

Comprehensive Pharmacology for Undergraduates

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By

Chandrashekar R

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This book is dedicated to
Late C. Rajan (father)
Nagamani R (mother)
Rashmi B.R. (wife)
Thrijal Raj (son)
and
Bhanvi Raj (daughter)

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ABBREVIATIONS

• 5-ASA	5- Amino salicylic acid
• 5-FU	5–fluorouracil
• 5-HT	5- Hydroxy tryptamine
• AADC	Aromatic L amino acid decarboxylase
• ABC	Abacavir
• ABV	Alcohol by volume
• ACE	Angiotensin converting enzyme
• ACE	Angiotensin converting enzyme
• Ach	Acetylcholine
• AchE	Acetylcholinesterase
• ACOG	American College of Obstetricians and Gynaecologists
• ACS	Acute coronary syndrome
• ACT	Artemisinin-based combination therapy
• ACTH	Adrenocorticotrophic hormone
• ACVIP	Advisory Committee on Vaccines and Immunization Practices
• AD	Alzheimer’s disease
• ADH	Antidiuretic hormone
• ADP	Adenosine diphosphate
• ADR	Adverse drug reaction
• ADS	Diphtheria antitoxin
• AE	Adverse events
• AGS	Gas gangrene antitoxin
• AHG	Antihemophilic globulin
• AIDS	Acquired immunodeficiency syndrome
• AIP	Aldosterone induced protein
• ALL	Acute lymphoblastic leukaemia
• AMA	Antimicrobial agent
• ANC	Acid neutralizing capacity
• ANC	Acid neutralizing capacity
• APC	Antigen presenting cells
• APD	Action potential duration

• APD	Acid peptic disease
• APL	Acute promyelocytic leukaemia
• aPTT	Activated partial thromboplastin time
• AQ	Amodiaquine
• AR	Androgen receptor
• ARB	Angiotensin receptor blocker
• ARE	Androgen responsive element
• ARS	Anti-rabies antiserum
• ARV	Antiretroviral therapy
• ASO-titre	Anti-streptolysin -O- titre
• ATG	Anti-thymocyte antibody
• ATS	Tetanus antitoxin
• ATV	Atazanavir
• AUC	Area under curve
• aVd	Apparent volume of distribution
• AZT	Zidovudine
• AZT	Azidothymidine
• BAL	British anti-lewisite
• BBB	Blood brain barrier
• BCG	Bacille calmette-guérin
• BD	Twice daily
• BDQ)	Bedaquiline
• BHC	Benzene hexachloride
• BMT	Bone marrow transplantation
• BNF	British national formulary
• BP	British pharmacopoeia
• BPH	Benign prostatic hypertrophy
• BRMs	Biologic response modifiers
• BTB	Blood-testis barrier
• BTB	Blood testis barrier
• BTC	Behind-the-counter
• BUN	Blood urea nitrogen
• BZD	Benzodiazepine
• C ₂ H ₆ O ₂	Ethylene glycol
• Ca ²⁺ -CAM	Calcium-calmodulin
• CAH	Congenital adrenal hyperplasia
• cAMP	Cyclic adenosine monophosphate
• C-AMB	Conventional formulation of amphotericin B
• CAP	Community-acquired pneumonia

• CBC	Complete blood count
• CBS	Colloidal bismuth subcitrate
• CCB	Calcium channel blocker
• CCNS	Cell cycle non-specific
• CCS	Cell cycle specific
• CD	Crohn's disease
• CDC	Centre for Disease Control and Prevention
• CDSCO	Central drugs standard control organization
• cGMP	Cyclic guanosine monophosphate
• CGRP	Calcitonin gene-related peptide
• CHF	Congestive heart failure
• CHF	Congestive heart failure
• CINV	Chemotherapy induced nausea and vomiting
• CKD	Chronic kidney disease
• CL	Drug clearance
• CLE	Cutaneous lupus erythematosus
• CLL	Chronic lymphocytic leukaemia
• CME	Continuing medical education
• CMI	Cell mediated immunity
• CMV	Cytomegalo virus
• COMT	Catechol-o-methyltransferase
• COMT	Catechol-O-methyltransferase
• COPD	Chronic obstructive pulmonary disease
• COPD	Chronic obstructive pulmonary disease
• COX	Cyclooxygenase
• COX-1	Cyclooxygenase -1 enzyme
• COX-2	Cyclooxygenase -2 enzyme
• COX-3	Cyclooxygenase -3 enzyme
• Cp	Desired plasma drug concentration
• CpSS	Steady state plasma concentration
• CPZ	Chlorpromazine
• CQ	Chloroquine
• CRH	Corticotropin-releasing hormone
• CSF	Cerebrospinal fluid
• CSF	Certainty safety factor
• CTZ	Chemoreceptor trigger zone
• CTZ	Chemoreceptor trigger zone
• CTZ	Chemoreceptor trigger zone
• CYP3A4	Cytochrome P 3A4

• cysLT1	Cysteinyl leukotriene receptor 1
• d4T	Stavudine
• DAG	Diacylglycerol
• DCGI	Drugs Controller General of India
• DDC	Dopa decarboxylase
• ddI	Didanosine
• DDS	Dapsone
• DDT	Dichloro-diphenyl-trichloroethane
• DEC	Diethylcarbamazine
• DHEA	Dehydroepiandrosterone
• DHEA	Dehydroepiandrosterone
• DHFA	Dihydrofolic acid
• DHFRase	Dihydrofolate reductase
• DHT	Dihydrotestosterone
• DHT	Dihydrotestosterone
• DIT	Diiodothyronine
• DLE	Discoid lupus erythematosus
• DLV	Delavirdine
• DM	Diabetes mellitus
• DMARDs	Disease modifying anti-rheumatic drugs
• DMPP	Dimethyl phenyl piperazinium iodide
• DNA	Deoxyribonucleic acid
• DOCA	Deoxycorticosterone acetate
• DORAs	Dial orexin receptor antagonist
• DOSS	Dioctyl sodium sulfosuccinate
• DOTS	Directly observed treatment short course
• DPP-4	Dipeptidyl peptidase - 4
• DPT	Diphtheria, pertussis and tetanus
• DRC	Dose response curve
• DRT	Dopamine reuptake transporter
• DRV	Darunavir
• DRV	Darunavir
• DT	Diphtheria and pertussis
• DTaP	Diphtheria, tetanus, and pertussis
• d-TC	Dextro-tubocurarine
• DTG	Dolutegravir
• DTI	Direct thrombin inhibitors
• DUB	Dysfunctional uterine bleeding
• δ -TC	Dextro-tubocurarine

• DVT	Deep vein thrombosis
• E2	Estradiol
• E3	Estriol
• EBV	Epstein Barr virus
• ECF	Extracellular fluid
• ECG	Electrocardiogram
• ECL	Enterochromaffin cell
• ECT	Electroconvulsive therapy
• ECT	Electroconvulsive therapy
• ED 50	Effective dose in 50%
• EDL	Essential drug list
• EDTA	Ethylenediaminetetraacetic acid
• EEA	European economic area
• EFV	Efavirenz
• EGF	Epidermal growth factor
• EGFR	Epidermal growth factor receptor
• EGFR	Epidermal growth factor receptor
• EMA	European medicines agency
• EMLA	Eutectic Mixture of Local Anaesthetics
• ENKs	Endogenous enkephalin
• ENL	Erythema nodosum leprosum
• ENT	Ear, nose & throat
• EPO	Erythropoietin
• ERP	Effective refractory period
• ESRD	End-stage renal disease
• ETC	Emtricitabine
• ETC	Electron transport chain
• Eto	Ethionamide
• ETV	Etavirine
• EU	European union
• F	Bioavailability
• FAAH	Fatty acid amide hydrolase
• FDC	Fixed-dose drug combination
• FPGS	Folylpolyglutamate synthase
• FPM	First –pass metabolism
• FPV	Fosamprenavir
• FSH	Follicle-stimulating hormone
• G6PD	Glucose-6-phosphate dehydrogenase
• GABA	Gamma amino butyric acid

- GAD Generalized anxiety disorder
- GCP Good clinical practise
- G-CSF Granulocyte colony stimulating factor
- GCV Ganciclovir
- GERD Gastroesophageal reflux disease
- GHB Gamma hydroxybutyrate
- GHRH Growth hormone releasing hormone
- GHRH Growth hormone releasing hormone
- GINA Global initiative for asthma
- GIP Glucose-dependent insulintropic polypeptide
- GIST Gastrointestinal stromal tumour
- GLP-1 Glucagon-like peptide-1
- GM-CSF Granulocyte Macrophage colony stimulating factor
- GnRH Gonadotropin releasing hormone
- GPCR G protein coupled receptors
- GRE Glucocorticoid responsive element
- GTP Guanosine triphosphate
- GTS Gilles de la Tourette syndrome
- GTS Gilles de la Tourette syndrome
- HAART Highly active antiretroviral regimens
- HBIG Hepatitis-B immune globulin
- HBsAg Hepatitis B surface antigen
- HBV Hepatitis b virus
- HCG Human chorion gonadotropic hormone
- HCL Hydrochloric acid
- HCV Hepatitis c virus
- HDCV Human diploid cell culture rabies vaccine
- HDL High density lipoprotein
- HICPAC Healthcare infection control practises advisory committee
- HIT Heparin induced thrombocytopenia
- HIV Human immunodeficiency virus
- HMA Hexamethyl melamine
- HMG-CoA 3-Hydroxy-3-Methyl glutaryl coenzyme A
- HMWH High molecular weight heparin
- HPA Hypothalamo pituitary-adrenal
- HPT Hyperparathyroidism
- HSP Heat shock protein

• HSV-1	Herpes simplex virus-1
• HSV2	Herpes simplex virus-2
• HVA	Homovanillic acid
• i.m	Intramuscular
• i.v	Intravenous
• IAP	Indian Academy of Paediatrics
• IBD	Inflammatory bowel disease
• IBS	Irritable bowel syndrome
• ICAM-1	Intracellular adhesion molecule -1
• ICF	Intracellular fluid
• IEC	Institutional ethics committee
• IFNs	Interferons
• IGF-1	Insulin-like growth factors-1
• IGF-2	Insulin-like growth factors-2
• IL-1	Interleukinin-1
• IL-2	Interleukinin-2
• INH	Isoniazid
• INR	International normalized ratio
• INV	Indinavir
• IOP	Intraocular pressure
• IP	Indian pharmacopoeia
• IP3	Inositol triphosphate
diacylglycerol	
• IPC	Indian pharmacopoeia commission
• IPV	Inactivated poliovirus vaccine
• IRB	Institutional review board
• IU	International unite
• JAK-STAT	Janus kinases
• KCL	Potassium chloride
• Km	Kanamycin
• KTZ	Ketoconazole
• L-AMB	Liposomal amphotericin B
• LAs	Local anaesthetics
• L-ASPase	<i>L-asparaginase</i>
• LC3-KAT	Long-chain 3-ketoacyl-coa thiolase
• LC-DST	Liquid culture drug sensitivity test
• LD	Lethal dose
• LD 50	Lethal dose in 50%
• LDL	Low density lipoprotein

• L-dopa	Levo- dihydroxyphenylalanine
• LDV	Ledipasavir
• Lf	Flocculation units
• LFT	Liver function test
• Lfx	Levofloxacin
• LH	Luteinizing hormone
• LMWH	Low molecular weight heparin
• LOX	Lipoxygenase
• LPA	Line probe assay
• LPV	Lopinavir
• LRTIs	Lower respiratory infections
• LSD	Lysergic acid amides dimethylamide
• LWC	Live whole cell
• µg	Microgram
• MAC	Mycobacterium avium complex
• MAO	Monoamine oxidase
• MAO	Monoamine oxidase
• MBC	Minimum bacterial concentrations
• MD	Maintenance dose
• MDMA	Methyl dioxy methamphetamine
• MDR-TB	Multi drug-resistant tuberculosis
• MDT	Multi drug therapy
• MDT	Dimethyltryptamine
• MEC	Minimum effective concentration
• mg	Milligram
• MIC	Minimum inhibitory concentration
• MIT	Monoiodothyronine
• MMF	Mycophenolate mofetil
• MMI	Methimazole
• MRE	Mineralocorticoid responsive element
• mRNA	Messenger ribose nucleic acid
• MRSA	Methicillin-resistant Staphylococcus aureus
• MSC	Maximum safe concentration
• MSH	Melanocyte stimulating hormone
• MTD	Maximum tolerated dose
• mTOR	Mammalian target of rapamycin
• MTP	Medical termination of pregnancy
• NACO	National aids control organization
• NDA	New drug application

• NDA	New drug application
• NDD	Neural network-based method for drug-drug interaction prediction
• NERT	Norepinephrine reuptake transporter
• NFI	Formulary india
• NFV	Nelfinavir
• NFκB	Nuclear transcription factor
• ng	Nanogram
• NHBPEP	National high blood pressure education program
• NLEM	National list of essential medicine
• NMDA	N-methyl-d-aspartate
• NMJ	Neuromuscular junction
• NNRTI	Non-nucleoside reverse transcriptase inhibitors
• NO	Nitric oxide
• NOEL	No observable effect level
• NPH	Neutral protamine hegdron
• NREM	Non-rapid eye movement
• NRTI	Nucleoside reverse transcriptase inhibitor
• NS5B	Non-structural protein 5B
• NSAID	Non-steroidal anti-inflammatory drug
• NSCLC	Non-squamous non-small cell lung cancer
• NSTEMI	Non-ST elevated myocardial infarction
• NTD	Neural tube defects
• NTEP	National tuberculosis elimination programme
• NTS	Nucleus tractus solitarius
• NVP	Nevirapine
• O/W	Oil-in-water emulsion
• OAT	Organic anion transporter
• OCD	Obsessive compulsive disorder
• OCP	Oral contraceptive pills
• OD	Once a day
• OPD	Outpatient department
• OPV	Poliomyelitis oral vaccine
• ORS	Oral rehydration salts
• OTC	Over the counter
• OX1R	Orexin receptors
• OX2R	Orexin receptors
• OXTR	Oxytocin receptor
• PACG	Primary angle closed glaucoma

• PAE	Post-antibiotic effect
• PAF	Platelet activating factor
• PAS	Para-amino-salicylic acid
• PBP	Penicillin binding proteins
• PCA	Patient controlled analgesics device
• PCEV	Purified chick embryo vaccine
• PCI	Percutaneous coronary intervention
• PCT	Paracetamol
• PD	Parkinson's disease
• PEMA	Phenylethylmalonamide
• PEP	Post-exposure prophylaxis
• PERT	Pancreatic enzyme replacement therapy
• PGA	Pteroyl glutamic acid
• PHC	Primary health care
• PI	Protease inhibitors
• PICO	Population, Intervention, Control, and Outcomes
• PIPE	Pharmacologically induced penile erections
• PKA	Protein kinase
• PKc	Protein kinase C
• PMDD	Premenstrual dysphoric disorder
• PMDD	Premenstrual dysphoric disorder
• PnG	Penicillin-G
• PnV	Penicillin-V
• POAG	Primary open angle glaucoma
• PPAR α	Proliferator-activated receptor- α
• PPAR γ	Proliferator-activated receptor- γ
• PPH	Post-partum haemorrhage
• PPI's	Proton pump inhibitors
• PRE	Progesterone responsive element
• PRM	Progesterone receptor modulator
• PSVT	Paroxysmal supraventricular tachycardia
• PTH	Parathyroid hormone
• PTSD	Post-traumatic stress disorder
• PTU	Propylthiouracil
• PUO	Pyrexia of unknown origin
• PUVA	Photosensitiser followed by ultraviolet A rays
• PVD	Peripheral vascular disease
• PVR	Peripheral vascular resistance
• PVRV	Purified vero cell rabies vaccine

• RANKL	Receptor activator of nuclear factor-ligand
• RARA-RXR	Retinoic acid receptors
• RAS	Renin angiotensin system
• RCC	Renal cell carcinoma
• rDNA	Recombinant deoxyribose nucleic acid technology
• REM	REM- Rapid eye movement
• RIG	Rabies immune globulin
• RIMA	Reversible inhibitor of monoamine oxidase
• RNTCP	Revised National tuberculosis Control Program
• RP	Reverse pharmacology
• RR-TB	Rifampicin-resistant tuberculosis
• RTI	Respiratory tract infection
• RTV	Ritonavir
• RyR	Ryanodine receptor
• s.c	Subcutaneous
• SABE	Subacute bacterial endocarditis
• SAM	S-adenosylmethionine
• Sch	Succinylcholine
• SERD	Selective oestrogen receptor down regulator
• SERM	Selective oestrogen receptors modulator
• SGLT-2	Sodium-glucose cotransporter 2
• SHBG	Sex hormone-binding globulin
• SMON	Subacute myelo-optic neuropathy
• SMR	Skeletal muscle relaxants
• SNRI	Serotonin and Norepinephrine reuptake inhibitors
• SOF	Sofosbuvir
• SPRM	Selective progesterone receptor modulator
• SQV	Saquinavir
• SRIF	Somatotropin release inhibiting factor
• SSG	Sodium stibogluconate
• SSRI	Serotonin reuptake inhibitors
• STAT	Signal transducer and activator of transcription proteins
• STEMI	ST-elevated myocardial infarction
• SUR1	Sulfonylurea receptor
• SVR	Sustained viral response
• TAB)	Typhoid –paratyphoid
• TCA	Tricyclic antidepressants

• TCID ₅₀	50 % tissue culture infectious dose
• TDF	Tenofovir
• TDM	Therapeutic drug monitoring
• TDS	Thrice daily
• THFA	Tetrahydro folic acid
• THFA	Tetrahydro folic acid
• TI	Therapeutic index
• TI	Therapeutic index
• TIA	Transient ischemic attack
• TID	Three times a day
• TMA	Tetramethyl ammonium
• Δ ⁹ THC	Tetrahydrocannabinol
• TNF-α	Tumour necrosis factor- α
• t-PA	Tissue thromboplastin
• TRE	Thyroid responsive element
• TRH	Thyrotropin-releasing hormone
• TSH	Thyroid stimulating hormone
• UC	Ulcerative colitis
• UFH	Unfractionated heparin
• UGT1A1	Uridine diphosphate glucuronosyltransferase 1A1
• US FDA	United states food and drug administration
• USP	United states pharmacopoeia
• UTI	Urinary tract infection
• UVA	Ultraviolet light-A rays
• UVA	Ultraviolet radiation
• UVB	Ultraviolet light-B rays
• vd	Volume of distribution
• VEL	Velpatasavir
• VIP	Vasoactive intestinal peptide
• VLDL	Very low-density lipoprotein
• VMA	Vanillyl mandelic acid
• VMAT	Vesicular monoamine transporter
• VRSA	Vancomycin-resistant streptococci aureus
• VTE	Venous thromboembolism
• VZV	Varicella-Zoster virus
• W/O	Water-in-oil emulsion
• WHO	World health organization
• WPW	Wolff-Parkinson-White syndrome

- XDR-TB Extensively drug-resistant tuberculosis
- ZDV Zidovudine

CHAPTER 1

INTRODUCTION TO PHARMACOLOGY

Pharmacology

The word “**pharmacology**” comes from the Greek words “**pharmakon**” and “**logia**”, the former meaning “to remedy”, the latter meaning “the study of.”

Definition of pharmacology

The study of drugs, medications, and their effects on the body is the focus of the medical and pharmaceutical science field of pharmacology.

Brief History

The Middle Ages, a period in European history that lasted from the fall of Roman civilization in the 5th century CE to the Renaissance, are when pharmacology first emerged. Avicenna lived during this period. Famous commentaries on Isaac, the Canon of Medicine, and John of St. Amand's on the Antedotary of Nicholas all recognised “pharmacy” as a separate scientific discipline, but until the middle of the 19th century, little progress was made in this area.

Terminology used and divisions of pharmacology

- **Clinical pharmacology:** A branch of pharmacology that deals with effects of drugs in humans
- **Neuropharmacology / Psychopharmacology:** A branch of pharmacology that deals with effects of drugs on behaviours and nervous system functioning
- **Pharmacogenetics:** A branch of pharmacology that deals with the effects of drugs in clinical testing of genetic variation that gives rise to differing responses to drugs

- **Pharmacogenomics:** A branch of pharmacology that deals with the effects of drugs and its application of genomic technologies to new drug discovery and further characterisation of older drugs. (see Chapter 115, pg. 852 - 853)
- **Pharmacoepidemiology:** A branch of pharmacology that deals with the effects of drugs in large numbers of people. (see Chapter 115, pg. 852 - 853)
- **Toxicology:** A branch of pharmacology that deals with the harmful effects of drugs
- **Pharmacognosy:** A branch of pharmacology that deals with the composition, use, and development of medicinal substances of biological origin and especially medicinal substances obtained from plants.

Definition of drug

Drug: “drogue” is the French word for “dry herb”.

A drug is a substance that is used to treat, diagnose, and prevent illness in both people and animals.

Sources of drugs

Given that pharmaceuticals may come from one or more sources, the following categories can be used to study drug sources: (see Table 1.1)

Table 1.1 Sources of drugs			
Natural	Semisynthetic	Synthetic	Biotechnology
Obtained from natural source a) From plants: Atropine from <i>Atropa belladonna</i> b) From Animals: Insulin, Heparin etc. c) Minerals: Iron, Iodine etc. d) Microorganisms: Penicillin antibiotic from fungi (e.g., <i>Penicillium notatum</i>)	Here chemical compounds are isolated from natural sources as the starting material and chemically modified. e.g., Semisynthetic penicillin's	Synthetic drugs are chemical compounds produced or synthesised in a laboratory. e.g., Sulphonamide (Antibacterial)	It involves the manipulation of microorganisms, such as bacteria, or biological substances, like enzymes, to perform a specific process. e.g., Insulin developed from recombinant DNA technology