PH BIO 6 – PHARMACOLOGY 1

AUTACOIDS, HISTAMINE, SEROTONIN, AND EICOSANOIDS

Simple Comprehensive Reviewer

I. AUTACOIDS

Definition

Autacoids are **locally acting chemical substances** produced by body tissues.

They regulate the activity of:

- Smooth muscles
- Nerves
- Glands
- Platelets
- Other tissues

They act **near the site where they are produced**, unlike hormones that travel through the bloodstream.

Functions of Autacoids

They are involved in many body processes such as:

- Inflammation
- Allergic reactions
- Pain
- Fever
- Asthma
- Gastrointestinal function
- Renal function
- Uterine function
- Blood clotting (hemostasis)

Main Examples (Mnemonic: BESH)

Letter	Autacoid
B	Bradykinin
E	Eicosanoids
S	Serotonin
H	Histamine

Receptors of Autacoids

Most autacoids work through **GPCRs (G-protein coupled receptors)**.

Examples:

Receptor	G-protein
H1	Gq
H2	Gs
5-HT1	Gi

5-HT2	Gq
5-HT4	Gs

II. HISTAMINE

Overview

Histamine is a **neurotransmitter and inflammatory mediator**.

Precursor

Histidine (an amino acid)

Produced by

- Mast cells
- Basophils

Found mostly in

- Skin
- Gastrointestinal tract
- Respiratory tract

Main Roles of Histamine

Histamine is involved in:

- Allergic reactions
- Inflammation
- Gastric acid secretion
- Neurotransmission

HISTAMINE RECEPTORS

H1 Receptors

Mainly involved in **allergic reactions**.

Effects:

Tissue	Effect
Blood vessels	Vasodilation
Bronchi	Bronchoconstriction
Endothelium	Edema
Nerves	Pain and itching
Brain	Wakefulness

H2 Receptors

Mainly in the **stomach**.

Effect:

Tissue	Effect
Parietal cells	Increased HCl secretion

H3 Receptors

Located in the **CNS**.

Effect:

- Inhibits release of histamine.

DRUGS AFFECTING HISTAMINE

Histamine Agonists

Betahistine

Used for **Vertigo**.

Mechanism:

- H1 agonist
- H3 antagonist

Side effects:

- Nausea
- Headache
- GI disturbances

Contraindications:

- Asthma
- Peptic ulcer
- Pheochromocytoma

VERTIGO

Vertigo is **a sensation of movement when there is none**.

Common symptoms:

- Nausea
- Vomiting
- Sweating
- Pallor

Cause:

- Vestibular disorders

ANTIHISTAMINES (H1 BLOCKERS)

These drugs **block H1 receptors** to treat allergies.

1st Generation Antihistamines

Characteristics

- Lipophilic
- Cross the **blood-brain barrier**
- Cause **sedation**

Examples:

Drug	Use
Diphenhydramine	Allergy, antiemetic
Dimenhydrinate	Motion sickness
Hydroxyzine	Anxiety
Promethazine	Pre-operative sedation
Chlorpheniramine	Cold medications

Cyproheptadine	Serotonin syndrome
Doxylamine	Insomnia

Motion Sickness Drugs

- Meclizine
- Cyclizine
- Buclizine

Used for:

- Motion sickness
- Vertigo

2nd Generation Antihistamines

Characteristics

- Hydrophilic
- Do NOT cross the BBB
- Less sedation

Preferred for people needing alertness (drivers, pilots).

Examples:

Drug	Brand
Cetirizine	Zyrtec
Levocetirizine	Xyzal
Loratadine	Claritin
Desloratadine	Clarinex
Fexofenadine	Allegra

H2 RECEPTOR ANTAGONISTS

Used to **reduce gastric acid**.

Mnemonic: **FRNC**

Drug	Notes
Famotidine	Most potent
Ranitidine	Moderate
Nizatidine	Moderate
Cimetidine	Least potent

Mechanism

They **block H2 receptors in the stomach** → ↓ acid secretion.

Clinical Uses

- Peptic ulcer disease
- Acute GI bleeding
- Adjunct in allergic reactions

Side Effects (Cimetidine)

- Drug interactions
- Gynecomastia

- Decreased libido
- Infertility
- Galactorrhea

III. SEROTONIN (5-HT)

Overview

Serotonin is a **neurotransmitter known as the "feel-good chemical".**

It controls:

- Mood
- Sleep
- Appetite
- Blood pressure
- Body temperature
- Vomiting
- Pain perception

Precursor

Tryptophan

Main Sources

- Platelets
- Enterochromaffin cells (intestine)
- Stomach
- Neurons

Peripheral Effects

Organ	Effect
Blood vessels	Vasoconstriction
Platelets	Aggregation
GI tract	Increased peristalsis
Bronchi	Bronchoconstriction
Uterus	Contraction

Diseases Related to Serotonin

- Migraine
- Carcinoid syndrome
- Anxiety
- Mood disorders
- Pulmonary hypertension

DRUGS AFFECTING SEROTONIN

5-HT1A Drugs

Buspirone

Used for:

- Generalized Anxiety Disorder (GAD)

Advantages:

- No sedation
- No addiction potential

Side effects:

- Headache
- Dizziness
- Nausea

Note: Takes **3–6 weeks to work**.

5-HT1B/1D Drugs (TRIPTANS)

Examples:

- Sumatriptan
- Naratriptan
- Zolmitriptan

Use:

- Acute migraine
- Cluster headache

Mechanism:

- Causes vasoconstriction

Side effects:

- Chest pain
- Dizziness
- High blood pressure

Contraindicated in:

- Hypertension
- Coronary artery disease

ERGOT ALKALOIDS

Examples:

Drug	Use
Ergotamine	Migraine
Ergonovine	Postpartum bleeding

Side effects:

- Hypertension
- Fibrosis
- Uterine contraction

5-HT3 ANTAGONISTS

Examples:

- Ondansetron
- Granisetron
- Dolasetron
- Palonosetron

Use:

Treatment of **chemotherapy-induced nausea and vomiting**

Side effects:

- QT prolongation
- Arrhythmias

5-HT4 DRUGS

Used for **constipation-dominant IBS**.

Examples:

- Tegaserod
- Cisapride
- Prucalopride

IV. EICOSANOIDS

Definition

Eicosanoids are **chemical mediators derived from arachidonic acid**.

"Eicosa" = **20 carbon atoms**

Types

1. Prostaglandins
2. Prostacyclin
3. Thromboxane
4. Leukotrienes

ARACHIDONIC ACID

Sources:

- Cell membrane phospholipids
- Foods (meat, eggs, fish, dairy)

Released during:

- Injury
- Inflammation

COX PATHWAY

Produces **Prostaglandins**

Two enzymes:

Enzyme	Function
COX-1	Protective functions
COX-2	Inflammation and pain

PROSTAGLANDIN EFFECTS

Organ	Effect
Blood vessels	Vasodilation or constriction
Lungs	Bronchoconstriction

GI	Cytoprotection
Platelets	Aggregation
Uterus	Contraction
Eyes	Decrease eye pressure

PROSTAGLANDIN ANALOG DRUGS

Drug	Use
Dinoprostone	Cervical ripening
Alprostadil	Erectile dysfunction
Misoprostol	Prevent NSAID ulcers
Latanoprost	Glaucoma
Epoprostenol	Pulmonary hypertension

LEUKOTRIENES

Produced via **Lipoxygenase pathway**.

Important types:

Leukotriene	Function
LTB4	Inflammation
LTC4, LTD4	Bronchoconstriction

LEUKOTRIENE DRUGS

Used for **asthma**.

5-LOX Inhibitor

Example:

- Zileuton

Side effect:

- Liver toxicity

Leukotriene Receptor Antagonists

Examples:

- Montelukast
- Zafirlukast

Use:

- Asthma
- Bronchospasm

Note:

Not for **acute asthma attack**.

QUICK MEMORY GUIDE

Autacoids

BESH

Bradykinin
Eicosanoids
Serotonin
Histamine

H2 Blockers

FRNC

Famotidine
Ranitidine
Nizatidine
Cimetidine

Migraine Drugs

TRIPTANS

Sumatriptan
Naratriptan
Zolmitriptan

Leukotriene Drugs

Montelukast / Zafirlukast

Asthma prevention

Comprehensive Reviewer

PCOL 2nd Exam (Concept-Based Study Guide)

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1. Methotrexate and Rheumatoid Arthritis

Question Concept

Why does **low-dose methotrexate** work as a **disease-modifying drug (DMARD)**?

Correct Concept

Methotrexate **increases extracellular adenosine**, which has strong **anti-inflammatory effects**.

Pathophysiology of Rheumatoid Arthritis

Rheumatoid arthritis is an **autoimmune inflammatory disease**.

Process:

1. Immune system attacks synovial joints
2. Inflammatory cytokines released
3. Synovial inflammation
4. Cartilage destruction
5. Bone erosion

Major inflammatory mediators:

- TNF-α
- IL-1
- IL-6

Methotrexate Mechanism

At **low doses (RA)**:

Methotrexate inhibits

AICAR transformylase

This increases:

Adenosine

Adenosine:

- suppresses inflammatory cytokines
- decreases immune cell activity
- reduces joint inflammation

Memory Trick

“Methotrexate Makes Adenosine.”

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2. Epinephrine Dose-Dependent Effects

Key Pharmacology Principle

Epinephrine activates **alpha and beta receptors**, but **different receptors dominate depending on dose**.

Receptor Effects

Receptor	Location	Effect
α1	Blood vessels	Vasoconstriction
β1	Heart	↑ HR and contractility
β2	Lungs, vessels	Bronchodilation + vasodilation

Low Dose Epinephrine

Dominant receptor:

β2

Effect:

- vasodilation
- decreased peripheral resistance
- decreased blood pressure

High Dose Epinephrine

Dominant receptor:

α1

Effect:

- strong vasoconstriction

- increased blood pressure

Memory Trick

“Low dose = Beta wins
High dose = Alpha wins.”

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3. Pilocarpine in Glaucoma

Question Concept

How does pilocarpine reduce **intraocular pressure**?

Pathophysiology of Glaucoma

Glaucoma occurs when **aqueous humor drainage is impaired**, causing:

- increased intraocular pressure
- optic nerve damage
- progressive vision loss

Aqueous Humor Flow

1. Ciliary body produces fluid
2. Posterior chamber
3. Pupil
4. Anterior chamber
5. Trabecular meshwork
6. Schlemm canal

Pilocarpine Mechanism

Pilocarpine = **muscarinic agonist**

It causes:

Ciliary muscle contraction

This:

- pulls the **scleral spur**
- opens the **trabecular meshwork**
- increases aqueous outflow

Result:

↓ **intraocular pressure**

Memory Trick

“PILOT opens the drain.”

Pilocarpine → opens trabecular drainage.

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4. Muscarinic Effects in the Eye

Muscarinic stimulation affects the **iris circular muscle**.

Effect

Miosis

Meaning:

Pupil constriction

Compare Autonomic Effects

System	Effect on Pupil
Parasympathetic	Miosis
Sympathetic	Mydriasis

Memory Trick

“Miosis = Muscarinic.”

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5. Bethanechol and Urinary Retention

Clinical Use

Bethanechol treats:

- postoperative urinary retention
- neurogenic bladder

Mechanism

Bethanechol stimulates:

M3 receptors

Effect:

- detrusor contraction
- bladder emptying

Side Effects

Because muscarinic receptors exist throughout the body:

- sweating
- salivation
- diarrhea
- abdominal cramps

These are called:

Parasympathomimetic effects

Memory Trick

SLUDGE

Letter	Meaning
S	Salivation
L	Lacrimation
U	Urination
D	Diarrhea
G	GI cramps
E	Emesis

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6. Minimum Alveolar

Concentration (MAC)

Definition

MAC is the **standard measure of inhalation anesthetic potency**.

It is the concentration preventing movement in **50% of patients**.

Interpretation

MAC	Potency
Low MAC	Highly potent
High MAC	Less potent

Example:

Halothane → low MAC → strong anesthetic

Memory Trick

“Low MAC = Mighty anesthetic.”

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7. Epinephrine in Anaphylactic Shock

Pathophysiology

Anaphylaxis causes:

- vasodilation
- bronchoconstriction
- hypotension
- airway swelling

Due to:

- histamine
- leukotrienes
- prostaglandins

Life-Saving Effect of Epinephrine

Most critical action:

α1 receptor stimulation

Effect:

- vasoconstriction
- increased blood pressure

Also:

- β2 → bronchodilation
- β1 → increased cardiac output

Memory Trick

“Anaphylaxis = EPI first.”

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8. Dissociative Anesthesia

Drug

Ketamine

Mechanism

Blocks:

NMDA receptors

Effect:

- dissociation
- analgesia
- hallucinations

Unique Feature

Patient appears **awake but disconnected from environment**.

Memory Trick

“Ketamine = K-hole.”

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9. Blood Brain Barrier

Definition

The **blood-brain barrier (BBB)** is a selective barrier that protects the brain.

Function

It prevents:

- toxins
- polar drugs
- pathogens

from entering the CNS.

Structure

Formed by:

- tight endothelial junctions
- astrocytes
- basement membrane

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10. NSAIDs Mechanism

Most NSAIDs inhibit:

Cyclooxygenase (COX)

This decreases production of:

- prostaglandins
- inflammatory mediators

COX Types

Enzyme	Function

COX-1	Protects stomach lining
COX-2	Inflammation

Important Concept

Selective **COX-2 inhibitors** reduce inflammation **without damaging gastric mucosa**.

Memory Trick

“COX-1 protects stomach, COX-2 causes pain.”

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11. Aspirin

Aspirin is unique because it **irreversibly inhibits COX**.

Mechanism:

Acetylation of the enzyme

Memory Trick

“Aspirin permanently shuts COX.”

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12. Autonomic Nervous System Divisions

Two main divisions:

System	Function
Sympathetic	Fight or flight
Parasympathetic	Rest and digest

Memory Trick

“Sympathetic = Stress
Parasympathetic = Peace.”

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13. Enteric Nervous System

The **ENS** is the intrinsic nervous system of the GI tract.

It can function **independently of the CNS**.

Role

Controls:

- peristalsis
- secretion
- GI motility

Even if **vagus nerve is cut**, GI reflexes can still occur.

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14. Opioid Receptors

There are three major opioid receptors:

Receptor	Function
μ (Mu)	Analgesia, euphoria, respiratory depression
κ (Kappa)	Spinal analgesia
δ (Delta)	Mood regulation

Most important

Mu receptor

Responsible for:

- morphine analgesia
- respiratory depression
- euphoria

Memory Trick

“MU = Major effects.”

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15. Opioid Tolerance

Chronic opioid use causes:

downregulation of mu receptors

Meaning:

- fewer receptors
- reduced drug response
- need higher doses

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16. Naloxone

Naloxone is a **pure opioid antagonist**.

Use:

opioid overdose reversal

Mechanism

Blocks:

mu opioid receptors

Memory Trick

“Naloxone knocks opioids off.”

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17. Organophosphate Poisoning

Organophosphates inhibit:

acetylcholinesterase

Result:

excess acetylcholine.

Symptoms:

- salivation
- sweating
- bronchospasm
- muscle weakness

Treatment

Two drugs:

1️⃣ **Atropine**
2️⃣ **Pralidoxime (2-PAM)**

Roles

Drug	Action
Atropine	blocks muscarinic receptors
Pralidoxime	regenerates AChE enzyme

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18. Beta Blockers in Asthma

Non-selective beta blockers block:

β1 + β2

Problem:

β2 receptors cause **bronchodilation**.

Blocking them can cause:

bronchospasm

Safer Option

Use **β1-selective blockers**

Examples:

- Metoprolol
- Atenolol

Memory Trick

“β1 = 1 heart.”

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19. Baroreceptor Reflex

When blood pressure **increases suddenly**:

Example:

Phenylephrine administration

Body responds with:

reflex bradycardia

Mechanism:

1. BP rises
2. Baroreceptors detect change
3. Vagus nerve activated
4. Heart rate decreases

Memory Trick

"High pressure → heart slows."

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20. Cholinesterase Inhibitors

These drugs inhibit:

Acetylcholinesterase

Result:

↑ acetylcholine

Used for:

- Myasthenia gravis
- Alzheimer's disease
- Glaucoma

Example Diagnostic Drug

Edrophonium

Used to diagnose:

Myasthenia gravis

Ultimate Exam Tip for This PCOL Exam

Most questions follow **three patterns**:

Pattern 1

Drug → receptor → physiological effect

Example:

Pilocarpine
→ Muscarinic receptor
→ Eye
→ Miosis + aqueous drainage.

Pattern 2

Pathophysiology → drug mechanism

Example:

Anaphylaxis
→ vasodilation
→ epinephrine α1 vasoconstriction.

Pattern 3

Side effects from receptor stimulation

Example:

Bethanechol
→ muscarinic stimulation
→ sweating + salivation.

I reviewed the **PCOL 3rd Exam PDF** you uploaded. The exam mainly focuses on these topics:

- **Antidepressants**
- **Antiepileptic (antiseizure) drugs**
- **Benzodiazepines and sedatives**
- **Drug mechanisms in the CNS**
- **Clinical drug selection for neurological disorders**

Below is a **Comprehensive Reviewer for the 3rd Exam** with:

- clear explanations
- mechanisms of action
- drug comparison tables
- pathophysiology connections
- memory tricks used by medical/pharmacy students

PCOL 3rd Exam Comprehensive Reviewer

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1. Antidepressants

Depression is associated with **low levels of monoamine neurotransmitters**:

- **Serotonin (5-HT)**
- **Norepinephrine (NE)**
- **Dopamine (DA)**

Antidepressant drugs increase these neurotransmitters in the brain.

Major Antidepressant Drug Classes

Class	Mechanism	Example	Key Side Effects
SSRIs	Block serotonin reuptake	Fluoxetine	Sexual dysfunction
SNRIs	Block serotonin + NE reuptake	Venlafaxine	Hypertension
TCAs	Block NE + serotonin	Amitriptyline	Anticholinergic effects
NDRI	Increase dopamine + NE	Bupropion	Seizures

Bupropion (High-Yield Exam Concept)

Mechanism

Bupropion is a **Norepinephrine–Dopamine Reuptake Inhibitor (NDRI).**

It increases:

- dopamine
- norepinephrine

Important Safety Concept

Bupropion **lowers the seizure threshold**.

Meaning:

Seizures can occur more easily.

Contraindications

Do NOT use in patients with:

- seizure disorders
- bulimia
- anorexia
- alcohol withdrawal

Memory Trick

“BUPROPION = Brain Stimulation → Seizures Possible.”

This is why many exam questions focus on **seizure risk**.

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2. Antiepileptic Drugs (AEDs)

Seizures occur due to **excessive electrical activity in the brain**.

Antiepileptic drugs work by:

- stabilizing neuronal membranes
- reducing excitatory neurotransmission
- increasing inhibitory neurotransmission

Major Mechanisms of Antiepileptic Drugs

Mechanism	Example Drug	Effect
Sodium channel blockade	Carbamazepine	Prevents repetitive firing

Calcium channel blockade	Ethosuximide	Stops absence seizures
Increase GABA	Benzodiazepines	Inhibitory neurotransmission
SV2A modulation	Levetiracetam	Stabilizes synaptic release

Uses

- epilepsy
- trigeminal neuralgia
- bipolar disorder

Memory Trick

“Carba-MAZE-pine blocks sodium channels.”

Think of a maze blocking signals.

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3. Carbamazepine

Mechanism

Carbamazepine blocks:

Voltage-gated sodium channels

This prevents neurons from firing repeatedly.

Unique Pharmacology

Carbamazepine is metabolized into an **active metabolite**:

Carbamazepine-10,11-epoxide

This metabolite contributes to its therapeutic effect.

4. Absence Seizures

Definition

Absence seizures are brief episodes of **loss of awareness** lasting:

5–20 seconds.

Common in children.

EEG Pattern

3 Hz spike-and-wave pattern

Drug of Choice

Ethosuximide

Mechanism

Ethosuximide blocks:

T-type calcium channels in the thalamus

This stops the abnormal rhythmic firing responsible for absence seizures.

Memory Trick

“E.T. phones home.”

- **E** → Ethosuximide
- **T** → T-type calcium channels

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5. Benzodiazepines

Benzodiazepines enhance **GABA activity**, the main inhibitory neurotransmitter in the CNS.

Mechanism

Benzodiazepines bind to:

GABA-A receptor

They increase:

frequency of chloride channel opening

Result:

- neuronal inhibition
- sedation
- anxiolysis
- anticonvulsant effect

Examples

Drug	Use
Diazepam	Anxiety, seizures
Lorazepam	Status epilepticus
Alprazolam	Panic disorder

Memory Trick

“Benzos Boost GABA.”

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6. Status Epilepticus

Definition

Continuous seizure activity lasting:

>5 minutes

This is a **medical emergency**.

First-Line Drug

Lorazepam

Reason:

- fast onset
- longer CNS duration than diazepam

Memory Trick

“LORAZ saves lives.”

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7. Benzodiazepine Antagonist

Drug

Flumazenil

Mechanism

Flumazenil is a **competitive antagonist** at the benzodiazepine binding site on the **GABA-A receptor**.

Use

- benzodiazepine overdose
- reversal of sedation

Important Risk

Can cause **withdrawal seizures** in chronic benzodiazepine users.

Memory Trick

“Flumazenil Flushes out benzos.”

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8. GABA in the Central Nervous System

GABA is the **major inhibitory neurotransmitter** in the brain.

When GABA receptors are activated:

- chloride enters the neuron
- the neuron becomes hyperpolarized
- neuronal firing decreases

Drug Types That Increase GABA

Drug	Mechanism
Benzodiazepines	Increase channel opening frequency
Barbiturates	Increase duration of opening
Valproate	Increase GABA concentration

Memory Trick

“GABA = Brain brake.”

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9. Sodium Channel Blocking Antiepileptics

These drugs stabilize neurons by blocking sodium channels.

Examples:

Drug	Main Uses
Carbamazepine	Partial seizures
Phenytoin	Tonic-clonic seizures
Lamotrigine	Bipolar + epilepsy

Mechanism

They prevent:

high-frequency neuronal firing

Memory Trick

“Sodium blockers stop seizure signals.”

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10. CNS Drug Penetration

For a drug to affect the brain, it must cross the **blood-brain barrier (BBB)**.

BBB characteristics:

- tight endothelial junctions
- lipid-soluble drugs cross easier
- large polar drugs cross poorly

Drugs That Cross BBB Easily

Usually:

- lipid-soluble
- small molecules

Example:

benzodiazepines.

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11. General CNS Drug Strategy

Many CNS drugs work by adjusting the balance between:

Excitatory	Inhibitory
Glutamate	GABA

Seizures occur when:

Excitation > Inhibition

Antiepileptic drugs restore balance.

Quick Drug Comparison Table (High Yield)

Drug	Mechanism	Main Use	Exam Tip
Bupropion	↑ NE + dopamine	Depression	Causes seizures
Carbamazepine	Na channel blocker	Epilepsy	Active metabolite
Ethosuximide	T-type Ca blocker	Absence seizure	DOC
Lorazepam	GABA enhancer	Status epilepticus	First line
Flumazenil	Benzo antagonist	Overdose	Reversal agent

Ultra-Fast Pharmacology Memory Map

For CNS drugs, remember this simple rule:

Seizure drugs do ONE of three things:

1️⃣ Block sodium channels
2️⃣ Block calcium channels
3️⃣ Increase GABA

If you remember this, **most seizure drug questions become easier.**

Most Likely Exam Trap Questions (Based on the PDF)

1️⃣ Which antidepressant causes **seizure risk**?
→ **Bupropion**

2️⃣ Which antiepileptic forms an **active epoxide metabolite**?
→ **Carbamazepine**

3️⃣ Drug of choice for **absence seizure**?
→ **Ethosuximide**

4️⃣ First-line treatment for **status epilepticus**?
→ **Lorazepam**

5️⃣ Drug used to **reverse benzodiazepine overdose**?
→ **Flumazenil**

PH BIO 6 – Pharmacology of Drugs Used in GIT Disorders

Comprehensive Reviewer

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1. Overview of Gastrointestinal (GI) Physiology

What is the Gastrointestinal System?

The **gastrointestinal (GI) system** is the group of organs responsible for:

- **Digestion of food**
- **Absorption of nutrients**
- **Elimination of waste**

Major Organs of the GI System

1. **Mouth**
2. **Esophagus**
3. **Stomach**
4. **Small intestine**
5. **Large intestine**
6. **Liver**
7. **Gallbladder**
8. **Pancreas**

How the GI System Connects to the Rest of the Body

Organ	Connection to Body Systems
Brain	Controls appetite, vomiting reflex, and motility
Nervous system	Enteric Nervous System regulates digestion
Liver	Processes absorbed nutrients and detoxifies drugs
Pancreas	Releases digestive enzymes and insulin
Bloodstream	Absorbed nutrients travel to all tissues

So the GI tract works closely with:

- **Nervous system**
- **Endocrine system**
- **Circulatory system**
- **Immune system**

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2. Gastric Acid Secretion

What is Gastric Acid?

Gastric acid (HCl) is a strong acid produced in the stomach that helps:

- digest proteins
- activate digestive enzymes
- kill bacteria

Where is it produced?

It is secreted by **parietal cells in the stomach lining**.

Main Mechanism

The acid is released through the **proton pump**:

H^+ / K^+ – ATPase

This pump exchanges hydrogen ions for potassium ions.

Substances that Stimulate Acid Production

Substance	Receptor	Function
Gastrin	Gastrin receptor	stimulates acid release
Histamine	H_2 receptor	increases acid secretion
Acetylcholine	M3 receptor	stimulates parietal cells

Easy Memory Trick

“GHA stimulates acid”

- **G**astrin
- **H**istamine
- **A**cetylcholine

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3. GI Motility

Definition

GI motility is the **movement of food through the digestive tract**.

It occurs through **peristalsis**, which is the wave-like muscle contraction of the intestines.

Controlled By

The **Enteric Nervous System (ENS)**.

The ENS is sometimes called the **"second brain"** because it can function independently of the brain.

Important Neurotransmitters

Chemical	Role
Serotonin (5-HT)	increases motility
Dopamine (D2)	decreases motility

Connection to the Nervous System

The ENS communicates with:

- **Vagus nerve**
- **Central nervous system**

This explains why **stress or emotions affect digestion**.

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4. Mucosal Defense System

The stomach must protect itself from its own acid.

Protective Mechanisms

Component	Function
Mucus	protects stomach lining
Bicarbonate (HCO_3^-)	neutralizes acid
Prostaglandins (PGE_2, PGI_2)	increase mucus and blood flow

Clinical Importance

When these defenses decrease, **ulcers can form**.

Example cause:

- **NSAIDs** decrease prostaglandins → stomach damage.

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5. Vomiting Reflex (Emesis)

Vomiting Center

Located in the **brainstem**.

This center receives signals from different parts of the body.

Main Triggers

Source	Explanation

Chemoreceptor Trigger Zone (CTZ)	detects toxins and drugs in blood
Vestibular system	motion sickness
GI vagal afferents	stomach irritation

Example

Food poisoning → stomach irritation → vagus nerve → vomiting center → vomiting.

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6. Common GI Disorders

Acid-Peptic Diseases

Gastroesophageal Reflux Disease (GERD)

Definition: Acid from the stomach flows back into the esophagus.

Symptoms

- heartburn
- chest pain
- regurgitation

Peptic Ulcer Disease (PUD)

Definition: Open sores in the stomach or duodenum.

Common causes:

- **Helicobacter pylori infection**
- **NSAIDs**

Stress-related Gastritis

Inflammation of the stomach caused by **severe illness or stress**.

Motility Disorders

Gastroparesis

Delayed emptying of the stomach.

Common in:

- diabetes
- nerve damage

Symptoms:

- nausea
- vomiting
- early satiety

Chronic Constipation

Infrequent bowel movements due to slow intestinal movement.

Irritable Bowel Syndrome (IBS)

A functional disorder causing:

- abdominal pain
- diarrhea or constipation
- bloating

It is related to **gut-brain interaction**.

Inflammatory Bowel Disease (IBD)

Two major types:

Crohn's Disease

- affects any part of GI tract
- patchy inflammation

Ulcerative Colitis

- affects colon only
- continuous inflammation

These diseases involve the **immune system attacking the intestines**.

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7. Drugs for Acid-Peptic Disorders

These drugs reduce stomach acid or protect the stomach lining.

Examples include:

- Proton Pump Inhibitors
- H2 blockers
- Antacids

They work by **blocking acid production or neutralizing acid**.

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8. Mucosal Protective Agents

Sucralfate

Mechanism

Forms a **thick protective paste** over ulcers.

Function

Acts like a **bandage for the stomach lining**.

Misoprostol

Definition

A **Prostaglandin E1 analog**.

Mechanism

- increases mucus
- increases bicarbonate
- reduces acid

Clinical Use

Prevents **NSAID-induced ulcers**.

Important Contraindication

Pregnancy because it can cause **abortion**.

Bismuth Subsalicylate

Mechanism

- coats ulcers
- kills **H. pylori bacteria**

Side Effect

Harmless **black stool or black tongue**.

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9. Prokinetic Drugs (Increase GI Motility)

Metoclopramide

Mechanism

- **D2 receptor antagonist**
- **5-HT4 receptor agonist**

Effects

- increases stomach emptying
- anti-nausea

Indications

- gastroparesis
- nausea and vomiting

Side Effects

- dystonia
- Parkinson-like symptoms
- tardive dyskinesia

Erythromycin

Originally an **antibiotic** but used off-label.

Mechanism

Mimics **motilin hormone**.

Motilin stimulates **gastric contractions**.

Used before **endoscopy** to empty stomach.

5-HT4 Agonists

Examples:

- **Prucalopride**
- **Tegaserod**

These drugs **increase intestinal motility**.

Used for **chronic constipation**.

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10. Laxatives

Used to treat constipation.

Types

Bulk-Forming

Example: **Psyllium**

Mechanism:

- absorbs water
- increases stool bulk

Osmotic Laxatives

Examples:

- **Polyethylene glycol (PEG)**
- **Lactulose**

Mechanism:

- pulls water into intestine

Used for **bowel preparation before colonoscopy**.

Stimulant Laxatives

Examples:

- **Bisacodyl**
- **Senna**

Mechanism:

- stimulates enteric nerves
- increases bowel movement

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11. Antidiarrheal Drugs

Loperamide

Mechanism

Opioid receptor agonist in the intestine.

Effects:

- slows intestinal movement
- increases water absorption

Important feature:

- **Does NOT cross the blood-brain barrier**
- therefore **low addiction risk**

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12. Antiemetic Drugs

Drugs used to prevent **nausea and vomiting**.

5-HT3 Antagonists

Examples:

- **Ondansetron**
- **Palonosetron**
- **Granisetron**

Mechanism

Blocks serotonin receptors in:

- vagus nerve
- CTZ

Clinical Use

Gold standard for chemotherapy-induced nausea and vomiting (CINV).

Neurokinin-1 (NK1) Antagonists

Examples:

- **Aprepitant**
- **Rolapitant**

Mechanism

Blocks **Substance P** at NK1 receptors.

Used for **delayed chemotherapy vomiting**.

Anticholinergics

Example:

Scopolamine

Mechanism

Blocks acetylcholine in the vestibular system.

Use

Motion sickness.

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13. Drugs for Inflammatory Bowel Disease

These drugs reduce **intestinal inflammation**.

Common categories include:

- Aminosalicylates
- Corticosteroids
- Immunosuppressants
- Biologic agents

They work by **suppressing immune reactions in the intestine**.

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14. Pancreatic Enzyme Therapy

Pancrelipase

Contains digestive enzymes:

- **Amylase** → breaks down carbohydrates
- **Lipase** → breaks down fats
- **Protease** → breaks down proteins

Use

For **pancreatic insufficiency**.

Common causes:

- **Cystic fibrosis**
- **Chronic pancreatitis**

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15. Bile Acid Therapy

Ursodiol

Mechanism

Reduces **cholesterol concentration in bile**.

Effects

- dissolves **small gallstones**
- improves bile flow

Used For

- gallstones
- primary biliary cholangitis

Super Quick 30-Second Oral Exam Summary

1. **Acid secretion** controlled by **Gastrin, Histamine, ACh via proton pumps**.
2. **GI motility** controlled by **enteric nervous system with serotonin and dopamine receptors**.
3. **Mucosal protection** comes from **mucus, bicarbonate, and prostaglandins**.
4. **Prokinetics increase motility**, **laxatives treat constipation**, **loperamide treats diarrhea**.
5. **Antiemetics block CTZ or vagal signals** to prevent vomiting.
