BP304T · B.PHARM THEORY

BP304T General Pharmacology

Unit I — Introduction to Pharmacology

Pills & Python Notes

From-zero teaching standard: every technical term is defined before use.

Syllabus coverage: Unit I (8 hours).

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Chapter 1: Introduction to Pharmacology: Definitions, History, Branches, Drug Sources, ICD & INN, Generic Medicines, Essential Drugs & Rational Drug Use

Learning Objectives

After studying this chapter, the student should be able to:

1. Define pharmacology, drug, and related basic terms in simple words.
2. Describe the historical development of pharmacology from ancient to modern times.
3. Name the main branches of pharmacology and explain the scope (work area) of each branch.
4. Explain the nature of drugs and list the main sources of drugs with examples.
5. Explain what ICD (International Classification of Diseases) and INN (International Non-proprietary Names) are and why they are important.
6. Explain the concept of generic medicines, essential drugs, and rational drug use (RDU).
7. Describe the Indian Government's initiatives to promote generic medicines, essential drugs, and rational drug use (Jan Aushadhi/PMBJP, NLEM, Schedule H/H1/X caution).
8. Differentiate between brand-name medicines and generic medicines.

Definitions

- **Pharmacology:** The science that studies drugs — what drugs are, how they work in the body, how the body handles drugs, and how drugs are used to treat or prevent diseases. (Simple meaning: "the science of medicines — how medicines act and how the body responds to them.")
- **Drug:** Any chemical substance (natural or man-made) that, when given to a living body, changes one or more body functions, and is used to diagnose, prevent, treat, or cure a disease. (Simple meaning: "a chemical that changes how the body works, used as medicine.")
- **Medicine:** A drug that is prepared in a suitable form (tablet, syrup, injection) and given in a proper dose to treat a patient. (Simple meaning: "a drug made ready for the patient to take.")
- **Pharmacokinetics:** The study of what the **body does to the drug** — how the drug is absorbed, distributed, metabolised, and excreted. (Memory trick: "kinetic = movement of the drug through the body.")
- **Pharmacodynamics:** The study of what the **drug does to the body** — how the drug produces its effect and its mechanism of action. (Memory trick: "dynamic = action of the drug on the body.")
- **Therapeutics:** The branch of medicine concerned with the treatment of disease using drugs.
- **Toxicology:** The science of poisons — studying harmful effects of drugs and chemicals and their treatment.
- **Chemotherapy:** Treatment of disease (especially infections and cancer) using chemical drugs that kill or stop the growth of disease-causing germs or cells.
- **Generic medicine:** A medicine that contains the same active drug, in the same amount and same form, as the original brand-name medicine, but is sold under the chemical (generic) name instead of a company's brand name. It is usually cheaper.
- **Essential drugs (essential medicines):** The medicines that satisfy the most important health needs of the majority of people, and that should always be available, in proper amounts, at a price people can afford.
- **Rational drug use (RDU):** Using medicines in the right way — the right drug, for the right patient, in the right dose, for the right duration, at the lowest cost.
- **ICD (International Classification of Diseases):** A system created by the World Health Organization (WHO) that gives every disease and health condition a standard code (letters + numbers), so that doctors and hospitals all over the world use the same names and codes for diseases.
- **INN (International Non-proprietary Name):** The official, single, worldwide name given by WHO to each drug's active chemical ingredient, so that the same drug is called by the same name in every country.

Terminology

- **Active ingredient:** The part of a medicine that actually produces the treatment effect (e.g., paracetamol in a Crocin tablet).
- **Brand name (trade name / proprietary name):** The name given by a manufacturing company to its medicine (e.g., Crocin, Disprin). One drug can have many brand names.
- **Generic name:** The common scientific name of the drug's active ingredient (e.g., paracetamol). One drug has only one generic name worldwide.
- **Pharmacopoeia:** An official book that lists quality standards for drugs and medicines (e.g., Indian Pharmacopoeia, British Pharmacopoeia).
- **Posology:** The study of drug doses — how much medicine should be given to a patient.
- **Placebo:** A substance with no active drug (e.g., a sugar tablet) used for comparison in drug testing or, rarely, for psychological effect.
- **Adverse drug reaction (ADR):** An unwanted or harmful effect caused by a medicine at normal doses.
- **Formulation:** The final form in which a drug is prepared for the patient (tablet, capsule, syrup, injection, ointment).
- **Dose:** The fixed amount of a drug given at one time (e.g., "500 mg paracetamol").
- **Dosage:** The full plan of giving the drug — dose + how often + for how many days (e.g., "500 mg, three times a day, for 5 days").
- **OTC (Over-The-Counter) drug:** A medicine that can be bought without a doctor's prescription (e.g., paracetamol tablets, antacid syrups).

Explanation

What is Pharmacology? — The Science of Medicines

Technical concept: Pharmacology is the biomedical science that studies drugs — their origin, chemical properties, actions on living systems, absorption, distribution, metabolism, excretion, and their use in the diagnosis, prevention, and treatment of disease.

Simple explanation: Imagine the human body is a big, complicated machine, and a drug is a tool that changes how the machine works. Pharmacology is the full science of these tools: where they come from, how they enter the machine, what they do inside it, how the machine removes them, and how to use them safely to repair the machine (treat disease). Every pharmacist must learn pharmacology because a pharmacist's main job is to handle medicines correctly and safely.

Example: When you have a headache, you take a paracetamol tablet. Pharmacology answers questions like: What is paracetamol made from? How does the tablet dissolve in your stomach? How does it reach your blood? How does it reduce pain? How much should you take? What happens if you take too much? All these answers belong to pharmacology.

Key takeaway: Pharmacology = the complete science of drugs: origin → entry into body → action → removal → safe use in treatment.

Why Pharmacology is Divided into Two Halves: Pharmacokinetics and Pharmacodynamics

Technical concept: Pharmacology is studied in two complementary halves. Pharmacokinetics (ADME: Absorption, Distribution, Metabolism, Excretion) describes the movement and fate of the drug in the body. Pharmacodynamics describes the biochemical and physiological effects of the drug on the body, including mechanism of action.

Simple explanation: Think of a drug as a guest visiting a house (your body):

- **Pharmacokinetics = what the house does to the guest:** the guest enters through the door (absorption), walks into different rooms (distribution), changes clothes (metabolism), and finally leaves the house (excretion).
- **Pharmacodynamics = what the guest does in the house:** the guest talks, eats, or fixes something (produces an effect on the body).

Example: You swallow an aspirin tablet. Pharmacokinetics: the tablet dissolves in the stomach → aspirin enters the blood (absorption) → travels to the painful joint (distribution) → the liver changes it (metabolism) → the kidneys remove it in urine (excretion). Pharmacodynamics: aspirin blocks pain-causing chemicals in the joint, so pain reduces.

Key takeaway: Pharmacokinetics = body acts on drug (ADME). Pharmacodynamics = drug acts on body (effect + mechanism). Both are needed to use a drug correctly.

Historical Perspectives of Pharmacology

Technical concept: Pharmacology developed over thousands of years — from ancient plant-based remedies, through the isolation of pure active chemicals in the 19th century, to modern receptor-based drug design and biotechnology.

Simple explanation: Long ago, people did not know what chemicals were. They simply observed that certain plants made sick people better. Slowly, scientists learned to take out the exact useful chemical from the plant, then learned to make medicines in factories, and today they design drugs on computers to fit exact targets in the body. The history of pharmacology is the story of moving from "this leaf helps" to "this exact molecule fits this exact receptor."

Example: Ancient people chewed willow bark for pain and fever (they did not know why it worked). In the 1800s, scientists isolated salicin from willow bark, then made acetylsalicylic acid — aspirin — in a factory. Today, we know aspirin blocks specific pain enzymes (COX enzymes). Same pain relief, but now we understand it completely.

Key takeaway: Pharmacology grew from observation of plants → isolation of pure chemicals → factory-made synthetic drugs → modern targeted drug design.

What is a Drug? — Definition, Nature, and Sources

Technical concept: A drug is a chemical substance of known structure (other than food) that, when administered to a living organism, produces a biological effect. The nature of drugs: they can be small organic molecules, proteins, minerals, or complex biological products. Sources of drugs: natural (plant, animal, mineral, microbial) and synthetic/semisynthetic (man-made in laboratories).

Simple explanation: A drug is a chemical that changes the body's working. It is not food — food gives energy, but a drug changes body functions (lowers fever, kills germs, reduces pain). Drugs come from nature (plants, animals, minerals, germs) or are made by scientists in laboratories.

Examples of drug sources:

- **Plant source:** Morphine (painkiller) from opium poppy; quinine (anti-malarial) from cinchona bark; digoxin (heart medicine) from foxglove plant.
- **Animal source:** Insulin (diabetes medicine) originally from pancreas of pigs/cattle; heparin (blood thinner) from animal tissues.
- **Mineral source:** Iron tablets for anaemia; magnesium and aluminium compounds used as antacids.
- **Microbial source:** Penicillin (antibiotic) from the Penicillium fungus; streptomycin from Streptomyces bacteria.
- **Synthetic (man-made) source:** Paracetamol, aspirin, and most modern tablets are fully made in chemical factories.
- **Semisynthetic source:** Started from a natural substance, then improved in the laboratory (e.g., amoxicillin made by modifying natural penicillin).

Key takeaway: Drug = chemical that changes body function (not food). Sources: plant, animal, mineral, microbial, synthetic, semisynthetic.

ICD — International Classification of Diseases

Technical concept: The ICD is the WHO's standard system for classifying diseases, injuries, and causes of death using alphanumeric codes. It allows uniform recording, reporting, and comparison of disease data across countries.

Simple explanation: Different doctors in different countries may call the same disease by different local names. The ICD gives every disease one standard code, like a roll number for diseases. So a hospital in Delhi and a hospital in London record the same disease with the same code — there is no confusion.

Example: Type 2 diabetes mellitus has an ICD code. Whether the patient is in India, Japan, or Brazil, the hospital records use the same ICD code for it. This helps governments count how many people have diabetes and plan health budgets.

Key takeaway: ICD = WHO's universal code system for diseases, so every country speaks the same "disease language."

INN — International Non-proprietary Names for Drugs

Technical concept: The INN system, coordinated by WHO, assigns a unique, globally recognised non-proprietary (generic) name to each pharmaceutical substance, so that the active ingredient is identified by the same name worldwide regardless of brand names.

Simple explanation: One drug can be sold under 50 different company brand names in 50 countries. That is confusing and dangerous. WHO gives every drug's active chemical ONE official world name — the INN. Doctors, pharmacists, and drug regulators everywhere use this name, so everyone knows exactly which chemical is meant.

Example: The painkiller chemical is called **paracetamol** (INN) all over the world. In India it is sold as Crocin, in other countries as Panadol or Tylenol — but the INN "paracetamol" is the same everywhere. A pharmacist seeing "paracetamol" on any prescription in any country knows exactly which chemical it is.

Key takeaway: INN = one official world name for each drug's active ingredient, given by WHO — it removes confusion caused by many brand names.

Generic Medicines

Technical concept: A generic medicine contains the same active pharmaceutical ingredient, in the same strength, dosage form, and route of administration as the innovator (brand-name) product, and is expected to be therapeutically equivalent. Generic names are usually the INN.

Simple explanation: When a company first invents a new drug, it sells it under its own brand name at a high price. After some years, other companies are allowed to make the SAME medicine with the same chemical and same strength, but they sell it under the chemical name (not a fancy brand name). This copy is called a generic medicine. It works the same but costs much less because the company did not spend money on invention and big advertisements.

Example: The company brand "Crocin" (paracetamol 500 mg) and a generic "Paracetamol 500 mg" tablet from another company both contain exactly 500 mg of paracetamol. Both reduce fever the same way. The generic one is much cheaper.

Key takeaway: Generic medicine = same chemical + same strength + same effect as the brand, but sold under the chemical name at a lower price.

Essential Drugs (Essential Medicines)

Technical concept: As defined by WHO, essential medicines are those that satisfy the priority health-care needs of the population. They should be available at all times, in adequate amounts, in appropriate dosage forms, with assured quality, and at a price the individual and the community can afford.

Simple explanation: Out of thousands of medicines in the market, only some are truly necessary for most people's most common health problems — like medicines for fever, pain, infections, diabetes, high blood pressure, and anaemia. WHO calls these "essential medicines." Every country should make sure these basic medicines are always available and affordable, especially for poor people. India's list is called NLEM (National List of Essential Medicines).

Example: Paracetamol (fever/pain), amoxicillin (common infections), iron + folic acid tablets (anaemia in pregnant women), insulin (diabetes), ORS (dehydration in diarrhoea) — these are essential medicines because lakhs of Indians need them regularly.

Key takeaway: Essential medicines = the short list of most-needed, affordable medicines that must always be available to everyone.

Rational Drug Use (RDU)

Technical concept: WHO defines rational drug use as: patients receive medications appropriate to their clinical needs, in doses that meet their own individual requirements, for an adequate period of time, and at the lowest cost to them and their community.

Simple explanation: Rational drug use means using medicines with full sense and responsibility — no extra medicines, no wrong medicines, no wrong doses. It is the opposite of careless medicine use, like taking antibiotics for a common cold (where they do not work) or stopping TB medicines halfway (which makes the disease stronger).

Example of rational use: A doctor diagnoses bacterial throat infection, prescribes the correct antibiotic at the correct dose for the full 7 days, and the patient completes the full course. **Example of irrational use:** A patient demands an antibiotic injection for a viral cold; the chemist sells 2 days of antibiotic tablets without prescription; the patient stops taking them after 2 days because "I feel better."

Key takeaway: RDU = right drug + right patient + right dose + right duration + lowest cost. Wrong use wastes money and can harm the patient and society (e.g., antibiotic resistance).

Indian Government Initiatives — Jan Aushadhi (PMBJP), NLEM, Schedule H/H1/X

Technical concept: The Government of India promotes generic medicines, essential drugs, and rational drug use through: (1) the Pradhan Mantri Bhartiya Janaushadhi Pariyojana (PMBJP) — dedicated outlets ("Jan Aushadhi Kendras") selling quality generic medicines at affordable prices; (2) the National List of Essential Medicines (NLEM) — India's official list of essential medicines, whose prices are controlled; (3) the Drugs and Cosmetics Rules Schedules H, H1, and X — legal controls on the sale of prescription medicines, habit-forming drugs, and narcotic/psychotropic medicines to prevent misuse.

Simple explanation: The Indian Government knows that medicines are costly for common people, and that wrong medicine use is dangerous. So it runs special programmes:

- **Jan Aushadhi / PMBJP:** Government-supported medical shops (Jan Aushadhi Kendras) that sell good-quality generic medicines at very low prices, so poor patients can afford treatment.
- **NLEM:** The government's official list of essential medicines for India. Medicines on this list get price control, so companies cannot charge unfair high prices for life-saving basic drugs.
- **Schedule H:** Medicines that can be sold ONLY with a doctor's prescription (most antibiotics, diabetes and BP medicines). The chemist must keep a record.
- **Schedule H1:** A stricter list — certain antibiotics and habit-forming medicines. The chemist must keep a separate register with patient and doctor details, and the medicine label carries a warning symbol/box.
- **Schedule X:** The strictest list — narcotic and psychotropic medicines (sleeping pills, strong painkillers like morphine-type drugs). Sale needs a special licence, prescriptions are kept on record, and stock is strictly counted.

Example: A poor patient with high blood pressure can buy the generic version of the BP medicine at a Jan Aushadhi Kendra at a fraction of the brand price. But if the patient asks the chemist for a Schedule H1 antibiotic without a prescription, the chemist must refuse — that is the law protecting rational drug use.

Key takeaway: PMBJP/Jan Aushadhi = cheap generics for the public; NLEM = India's essential-medicines list with price control; Schedules H, H1, X = increasing levels of legal control on prescription-only and habit-forming medicines.

Classifications

Classification 1: Sources of Drugs

Source type	Meaning	Examples
Plant	Obtained from leaves, roots, bark, seeds of plants	Morphine (opium poppy), quinine (cinchona bark), digoxin (foxglove), atropine (belladonna)
Animal	Obtained from animal organs, tissues, or products	Insulin (pancreas), heparin (animal tissue), thyroid extract
Mineral	Obtained from natural mineral sources	Iron (anaemia), magnesium/aluminium antacids, zinc
Microbial	Produced by fungi or bacteria	Penicillin (Penicillium fungus), streptomycin (Streptomyces)
Synthetic	Fully made by chemical reactions in factories	Paracetamol, aspirin, sulpha drugs
Semisynthetic	Natural substance chemically improved in the lab	Amoxicillin (from penicillin), many modern antibiotics
Biotechnological	Made using living cells/genetic engineering	Human insulin, vaccines, monoclonal antibodies

Classification 2: Branches of Pharmacology

Branch	What it studies (scope)
Pharmacokinetics	What the body does to the drug — absorption, distribution, metabolism, excretion (ADME)
Pharmacodynamics	What the drug does to the body — effects and mechanism of action
Pharmacotherapeutics	Use of drugs for treating diseases in patients
Clinical pharmacology	Scientific study of drugs in human beings — testing safety and effectiveness
Toxicology	Harmful/poisonous effects of drugs and chemicals, and their treatment
Chemotherapy	Drugs that kill germs or cancer cells
Pharmacogenetics / Pharmacogenomics	How a person's genes change their response to drugs
Pharmacoepidemiology	Study of drug use and drug effects in large populations
Pharmacoeconomics	Cost vs. benefit of drug treatments — which treatment gives best value for money
Pharmacovigilance	Detecting, collecting, and preventing side effects (adverse drug reactions) of marketed medicines

Classification 3: Types of Drug Names

Name type	Given by	Example (for the same chemical)
Chemical name	Chemists (describes the molecule)	N-(4-hydroxyphenyl)acetamide
Generic name / INN	WHO (official world name)	Paracetamol
Brand name / trade name	Manufacturing company	Crocin, Calpol, Dolo

Classification 4: Medicines by Legal Sale Control (India)

Schedule (Drugs and Cosmetics Rules)	Control level	Meaning
Schedule H	Prescription only	Sold only on a registered doctor's prescription; chemist keeps records
Schedule H1	Prescription only + stricter record	Listed antibiotics/habit-forming drugs; separate register; warning label
Schedule X	Strictest control	Narcotic/psychotropic drugs; special licence; prescriptions retained; stock strictly accounted

Mechanisms

Mechanism 1: How a generic medicine is shown to be equivalent to the brand medicine (bioequivalence — concept level). Step 1: The generic tablet contains the same active chemical in the same amount as the brand tablet. Step 2: When swallowed, it must dissolve and release the drug the same way. Step 3: The drug must enter the blood at the same speed and reach the same blood levels as the brand. Step 4: If blood levels match, the effect on the body matches → the generic works the same as the brand. Simple meaning: "Same chemical + same blood levels = same treatment effect."

Mechanism 2: How the INN system prevents medication errors. Step 1: WHO publishes one INN for each new drug's active ingredient. Step 2: All countries and companies use this INN on labels, prescriptions, and textbooks. Step 3: A doctor in any country writing the INN, and a pharmacist in any country reading it, both mean the same chemical. Step 4: Confusion from dozens of different brand names disappears → fewer wrong-medicine errors.

Mechanism 3: How price control on NLEM medicines helps patients. Step 1: Government lists essential medicines in NLEM. Step 2: Maximum prices are fixed for these medicines. Step 3: Companies cannot sell them above the fixed price. Step 4: Essential treatment stays affordable for common people.

Diagrams

DIAGRAM 1: The two halves of pharmacology. Draw two large boxes side by side. Left box labelled "PHARMACOKINETICS — What the BODY does to the DRUG", containing four arrows in a row: "Absorption (drug enters blood)" → "Distribution (drug travels in body)" → "Metabolism (liver changes drug)" → "Excretion (kidney removes drug)". Right box labelled "PHARMACODYNAMICS — What the DRUG does to the BODY", containing: "Drug reaches target (receptor/enzyme)" → "Produces effect (lowers pain/fever/BP)" → "Also may produce side effects". Below both boxes, one line: "Both halves together decide the correct dose."

DIAGRAM 2: Sources of drugs — tree diagram. Draw a trunk labelled "SOURCES OF DRUGS". From the trunk, seven branches: "Plant (morphine, quinine)", "Animal (insulin, heparin)", "Mineral (iron, antacids)", "Microbial (penicillin)", "Synthetic (paracetamol, aspirin)", "Semisynthetic (amoxicillin)", "Biotechnology (vaccines, human insulin)".

DIAGRAM 3: Three names of one drug. Draw one tablet in the centre. Three labels point to it: "Chemical name — long scientific name of the molecule", "Generic name / INN — paracetamol (same worldwide)", "Brand names — Crocin, Calpol, Dolo (different companies)".

DIAGRAM 4: Levels of medicine-sale control in India — pyramid. Draw a pyramid with three layers. Bottom (widest) layer: "Schedule H — prescription-only medicines (antibiotics, BP/diabetes drugs)". Middle layer: "Schedule H1 — stricter register + warning (some antibiotics, habit-forming drugs)". Top (narrowest) layer: "Schedule X — strictest control (narcotics, sleeping pills)". Caption: "Higher up = more dangerous if misused = stricter legal control."

Flowcharts

FLOWCHART 1: From ancient remedy to modern medicine. Ancient observation ("this plant reduces fever") → Collection of the useful plant part → Isolation of the pure active chemical in the laboratory → Testing of the chemical for effect and safety → Factory manufacture of the pure drug as tablets/injections → Doctor prescribes it → Pharmacist dispenses with correct counselling.

FLOWCHART 2: How a prescription medicine reaches the patient safely (rational drug use chain). Patient's symptoms → Doctor examines and diagnoses the disease → Doctor selects the right drug, dose, and duration (rational choice) → Doctor writes a clear prescription using the generic name → Pharmacist checks the prescription, dispenses the correct medicine, and counsels the patient → Patient takes the full course exactly as directed → Disease cured, no waste, no harm.

FLOWCHART 3: What goes wrong in irrational drug use. Patient demands quick relief → Chemist sells antibiotic without prescription (illegal) OR patient self-medicates with leftover tablets → Wrong drug / wrong dose / incomplete course → Disease not cured + money wasted + side effects + germs become resistant → Next time the antibiotic fails for everyone (antibiotic resistance).

Infographic Concept Box

Title: "PHARMACOLOGY IN ONE PAGE — Know Your Medicine" Content layout (one page, big fonts, icons):

- Top banner: "PHARMACOLOGY = Science of Medicines 💊"
- Row 1 (two panels): Left panel "BODY acts on DRUG — Pharmacokinetics: Absorption → Distribution → Metabolism → Excretion (ADME)"; Right panel "DRUG acts on BODY — Pharmacodynamics: reaches target → produces effect".
- Row 2: "Every drug has 3 names: Chemical name (scientific) | Generic/INN name — paracetamol (same worldwide, given by WHO) | Brand names — Crocin, Calpol, Dolo (company names)".
- Row 3: "Drug sources wheel: 🌱 Plant (morphine) | 🐄 Animal (insulin) | ⛏️ Mineral (iron) | 🍄 Microbe (penicillin) | 🧪 Lab-made (paracetamol)".
- Row 4: "SMART medicine use — RDU: Right drug ✔ Right patient ✔ Right dose ✔ Right duration ✔ Lowest cost ✔".
- Bottom strip: "🇮🇳 India cares: Jan Aushadhi Kendras = cheap generics | NLEM = essential list with price control | Schedules H → H1 → X = rising legal control on risky medicines".
- Footer line: "Ask your pharmacist before starting or stopping any medicine!"

Tables

Table 1: Branches of pharmacology — quick comparison

Branch	One-line meaning	Example question it answers
Pharmacokinetics	Body's action on the drug (ADME)	"How fast does this tablet enter the blood?"
Pharmacodynamics	Drug's action on the body	"How does this drug lower blood pressure?"
Pharmacotherapeutics	Using drugs to treat patients	"Which drug is best for this patient's asthma?"
Toxicology	Study of poisons and harmful effects	"What is the antidote for this poisoning?"
Chemotherapy	Drugs that kill germs/cancer cells	"Which antibiotic kills these bacteria?"
Pharmacovigilance	Tracking side effects of marketed drugs	"Are patients reporting a new side effect of this drug?"
Pharmacoeconomics	Cost vs. benefit of treatments	"Which diabetes treatment gives best value for money?"

Table 2: Brand-name vs generic medicine

Feature	Brand-name medicine	Generic medicine
Name on pack	Company's brand name (e.g., Crocin)	Chemical/generic name (e.g., Paracetamol)
Active ingredient	Paracetamol 500 mg	Paracetamol 500 mg (same)
Strength and form	500 mg tablet	500 mg tablet (same)
Treatment effect	Reduces fever/pain	Reduces fever/pain (same)
Price	Higher	Lower (cheaper)
Why the price differs	Company spent on research + advertising	No research/advertising cost; competition lowers price

Table 3: Milestones in the history of pharmacology (conceptual timeline)

Period	What happened	Significance
Ancient times	Plant, animal, and mineral remedies used by observation and tradition (Ayurveda, Chinese, Egyptian, Greek medicine)	First medicines; based on experience, not chemistry
1800s	Pure active chemicals isolated from plants (morphine from opium, quinine from cinchona)	Treatment became exact — known chemical, known amount
Late 1800s–1900s	Synthetic drugs made in factories (aspirin, sulpha drugs); Paul Ehrlich's "magic bullet" idea for chemotherapy	Mass-produced, affordable medicines; targeted germ-killing
Mid 1900s	Antibiotics (penicillin), vaccines, and modern drug testing; receptors and mechanisms discovered	Infections controlled; drug action understood scientifically
Modern era	Biotechnology drugs (insulin, monoclonal antibodies), computer-aided drug design, pharmacogenomics	Medicines designed for exact body targets and individual genes

Examples

1. **Pharmacokinetics vs pharmacodynamics:** You take a cetirizine tablet for allergy. Pharmacokinetics: tablet dissolves in the stomach, cetirizine enters blood within 1 hour, travels everywhere, liver processes it, kidneys remove it. Pharmacodynamics: cetirizine blocks histamine action, so sneezing and itching stop.
2. **INN in practice:** A prescription written in Germany says "Paracetamol 500 mg." An Indian pharmacist understands it perfectly because paracetamol is the INN — no translation needed.
3. **ICD in practice:** A hospital records a dengue case using the ICD code for dengue. The government adds up all such codes across India and knows exactly how many dengue cases occurred this year.
4. **Generic saving money:** A month's brand-name BP medicine costs the patient ₹300; the same generic from a Jan Aushadhi Kendra costs ₹60. Same chemical, same effect — ₹240 saved every month.
5. **Essential drug:** ORS (oral rehydration salts) for diarrhoea-dehydration in children — cheap, life-saving, needed by lakhs of families: a classic essential medicine.
6. **Rational drug use:** A doctor prescribes iron tablets for 3 months to an anaemic pregnant woman and explains she must complete the course — right drug, right patient, right dose, right duration.
7. **Irrational drug use:** A student takes an antibiotic for 2 days for a viral cold and stops — the cold was viral (antibiotic useless), the course incomplete (resistance risk), money wasted.

Analogies

1. **Pharmacokinetics vs pharmacodynamics — the guest and the house:** The drug is a guest; the body is the house. Pharmacokinetics = what the house does to the guest (entry, movement through rooms, change of clothes, exit). Pharmacodynamics = what the guest does inside the house (the work or effect).
2. **INN — one roll number for every student:** In a school, every student has one unique roll number even if classmates call them by nicknames. INN is the drug's "roll number" — one official name worldwide, whatever nicknames (brand names) companies give.
3. **ICD — pin codes for diseases:** Just as every town has one PIN code so letters reach correctly, every disease has one ICD code so health records match correctly across the world.
4. **Generic vs brand — same shirt, different shop:** The same cotton shirt sold in a big-brand showroom and in a local shop is the same shirt; the showroom charges more for the brand board. Generic and brand medicines are the same chemical; the brand charges more for the brand name.
5. **Essential medicines — the basic food thali:** A thali has only the necessary items — roti, dal, sabzi, rice — not 100 dishes. The essential medicines list is the "basic thali" of medicines: only what most people truly need.
6. **Schedule H/H1/X — security levels:** Like airport security has normal, strict, and highest-alert levels, medicine sale has Schedule H (prescription needed), H1 (prescription + special register), and X (strictest licence and counting).

Pharmacy Relevance

- A pharmacist is the last safety checkpoint before a medicine reaches the patient — knowledge of drug names (INN vs brand), schedules (H/H1/X), and rational use is used at the counter every single day.
- When a prescription says a brand name, the pharmacist uses INN knowledge to identify the exact chemical and can offer the cheaper generic equivalent where allowed — directly saving the patient money.
- Schedule H1 and X registers are legal duties of the pharmacist; wrong sale of these medicines can cause addiction, resistance, or legal punishment for the pharmacy.
- Counselling patients to complete the full antibiotic course and not to self-medicate is rational-drug-use work that only a knowledgeable pharmacist can do properly.
- Jan Aushadhi Kendras are often run by pharmacists — this chapter is literally the job description of that role.
- Pharmacovigilance (reporting side effects) starts with the pharmacist noticing and reporting ADRs — a branch of pharmacology introduced here.

India Context

- **Jan Aushadhi / PMBJP:** The Government of India supports dedicated outlets called Pradhan Mantri Bhartiya Janaushadhi Kendras that sell quality generic medicines at affordable prices, so that common people — especially the poor — can afford treatment. Pharmacists play a central role in running these Kendras.
- **NLEM (National List of Essential Medicines):** India's official list of essential medicines, prepared by the government. Medicines on this list are considered most needed for the country's health, and their prices are controlled so companies cannot overcharge.
- **Schedules H, H1, X (Drugs and Cosmetics Rules, 1945):** Indian law divides risky medicines into these schedules. Schedule H: prescription-only sale. Schedule H1: prescription-only plus a separate register and caution labelling (covers certain antibiotics and habit-forming drugs). Schedule X: narcotic and psychotropic substances with the strictest licensing and record-keeping. Every Indian retail pharmacist must follow these schedules daily.
- **Ayurveda heritage:** India's own ancient system (Charaka Samhita, Sushruta Samhita) used plant, mineral, and animal remedies thousands of years ago — an Indian root of the "natural sources of drugs" studied in pharmacology.
- **India — "pharmacy of the world":** India manufactures huge quantities of generic medicines supplied across the globe; understanding generics is therefore directly connected to India's pharmaceutical industry and to the pharmacist's career.

Key Points

1. Pharmacology = science of drugs: origin, action, fate in the body, and use in treatment.
2. Pharmacokinetics = what the body does to the drug (ADME: Absorption, Distribution, Metabolism, Excretion).
3. Pharmacodynamics = what the drug does to the body (effect + mechanism of action).
4. A drug is a chemical (not food) that changes body function and is used to diagnose, prevent, treat, or cure disease.
5. Drug sources: plant, animal, mineral, microbial, synthetic, semisynthetic, biotechnological.
6. ICD = WHO's universal code system for diseases. INN = WHO's single worldwide name for each drug's active ingredient.
7. One drug has one INN/generic name but can have many brand names.
8. Generic medicine = same active ingredient, strength, form, and effect as the brand, sold under the chemical name at a lower price.
9. Essential medicines = the most-needed, affordable medicines that must always be available (India's list = NLEM).
10. Rational drug use = right drug, right patient, right dose, right duration, lowest cost.
11. Jan Aushadhi (PMBJP) = government-supported Kendras selling affordable generic medicines.
12. Schedule H → H1 → X = increasing legal strictness on sale of prescription-only, habit-forming, and narcotic medicines in India.

Common Confusions (with corrections)

1. **Confusion:** "Pharmacology and pharmacy are the same thing."

Correction: Pharmacy is the profession of preparing and dispensing medicines; pharmacology is the *science* of how drugs work. A pharmacist *studies* pharmacology to practise pharmacy.

1. **Confusion:** "Pharmacokinetics and pharmacodynamics are the same."

Correction: Pharmacokinetics = body acts on drug (ADME). Pharmacodynamics = drug acts on body (effect). They are opposite directions — remember the guest-and-house analogy.

1. **Confusion:** "Drug and medicine are the same word."

Correction: A drug is the active chemical; a medicine is the drug prepared in a finished form (tablet, syrup) ready for the patient.

1. **Confusion:** "Generic medicines are duplicate/fake medicines."

Correction: Generics are legal, quality-tested copies with the same active ingredient, strength, and effect as the brand — only the name and price differ. Fake (spurious) medicines are a totally different, illegal category.

1. **Confusion:** "INN and brand name are two names given by the company."

Correction: The INN is given by WHO and is the same worldwide; the brand name is given by the company and differs from company to company.

1. **Confusion:** "Essential medicines are only for poor countries."

Correction: Every country, rich or poor, needs a priority list of most-needed medicines; WHO's essential-medicines idea applies globally.

1. **Confusion:** "Schedule H medicines can be sold without prescription if the patient is known to the chemist."

Correction: No — Schedule H legally requires a valid prescription from a registered medical practitioner, every time, for every patient.

Common Mistakes (with corrections)

1. **Mistake:** Writing in exams that pharmacokinetics is "the study of drug action."

Correction: Drug *action/effect* is pharmacodynamics. Pharmacokinetics is drug *movement and fate* (ADME).

1. **Mistake:** Listing only plant and synthetic as drug sources and missing microbial, mineral, animal, and semisynthetic sources.

Correction: Memorise all seven: plant, animal, mineral, microbial, synthetic, semisynthetic, biotechnological — with one example each.

1. **Mistake:** Saying ICD gives names to drugs.

Correction: ICD classifies *diseases*; INN names *drugs*. Do not swap them.

1. **Mistake:** Claiming generics are less effective because they are cheaper.

Correction: Price difference comes from no research/advertising cost and competition — not from weaker effect. Same chemical, same strength = same effect.

1. **Mistake:** Describing rational drug use as only "correct dose."

Correction: RDU has five parts — right drug, right patient, right dose, right duration, lowest cost. All five must be mentioned.

1. **Mistake:** Mixing up Schedule H1 and Schedule X.

Correction: H1 = listed antibiotics/habit-forming drugs with a separate register and caution label; X = narcotics/psychotropics with the strictest licensing and stock control.

Mnemonics

1. **ADME (pharmacokinetics):** "**A** Drug **M**oves **E**verywhere" — **A**bsorption → **D**istribution → **M**etabolism → **E**xcretion.
2. **Drug sources — "PAM MSS B":** "**P**lant, **A**nimal, **M**ineral, **M**icrobial, **S**ynthetic, **S**emisynthetic, **B**iotech" — "Pharmacist **PAM** always **MSS** the **B**est drugs."
3. **RDU five rights — "5 R's":** **R**ight drug, **R**ight patient, **R**ight dose, **R**ight duration, **R**easonable (lowest) cost.
4. **Schedules rising strictness — "H, H1, X":** "**H**ard, **H**arder, **H**ardest" — H = prescription needed, H1 = prescription + register, X = strictest licence.
5. **INN vs ICD:** "**INN** names the **N**eedle (the drug); **ICD** codes the **C**ondition (the disease)."

Exam Summary

- Pharmacology studies drugs: their sources, how the body handles them (pharmacokinetics/ADME), what they do to the body (pharmacodynamics), and their safe use in treatment.
- History moved from ancient plant remedies → isolation of pure chemicals (morphine, quinine) → synthetic factory drugs (aspirin) → antibiotics → modern biotechnology and targeted design.
- Main branches: pharmacokinetics, pharmacodynamics, pharmacotherapeutics, clinical pharmacology, toxicology, chemotherapy, pharmacovigilance, pharmacoeconomics (plus pharmacogenetics, pharmacoepidemiology).
- Drugs come from plants, animals, minerals, microbes, synthetic chemistry, semisynthesis, and biotechnology.
- ICD = WHO disease codes (same disease language worldwide). INN = WHO's single global name for each drug's active ingredient.
- Every drug has three names: chemical name, generic/INN name, brand name(s).
- Generic medicines = same chemical, strength, form, and effect as the brand, cheaper. Essential medicines = most-needed, affordable, always-available list (India: NLEM, with price control).
- Rational drug use = right drug + right patient + right dose + right duration + lowest cost; irrational use causes waste, harm, and antibiotic resistance.
- India: Jan Aushadhi/PMBJP Kendras sell affordable generics; Schedules H (prescription-only), H1 (prescription + register + caution), X (narcotics/psychotropics, strictest control) govern medicine sale.

One-Minute Revision

Pharmacology = science of medicines. Two halves: pharmacokinetics (body→drug: ADME) and pharmacodynamics (drug→body: effect). Drugs come from plants, animals, minerals, microbes, labs (synthetic/semisynthetic), and biotechnology. ICD codes diseases (WHO); INN names drugs (WHO) — one world name per chemical. Generic = same chemical as brand, cheaper. Essential medicines = most-needed list (India: NLEM, price-controlled). Rational use = right drug, patient, dose, duration, lowest cost. India: Jan Aushadhi Kendras = cheap generics; Schedule H = prescription only, H1 = +register, X = strictest (narcotics).

Exam Questions

Short-answer questions:

1. Define pharmacology and differentiate between pharmacokinetics and pharmacodynamics with one example each.
2. Write short notes on: (a) INN, (b) ICD.
3. Classify the sources of drugs with two examples of each.
4. Differentiate between brand-name and generic medicines (any four points).
5. Define essential medicines and explain the NLEM concept in brief.
6. Define rational drug use and give two examples each of rational and irrational drug use.
7. Write a short note on Jan Aushadhi (PMBJP) scheme.
8. Differentiate between Schedule H, H1, and X drugs.

Long-answer questions:

1. Define pharmacology. Describe its historical development and explain the scope of its major branches.
2. Define "drug." Describe the nature and various sources of drugs with suitable examples.
3. Explain the concepts of generic medicines, essential drugs, and rational drug use. Describe the Indian Government's initiatives (Jan Aushadhi/PMBJP, NLEM, Schedules H/H1/X) to promote these concepts.
4. Write detailed notes on ICD and INN. Explain why standard names and codes for diseases and drugs are necessary in modern healthcare.

MCQs (with answers):

1. Pharmacokinetics is the study of:

a) Drug action on the body b) What the body does to the drug (ADME) c) Poisonous effects of drugs d) Cost of drug therapy **Answer: b**

1. The "M" in ADME stands for:

a) Movement b) Metabolism c) Mixing d) Measurement **Answer: b**

1. INN (International Non-proprietary Name) is assigned by:

a) The manufacturing company b) WHO c) The national government only d) The pharmacist **Answer: b**

1. ICD is used for:

a) Naming new drugs b) Coding/classifying diseases c) Fixing drug prices d) Testing drug quality **Answer: b**

1. Which of the following is a microbial source of a drug?

a) Morphine b) Insulin from pig pancreas c) Penicillin d) Iron tablets **Answer: c**

1. Quinine is obtained from:

a) Opium poppy b) Cinchona bark c) Foxglove plant d) Streptomyces bacteria **Answer: b**

1. A generic medicine differs from the brand-name product mainly in:

a) Active ingredient b) Strength of the active ingredient c) Name under which it is sold and usually its price d) Therapeutic effect **Answer: c**

1. India's National List of Essential Medicines is abbreviated as:

a) NLEM b) PMBJP c) OTC d) ADR **Answer: a**

1. Pradhan Mantri Bhartiya Janaushadhi Kendras mainly sell:

a) Only Ayurvedic medicines b) Quality generic medicines at affordable prices c) Imported brand medicines d) Veterinary medicines **Answer: b**

1. Which schedule requires a separate register and caution labelling for listed antibiotics and habit-forming drugs?

a) Schedule H b) Schedule H1 c) Schedule X d) Schedule C **Answer: b**

1. Narcotic and psychotropic medicines with the strictest sale control fall under:

a) Schedule H b) Schedule G c) Schedule X d) Schedule P **Answer: c**

1. Which of the following is an example of IRRATIONAL drug use?

a) Completing the full antibiotic course prescribed by a doctor b) Taking an antibiotic for 2 days for a viral cold and then stopping c) Taking iron tablets for the full 3 months for anaemia as advised d) Buying ORS for a child with diarrhoea **Answer: b**

Viva questions:

1. What is the full form of ADME? What does each letter mean?
2. Give one example each of a plant-source, mineral-source, and microbial-source drug.
3. What is the difference between a drug and a medicine?
4. Expand INN and ICD. Which organisation manages them?
5. Why does one drug have many brand names but only one INN?
6. Are generic medicines less effective than brand medicines? Justify.
7. Name the Indian Government scheme that sells affordable generic medicines through special Kendras.
8. What is the difference between Schedule H and Schedule X?
9. Define rational drug use in one sentence.
10. Why should antibiotics not be sold without a prescription?

Application-based questions:

1. A patient with high blood pressure cannot afford the prescribed brand-name tablet costing ₹300/month. As a pharmacist, what legal, safe alternative can you suggest, and where can the patient get it? (Generic equivalent; Jan Aushadhi Kendra.)
2. A customer asks for "4 tablets of an antibiotic" without a prescription for his cold. What should you do, and which legal schedule and which concept (RDU) support your decision? (Refuse; Schedule H/H1; irrational use — viral cold, incomplete course, resistance risk.)
3. A prescription from a foreign doctor reads "Paracetamol 500 mg." The patient is worried the Indian chemist will not understand it. Explain why there is no problem. (Paracetamol is the INN — same name worldwide.)
4. Your pharmacy receives a drug labelled only with a company brand name you have never seen. How do you identify the actual chemical inside? (Check the generic/INN name printed on the label/pack.)

Chapter 2: Routes of Drug Administration

Learning Objectives

After studying this chapter, the student should be able to:

1. Define "route of drug administration" and explain why the route matters.
2. List the major routes of drug administration (enteral, parenteral, topical/inhalational).
3. Describe each route — oral, sublingual, buccal, rectal, inhalation, nasal, transdermal, subcutaneous, intramuscular, intravenous, intrathecal, epidural, intra-arterial, intra-articular, intracardiac — with how the drug is given.
4. State the advantages and disadvantages of each route.
5. Explain first-pass metabolism and why it matters for the oral route.
6. Choose the suitable route for common situations (emergency, vomiting patient, unconscious patient, child, long-term treatment).
7. Explain special precautions for parenteral (injection) routes — sterility, technique, and risks.

Definitions

- **Route of drug administration:** The path or way by which a drug is brought into the body (e.g., by mouth, by injection, through the skin, by inhalation).
- **Enteral routes:** Routes in which the drug passes through the gastrointestinal tract (stomach–intestine) — mainly oral, sublingual, buccal, and rectal. ("Enteral" = through the intestine.)
- **Parenteral routes:** Routes in which the drug is given by injection, bypassing the gastrointestinal tract — e.g., intravenous, intramuscular, subcutaneous, intradermal, intrathecal, epidural. ("Parenteral" = beside the intestine, i.e., not through it.)
- **Topical routes:** Routes in which the drug is applied on a body surface (skin, eyes, ears, nose) to act mainly at that spot.
- **First-pass metabolism (first-pass effect):** When a drug swallowed by mouth is absorbed from the intestine, the blood carries it first to the liver, where a large part of the drug may be broken down (metabolised) before it ever reaches the rest of the body — so less active drug is available for action.
- **Bioavailability:** The fraction (percentage) of the given drug dose that actually reaches the blood in active form. IV injection = 100% bioavailability.
- **Bolus:** A single, rapid injection of a drug dose given all at once (e.g., an IV bolus).
- **Infusion:** Slow, continuous dripping of a drug solution into a vein over minutes to hours (e.g., glucose-saline drip).
- **Depot injection:** An intramuscular or subcutaneous injection designed to release the drug slowly over days or weeks.

Terminology

- **Sublingual:** Placed under the tongue.
- **Buccal:** Placed between the cheek (gum) and the teeth/cheek wall.
- **Inhalation:** Breathed in as a gas, vapour, or fine mist into the lungs.
- **Transdermal:** Delivered across (through) the skin into the blood, usually via a patch.
- **Subcutaneous (SC):** Injected into the fatty layer just under the skin.
- **Intramuscular (IM):** Injected deep into a muscle.
- **Intravenous (IV):** Injected directly into a vein.
- **Intrathecal:** Injected into the spinal canal fluid (cerebrospinal fluid) around the spinal cord.
- **Epidural:** Injected into the space just outside the spinal cord's covering layers (used famously for painless childbirth).
- **Intra-arterial:** Injected directly into an artery.
- **Intra-articular:** Injected directly into a joint space.
- **Intracardiac:** Injected directly into the heart muscle/chamber (emergency only, rarely used today).
- **Aseptic technique:** Methods that keep everything germ-free during injections (sterile needle, sterile drug, cleaned skin).

Explanation

Why Does the Route of Administration Matter?

Technical concept: The route determines the speed of onset of drug action, the fraction of the dose reaching the blood (bioavailability), whether first-pass metabolism occurs, and the suitability for the patient's condition (conscious/unconscious, vomiting, emergency).

Simple explanation: The same drug can act in 1 minute or in 1 hour depending on HOW you give it. A heart-attack patient needs the drug in the blood within seconds — a tablet that takes an hour to work could be too late. A vomiting patient cannot keep a tablet down. An unconscious patient cannot swallow. So the doctor must choose the correct "entry door" for the drug. Choosing the wrong route can make treatment fail or harm the patient.

Example: Nitroglycerin for sudden chest pain (angina) is placed UNDER the tongue (sublingual) — it enters the blood in 1–2 minutes and relieves pain fast. If the same patient swallowed it as a tablet, the liver would destroy most of it (first-pass effect) and relief would be too slow.

Key takeaway: Route decides speed, amount reaching blood, and suitability for the patient's condition — it is a treatment decision, not a minor detail.

The Big Picture: Three Families of Routes

Technical concept: Routes are grouped as enteral (via GI tract: oral, sublingual, buccal, rectal), parenteral (by injection, bypassing GI tract: IV, IM, SC, intrathecal, epidural, intra-arterial, intra-articular, intracardiac, intradermal), and others (inhalation, nasal, transdermal, topical).

Simple explanation: Think of three families:

1. **Enteral family** — drug travels through the stomach–intestine path (mouth, under tongue, cheek, rectum).
2. **Injection (parenteral) family** — drug is pushed directly into blood, muscle, skin, spine, or joints with a needle.
3. **Surface & breath family** — drug is breathed into lungs, sprayed into the nose, or stuck on the skin as a patch.

Key takeaway: Three families — enteral (through gut), parenteral (injection, bypassing gut), and surface/breath (lungs, nose, skin).

Oral Route (by mouth)

Technical concept: The drug is swallowed as tablet, capsule, or syrup; it dissolves in the GI tract, is absorbed mainly from the small intestine into the portal blood, passes through the liver (first-pass metabolism), then enters general circulation.

Simple explanation: The most common and easiest route — just swallow the tablet with water. The tablet travels to the stomach and intestine, dissolves, and the drug enters the blood. But there is a catch: blood from the intestine goes to the liver FIRST, and the liver may destroy a large part of the drug before it reaches the body — this is the first-pass effect. So oral drugs often need larger doses.

Advantages: Most convenient, painless, and cheapest; no skilled person needed — patient takes it at home; safest route (drug can sometimes be removed by vomiting/stomach wash in overdose); suitable for long-term daily treatment (BP, diabetes, TB medicines).

Disadvantages: Slow onset (30 minutes to 2 hours); cannot be used in vomiting, unconscious, or uncooperative patients (small children, mentally disturbed); some drugs are destroyed by stomach acid or digestive enzymes (e.g., insulin is a protein — stomach digests it, so it can never be given orally); first-pass metabolism reduces the effective amount; food and other drugs can interfere with absorption; unpleasant taste of some syrups.

Example: Paracetamol tablet for fever; amoxicillin capsule for infection; metformin tablet for diabetes — all oral.

Key takeaway: Oral = easiest, cheapest, safest for long-term use, but slow and blocked by vomiting, unconsciousness, stomach destruction, and first-pass liver loss.

Sublingual Route (under the tongue)

Technical concept: The tablet or spray is placed under the tongue, where the thin mucosa and rich blood supply allow rapid absorption directly into systemic circulation, bypassing the liver's first-pass metabolism.

Simple explanation: Under your tongue the skin is very thin and full of blood vessels — like a thin sponge over a river of blood. A small tablet kept there dissolves and the drug jumps straight into the blood within 1–3 minutes, WITHOUT going to the liver first. Perfect for emergencies like sudden chest pain.

Advantages: Very fast action (1–3 minutes); bypasses first-pass liver metabolism so smaller doses work; can be used when swallowing is difficult; patient can self-administer in an emergency.

Disadvantages: Only suitable for small doses of potent drugs (the space under the tongue is tiny); the drug must dissolve in saliva — dry mouth is a problem; the patient must not swallow or chew it, and must not eat/drink/smoke during use; irritant drugs can burn the mouth lining.

Example: Nitroglycerin sublingual tablet or spray for sudden angina (chest pain) — relief in minutes.

Key takeaway: Sublingual = under-the-tongue, emergency-fast, bypasses the liver, but only for tiny doses.

Buccal Route (between cheek and gum)

Technical concept: Similar to sublingual — the drug is held between the cheek and gum, absorbed through the buccal mucosa directly into systemic blood, avoiding first-pass metabolism; absorption is slower than sublingual but the drug stays in place longer.

Simple explanation: Like sublingual's cousin — instead of under the tongue, the tablet is tucked between the cheek and the gum (like tobacco chewers hold tobacco). It dissolves slowly and the drug enters the blood steadily, again bypassing the liver.

Advantages: Bypasses first-pass metabolism; longer contact time than sublingual, so steadier absorption; useful when the patient cannot swallow.

Disadvantages: Small area — only small doses; slow compared to sublingual; talking/eating disturbs the tablet; some drugs irritate the cheek lining.

Example: Buccal midazolam preparations used in some countries for emergency fits in children who cannot swallow.

Key takeaway: Buccal = cheek-pocket route; slower but steadier than sublingual; also bypasses the liver.

Rectal Route (through the rectum)

Technical concept: The drug is given as a suppository, enema, or rectal gel; absorbed through the rectal mucosa. Part of the rectal blood supply bypasses the liver (partial avoidance of first-pass effect).

Simple explanation: When a patient is vomiting continuously or unconscious and cannot swallow, medicines can be given through the rectum (the last part of the large intestine) as a suppository — a soft bullet-shaped solid that melts inside the body. About half the drug bypasses the liver.

Advantages: Usable in vomiting or unconscious patients and small children; partly bypasses first-pass metabolism; useful for local effect on the rectum (piles/hemorrhoid treatment); the drug can be removed if needed before full absorption in some cases.

Disadvantages: Embarrassing and uncomfortable for the patient — poor acceptance; absorption is slow, incomplete, and unpredictable (variable); the drug may irritate the rectum; cannot be used in diarrhoea (drug flushed out); dose accuracy is poor.

Example: Paracetamol suppository for a vomiting child with high fever; diazepam rectal gel for emergency fits; glycerin suppository as a laxative for constipation.

Key takeaway: Rectal = backup route for vomiting/unconscious patients and children; partly bypasses liver but absorption is unpredictable and acceptance is low.

Inhalation Route (breathed into the lungs)

Technical concept: The drug is inhaled as a gas, vapour, or aerosol; the lungs offer a huge surface area with thin membranes and rich blood supply, giving almost instant absorption into blood — or a direct local effect on the airways.

Simple explanation: The lungs are like a giant thin sponge with an enormous surface — perfect for fast drug entry. Asthma patients puff medicine from an inhaler: the mist goes straight to the airways and opens them within minutes. Anaesthesia gases also work this way — breathed in, the patient sleeps within seconds.

Advantages: Extremely fast absorption into blood (seconds to minutes); direct local action on lungs/airways with small doses (asthma inhalers) — fewer whole-body side effects; bypasses the liver; the dose can be stopped quickly by stopping inhalation (important for anaesthesia).

Disadvantages: Needs special devices (inhalers, nebulisers) and correct technique — many patients use inhalers wrongly; only drugs that can be made into gases or fine mists; can irritate the airways and cause cough; difficult for very small children and the elderly without help; large or expensive equipment for nebulisation.

Example: Salbutamol inhaler (Asthalin) for asthma attacks — opens airways in minutes; general anaesthesia gases for surgery.

Key takeaway: Inhalation = fastest surface route via the lungs; ideal for asthma (local) and anaesthesia, but needs devices and correct technique.

Nasal Route (sprayed into the nose)

Technical concept: Drug sprayed or dropped into the nasal cavity is absorbed through the thin, vascular nasal mucosa — giving quick local or systemic effects and partially bypassing first-pass metabolism; the nose also offers a path toward the brain for some drugs.

Simple explanation: The inside of the nose is thin, moist, and full of blood vessels. A spray here works fast — either locally (clearing a blocked nose) or for the whole body (some migraine sprays, some vaccines). Children often prefer a nasal spray to an injection.

Advantages: Quick absorption; easy and painless — no injection; useful for local nose conditions (cold, allergy); some systemic drugs and vaccines can be given this way; partly bypasses the liver.

Disadvantages: Only tiny volumes fit in the nose; a running/blocked nose washes the drug away; frequent use can irritate or damage the nasal lining; drug may drip down the throat and get swallowed (then it behaves like an oral dose).

Example: Xylometazoline nasal drops for a blocked nose (local decongestant); nasal spray vaccines; desmopressin nasal spray.

Key takeaway: Nasal = quick, painless spray route for local nose treatment and some fast-acting systemic drugs; limited by small volume and nasal irritation.

Transdermal Route (patch on the skin)

Technical concept: A medicated adhesive patch stuck on the skin releases the drug slowly through the skin layers into the blood over hours to days, giving steady blood levels and avoiding first-pass metabolism.

Simple explanation: Like a slow-release sticker. You stick a patch on clean, dry skin (arm, chest, back), and it quietly pushes a steady trickle of medicine into your blood for 1–7 days. No daily tablets, no injections — useful for long-term treatment.

Advantages: Steady drug levels for days — no peaks and valleys; painless and convenient; bypasses the liver and the stomach (good for drugs destroyed orally or irritating the stomach); patient can remove the patch to stop the drug; improves compliance in long-term therapy.

Disadvantages: Very slow onset — useless in emergencies; only small, potent, fat-soluble drugs can cross the skin; skin irritation, allergy, or rashes under the patch; absorption varies with skin condition, sweating, and body heat; patches are costlier than tablets; the patch must stay stuck — bathing/sweating can loosen it.

Example: Nitroglycerin patch for angina prevention; nicotine patch to help quit smoking; fentanyl patch for chronic severe pain; hormone (oestrogen) patches.

Key takeaway: Transdermal patch = slow, steady, multi-day drug delivery through skin; great for long-term therapy, useless for emergencies.

Subcutaneous Route (SC — under the skin)

Technical concept: The drug is injected with a short needle into the loose fatty tissue just beneath the skin; absorption into blood is slow and steady because fat has fewer blood vessels than muscle.

Simple explanation: A small injection into the pinchable fat under the skin (upper arm, thigh, belly). Because fat has limited blood flow, the drug enters the blood slowly and steadily — ideal for medicines needed in steady amounts, like insulin.

Advantages: Slow, sustained absorption — good for insulin and some hormones/vaccines; patient can learn self-injection (diabetics inject insulin daily at home); less painful than deep IM injections; depot preparations can last weeks.

Disadvantages: Only small volumes (usually up to 1–2 mL); slow onset — not for emergencies; irritant drugs cause pain, swelling, or tissue damage in the fat; repeated injections at the same spot damage the tissue (patients must rotate sites); needs sterile needle technique.

Example: Insulin injections for diabetes (self-injected into belly/thigh fat); some vaccines; heparin injections.

Key takeaway: SC = shallow injection into fat; slow and steady; the self-injection route for insulin.

Intramuscular Route (IM — into the muscle)

Technical concept: The drug is injected deep into a large muscle (buttock/gluteal, thigh, or upper arm/deltoid); muscles have a rich blood supply, so absorption is faster than SC but slower than IV; oily/depot preparations release drug over days–weeks.

Simple explanation: A deep injection into a big muscle — usually the buttock or thigh. Muscles have plenty of blood vessels, so the drug enters the blood faster than a fat injection but still slower than a vein injection. Thick or oily medicines that cannot go into veins are given this way.

Advantages: Faster absorption than SC; larger volumes than SC (up to 3–5 mL in large muscles); suitable for oily/depot injections that release drug for weeks (e.g., monthly contraceptive injection); usable when the patient cannot swallow; moderate onset — good for non-emergency but prompt action.

Disadvantages: Painful; needs a trained person — cannot self-inject easily; risk of hitting a nerve or blood vessel (sciatic nerve injury in buttock injections is a classic danger); irritant drugs cause muscle pain and abscess; cannot be withdrawn once injected; dangerous in patients on blood thinners (bleeding into muscle).

Example: Diclofenac IM injection for severe pain; benzathine penicillin IM depot for rheumatic fever prevention; tetanus toxoid vaccine into the deltoid muscle.

Key takeaway: IM = deep muscle injection; faster than SC, handles larger/oily doses, but painful and needs trained hands — nerve injury is the classic risk.

Intravenous Route (IV — into the vein)

Technical concept: The drug is injected directly into a vein as a bolus or slow infusion; bioavailability is 100% and onset is immediate (seconds), because the drug enters circulating blood at once with no absorption step and no first-pass loss.

Simple explanation: The fastest route of all — the drug goes straight into the bloodstream through a vein (usually in the arm). Effect starts in seconds. This is the emergency route: heart attack, severe infection, dehydration drips, and anaesthesia all use IV. The full dose reaches the blood — nothing is lost.

Advantages: Immediate action (seconds) — the emergency route; 100% of the dose reaches the blood (no absorption loss, no first-pass effect); large fluid volumes can be given (saline/glucose drips); irritant drugs that would damage muscle can be diluted in the drip; dose can be precisely controlled and stopped instantly by closing the drip.

Disadvantages: Highest risk route — once injected, the drug cannot be taken back; too-fast injection can cause sudden collapse or death; strict sterility needed — germs entering the vein cause life-threatening blood infection (sepsis); vein irritation, clots (thrombophlebitis), and air bubbles (air embolism) are dangers; needs skilled staff, needles, and hospital setup; most expensive and least convenient.

Example: IV antibiotics for severe pneumonia; emergency adrenaline injection in anaphylactic shock; saline/glucose drip for dehydration; IV anaesthesia drugs.

Key takeaway: IV = direct-to-blood, seconds-fast, 100% dose available — the emergency route, but also the most dangerous if done wrong (cannot be withdrawn; infection risk).

Intrathecal Route (into the spinal fluid)

Technical concept: The drug is injected through the lower back into the cerebrospinal fluid (CSF) surrounding the spinal cord, delivering the drug directly to the brain and spinal cord, bypassing the blood–brain barrier.

Simple explanation: The brain and spinal cord are protected by a tight security wall (blood–brain barrier) that blocks most drugs in the blood. In serious infections of the brain coverings (meningitis) or spinal anaesthesia, the doctor injects the drug directly into the fluid around the spinal cord in the lower back — reaching the target directly.

Advantages: Drug reaches brain/spinal cord directly, bypassing the blood–brain barrier; small doses work (fewer whole-body side effects); essential for spinal anaesthesia and some brain infections/cancers.

Disadvantages: Highly skilled procedure — must be done by an expert doctor under strict sterile conditions; risk of spinal injury, infection (meningitis), bleeding, or severe headache; only tiny volumes can be injected; the drug and equipment must be absolutely sterile and preservative-free.

Example: Spinal anaesthesia for lower-body surgery (caesarean delivery); intrathecal antibiotics for resistant meningitis; intrathecal methotrexate for brain cancer.

Key takeaway: Intrathecal = injection into spinal fluid; the only way to beat the blood–brain barrier — expert-only, tiny volumes, strict sterility.

Epidural Route (outside the spinal covering)

Technical concept: The drug is injected or infused into the epidural space (just outside the dura membrane covering the spinal cord); commonly used for long-lasting pain relief, e.g., during childbirth, via a thin tube (catheter).

Simple explanation: A cousin of the intrathecal route — instead of going inside the spinal fluid, the drug is placed in the space just OUTSIDE the spinal cord's covering, in the lower back. A thin tube can keep giving painkiller medicine for hours. Famous for "painless delivery" — the mother feels no labour pain but stays awake.

Advantages: Excellent long-lasting pain relief (labour, post-surgery) while the patient stays conscious; lower drug doses than general anaesthesia; the catheter allows top-up doses over hours.

Disadvantages: Expert-only hospital procedure; risks include low blood pressure, incomplete pain relief, headache, infection, or nerve injury (rare); needs monitoring and resuscitation backup.

Example: Epidural analgesia for painless childbirth; epidural pain relief after major abdominal surgery.

Key takeaway: Epidural = painkiller space outside the spinal covering; famous for painless labour; expert hospital-only procedure.

Intra-arterial Route (into an artery)

Technical concept: The drug is injected into an artery so that a high concentration reaches one specific organ or region (e.g., a limb or the liver) before dilution in the general circulation; used for targeted chemotherapy or X-ray contrast studies.

Simple explanation: Arteries carry blood FROM the heart TO the organs. Injecting into the artery supplying one organ floods that organ with a high drug concentration — like delivering water directly to one field through its own pipe instead of flooding the whole village. Used to attack a cancer in one organ with strong chemotherapy while sparing the rest of the body.

Advantages: Very high drug concentration at the target organ/region; lower whole-body side effects for targeted cancer treatment; useful for contrast dyes in angiography (X-ray of blood vessels).

Disadvantages: Technically difficult and risky — arteries are deep and high-pressure; accidental blockage can cut off blood supply and damage tissue (gangrene risk); expert-only, hospital-only procedure.

Example: Intra-arterial chemotherapy for liver cancer; contrast dye injected into coronary arteries during angiography.

Key takeaway: Intra-arterial = direct-to-organ via its artery; maximum local concentration for targeted cancer therapy — difficult and risky.

Intra-articular Route (into a joint)

Technical concept: The drug is injected directly into the joint cavity (e.g., knee, shoulder) to treat local joint disease with high local concentration and minimal systemic exposure.

Simple explanation: For a painful, swollen knee joint (arthritis), swallowing tablets sends only a little drug to the knee. Injecting the medicine directly INTO the knee joint space puts a strong dose exactly where it is needed, with little effect on the rest of the body.

Advantages: High drug concentration exactly at the diseased joint; minimal whole-body side effects; long-lasting relief from a single injection (steroid injections can relieve for weeks–months).

Disadvantages: Joint infection (septic arthritis) is a serious risk if sterility fails; repeated steroid injections can damage the joint cartilage; painful procedure needing an expert; only for joint-local disease.

Example: Corticosteroid injection into the knee for osteoarthritis flare-up; hyaluronic acid injections for knee joints.

Key takeaway: Intra-articular = injection into the joint space; strong local relief for arthritis with minimal body-wide effects — infection is the feared complication.

Intracardiac Route (into the heart)

Technical concept: The drug is injected directly into the heart chamber or heart muscle — historically used in extreme cardiac emergencies when no vein is accessible.

Simple explanation: In a desperate emergency — heart stopped, no vein found — a long needle was pushed through the chest wall directly into the heart to inject life-saving drugs. This was done in the past; today it is almost never used because IV and intraosseous (into bone marrow) routes are safer.

Advantages: Delivers the drug to the heart instantly when all other routes have failed (historical last-resort value).

Disadvantages: Extremely dangerous — can puncture lungs, damage heart muscle, or cause fatal bleeding; blind procedure; superseded by safer emergency routes; essentially obsolete in modern practice.

Example: (Historical) intracardiac adrenaline during cardiac arrest when IV access was impossible — now replaced by IV/intraosseous adrenaline.

Key takeaway: Intracardiac = direct heart injection; a historical last-resort emergency route, now essentially obsolete — know it for exams, never as routine practice.

Classifications

Classification 1: Routes grouped by family

Family	Routes included	Key feature
Enteral (through GI tract)	Oral, sublingual, buccal, rectal	Convenient; subject to first-pass (except sublingual/buccal/partial rectal)
Parenteral (injection, bypassing GI tract)	IV, IM, SC, intradermal, intrathecal, epidural, intra-arterial, intra-articular, intracardiac	Faster; sterile technique needed; bypass first-pass
Surface / breath	Inhalation, nasal, transdermal, topical (skin/eye/ear)	Local or systemic via lungs, nose, or skin

Classification 2: Routes by speed of onset (fastest to slowest)

Rank	Route	Typical onset
1 (fastest)	IV / intracardiac	Seconds
2	Inhalation	Seconds–minutes
3	Sublingual	1–3 minutes
4	IM	10–20 minutes
5	SC	15–30 minutes
6	Oral / rectal	30 minutes–2 hours
7 (slowest)	Transdermal	Hours

Classification 3: First-pass metabolism by route

Route	First-pass metabolism?	Reason
Oral	Yes — significant	Portal blood carries drug to liver first
Sublingual / buccal	No	Absorbed directly into systemic veins, bypassing portal blood
Rectal	Partial (about half bypasses)	Lower rectal veins bypass the liver; upper ones do not
IV, IM, SC, inhalation, nasal, transdermal	No	Drug enters systemic blood without passing through portal circulation first

Mechanisms

Mechanism 1: First-pass metabolism (why oral doses are partly lost). Step 1: Patient swallows the tablet. Step 2: Tablet dissolves; drug absorbed from the small intestine into tiny blood vessels. Step 3: These vessels join the portal vein, which carries ALL intestinal blood straight to the liver. Step 4: The liver — the body's chemical factory — breaks down (metabolises) a large fraction of the drug. Step 5: Only the surviving fraction leaves the liver into general blood circulation to act on the body. Simple meaning: "The liver takes its tax before the drug reaches the body — so oral doses must be larger."

Mechanism 2: Why sublingual drugs bypass the liver. Step 1: Tablet placed under the tongue dissolves in saliva. Step 2: Drug crosses the thin mucosa into the small veins under the tongue. Step 3: These veins drain into the jugular/systemic veins — NOT the portal vein. Step 4: Drug reaches the heart and general circulation directly, with no first liver pass. Simple meaning: "Under-tongue veins join the main bloodstream directly, skipping the liver's first check."

Mechanism 3: How a transdermal patch gives steady blood levels for days. Step 1: Patch stuck on skin holds a reservoir of drug. Step 2: Drug slowly diffuses through skin layers at a near-constant rate. Step 3: Tiny blood vessels in the skin carry it into general circulation continuously. Step 4: Constant input balances the body's constant removal → steady blood level, no peaks and valleys.

Diagrams

DIAGRAM 1: First-pass metabolism — oral vs IV. Draw a human outline. For ORAL: draw an arrow from the mouth → stomach/intestine → a thick arrow labelled "portal vein" → LIVER (drawn large, labelled "liver destroys much of the drug — first-pass effect") → a thinner arrow → heart/general blood → body tissues. For IV: draw a syringe into an arm vein → arrow straight to heart/general blood → body tissues, with a note "100% reaches blood — no first-pass loss."

DIAGRAM 2: Injection depths — skin cross-section. Draw layers top to bottom: "Skin surface" → "Epidermis/dermis (intradermal — shallowest)" → "Fatty layer (subcutaneous — short needle, 45°)" → "Muscle (intramuscular — long needle, 90°)" → "Vein (intravenous — into the blood vessel)". Label each with its needle angle and depth. Caption: "Deeper = faster absorption: vein (seconds) > muscle (minutes) > fat (slow)."

DIAGRAM 3: Sublingual vs buccal placement. Draw a simple open-mouth diagram. Mark "SUBLINGUAL: tablet under the tongue (rich blood vessels, 1–3 min)" with an arrow under the tongue, and "BUCCAL: tablet between cheek and gum (slower, steadier)" with an arrow at the cheek. Both arrows labelled "direct to blood — bypasses liver."

DIAGRAM 4: Spinal routes — intrathecal vs epidural. Draw a side view of the lower spine: skin → muscle → "EPIDURAL SPACE (drug placed here — outside the covering)" → dura membrane (covering) → "SUBARACHNOID SPACE with spinal fluid (intrathecal injection goes HERE — inside the fluid)". Caption: "Epidural = outside the dura; intrathecal = inside the spinal fluid."

Flowcharts

FLOWCHART 1: Choosing the right route — decision path. Patient needs medicine → Is it an emergency needing seconds? → YES → IV route → NO → Can the patient swallow and is the gut working? → YES → Oral route (cheapest, easiest) → NO (vomiting/unconscious) → Can we use sublingual/rectal? → Emergency pain/fits → Sublingual or rectal → Needs steady long-term drug → Transdermal patch or depot IM/SC injection → Needs drug in lungs → Inhalation → Needs drug in brain/spinal cord → Intrathecal (expert only).

FLOWCHART 2: Journey of an oral tablet. Tablet swallowed with water → Reaches stomach → Moves to small intestine → Dissolves and drug absorbed into intestinal blood vessels → Portal vein carries blood to the LIVER → Liver metabolises (destroys) part of the drug — FIRST-PASS EFFECT → Remaining drug enters general blood circulation → Distributed to body tissues → Reaches the target organ → Produces effect → Later removed by kidneys.

FLOWCHART 3: Safe injection practice (parenteral routes). Check the prescription (right drug, dose, route) → Wash hands, wear gloves → Take a sterile, sealed needle-syringe → Check drug name, expiry, and clarity → Clean the skin site with antiseptic → Give the injection with correct depth/angle for the route → Dispose of the needle safely in a puncture-proof container (never recap with two hands) → Record the dose given.

Infographic Concept Box

Title: "ROUTES OF DRUG ADMINISTRATION — Pick the Right Door 🚪💊" Content layout (one page, big fonts, icons):

- Top banner: "Same drug, different door = different speed!"
- Speed ladder (fastest at top): "⚡ IV — seconds (emergency king) | 💨 Inhalation — seconds–minutes (asthma) | 👅 Sublingual — 1–3 min (chest pain, under tongue) | 💪 IM — 10–20 min | 💧 SC — 15–30 min (insulin) | 💊 Oral — 30 min–2 h (daily tablets) | 🩹 Transdermal patch — hours (steady for days)".
- Centre panel: "LIVER TAX ALERT 🏦 — Oral drugs pay first-pass tax in the liver; sublingual, buccal, IV, IM, SC, inhalation, nasal & patch SKIP the tax!"
- Bottom-left: "Patient guide: Vomiting/unconscious? → rectal/sublingual/injection. Child? → syrup/suppository. Long-term BP/diabetes? → oral tablet. Quit smoking? → nicotine patch."
- Bottom-right: "⚠️ Injection rules: sterile needle every time • right depth for the route • never recap • IM buttock = beware the sciatic nerve!"
- Footer: "Specialist-only doors: intrathecal (spinal fluid), epidural (painless delivery), intra-articular (joints), intra-arterial (targeted cancer therapy)."

Tables

Table 1: Route-by-route advantages and disadvantages (master table)

Route	How given	Advantages	Disadvantages
Oral	Swallowed tablet/capsule/syrup	Easiest, cheapest, painless; self-administration; best for long-term therapy	Slow (30 min–2 h); first-pass loss; not for vomiting/unconscious patients; some drugs destroyed by stomach
Sublingual	Tablet/spray under the tongue	Very fast (1–3 min); bypasses liver; emergency self-use	Tiny doses only; must not swallow; dry mouth/irritation problems
Buccal	Tablet between cheek and gum	Bypasses liver; steadier than sublingual	Small doses; slow; disturbed by talking/eating
Rectal	Suppository/enema	Usable in vomiting/unconscious patients, children; partly bypasses liver	Poor acceptance; unpredictable absorption; not in diarrhoea
Inhalation	Gas/aerosol breathed into lungs	Seconds-fast; direct lung action, small doses; bypasses liver	Needs device + technique; airway irritation; not for all drugs
Nasal	Spray/drops in nose	Quick, painless, easy	Tiny volume; washed away by cold; nasal irritation
Transdermal	Patch on skin	Steady levels for days; painless; bypasses liver/stomach	Very slow onset; only small potent drugs; skin irritation; costly
Subcutaneous	Injection into fat under skin	Slow-steady; self-injection (insulin); depot possible	Small volumes; slow onset; tissue damage on repeat at same site
Intramuscular	Deep injection into muscle	Faster than SC; larger/oily/depot doses	Painful; nerve/vessel injury risk; needs trained person
Intravenous	Injection/infusion into vein	Seconds-fast; 100% bioavailability; large volumes; controllable	Cannot withdraw; infection/embolism risk; needs skill + setup
Intrathecal	Injection into spinal fluid	Bypasses blood–brain barrier; tiny doses work	Expert-only; spinal injury/infection risk; strict sterility
Epidural	Injection outside spinal covering	Long pain relief, patient awake (painless labour)	Expert-only; BP fall, headache, monitoring needed
Intra-arterial	Injection into an artery	High concentration to one organ (targeted cancer therapy)	Difficult, risky; blockage can damage tissue
Intra-articular	Injection into joint space	Strong local joint relief; minimal body-wide effects	Joint infection risk; cartilage damage on repeat
Intracardiac	Injection into the heart	Last-resort instant delivery (historical)	Extremely dangerous; essentially obsolete today

Table 2: Which route for which patient? (quick selection guide)

Patient situation	Best route(s)	Why
Heart attack / shock emergency	IV	Seconds-fast, 100% dose in blood
Sudden chest pain (angina) at home	Sublingual	1–3 min relief, patient can self-use
Vomiting child with fever	Rectal (suppository)	Cannot swallow; works without gut cooperation
Unconscious patient	IV / rectal / IM	Swallowing impossible
Daily BP/diabetes treatment for years	Oral	Cheapest, easiest, safe for long term
Diabetic needing daily insulin	Subcutaneous	Insulin destroyed if swallowed; self-injection
Asthma attack	Inhalation	Direct to airways in minutes
Steady medicine for days (quit smoking, chronic pain)	Transdermal patch	One patch, steady levels, no daily tablets
Brain/spinal infection needing direct drug	Intrathecal	Bypasses blood–brain barrier
Painless childbirth	Epidural	Pain relief while mother stays awake

Examples

1. **Emergency:** A patient collapses with anaphylactic shock after a bee sting — adrenaline is given IM/IV for action within seconds–minutes. A tablet would be fatally slow.
2. **Sublingual:** An elderly man feels sudden chest tightness (angina) — he places a nitroglycerin tablet under his tongue; pain eases in 2 minutes.
3. **Oral long-term:** A 50-year-old with high BP takes one amlodipine tablet every morning for years — cheap, simple, effective.
4. **SC self-injection:** A diabetic college student injects insulin into her belly fat before meals every day — she learned the technique in one training session.
5. **Inhalation:** A schoolboy with asthma carries a salbutamol inhaler; during a sudden attack on the playground, two puffs open his airways in minutes.
6. **Transdermal:** A man trying to quit smoking wears a nicotine patch daily — steady nicotine without cigarettes or tablets.
7. **Rectal:** A 3-year-old with 103°F fever is vomiting repeatedly — the doctor advises a paracetamol suppository instead of syrup.
8. **IM depot:** A young woman takes a monthly contraceptive IM injection — one visit covers the whole month.
9. **Intrathecal:** A patient with resistant meningitis receives antibiotics directly into the spinal fluid because IV antibiotics cannot cross the blood–brain barrier in enough quantity.
10. **Intra-articular:** A 65-year-old with a severely painful arthritic knee gets a steroid injection into the joint and walks comfortably for months.

Analogies

1. **Routes as entry doors to a building (the body):** Oral = the long main corridor (slow, with a security check — the liver). IV = the VIP express elevator straight to the top floor (seconds). Sublingual = the side express door. Transdermal patch = a slow goods lift running all day. Injections = service entries needing a trained guard (nurse/doctor).
2. **First-pass effect as an entry tax:** Swallowed drugs must pass through the liver's "toll booth," which keeps part of the drug as tax. Sublingual/IV drugs take the toll-free expressway.
3. **IM vs SC as watering plants:** SC is like a drip-irrigation pipe in shallow soil (slow, steady). IM is like pouring water into deep, rich soil with many roots (faster uptake).
4. **Inhaler as a fire extinguisher for the lungs:** Just as you spray a fire extinguisher directly at the fire, the inhaler sprays medicine directly at the narrowed airways — small amount, exactly where needed.
5. **Transdermal patch as a slow-release air freshener:** A plug-in freshener releases fragrance steadily for days without refilling — the patch releases medicine steadily for days without re-dosing.
6. **Intrathecal as a VIP pass through a fortress:** The blood–brain barrier is a fortress wall; intrathecal injection is the secret tunnel that delivers the drug directly inside.

Pharmacy Relevance

- The pharmacist must know which dosage forms suit which route — tablets for oral, suppositories for rectal, patches for transdermal, sterile injections for parenteral — because dispensing the wrong form for the intended route is a serious error.
- Counselling points come straight from this chapter: "keep the sublingual tablet under the tongue, do not swallow"; "rotate insulin injection sites"; "use the inhaler with correct technique"; "do not chew the transdermal patch."
- Pharmacists prepare and dispense sterile injections and IV admixtures in hospitals — aseptic technique from this chapter is daily practice.
- Understanding onset times lets the pharmacist explain to patients why the emergency injection works in seconds while the tablet takes an hour — improving trust and compliance.
- Safe needle disposal and the "never recap" rule protect the pharmacist and staff from needle-stick injuries.

India Context

- India's huge TB, diabetes, and hypertension programmes run mainly on the **oral route** (DOTS TB tablets, daily metformin) because it is cheapest and needs no skilled staff — a direct public-health application of route selection.
- **Jan Aushadhi Kendras** mostly dispense oral generics (tablets/capsules), keeping treatment affordable; injectables are hospital-based.
- India's Universal Immunisation Programme delivers vaccines by **IM/SC routes** (e.g., deltoid IM) through lakhs of trained health workers — route knowledge at national scale.
- **NLEM** includes essential injectables (IV antibiotics, oxytocin IM for childbirth) that every district hospital must stock — pharmacists manage this inventory.
- Rural realities: where hospital access is far, the pharmacist's counselling on correct inhaler technique and insulin site rotation directly decides treatment success.

Key Points

1. Route of administration = the path by which a drug enters the body; it decides speed, bioavailability, and suitability.
2. Three families: enteral (oral, sublingual, buccal, rectal), parenteral/injection (IV, IM, SC, intrathecal, epidural, intra-arterial, intra-articular, intracardiac), surface/breath (inhalation, nasal, transdermal).
3. Oral is the most common — easiest and cheapest — but slow, with first-pass liver loss, and unusable in vomiting/unconscious patients.
4. First-pass metabolism: oral drugs pass through the liver before reaching the body; sublingual, buccal, IV, IM, SC, inhalation, nasal, and transdermal routes bypass it.
5. IV is the fastest (seconds) with 100% bioavailability — the emergency route — but the most dangerous if done wrong.
6. Sublingual (under tongue, 1–3 min) is the emergency self-use route for angina; buccal is its slower, steadier cousin.
7. Inhalation gives seconds-fast lung action (asthma) but needs devices and correct technique.
8. Transdermal patches give steady drug levels for days — ideal for long-term therapy, useless in emergencies.
9. SC (fat) = slow-steady, self-injectable (insulin); IM (muscle) = faster, larger/oily doses, painful, nerve-injury risk.
10. Intrathecal (spinal fluid) bypasses the blood–brain barrier; epidural gives painless labour; intra-articular targets joints; intra-arterial targets single organs; intracardiac is essentially obsolete.
11. All injections need strict sterility, correct depth/angle, and safe needle disposal.

Common Confusions (with corrections)

1. **Confusion:** "Sublingual and oral are the same because both involve the mouth."

Correction: Oral = swallowed, goes through stomach and liver (first-pass). Sublingual = kept under the tongue, absorbed directly into blood, bypasses the liver. Different speed, different fate.

1. **Confusion:** "IM and IV injections are interchangeable."

Correction: IV goes into a vein (seconds, 100%); IM goes into muscle (minutes, slower). Oily/depot drugs for IM can be fatal if given IV. Never swap without checking.

1. **Confusion:** "Intrathecal and epidural are the same spinal injection."

Correction: Intrathecal = INSIDE the spinal fluid (past the dura); epidural = OUTSIDE the dura covering. Different spaces, different drugs and doses.

1. **Confusion:** "The transdermal patch works fast like an injection."

Correction: Patches take hours to reach effective levels — they are for steady long-term treatment, never emergencies.

1. **Confusion:** "If a patient vomits after swallowing a tablet, the rectal route will have the same absorption."

Correction: Rectal absorption is slower and unpredictable compared to oral — it is a backup, not an equal replacement.

1. **Confusion:** "Insulin can be taken as a tablet if the dose is increased."

Correction: No — insulin is a protein; stomach acid and digestive enzymes destroy it completely. It must be injected (SC).

Common Mistakes (with corrections)

1. **Mistake:** Writing that the oral route bypasses first-pass metabolism.

Correction: Oral has the MOST first-pass loss; it is sublingual/buccal/parenteral routes that bypass it.

1. **Mistake:** Listing only IV, IM, SC as parenteral routes and forgetting intrathecal, epidural, intra-arterial, intra-articular.

Correction: The syllabus names all of them — memorise the full list with one example each.

1. **Mistake:** Saying inhalation is slow because "breathing is gentle."

Correction: Inhalation is one of the FASTEST routes (seconds–minutes) due to the lungs' huge thin surface.

1. **Mistake:** Recommending the IM route for self-injection at home.

Correction: IM needs trained hands (nerve/vessel risk); SC (insulin) is the self-injection route.

1. **Mistake:** Confusing bioavailability of IV (100%) with oral (always less than 100% due to incomplete absorption + first-pass).

Correction: IV = 100% by definition; oral is always lower.

1. **Mistake:** Describing intracardiac injection as a routine emergency method.

Correction: It is historical/last-resort and essentially obsolete — modern emergencies use IV or intraosseous routes.

Mnemonics

1. **Speed ladder — "I IS SIM ORT":** "**I**V → **I**nhalation → **S**ublingual → **I**M → **S**C/**M**... " Better: "**V**ery **I**mportant **S**oldiers **M**arch **S**lowly **O**n **R**oads **T**oday" — **V**(IV) → **I**(nhalation) → **S**(ublingual) → **M**(IM) → **S**(SC) → **O**(ral) → **T**(ransdermal), fastest to slowest.
2. **First-pass bypassers — "SBI INT P":** "**S**ublingual, **B**uccal, **I**V, **I**M, **I**nhalation, **N**asal, **T**ransdermal, **P**arenteral (all injections)" bypass the liver — "The liver takes **tax** only on the **oral** road."
3. **Injection depth order — "Vein, Muscle, Fat, Skin":** deepest → shallowest = fastest → slowest absorption.
4. **Spinal spaces — "EPI = Envelope (outside); INTRA = Inside": Epi**dural = outside the dura envelope; **Intra**thecal = inside the thecal (fluid) sac.
5. **SC vs IM — "Fat is Slow, Muscle is More (faster)":** SC (fat) slow-steady; IM (muscle) faster.

Exam Summary

- Route of administration decides onset speed, bioavailability, first-pass loss, and fit for the patient's condition.
- Enteral: oral (commonest; slow; first-pass loss; not for vomiting/unconscious), sublingual (1–3 min emergency, bypasses liver), buccal (slower, steadier), rectal (backup for vomiting/children; unpredictable).
- Parenteral: IV (seconds, 100%, emergency — most risky), IM (minutes; larger/oily/depot doses; nerve risk), SC (slow-steady; insulin self-injection), intrathecal (spinal fluid; beats blood–brain barrier), epidural (painless labour), intra-arterial (targeted organ chemotherapy), intra-articular (joint injections), intracardiac (obsolete last resort).
- Surface/breath: inhalation (seconds-fast; asthma/anaesthesia; needs device technique), nasal (quick painless spray), transdermal patch (steady levels for days; never for emergencies).
- First-pass metabolism hits the oral route hardest; all parenteral, sublingual, buccal, inhalation, nasal, and transdermal routes bypass it.
- Injections demand strict sterility, correct depth/angle, and safe sharps disposal.

One-Minute Revision

Three route families: enteral (oral, sublingual, buccal, rectal), injection/parenteral (IV, IM, SC, intrathecal, epidural, intra-arterial, intra-articular), surface/breath (inhalation, nasal, transdermal). Speed: IV (seconds) > inhalation > sublingual (1–3 min) > IM > SC > oral/rectal (30 min–2 h) > transdermal (hours). Liver's first-pass tax hits oral drugs; sublingual, buccal, and all injections/inhalation/nasal/patch skip it. IV = emergency king but most dangerous. SC = insulin self-injection. IM = deep, painful, nerve risk. Intrathecal beats the blood–brain barrier; epidural = painless labour; intracardiac = obsolete.

Exam Questions

Short-answer questions:

1. Define "route of drug administration." Classify the routes with examples.
2. Explain first-pass metabolism with a neat labelled diagram. Which routes bypass it?
3. Write the advantages and disadvantages of the oral route.
4. Why is the sublingual route preferred in angina? Explain with the mechanism.
5. Compare and contrast IM and SC injections (any four points).
6. Write short notes on: (a) transdermal route, (b) inhalation route.
7. Differentiate between intrathecal and epidural routes.
8. A vomiting child cannot swallow paracetamol syrup — which route will you suggest and why?

Long-answer questions:

1. Classify the routes of drug administration. Describe the advantages and disadvantages of the oral, sublingual, intravenous, intramuscular, and subcutaneous routes with examples.
2. Explain the parenteral routes of drug administration in detail, including the special routes — intrathecal, epidural, intra-arterial, intra-articular, and intracardiac. Add a note on aseptic precautions.
3. A patient is brought unconscious to the casualty after a road accident and needs urgent medication. Discuss which routes are suitable and which are unsuitable, giving reasons. Explain the concept of bioavailability and first-pass metabolism in your answer.

MCQs (with answers):

1. Which route gives 100% bioavailability?

a) Oral b) Intravenous c) Transdermal d) Rectal **Answer: b**

1. First-pass metabolism mainly reduces the effectiveness of drugs given by which route?

a) Sublingual b) Intravenous c) Oral d) Inhalation **Answer: c**

1. Nitroglycerin in angina is given by the sublingual route because:

a) It tastes pleasant b) It is absorbed in 1–3 minutes and bypasses the liver c) It cannot be made as a tablet d) It works only in the mouth **Answer: b**

1. Which route is most suitable for self-administration of insulin?

a) Intramuscular b) Subcutaneous c) Intravenous d) Oral **Answer: b**

1. The slowest onset among the following is seen with:

a) IV injection b) Inhalation c) Sublingual tablet d) Transdermal patch **Answer: d**

1. Intrathecal injection is given into the:

a) Muscle b) Vein c) Cerebrospinal fluid around the spinal cord d) Joint cavity **Answer: c**

1. Epidural anaesthesia is famous for:

a) Brain surgery b) Painless childbirth c) Dental extraction d) Eye surgery **Answer: b**

1. Which of the following bypasses first-pass metabolism?

a) Oral tablet b) Sublingual tablet c) Both a and b d) Neither **Answer: b**

1. A depot IM injection is used when:

a) Seconds-fast action is needed b) Slow release of drug over days–weeks is needed c) The patient is vomiting d) The drug must reach the brain **Answer: b**

1. The classic danger of a gluteal (buttock) IM injection is injury to the:

a) Femoral artery b) Sciatic nerve c) Radial nerve d) Jugular vein **Answer: b**

1. Which route delivers the drug directly to a diseased joint?

a) Intra-arterial b) Intra-articular c) Intrathecal d) Intracardiac **Answer: b**

1. Intracardiac injection in modern practice is:

a) The first choice in all emergencies b) Used routinely for vaccinations c) Essentially obsolete, replaced by IV/intraosseous routes d) The preferred route for insulin **Answer: c**

Viva questions:

1. What is the full form of ADME? Which route skips absorption completely?
2. Why can't insulin be given orally?
3. Name three routes that bypass first-pass metabolism.
4. Which is faster — IM or SC? Why?
5. What is the difference between a bolus and an infusion?
6. Why must intrathecal drugs be preservative-free and absolutely sterile?
7. Give one example each of a drug given by inhalation and by transdermal patch.
8. What should a diabetic patient remember about insulin injection sites?
9. Why is the IV route called the most dangerous route despite being the fastest?
10. Which spinal route is used for painless delivery — intrathecal or epidural?

Application-based questions:

1. A 60-year-old man with sudden severe chest pain is at home, far from a hospital. His prescription includes sublingual nitroglycerin tablets. Explain to his family exactly how to use them and why this route was chosen over swallowing a tablet. (Under tongue, don't swallow; 1–3 min onset; bypasses liver; oral would be too slow with first-pass loss.)
2. A mother asks why the doctor prescribed a paracetamol suppository instead of syrup for her vomiting 4-year-old. Justify the choice and state two disadvantages she should know. (Rectal works without swallowing; disadvantages: unpredictable absorption, discomfort/poor acceptance.)
3. An asthma patient complains his inhaler "doesn't work." List three counselling points about the inhalation route you would check. (Shake the inhaler, breathe in deeply while pressing, hold breath ~10 seconds, rinse mouth after steroid inhaler.)
4. During a busy casualty shift, a junior suggests giving an oily IM depot preparation IV "for faster action." Explain why this is dangerous and potentially fatal. (Oily/particle preparations block blood vessels → embolism; IM-only formulations must never go IV.)

UNIT I — REFERENCES

1. Brunton, Hilal-Dandan & Knollmann, Goodman and Gilman's The Pharmacological Basis of Therapeutics, McGraw-Hill.
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3. Katzung & Trevor, Basic and Clinical Pharmacology, McGraw-Hill.
4. Whalen & Finkel, Lippincott's Illustrated Reviews: Pharmacology, Wolters Kluwer.
5. Tripathi, Essentials of Medical Pharmacology, Jaypee.