Crown to Cortex

Pharmacology

Pharmacokinetics

The Unhackables Medical

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How to read this topic

Pharmacokinetics explains what the body does to a drug: absorption, distribution, metabolism, and excretion. Exam questions usually test bioavailability, volume of distribution, clearance, half-life, loading dose, maintenance dose, enzyme induction, renal impairment, and nonlinear kinetics.

Classify

Place the drug in the correct class before reading the clinical stem.

v

Mechanism

Convert receptor, enzyme, or pathway action into expected benefit.

v

Patient filter

Apply pregnancy, renal/hepatic disease, ECG, electrolyte, allergy, and interaction filters.

v

Exam answer

Choose the drug that fits the indication and avoids the hidden contraindication.

Classification map

Class / axis	High-yield details
Absorption	pH partition, gastric emptying, first-pass effect, transporters
Distribution	protein binding, Vd, barriers, tissue reservoirs
Metabolism	Phase I CYP, Phase II conjugation, prodrugs, active metabolites
Excretion	GFR, secretion, reabsorption, urinary pH manipulation

Prototype drug map

Prototype	What to remember
High Vd	chloroquine, digoxin, amiodarone
Low Vd	heparin, warfarin, aminoglycosides
Zero-order	phenytoin, ethanol, aspirin high dose
Enzyme induction	rifampicin, carbamazepine, phenytoin, phenobarbitone
Enzyme inhibition	macrolides, azoles, ritonavir, cimetidine, grapefruit

Mechanism to clinical use

1. Absorption

Mechanism anchor: pH partition, gastric emptying, first-pass effect, transporters. In NEET PG style questions, this becomes important when the stem asks for drug choice, mechanism of toxicity, resistance, organ-specific effect, or a contraindication. Always connect the class to the expected physiological change rather than memorizing the name alone.

Clinical conversion: ask whether the desired effect is immediate symptom relief, disease modification, prophylaxis, reversal of toxicity, or long-term prevention. The same class can be correct or wrong depending on timing, route, patient risk, and monitoring feasibility.

2. Distribution

Mechanism anchor: protein binding, Vd, barriers, tissue reservoirs. In NEET PG style questions, this becomes important when the stem asks for drug choice, mechanism of toxicity, resistance, organ-specific effect, or a contraindication. Always connect the class to the expected physiological change rather than memorizing the name alone.

Clinical conversion: ask whether the desired effect is immediate symptom relief, disease modification, prophylaxis, reversal of toxicity, or long-term prevention. The same class can be correct or wrong depending on timing, route, patient risk, and monitoring feasibility.

3. Metabolism

Mechanism anchor: Phase I CYP, Phase II conjugation, prodrugs, active metabolites. In NEET PG style questions, this becomes important when the stem asks for drug choice, mechanism of toxicity, resistance, organ-specific effect, or a contraindication. Always connect the class to the expected physiological change rather than memorizing the name alone.

Clinical conversion: ask whether the desired effect is immediate symptom relief, disease modification, prophylaxis, reversal of toxicity, or long-term prevention. The same class can be correct or wrong depending on timing, route, patient risk, and monitoring feasibility.

4. Excretion

Mechanism anchor: GFR, secretion, reabsorption, urinary pH manipulation. In NEET PG style questions, this becomes important when the stem asks for drug choice, mechanism of toxicity, resistance, organ-specific effect, or a contraindication. Always connect the class to the expected physiological change rather than memorizing the name alone.

Clinical conversion: ask whether the desired effect is immediate symptom relief, disease modification, prophylaxis, reversal of toxicity, or long-term prevention. The same class can be correct or wrong depending on timing, route, patient risk, and monitoring feasibility.

Drug signatures

Drug / class	Mechanism cue	Use cue	Toxicity cue
High Vd	chloroquine, digoxin, amiodarone	Know preferred indication	Know signature adverse effect
Low Vd	heparin, warfarin, aminoglycosides	Know preferred indication	Know signature adverse effect
Zero-order	phenytoin, ethanol, aspirin high dose	Know preferred indication	Know signature adverse effect
Enzyme induction	rifampicin, carbamazepine, phenytoin, phenobarbitone	Know preferred indication	Know signature adverse effect
Enzyme inhibition	macrolides, azoles, ritonavir, cimetidine, grapefruit	Know preferred indication	Know signature adverse effect

Clinical edges

- Renal failure: reduce dose or extend interval for renally cleared drugs; monitor aminoglycosides, vancomycin, lithium, digoxin
- Liver disease: avoid high extraction drugs when hepatic blood flow is compromised; watch protein binding
- Poisoning: urine alkalinization for salicylates and phenobarbitone; dialysis when low Vd and low protein binding
- Pregnancy: increased Vd and GFR can lower levels of selected drugs
- A low albumin state increases free fraction of highly protein-bound drugs such as phenytoin and warfarin.
- Weak acids are trapped in alkaline urine; weak bases are trapped in acidic urine.
- Enzyme induction lowers levels of many substrate drugs, while enzyme inhibition raises toxicity risk.
- Renal dose adjustment is essential for aminoglycosides, vancomycin, lithium, digoxin, and many antivirals.

Adverse effects and contraindication logic

High Vd

Expected exam cue: chloroquine, digoxin, amiodarone. When this drug or class appears in a clinical vignette, actively look for allergy, pregnancy risk, renal or hepatic impairment, ECG abnormality, electrolyte disturbance, bleeding risk, respiratory disease, CNS depression, or interacting medicines.

How to eliminate options: reject drugs that worsen the dominant clinical danger in the stem, even if their mechanism seems suitable. This is especially important in pharmacology questions where the wrong option is often a contraindicated first-line drug.

Low Vd

Expected exam cue: heparin, warfarin, aminoglycosides. When this drug or class appears in a clinical vignette, actively look for allergy, pregnancy risk, renal or hepatic impairment, ECG abnormality, electrolyte disturbance, bleeding risk, respiratory disease, CNS depression, or interacting medicines.

How to eliminate options: reject drugs that worsen the dominant clinical danger in the stem, even if their mechanism seems suitable. This is especially important in pharmacology questions where the wrong option is often a contraindicated first-line drug.

Zero-order

Expected exam cue: phenytoin, ethanol, aspirin high dose. When this drug or class appears in a clinical vignette, actively look for allergy, pregnancy risk, renal or hepatic impairment, ECG abnormality, electrolyte disturbance, bleeding risk, respiratory disease, CNS depression, or interacting medicines.

How to eliminate options: reject drugs that worsen the dominant clinical danger in the stem, even if their mechanism seems suitable. This is especially important in pharmacology questions where the wrong option is often a contraindicated first-line drug.

Enzyme induction

Expected exam cue: rifampicin, carbamazepine, phenytoin, phenobarbitone. When this drug or class appears in a clinical vignette, actively look for allergy, pregnancy risk, renal or hepatic impairment, ECG abnormality, electrolyte disturbance, bleeding risk, respiratory disease, CNS depression, or interacting medicines.

How to eliminate options: reject drugs that worsen the dominant clinical danger in the stem, even if their mechanism seems suitable. This is especially important in pharmacology questions where the wrong option is often a contraindicated first-line drug.

Enzyme inhibition

Expected exam cue: macrolides, azoles, ritonavir, cimetidine, grapefruit. When this drug or class appears in a clinical vignette, actively look for allergy, pregnancy risk, renal or hepatic impairment, ECG abnormality, electrolyte disturbance, bleeding risk, respiratory disease, CNS depression, or interacting medicines.

How to eliminate options: reject drugs that worsen the dominant clinical danger in the stem, even if their mechanism seems suitable. This is especially important in pharmacology questions where the wrong option is often a contraindicated first-line drug.

Exam traps

- Half-life changes time to steady state, not the final steady-state concentration when dosing rate is unchanged.
- Loading dose changes onset of target level, not elimination capacity.
- Bioavailability is not the same as absorption when first-pass metabolism is high.
- Highly lipid-soluble drugs often have large Vd and are poorly removed by dialysis.
- In Pharmacokinetics, do not memorize a class without its route, onset, elimination, and monitoring.
- Toxicity questions often hide the drug name and reveal the answer through one adverse-effect signature.
- Contraindications are tested more often than rare mechanisms.
- A drug can be first-line in one patient and dangerous in another.

Last-day revision grid

Question	Answer to recall quickly
Best prototype?	High Vd, Low Vd, Zero-order, Enzyme induction
Most tested danger?	toxicity, contraindication, interaction, and monitoring
Emergency angle?	route, onset, antidote, supportive care
Do-not-miss filter?	pregnancy, renal/hepatic failure, ECG/electrolytes, bleeding or respiratory risk

High-yield definitions

Term	Definition / exam meaning
Absorption	pH partition, gastric emptying, first-pass effect, transporters
Distribution	protein binding, Vd, barriers, tissue reservoirs
Metabolism	Phase I CYP, Phase II conjugation, prodrugs, active metabolites
Excretion	GFR, secretion, reabsorption, urinary pH manipulation
High Vd	chloroquine, digoxin, amiodarone
Low Vd	heparin, warfarin, aminoglycosides
Zero-order	phenytoin, ethanol, aspirin high dose
Enzyme induction	rifampicin, carbamazepine, phenytoin, phenobarbitone
Enzyme inhibition	macrolides, azoles, ritonavir, cimetidine, grapefruit
Bioavailability	Fraction of administered dose reaching systemic circulation unchanged; IV equals 100 percent.
Volume of distribution	Apparent space occupied by drug; high Vd suggests tissue binding or lipid solubility.

How this helps in Pharmacokinetics: this page is meant to convert memorized pharmacology into option elimination. Read the left column first, then force yourself to say the mechanism, clinical use, toxicity, and reason another option is wrong.

Drug-by-drug comparison

Comparison	How to separate them in an exam stem	Most useful discriminator
High Vd vs Low Vd	High Vd is recalled by: chloroquine, digoxin, amiodarone. Low Vd is recalled by: heparin, warfarin, aminoglycosides.	Indication, toxicity pattern, route/onset, or contraindication hidden in the stem.
Zero-order vs Enzyme induction	Zero-order is recalled by: phenytoin, ethanol, aspirin high dose. Enzyme induction is recalled by: rifampicin, carbamazepine, phenytoin, phenobarbitone.	Indication, toxicity pattern, route/onset, or contraindication hidden in the stem.

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Toxicity signatures

Drug / class	Toxicity pattern to actively search for	Immediate exam response
High Vd	Link the prototype clue to organ toxicity, laboratory change, ECG change, bleeding, CNS depression, allergy, or pregnancy risk. Cue: chloroquine, digoxin, amiodarone	Stop/avoid the drug if the stem contains the danger sign; choose antidote or safer alternative when asked.
Low Vd	Link the prototype clue to organ toxicity, laboratory change, ECG change, bleeding, CNS depression, allergy, or pregnancy risk. Cue: heparin, warfarin, aminoglycosides	Stop/avoid the drug if the stem contains the danger sign; choose antidote or safer alternative when asked.
Zero-order	Link the prototype clue to organ toxicity, laboratory change, ECG change, bleeding, CNS depression, allergy, or pregnancy risk. Cue: phenytoin, ethanol, aspirin high dose	Stop/avoid the drug if the stem contains the danger sign; choose antidote or safer alternative when asked.
Enzyme induction	Link the prototype clue to organ toxicity, laboratory change, ECG change, bleeding, CNS depression, allergy, or pregnancy risk. Cue: rifampicin, carbamazepine, phenytoin, phenobarbitone	Stop/avoid the drug if the stem contains the danger sign; choose antidote or safer alternative when asked.
Enzyme inhibition	Link the prototype clue to organ toxicity, laboratory change, ECG change, bleeding, CNS depression, allergy, or pregnancy risk. Cue: macrolides, azoles, ritonavir, cimetidine, grapefruit	Stop/avoid the drug if the stem contains the danger sign; choose antidote or safer alternative when asked.
Pharmacokinetics	Any severe allergy, organ failure, pregnancy risk, or dangerous interaction can override first-line status.	Do not pick a drug only because it is famous.

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Contraindication filters

Clinical filter	What it changes	Exam habit
Pregnancy/lactation	Avoid teratogenic, fetal-toxic, or neonatal-toxic drugs; prefer established safer options.	Always scan age/sex/history lines.
Renal impairment	Accumulation increases toxicity for renally cleared drugs; dose interval may need extension.	Look for creatinine, oliguria, CKD, elderly patient.
Hepatic disease	Reduced metabolism, low albumin, and bleeding risk can change drug choice.	Check jaundice, cirrhosis, INR, albumin.
ECG/electrolytes	QT prolongation, heart block, hypokalemia, and hyperkalemia decide many answers.	Never ignore ECG and potassium.
Respiratory disease	Bronchospasm or respiratory depression risk can make a familiar drug unsafe.	Asthma/COPD/sleep apnea are not decorative details.
Bleeding risk	Antiplatelets, anticoagulants, thrombolytics, NSAIDs, and marrow-toxic drugs need caution.	Check ulcer, surgery, stroke, platelets, INR.
High Vd	chloroquine, digoxin, amiodarone	Ask: where is this drug dangerous?
Low Vd	heparin, warfarin, aminoglycosides	Ask: where is this drug dangerous?
Zero-order	phenytoin, ethanol, aspirin high dose	Ask: where is this drug dangerous?

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Drug interaction map

Interaction type	Mechanism	Common exam expression
CYP induction	Increases metabolism of substrate drugs and can cause treatment failure.	Rifampicin/carbamazepine/phenytoin reducing OCP, warfarin, antiretroviral, or steroid effect.
CYP inhibition	Raises substrate levels and toxicity.	Macrolide/azole/ritonavir/cimetidine/grapefruit toxicity stem.
Additive toxicity	Two drugs injure the same organ or pathway.	QT plus QT, bleeding plus bleeding, nephrotoxic plus nephrotoxic, CNS depressant plus CNS depressant.
Pharmacodynamic opposition	One drug blocks the desired effect of another.	NSAID reducing antihypertensive effect; beta blocker opposing beta agonist.
High Vd	chloroquine, digoxin, amiodarone	Check whether the vignette adds another drug that amplifies toxicity or reduces benefit.
Low Vd	heparin, warfarin, aminoglycosides	Check whether the vignette adds another drug that amplifies toxicity or reduces benefit.
Zero-order	phenytoin, ethanol, aspirin high dose	Check whether the vignette adds another drug that amplifies toxicity or reduces benefit.
Enzyme induction	rifampicin, carbamazepine, phenytoin, phenobarbitone	Check whether the vignette adds another drug that amplifies toxicity or reduces benefit.

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Monitoring and dose adjustment

Monitoring target	Why it matters	What to remember
Clinical endpoint	Symptom relief or prevention outcome confirms benefit.	Pain, BP, seizure control, infection response, glucose, dyspnea, psychosis, bleeding.
Laboratory endpoint	Detects efficacy and silent toxicity.	Renal function, liver enzymes, CBC, electrolytes, coagulation, glucose, drug levels.
ECG	Many drugs alter conduction, QT, or rhythm.	QT prolongation, AV block, QRS widening, torsades risk.
Therapeutic drug monitoring	Needed when therapeutic window is narrow.	Lithium, digoxin, phenytoin, valproate, aminoglycosides, vancomycin, tacrolimus.
High Vd	Monitoring depends on the toxicity implied by its mechanism and elimination.	chloroquine, digoxin, amiodarone
Low Vd	Monitoring depends on the toxicity implied by its mechanism and elimination.	heparin, warfarin, aminoglycosides
Zero-order	Monitoring depends on the toxicity implied by its mechanism and elimination.	phenytoin, ethanol, aspirin high dose

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Rapid pathway

Read the stem

Disease, severity, age, pregnancy, organ function, emergency status.

V

Name the class

Mechanism and prototype before option elimination.

V

Apply exclusions

Contraindications, interactions, and toxicity signatures.

V

Pick final answer

Most specific safe drug for that exact stem.