

MUSICAL PHARMACOLOGY

*A mechanism-first textbook of
pharmacology
with the memory devices that carry it*

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The fourteen sections and the eighty chapters, by the titles they carry

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Preface

What this book is for, how it is built, and what it does not claim

A student can pass a pharmacology examination by holding several hundred lists in mind for about a fortnight. I have watched it done, I have examined the people who did it, and I have taught the ones who came back two years later having kept none of it. The lists are not the problem. The problem is that a list is the answer to a question nobody asked out loud, and a student who never hears the question has nothing to hang the answer on.

This book is an attempt to put the questions back.

It asks what a drug does to a molecule, what that molecule does to a cell, what the cell does to an organ, and what the organ does to a patient — and it asks them in that order, because that is the order in which the answers explain one another. An adverse effect stops being a separate list to memorise the moment you can see that it is the same mechanism arriving in the wrong organ. A contraindication stops being arbitrary the moment you can see which step of the chain the patient cannot afford.

How the book is arranged

There are eighty chapters in fourteen sections. The sections follow the body: general principles first, then the autonomic nervous system, the autacoids, the respiratory and endocrine systems, the drugs acting at the neuromuscular junction and on nerve conduction, the central nervous system, the cardiovascular system, the kidney, the blood, the gut, the antimicrobials, the antineoplastics, and finally the applied topics that draw on all of them.

Within a chapter the arrangement is musical, and it is not an ornament. Each chapter opens with a patient or a problem, states the one or two rules

that generate everything else in it, develops the drug classes as a melody develops a theme, sets up a counterpoint where two drugs that look alike behave in opposite ways, and closes by gathering what a reader should carry out of it. That shape came out of teaching this material aloud, and it survived into print because it is how the material actually hangs together, not because the metaphor was pleasing.

The consequence worth knowing in advance is that a chapter is meant to be read forwards. The classification in the middle will look arbitrary if you arrive at it without the rule stated at the beginning, because the classification is derived from that rule.

The memory devices

Scattered through the book are devices for holding a list in mind — a string of letters, a line of verse, a sentence built to a borrowed metre. They are older than the book. They come out of more than a thousand recordings in English, Hindi and Arabic in which a list is almost never read out as a list; it is hung on something a listener already carries. The device is the index and the pharmacology is the content, and that division of labour is why the recordings worked.

Several of these carriers were audible before they were legible: the letters fell where the beats fell, and on the page the beats are gone. Where that happened the device has been rebuilt as something a reader can use rather than transcribed and left to limp. Where a carrier could not be used at all, the letters are printed and the carrier is not, with a line saying so. A missing device costs a reader a retrieval aid; a fabricated one costs them their trust in every other device in the book. The full policy is set out in A Note on the Memory Devices.

Chapter 1

Introduction and Routes of Administration

What a drug is, what it is called, what it is made into, and how it is given

Tier C chapter • first draft • written on the frozen Movement I corpus map

Discharges CBME competencies PH1.1, PH1.3 and PH1.11 — principles of pharmacology, drug formulations and delivery systems, and the routes of drug administration

A note on this chapter

This is the first chapter of the book and it does the work that every later chapter assumes: it fixes the vocabulary. A student who is unclear about the difference between a drug's three names, or who cannot say why one preparation is a tablet and another a patch, will meet those confusions again in every chapter that follows.

It ends with routes of administration, which is where the pharmacology begins to bite: the route determines how fast a drug acts, how much of it arrives, and — as Chapter 2 shows in detail — whether it arrives at all.

MOVEMENT 1 The Opening Note

A child is brought to a rural clinic in anaphylaxis after a wasp sting. The clinic has adrenaline. The nurse gives it into the deltoid muscle and the child recovers.

Had she given it intravenously, at that dose, the child might have died.

The drug was correct, the dose was correct, and the difference between recovery and cardiac arrhythmia was the route. Intramuscular adrenaline is absorbed over minutes into a well-perfused muscle, producing a rising concentration the circulation can accommodate. The same milligram given as an intravenous bolus arrives at the heart in seconds at a concentration no one intended.

That is the argument of this chapter in a single case. A prescription is not a drug and a dose; it is a drug, a dose, a formulation and a route, and the last two are not administrative details. They are pharmacology.

The chapter begins further back, though, because before a drug can be given it has to be identified, named and made into something. Those three

questions — what is it, what is it called, what has it been made into — come first.

MOVEMENT 2 The Rhythm — what a drug is, and where it comes from

A drug is any substance used in the diagnosis, prevention, treatment or cure of disease, or to modify a physiological function. The definition is deliberately wide. It admits diagnostic contrast media, which treat nothing; oral contraceptives, which modify a normal function rather than correcting an abnormal one; and vaccines, which are given to people who are well.

Pharmacology is the study of the interaction of drugs with living systems. It divides into the two halves this movement of the book is built on — pharmacokinetics, what the body does to the drug, and pharmacodynamics, what the drug does to the body — and into the applied disciplines that grow out of them: therapeutics, toxicology, clinical pharmacology, pharmacovigilance and pharmacogenomics.

parasympathetic effects and the presentation of organophosphate poisoning in Chapter 10, which is the same list with nothing to oppose it.

3.2 The cholinergic receptors

Receptor	Where	Coupling	Effect when occupied
M ₁	Gastric glands; autonomic ganglia; CNS neurons	Gq	Gastric acid secretion
M ₂	Heart — atria preferentially	Gi	Slows rate; slows atrioventricular conduction
M ₃	All other smooth muscle and glands — bronchi, gut, bladder detrusor, iris sphincter, ciliary muscle, salivary and lacrimal glands	Gq	Contraction of smooth muscle; secretion from glands
M ₄ , M ₅	Predominantly central	Gi / Gq respectively	Not required for the drug pharmacology of this movement
N _N	All autonomic ganglia, both divisions; adrenal medulla	Ligand-gated cation channel	Fast depolarisation of the postganglionic neuron
N _M	Skeletal neuromuscular junction	Ligand-gated cation channel	End-plate depolarisation and contraction

FIRST EAT, THEN FALL IN LOVE, THE REST LATER MNEMONIC — RECOVERED FROM THE RECORDINGS

Pehle khao — first eat → M₁ → gastric glands

Phir dil lagao — then give your heart → M₂ → the heart

Baaki kaam baad mein — the rest later → M₃ → all other smooth muscle and glands

This is the channel's signature device and it appears in five separate recordings. It carries M₁ to M₃ completely and stops there; M₄ and M₅ are not in it and are not added here, because a device extended past what it holds stops being reliable. The clinically decisive item is the third: **M₃ contracts all smooth muscle**, which predicts peristalsis, bronchoconstriction and bladder emptying from one fact instead of three.

3.3 The adrenergic receptors

Receptor	Where	Coupling	Effect when occupied
α ₁	Vascular smooth muscle; radial muscle of the iris; bladder trigone and internal sphincter; prostate	Gq	Vasoconstriction and a rise in blood pressure; mydriasis; urinary retention
α ₂	Presynaptic nerve terminal; also platelets and pancreatic β cells	Gi	Autoreceptor — inhibits further noradrenaline release. Negative feedback
β ₁	Heart; juxtaglomerular cells of the kidney	Gs	Increased rate and force; renin release
β ₂	Bronchial smooth muscle; uterus; skeletal muscle vasculature; liver	Gs	Bronchodilatation; uterine relaxation; glycogenolysis
β ₃	Adipose tissue; bladder detrusor	Gs	Lipolysis; detrusor relaxation

ONE HEART, TWO LUNGS — AND KISS MNEMONIC — RECOVERED FROM THE RECORDINGS