Pharmacology
for Pharmacy Students

Second Edition

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.

Padmaja Udaykumar MD

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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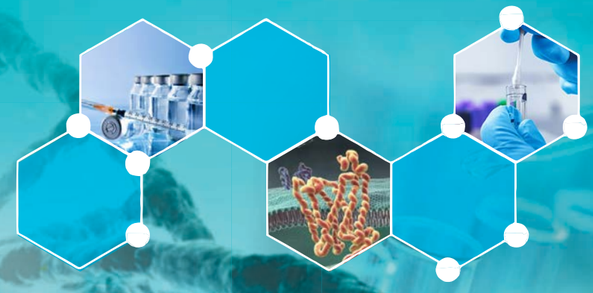

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to

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

Acknowledgements

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

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

PABA Para-aminobenzoic acid
PAE Post-antibiotic effect
PAF Platelet activating factor
PAS Para-aminosalicyclic acid
PBPs Penicillin binding proteins
PBL Paucibacillary leprosy
PD Parkinson's disease
PDE Phosphodiesterase
PG Prostaglandin
PGI_2 Prostacyclin
PI Protease inhibitor
PLA Phospholipase A
PLC Phospholipase C
PnG Penicillin G
POMC Pro-opiomelanocortin
PP Partial pressure
PPA Phenyl propanolamine
PPAR Paroxisome proliferator-activated receptor
PPH Post-partum haemorrhage
PPI Proton pump inhibitor
PPNG Penicillinase producing *N. gonorrhoeae*
PSVT Paroxysmal supra-ventricular tachycardia
PT Proximal tubule
PTCA Percutaneous transluminal coronary angioplasty
PTH Parathyroid hormone
PTP Post-tetanic potentiation

QID Four times a day

R Rifampin (rifampicin)
RAS Renin-angiotensin system
RBC Red blood cells
REM Rapid eye movement (sleep)
RNA Ribonucleic acid
RNTCP Revised National Tuberculosis Control Programme
RP Refractory period
RyR Ryanodine receptor

SA Sinoatrial (node)
SAARD Slow acting antirheumatic drug
SBE Subacute bacterial endocarditis
sc/SC Subcutaneous
SCh Succinylcholine
SERDs Selective estrogen receptor down regulators
SERM Selective estrogen receptor modulator
SERT Serotonin transporter
SL Sublingual
SMON Subacute myelo-optic neuropathy
SNRI Serotonin and noradrenaline reuptake inhibitor
SOS as required
SPF Sun protection factor
SR Sustained release
SRS-A Slow reacting substance of anaphylaxis
STAT Signal transducer and activator transcription
STEMI ST-segment elevation myocardial infarction
Susp Suspension
Syr Syrup

t½ Half life
tab Tablet
TBG Thyroxine binding globulin
TCAs Tricyclic antidepressants
TDM Therapeutic drug monitoring
TDS Three times a day
TG Triglyceride
6-TG 6-Thioguanine
THC Tetrahydrocannabinol
THFA Tetrahydrofolic acid
TIAs Transient ischaemic attacks
TNF-α Tumor necrosis factor α
t-PA Tissue plasminogen activator
TRH Thyroid releasing hormone
TSH Thyroid stimulating hormone
TTS Transdermal therapeutic system

U Unit
UDP Uridine diphosphate
UTI Urinary tract infection

VF Ventricular fibrillation
VIP Vasoactive intestinal peptide
Vit Vitamin
VLDL Very low density lipoprotein
VMA Vanilyl mandelic acid
VMC Vasomotor centre
VRSA Vancomycin resistant *Staphylococcus aureus*
VT Ventricular tachycardia
vWF von Willebrand factor

WBC White blood cells
WHO World Health Organization
WPW Wolff-Parkinson-White syndrome
XDR-TB Extensively drug resistant-TB

Z Pyrazinamide