

Pharmacology

for Pharmacy Students

Second
Edition

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for Pharmacy Students

As per latest syllabus prescribed by Pharmacy Council of India

is the thoroughly revised, completely updated and moderately enlarged edition of an exemplary textbook in pharmacology meant for bachelor in pharmacy students, following the latest syllabus prescribed by Pharmacy Council of India (PCI). Besides BPharm, it will also serve as a textbook for the students of Pharm D and D Pharm courses.

Highlights of the textbook

- Written in simple and easy to understand language.
- Contents presented as per the latest syllabus prescribed by Pharmacy Council of India (PCI) in the semester system.
- Single textbook completely covers pharmacology syllabus for 4th, 5th and 6th semesters of B Pharm course.
- Flowcharts explain every mechanism of action.
- Multiple boxes and tables given throughout the book.
- Student-friendly format for easy comprehension.
- 'Compare and Contrast' series introduced in the book helps in understanding the subject better and retaining the facts longer with clarity and ease to recall.
- Some mnemonics added to remember important facts and statements.

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is Professor and Head, Department of Pharmacology, Father Muller Medical College, Mangalore, Karnataka. She has a keen interest in medical education with an experience in teaching of more than 32 years and has been on the boards of studies of many universities. She has published several titles and this is the 22nd book in the series of textbooks meant for medical, pharmacy, dental, nursing and physiotherapy students. Her other publications brought out by CBSPD are *Medical Pharmacology* and *Pharmacology Companion*. She also has several research papers to her credit. She has rich experience in clinical pharmacology, conducted and coordinated several clinical trials, and has been advising clinicians on the appropriate and rational use of drugs.



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to

*my dear
students*

Preface to the Second Edition

The second edition of *Pharmacology for Pharmacy Students* has seen the light of the day much earlier than expected. It happens to be a small source of personal solace at the heights of COVID crisis across the world.

All chapters are thoroughly revised, keeping in mind B Pharm, D Pharm, and Pharm D students. Topics on 'biologics and biosimilars' and treatment of heavy metal poisoning, have been added. The syllabus of Pharmacy Council of India is covered in entirety and the chapters are arranged semester-wise. More flowcharts, figures and mnemonics are added.

Hope this book makes learning pharmacology easy and pleasurable.

It was a pleasant surprise to receive positive feedback both from the students and staff from across the country and abroad through mail.

Please continue to send your valuable feedback to padmajaudaykumar@gmail.com

Padmaja Udaykumar

Preface to the First Edition

Pharmacists play a major role in drug development. In fact, they are involved in the entire process of drug use right from research, development, manufacture, storing and reaching it to the patient. Hence extensive knowledge of pharmacology is needed for effective and appropriate functioning in their career.

However, since there are multiple subjects to be covered in a relatively short span during their course, it is necessary to simplify the subject. Books in pharmacology meant only for pharmacy students are hard to find. Hence, to reduce the burden of the students, this book has been published exclusively for the pharmacy students.

The Pharmacy Council of India has revised the syllabus for pharmacy and also made it semester-wise. The latest syllabus of PCI is covered and the chapters are arranged as per semester sequence. Flowcharts, tables and figures have been used all through the book for better understanding. Compare and contrast tables help in better retention of the topics.

Pharm D a recently introduced course in pharmacy, also brings with it various challenges of training the students to attain the objectives of the syllabus. Extensive knowledge of pharmacology is mandatory and the subject is spread out through the course. **Pharmacology for Pharmacy Students**, covers the topics prescribed for Pharm D students too. Many colleges have already prescribed **Medical Pharmacology** for Pharm D students and may now also find this book useful.

Hope this book makes reading pharmacology a pleasurable experience.

Please mail your valuable feedback to padmajaudaykumar@gmail.com

Padmaja Udaykumar

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I thank the management of Fr Muller Medical College: Rev Fr Richard Coelho, Director; Rev Fr Rudolf Ravi DSa and Rev Fr Ajith Menezes, Administrators; Rev Fr Nelson Pais, Assistant Administrator; Dr Jayaprakash Alva; Dean and Dr B Sanjeev Rai, Chief of Research, for their support.

I thank my husband Dr Udaykumar K, Medical Superintendent, Fr Muller Medical College Hospital, for his constant encouragement.

I thank Mr SK Jain, CMD, and Mr YN Arjuna, Senior Vice President—Publishing, Editorial and Publicity, CBS Publishers & Distributors, for persuading me to write and for publishing this book. I am grateful to the staff of CBS, Ms Ritu Chawla and her team for the meticulous work in bringing out this book.

Padmaja Udaykumar

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Abbreviations

Ang I/II/III	Angiotensin I/II/III	CNS	Central nervous system
AC	Adenylyl cyclase	C.O.	Cardiac output
ACE	Angiotensin II converting enzyme	COMT	Catechol-O-methyl transferase
ACh	Acetylcholine	COX	Cyclo-oxygenase
AChE	Acetylcholinesterase	CPZ	Chlorpromazine
ACT	Artemisinin-based combination therapy	CSF	Cerebrospinal fluid
ACTH	Adrenocorticotrophic hormone	CTZ	Chemoreceptor trigger zone
AD	Alzheimer's disease	CV	Cardiovascular
ADH	Antidiuretic hormone	CVS	Cardiovascular system
ADP	Adenosine diphosphate	DA	Dopamine
Adr	Adrenaline	DAD	Delayed afterdepolarization
ADR	Adverse drug reaction	DAG	Diacyl glycerol
AF	Atrial fibrillation	DAM	Diacetyl monoxime
AFI	Atrial flutter	DEC	Diethyl carbamazine citrate
AHG	Antihaemophilic globulin	DHE	Dihydroergotamine
AIDS	Acquired immunodeficiency syndrome	DHFA	Dihydro folic acid
AMP	Adenosine monophosphate	DHFR	Dihydrofolate reductase
AMPA	α -aminohydroxy methylisoxazole propionic acid	DM	Diabetes mellitus
ANC	Acid neutralizing capacity	DI	Diabetes insipidus
ANP	Atrial natriuretic peptide	DMPA	Depot medroxyprogesterone acetate
ANS	Autonomic nervous system	DNA	Deoxyribonucleic acid
ARS	Anti-rabies serum	DOCA	Desoxy corticosterone acetate
5-ASA	5-amino salicylic acid	dopa	Dihydroxyphenyl alanine
ATG	Antithymocyte globulin	DOPAA	3,4-Dihydroxyphenyl acetic acid
ATP	Adenosine triphosphate	DOSS	Diocetyl sulfosuccinate
ATS	Antitetanus serum	DOTS	Directly observed treatment short course
AZT	Zidovudine	DPT	Diphtheria–Pertussis–Tetanus triple antigen
BAL	British anti-Lewisite	DRC	Dose-response curve
BD	Twice daily	DT	Distal tubule
BPH	Benign prostatic hypertrophy	DUB	Dysfunctional uterine bleeding
BMD	Bone mineral density	EACA	Epsilon aminocaproic acid
BMR	Basal metabolic rate	EAD	Early after depolarization
BNP	Brain natriuretic peptide	ECG	Electrocardiogram
BP	Blood pressure	ECT	Electroconvulsive therapy
BSA	Body surface area	ED	Erectile dysfunction
BZD	Benzodiazepine	EEG	Electroencephalogram
CCB	Calcium channel blocker	ENS	Enteric nervous system
CD	Collecting duct	EPO	Erythropoietin
CHF	Congestive heart failure	EPS	Extrapyramidal symptoms
ChE	Cholinesterase	EPSP	Excitatory postsynaptic potential
Chy. rem	Chylomicron remnants	ER	Estrogen receptor
CHD	Coronary heart disease	ESR	Erythrocyte sedimentation rate
CCF	Congestive cardiac failure	FFA	Free fatty acid
CL	Clearance	FSH	Follicle stimulating hormone
CMV	Cytomegalovirus	5-FU	5-Fluorouracil

GABA	Gamma aminobutyric acid	IU	International unit
GC	Guanylyl cyclase	IV/iv	Intravenous
GCP	Good clinical practice	JAK	Janus-kinase
G-CSF	Granulocyte colony stimulating factor	JNC	Joint National Committee
GDP	Guanosine diphosphate	KTZ	Ketoconazole
GERD	Gastroesophageal reflux disease	LA	Local anaesthetic
GFR	Glomerular filtration rate	LDL	Low density lipoprotein
GH	Growth hormone	LES	Lower esophageal sphincter
GHRH	Growth hormone releasing hormone	LH	Luteinizing hormone
GHRIH	Growth hormone release inhibitory hormone	LL	Lepromatous leprosy
GIT	Gastrointestinal tract	LMW	Low molecular weight
GITS	Gastrointestinal therapeutic system	LOX	Lipoxygenase
GLUT	Glucose transporter	LSD	Lysergic acid diethylamide
GMCSF	Granulocyte macrophage colony stimulating factor	LT	Leukotriene
GnRH	Gonadotropin releasing hormone	LVF	Left ventricular failure
G6PD	Glucose-6-phosphate dehydrogenase	MAC	<i>Mycobacterium avium</i> complex
GTCS	Generalised tonic-clonic seizures	MAO	Monoamine oxidase
GTN	Glyceryl trinitrate	MDR	Multidrug resistant
GTP	Guanosine triphosphate	MI	Myocardial infarction
H	Isoniazid	MIC	Minimal inhibitory concentration
HAART	Highly active antiretroviral therapy	MLCK	Myosin light chain kinase
Hb	Haemoglobin	MMF	Mycophenolate mofetil
HBV	Hepatitis B virus	6-MP	6-Mercaptopurine
HCG	Human chorionic gonadotropin	MPTP	4-methyl-4-phenyltetrahydropyridine
HDL	High density lipoprotein	Mtx	Methotrexate
5-HIAA	5-hydroxyindoleacetic acid	MW	Molecular weight
HIV	Human immunodeficiency virus	NA	Noradrenaline
HMG-CoA	Hydroxymethyl glutaryl coenzyme A	NADP	Nicotinamide adenine dinucleotide phosphate
HMW	High molecular weight	NAG	N-acetyl glucosamine
HPA axis	Hypothalamopituitary adrenal axis	NAM	N-acetyl muramic acid
hr	Hour	NANC	Nonadrenergic noncholinergic
HR	Heart rate	NET	Norepinephrine transporter
HRT	Hormone replacement therapy	NMDA	N-methyl-D-aspartate
5-HT	5-hydroxytryptamine	NNRTI	Non-nucleoside reverse transcriptase inhibitor
HVA	Homovanilic acid	NSAID	Nonsteroidal anti-inflammatory drug
IBD	Inflammatory bowel disease	NSTEMI	Non-ST-segment elevation myocardial infarction
IBS	Irritable bowel syndrome	NTG	Nitroglycerine
ID	Intradermal (injection)	NTS	Nucleus tractus solitarius
Ig	Immunoglobulin	NVBDCP	National vector-borne disease control programme
IGF	Insulin-like growth factor	OCD	Obsessive-compulsive disorder
IL	Interleukin	OD	Once daily
IM/im	Intramuscular	OPV	Oral poliomyelitis vaccine
INH	Isonicotinic acid hydrazide	ORS	Oral rehydration salt (solution)
INR	International normalized ratio	ORT	Oral rehydration therapy
IOP	Intraocular pressure		
IP	Inositol triphosphate		
IPSP	Inhibitory postsynaptic potential		
ISA	Intrinsic sympathomimetic activity		

PABA	Para-aminobenzoic acid	SMON	Subacute myelo-optic neuropathy
PAE	Post-antibiotic effect	SNRI	Serotonin and noradrenaline reuptake inhibitor
PAF	Platelet activating factor	SOS	as required
PAS	Para-aminosalicylic acid	SPF	Sun protection factor
PBPs	Penicillin binding proteins	SR	Sustained release
PBL	Paucibacillary leprosy	SRS-A	Slow reacting substance of anaphylaxis
PD	Parkinson's disease	STAT	Signal transducer and activator transcription
PDE	Phosphodiesterase	STEMI	ST-segment elevation myocardial infarction
PG	Prostaglandin	Susp	Suspension
PGI ₂	Prostacyclin	Syr	Syrup
PI	Protease inhibitor	$t_{1/2}$	Half life
PLA	Phospholipase A	tab	Tablet
PLC	Phospholipase C	TBG	Thyroxine binding globulin
PnG	Penicillin G	TCAs	Tricyclic antidepressants
POMC	Pro-opiomelanocortin	TDM	Therapeutic drug monitoring
PP	Partial pressure	TDS	Three times a day
PPA	Phenyl propanolamine	TG	Triglyceride
PPAR	Peroxisome proliferator-activated receptor	6-TG	6-Thioguanine
PPH	Post-partum haemorrhage	THC	Tetrahydrocannabinol
PPI	Proton pump inhibitor	THFA	Tetrahydrofolic acid
PPNG	Penicillinase producing <i>N. gonorrhoeae</i>	TIAs	Transient ischaemic attacks
PSVT	Paroxysmal supra-ventricular tachycardia	TNF- α	Tumor necrosis factor α
PT	Proximal tubule	t-PA	Tissue plasminogen activator
PTCA	Percutaneous transluminal coronary angioplasty	TRH	Thyroid releasing hormone
PTH	Parathyroid hormone	TSH	Thyroid stimulating hormone
PTP	Post-tetanic potentiation	TTS	Transdermal therapeutic system
QID	Four times a day	U	Unit
R	Rifampin (rifampicin)	UDP	Uridine diphosphate
RAS	Renin-angiotensin system	UTI	Urinary tract infection
RBC	Red blood cells	VF	Ventricular fibrillation
REM	Rapid eye movement (sleep)	VIP	Vasoactive intestinal peptide
RNA	Ribonucleic acid	Vit	Vitamin
RNTCP	Revised National Tuberculosis Control Programme	VLDL	Very low density lipoprotein
RP	Refractory period	VMA	Vanillyl mandelic acid
RyR	Ryanodine receptor	VMC	Vasomotor centre
SA	Sinoatrial (node)	VRSA	Vancomycin resistant <i>Staphylococcus aureus</i>
SAARD	Slow acting antirheumatic drug	VT	Ventricular tachycardia
SBE	Subacute bacterial endocarditis	vWF	von Willebrand factor
sc/SC	Subcutaneous	WBC	White blood cells
SCh	Succinylcholine	WHO	World Health Organization
SERDs	Selective estrogen receptor down regulators	WPW	Wolff-Parkinson-White syndrome
SERM	Selective estrogen receptor modulator	XDR-TB	Extensively drug resistant-TB
SERT	Serotonin transporter	Z	Pyrazinamide
SL	Sublingual		