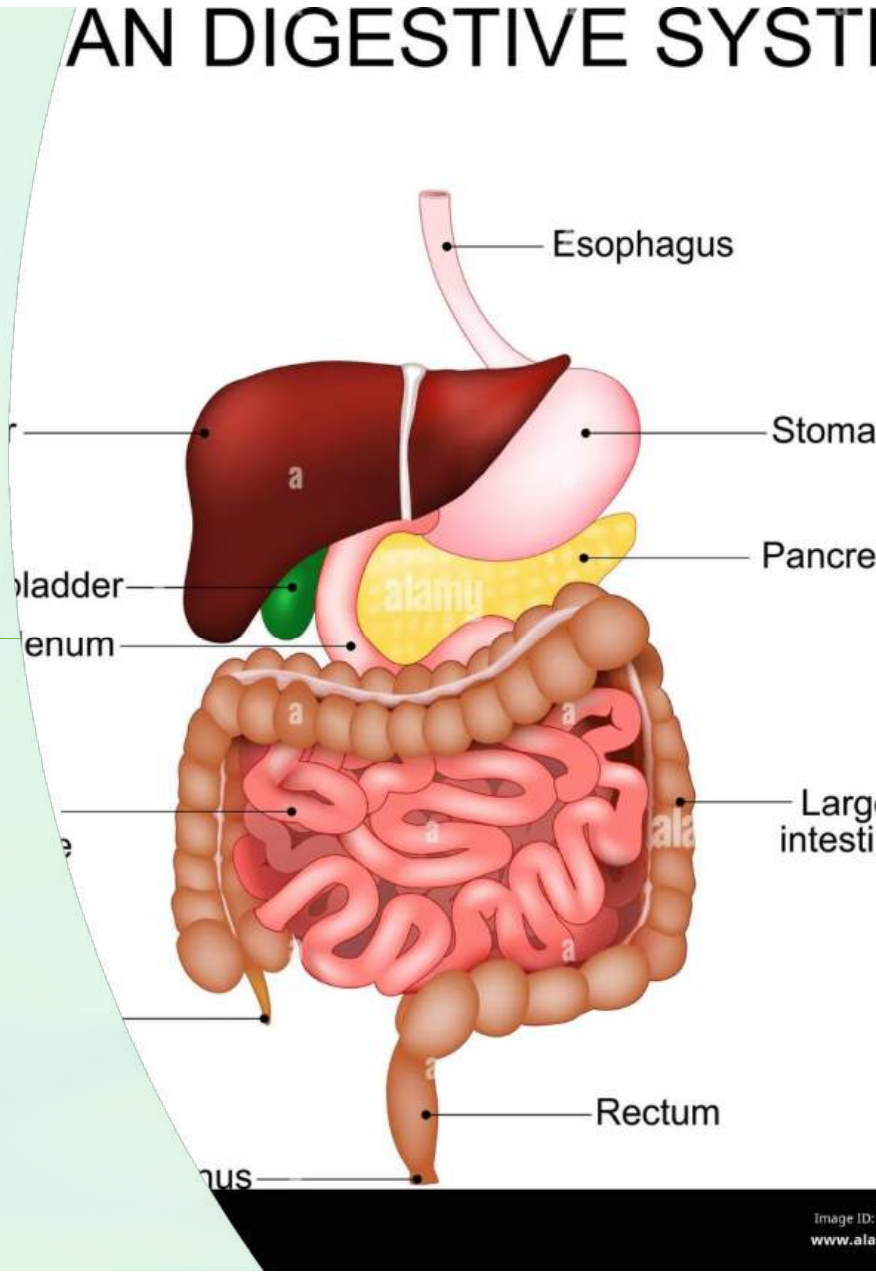
Chemotherapy

Mucosal damage → inflammatory/secretory diarrhea

Constipation: A Medical Overview

A comprehensive, evidence-based guide for medical students — covering definition, pathophysiology, etiology, classification, symptoms, and clinical pearls.

PATHOPHYSIOLOGY · MEDICAL SCHOOL



What Is Constipation?

Clinical Definition

Constipation is **not a single disease** but a clinical syndrome characterized by **unsatisfactory defecation**.

Key concept: Constipation = "unsatisfactory defecation", not just low frequency. *(PubMed, PMID 22114753)*

<3 bowel movements/week	**Difficult stool passage**	**Hard or lumpy stools**	**Incomplete evacuation**

Rome IV Diagnostic Criteria

The research-standard diagnosis requires **≥2 of the following** for **≥3 months**:

1

Straining

>25% of defecations

2

Hard stools

Bristol Type 1–2

3

Incomplete evacuation

Persistent sensation

4

Anorectal obstruction

Sensation of blockage

5

Manual maneuvers

Digital assistance needed

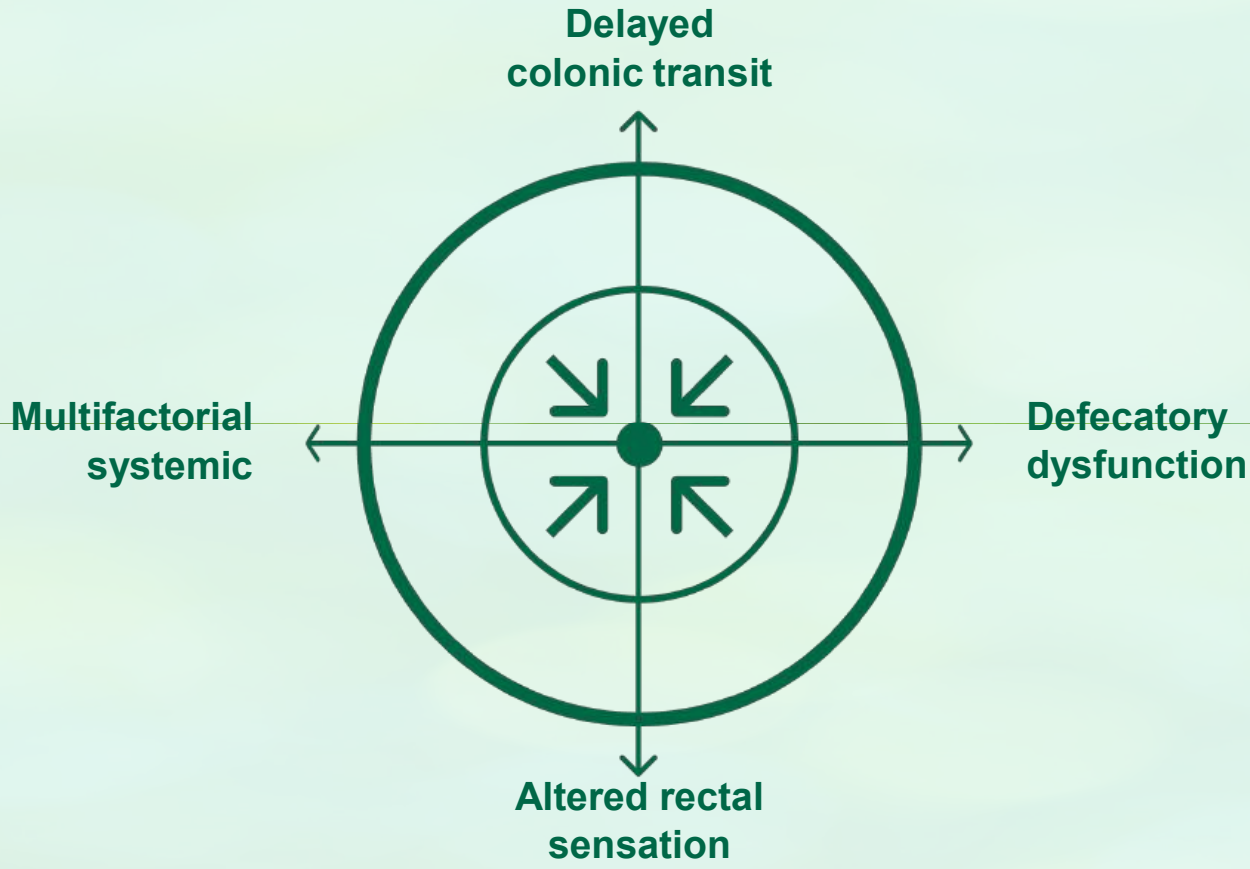
6

<3 BMs/week

Spontaneous movements

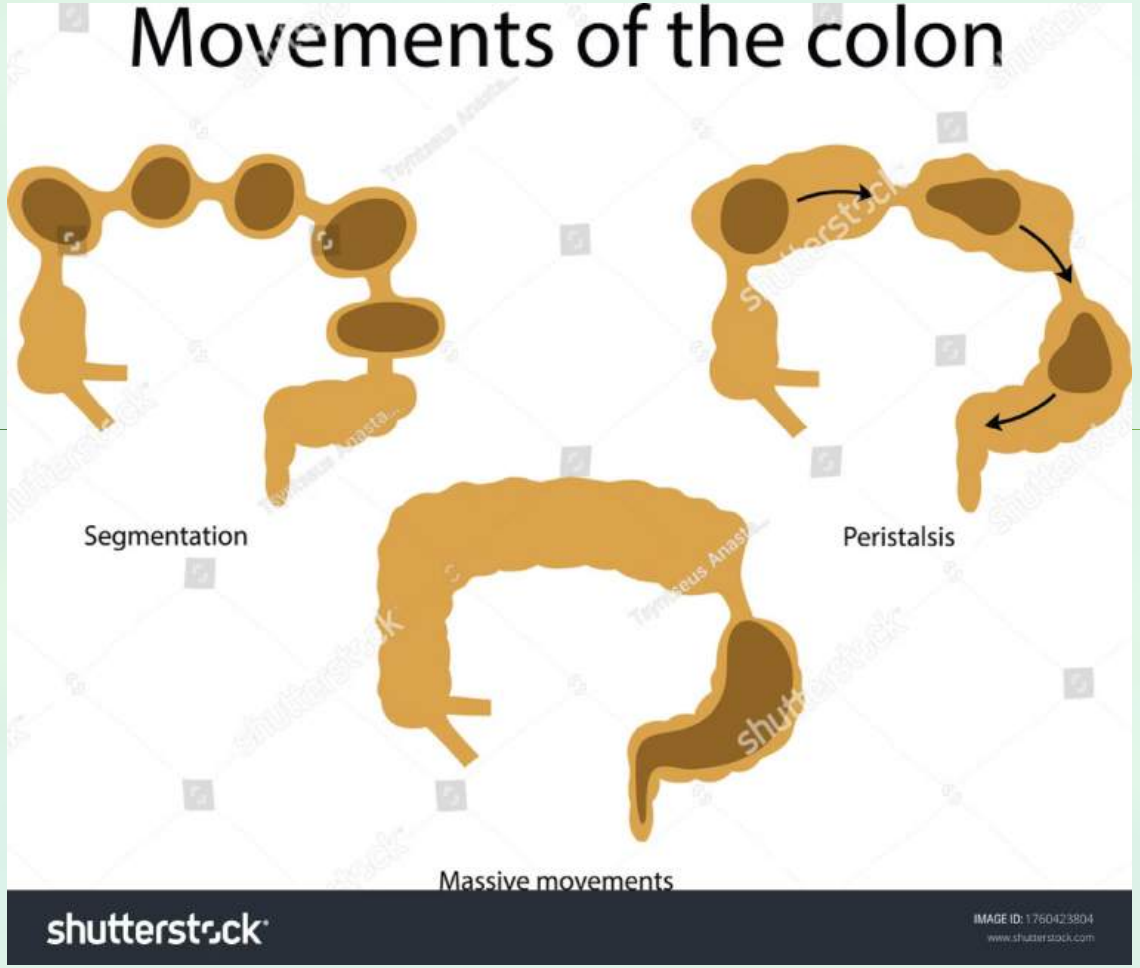
Source: Medscape — Constipation Overview (emedicine.medscape.com/article/184704)

Pathophysiology: Core Mechanisms



Constipation results from multifactorial dysfunction of colonic transit and defecation — often no single cause is identified.
(NCBI StatPearls; NCBI NBK513291)

Mechanism A: Delayed Colonic Transit

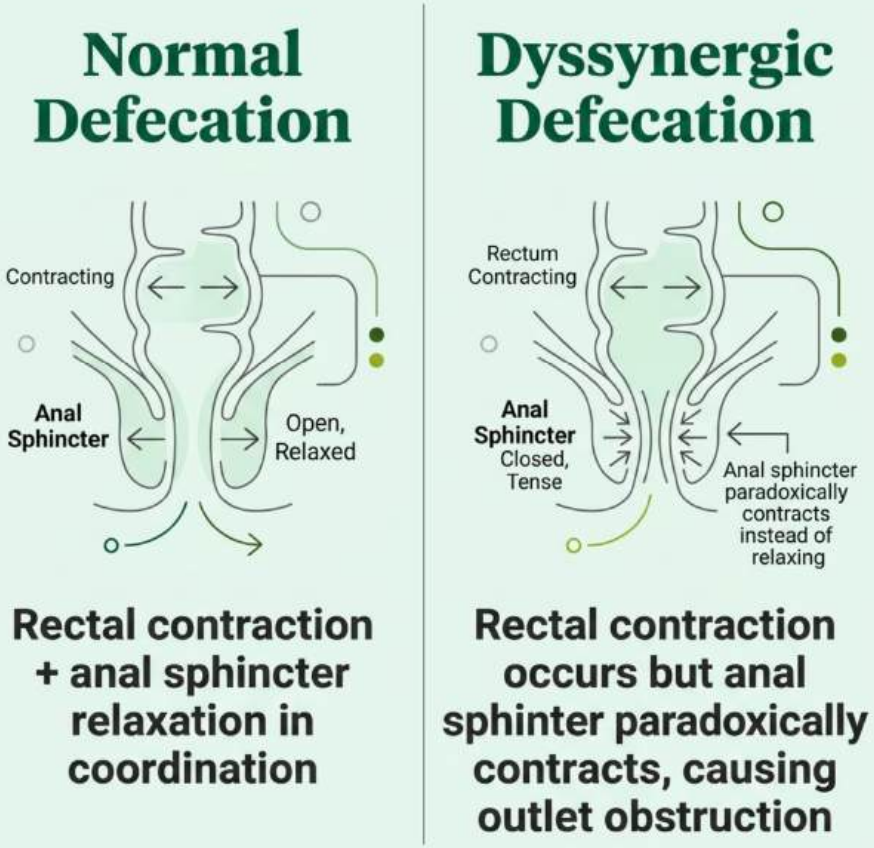


Slow-Transit Constipation (STC)

- Reduced peristaltic activity → prolonged stool retention in colon
- Extended contact time → ↑ water absorption → hard, dry stool
- Associated with reduced enteric neuron density and altered motility signaling

Result: Stool moves too slowly through the colon, becoming dehydrated and difficult to pass. *(NCBI StatPearls)*

Mechanism B: Defecatory (Outlet) Dysfunction



Dyssynergic Defecation

Failure of coordination between:

- Rectal contraction — pushes stool downward
- Anal sphincter relaxation — must open to allow passage

When the sphincter paradoxically contracts during straining, evacuation fails. Also called pelvic floor dysfunction.

Source: PubMed PMID 28185025

Mechanism C & D: Sensation & Systemic Factors

Altered Rectal Sensation

- Reduced urge to defecate
- Blunted recto-anal reflex
- Common in elderly and neurologic disease

Multifactorial Systemic

- Neural, endocrine, muscular, and behavioral components interact
- Often no single cause identified
- Classified as **functional constipation**

Summary: Transit problem (colon) + Evacuation problem (rectum/pelvic floor) — these often overlap. *(NCBI NBK513291)*

Etiology: Primary (Functional)

Primary constipation is a diagnosis of exclusion — no identifiable organic cause.

Normal-Transit Constipation

Normal colonic movement but perceived difficulty passing stool

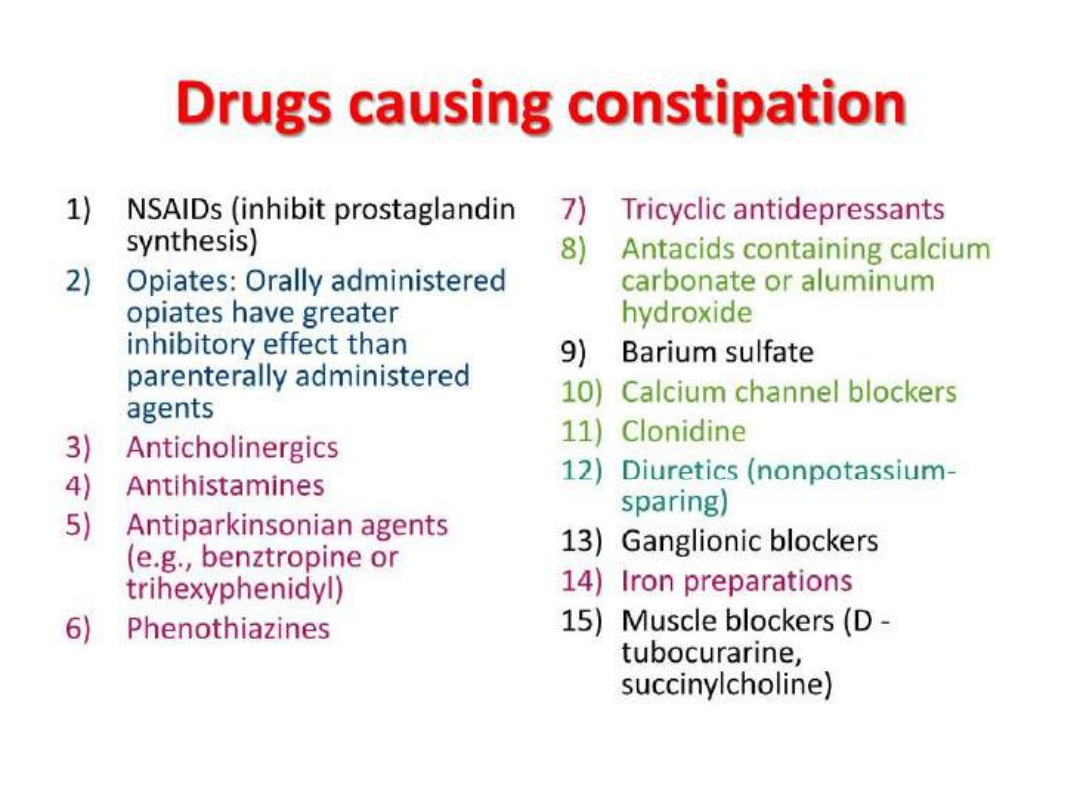
Slow-Transit Constipation

Reduced colonic motility; stool moves too slowly

Pelvic Floor Dysfunction

Impaired evacuation mechanics; dyssynergic defecation

Etiology: Secondary — Medications



Drug-Induced Constipation

Among the most common and reversible causes:

Source: MSD Manuals — Constipation (msdmanuals.com)

→ **Opioids**
Bind μ-receptors in gut → ↓ motility, ↑ sphincter tone

→ **Antidepressants (TCAs)**
Anticholinergic side effects

→ **Anticholinergics**
Block muscarinic receptors → reduced peristalsis

→ **Calcium Channel Blockers**
Reduce smooth muscle contractility

Etiology: Secondary — Metabolic, Neurologic & Structural

Metabolic & Endocrine

- Hypothyroidism
- Diabetes mellitus
- Hypercalcemia

Neurologic Disorders

- Parkinson disease
- Multiple sclerosis
- Spinal cord injury

Structural / Anatomic

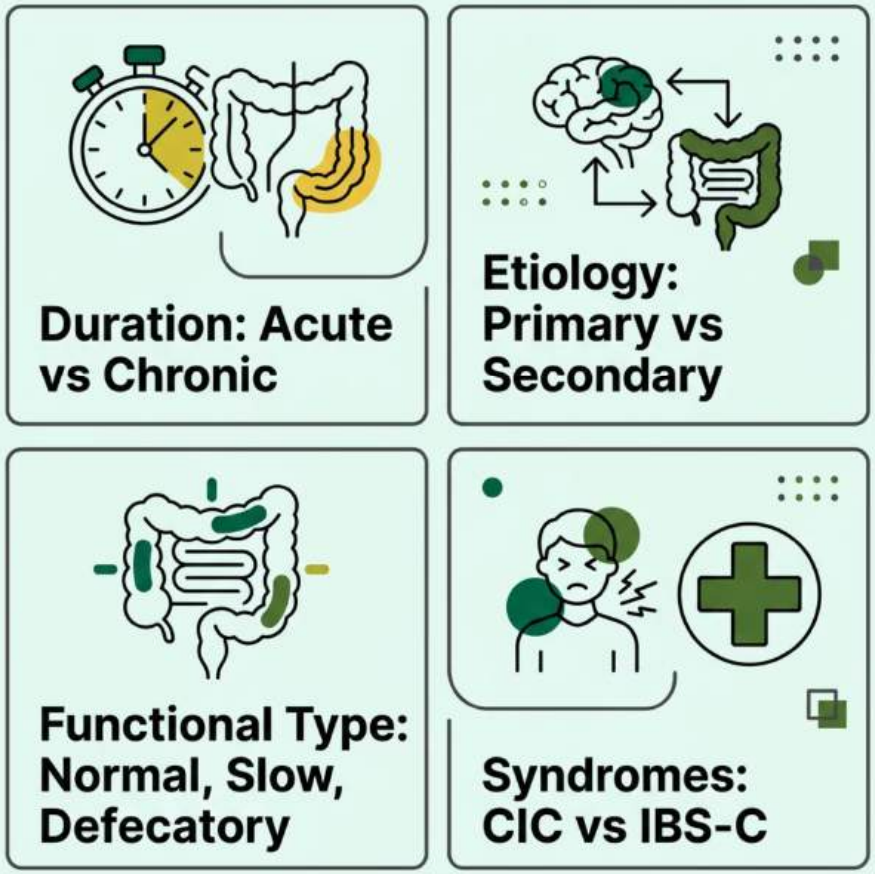
- Colorectal cancer
- Strictures
- Rectocele, prolapse

Lifestyle Factors

- Low fiber intake
- Dehydration
- Sedentary lifestyle

Sources: Medscape; NCBI StatPearls; NCBI NBK513291

Classification of Constipation



Key Distinction: IBS-C vs Chronic Idiopathic Constipation

IBS with constipation (IBS-C) is distinguished by the dominance of abdominal pain as a core symptom, whereas chronic idiopathic constipation may have minimal pain.

Exam tip: Functional classification (normal transit / slow transit / defecatory disorder) is the most clinically and exam-relevant framework. *(NCBI NBK513291)*

Symptoms & Clinical Presentation

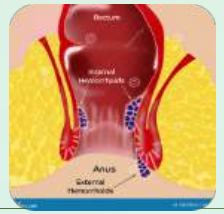
Core Symptoms

- Infrequent bowel movements
- Hard, dry stools
- Excessive straining
- Incomplete evacuation

Additional Symptoms

- Abdominal bloating
- Abdominal discomfort or pain
- Prolonged defecation time
- Need for manual maneuvers

Complications of Chronic Constipation



Hemorrhoids

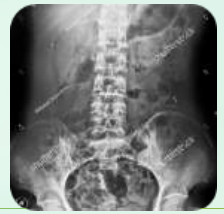
Increased straining raises venous pressure in anorectal plexus

Anal Fissures

Hard stool passage causes mucosal tears and pain

Rectal Prolapse

Chronic straining weakens pelvic floor support structures

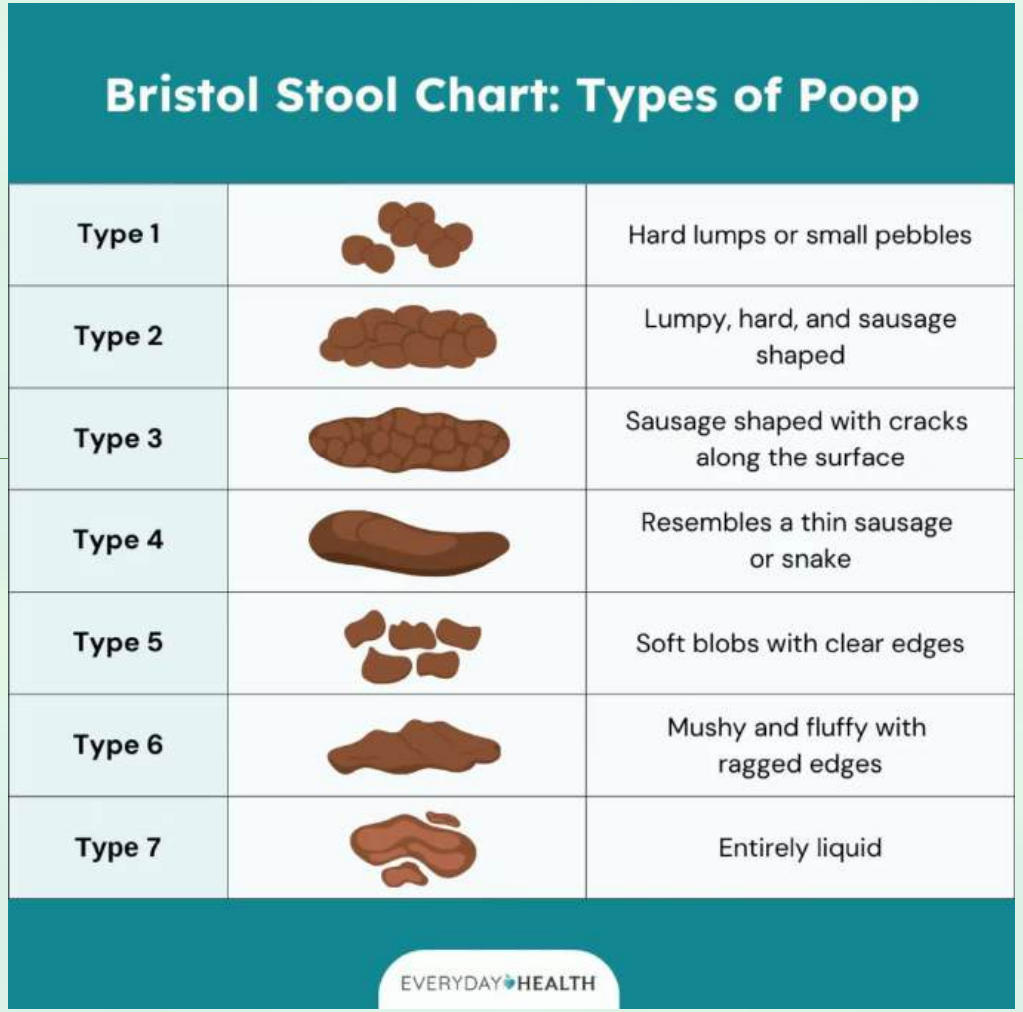


Fecal Impaction

Especially in elderly — hardened stool mass obstructs rectum

Source: MSD Manuals — Constipation (msdmanuals.com)

Bristol Stool Scale



Clinical Relevance

The Bristol Stool Scale classifies stool consistency into 7 types:

Types 1–2

Constipation — hard, lumpy, difficult to pass

Types 3–4

Normal — smooth, sausage-shaped, easy to pass

Types 5–7

Diarrhea — soft, mushy, or liquid

Types 1–2 are used in Rome IV criteria to define constipation-associated stool form.

Diagnostic Approach

History & Rome IV

Red Flags

Exclude Secondary

Functional Subtype

A systematic approach ensures secondary (organic) causes are excluded before diagnosing functional constipation. *(MSD Manuals; Medscape)*

Red Flags — When to Investigate Further

Unexplained Weight Loss

May indicate malignancy or systemic disease

Blood in Stool

Hematochezia or melena — requires urgent investigation

New-Onset in Elderly

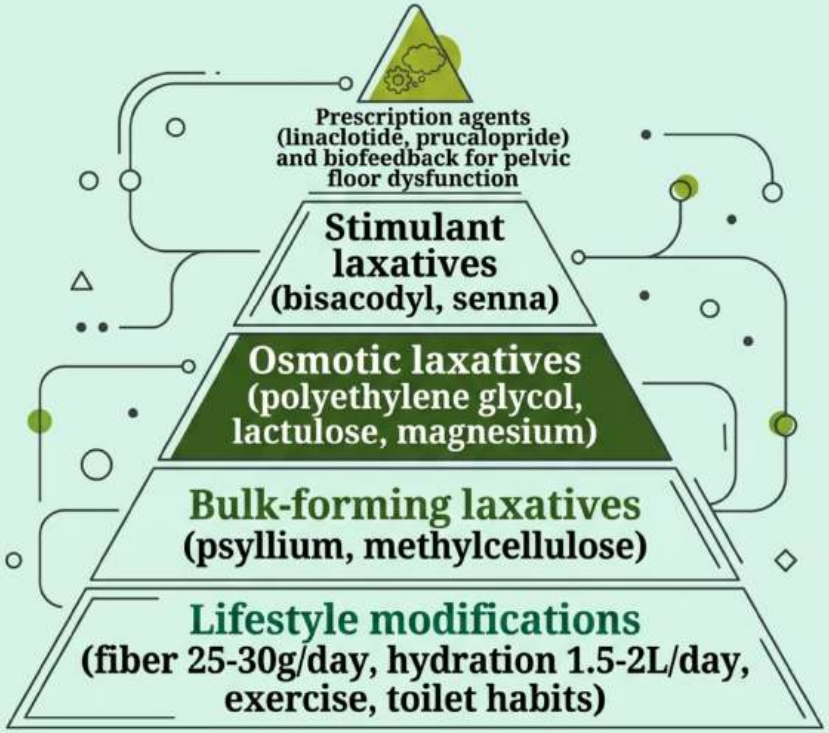
Suspect colorectal cancer until proven otherwise

Fever + Abdominal Pain

Consider obstruction, volvulus, or inflammatory cause

Source: MSD Manuals — Constipation (msdmanuals.com)

Treatment Overview



Stepwise Approach

- **First line:** Dietary fiber, hydration, physical activity
- **Second line:** Bulk-forming and osmotic laxatives
- **Third line:** Stimulant laxatives (short-term)
- **Refractory:** Secretagogues (linaclotide), prokinetics (prucalopride)
- **Pelvic floor dysfunction:** Biofeedback therapy — first-line

Treat the underlying cause in secondary constipation before escalating laxative therapy.

Key Clinical Pearls for Medical Students

Symptom complex, not a disease

Constipation is a clinical syndrome — always look for the underlying mechanism.

Frequency alone is insufficient

Focus on stool quality, evacuation completeness, and straining — not just BM count.

Distinguish transit vs. evacuation disorder

Slow-transit responds to laxatives; pelvic floor dysfunction requires biofeedback.

Never miss red flags

Weight loss + blood in stool + new onset in elderly → colonoscopy urgently.

Exam-Oriented Summary

1

Definition

Unsatisfactory defecation — Rome IV: ≥2 criteria for ≥3 months

2

Pathophysiology

Delayed transit + defecatory dysfunction + altered sensation

3

Etiology

Primary (functional) vs Secondary (medications, metabolic, neurologic, structural)

4

Classification

By duration, etiology, and functional subtype (NTC / STC / defecatory disorder)

5

Symptoms

Infrequency + straining + hard stools + incomplete evacuation + complications