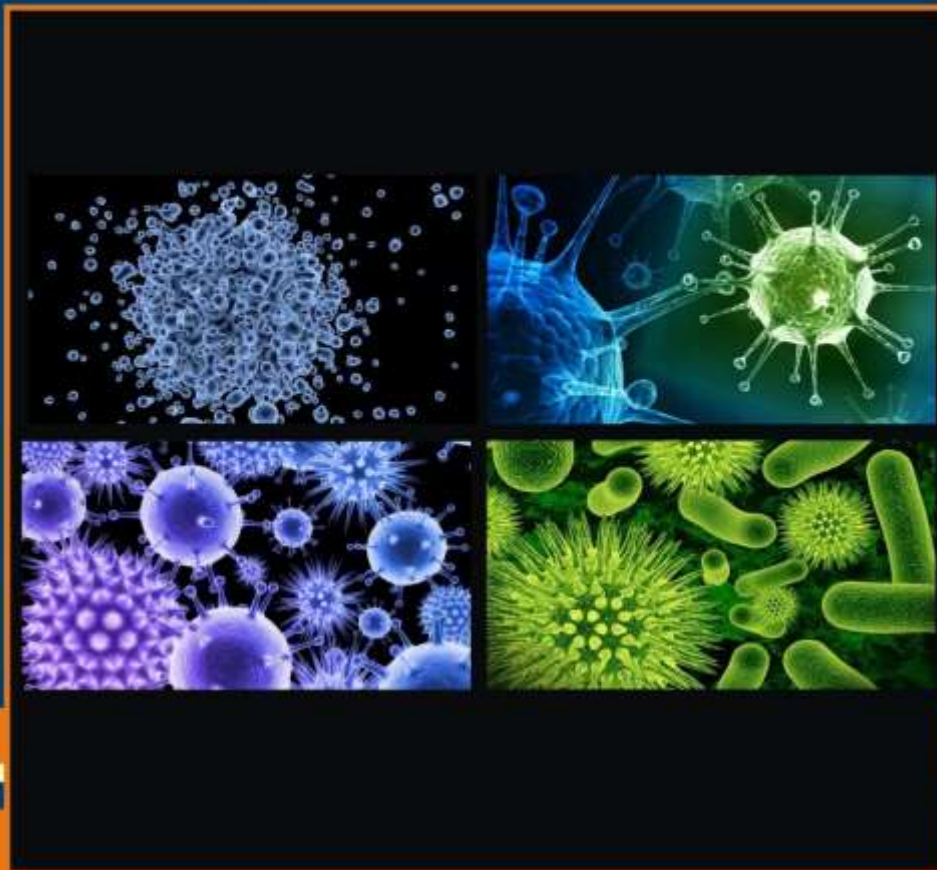


Basics of Medical Microbiology and Virology



Dr. Ishan Y. Pandya
Dr. Renuka Sharma
Dr. C. Ravinder Singh

Kripa Drishti Publications, Pune.

**BASICS OF MEDICAL
MICROBIOLOGY AND
VIROLOGY**

Dr. Ishan Y. Pandya

Dr. Renuka Sharma

Dr. C. Ravinder Singh

Kripa-Drishti Publications, Pune.

Book Title: **Basics of Medical Microbiology and Virology**

Authored by: **Dr. Ishan Y. Pandya, Dr. Renuka Sharma,
Dr. C. Ravinder Singh**

1st Edition

ISBN: **978-93-90847-58-7**



Published: **June 2021**

Publisher:



Kripa-Drishti Publications

A/ 503, Poorva Height, SNO 148/1A/1/1A,
Sus Road, Pashan- 411021, Pune, Maharashtra, India.

Mob: +91-8007068686

Email: editor@kdpublications.in

Web: <https://www.kdpublications.in>

© Copyright **KRIPA-DRISHTI PUBLICATIONS**

All Rights Reserved. No part of this publication can be stored in any retrieval system or reproduced in any form or by any means without the prior written permission of the publisher. Any person who does any unauthorized act in relation to this publication may be liable to criminal prosecution and civil claims for damages. [The responsibility for the facts stated, conclusions reached, etc., is entirely that of the author. The publisher is not responsible for them, whatsoever.]

PREFACE

Medical microbiology, the large subset of microbiology that is applied to medicine, is a branch of medical science concerned with the prevention, diagnosis and treatment of infectious diseases. Disease causing agents may be acellular or cellular organisms that attack on hosts and controls over its metabolic machineries thus situation may fatal to host. Viruses and prions are acellular pathogens and protozoan, fungus, or helminths are cellular organism that infects to the humans. Beijerinck used the word 'virus' to described the mysterious agent in his '*contagium vivum fluidum*'. Viruses can be classified according to the host cell they infect: animal viruses, plant viruses, fungal viruses, and bacteriophages and in size from about 30-450 nm and their shape and structure are studied by electron microscopy, NMR spectroscopy, and X-ray crystallography. The history of medical microbiology is oldest among the field of medicines, usually after the discovery of microscopes by Antony-von-Leeuwenhoek it was originally more explored and understood. In 1796, Edward Jenner developed a method using cowpox to successfully immunize a child against smallpox. The same principles are used for developing vaccines today. In 1857 Louis Pasteur also designed vaccines against several diseases such as anthrax, fowl cholera and rabies. Later, in 1867 Joseph Lister is considered to be the father of antiseptic surgery and in 1884 Robert Koch first scientists to focus on the isolation of bacteria in pure culture. In 1884, Hans Christian Gram developed a staining method for bacterial studies under a microscope. In 1910 Paul Ehrlich tested multiple combinations of *arsenic based chemicals* on infected rabbits with syphilis. In 1929 Alexander Fleming developed the 'boon of medicine' antibiotic penicillin. In 1939 Gerhard Domagk 'founder of sulfa-drugs' discovered *Prontosil* red protected mice from pathogenic streptococci and staphylococci without toxicity. With the advancement under scientific research, Walter Gilbert and Frederick singer developed a DNA sequencing technique in 1977, caused a rapid change the development of vaccines, medical treatments and diagnostic methods, this leading work become milestone for the development of first genetically engineered vaccine

in 1986 for hepatitis B. In 1995 a team at The Institute for Genomic Research sequenced the first bacterial genome; Haemophilus influenzae. Today, PCR, Chromatography, ELISA, ELISPOT and many other techniques are developed for the rapid diagnosis of the diseases. The book 'Basics of Medical Microbiology and Virology' covers all about the history of microbiology, diagnosis of microbial diseases and applications of molecular diagnostics or modern methods of microbial diagnosis, bacteriology and pathogenesis of Streptococci, Bacillus, Clostridium, Corynebacterium, Salmonella, medical mycology of dermatophyte, Cryptococcus, Histoplasma, and Candida, medical parasitology of Entamoeba, Giardia, Plasmodium, Taenia etc. Another section of the book is about virology informing about classification of viruses, cultivation of plant and animal viruses, Viral assays, and structure and life cycles of adenoviruses and retroviruses, and vaccines production, and future of vaccines i.e., nanovaccines. As the science and research in progressing, the dependence upon the technologies is increasing, it may possible that soon many new inventions upon the biochips, or nanochips will useful in field of medicine, thus pathogen will recognised before generating the infection or disease and prior treatment of the disease will save the life. We are sure that the book 'Basics of medical microbiology and virology' will significant in direction of medicine, and useful for better understanding of the concepts of medicine to many graduates and researchers, worldwide.

Dr. Ishan Y. Pandya, Dr. Renuka Sharma, Dr. C. Ravinder Singh.

INDEX

Chapter 1: Basics in Medical Microbiology	1
1.1 History of Microbiology:.....	1
1.2 Classification of Microbes, Culture, and Identification:	5
1.2.1 Classification of Microbes:	5
1.2.2 Identification of Microorganisms:.....	7
1.2.3 Culture:	9
1.3 Microbial Diseases Including Infectious Diseases Overview:	12
1.3.1 Microbial Diseases:	12
1.3.2 Infectious Diseases:.....	15
1.4 Medically Important Microbes:.....	17
1.5 Microbial Diseases - Sources, Route of Transmission:.....	20
1.5.1 Source of Infection:	20
1.6 Pathogenesis - Adhesion, Invasion, Host Cell Damage, Release of Pathogens:	29
1.6.1 Pathogenesis:	29
1.6.2 Adhesion:.....	32
1.6.3 Invasion:	38
1.6.4 Host Cell Damage:	39
1.7 Microbial Virulence and Virulence Factors:.....	41
1.7.1 Microbial Virulence Factors:.....	41
1.8 Signs and Symptoms of Microbial Diseases:	48
1.9 Treatment, Prevention and Control of Microbial Infections:	49
1.9.1 Precautions:	51
1.9.2 Control of Microbial Infections:.....	54
1.10 Antigen-Antibody Interactions Types:.....	54
1.10.1 Agglutination:.....	55
1.10.2 Precipitation:	58
1.10.3 Complement Fixation:.....	60
1.11 Immunity of Microbial Diseases:	61
1.11.1 Innate and Adaptive Immunity:.....	62
1.12 References:	75
Chapter 2: Diagnosis of Microbial Diseases	78
2.1 Diagnosing Microbial Diseases:.....	78
2.2 Collection of Clinical Pathogens:.....	79
2.2.1 Sample Collection:	79
2.2.2 Specimen Selection, Collection and Processing:	81
2.3 Transport and Preliminary Processing of Clinical Pathogens:	82
2.3.1 Transport:	82

2.3.2 Processing of Samples:.....	85
2.3.3 Immunological and Molecular Diagnosis of Microbial Diseases:	87
2.3.4 Application of Molecular Diagnostics:	89
2.4 Modern Methods of Microbial Diagnosis:	95
2.4.1 Modern Diagnostic:.....	95
2.4.2 Conventional Diagnostic Methods:.....	97
2.4.3 Conventional Bacteriological-Based Methods:.....	98
2.4.4 Rapid Methods: State of the Art:	99
2.5 References:	101

Chapter 3: Bacteriology..... 103

3.1 Bacteriology:	103
3.1.1 Characteristics of Bacteria:	106
3.1.2 Structure of Bacteria:	106
3.1.3 Size and Shape Bacteria:	107
3.1.4 Similarities to Eukaryotes:	108
3.1.5 Unique Features:	109
3.1.6 Classification of Bacteria:	110
3.2 Pathogenesis:.....	112
3.2.1 Pathogen Transmission:	113
3.2.2 Droplet Transmission:	113
3.2.3 Airborne Transmission:.....	114
3.2.4 Fecal-Oral Transmission:	114
3.2.5 Vectorborne Transmission:	114
3.3 Pathology:.....	124
3.3.1 Types of Pathology:	125
3.4 Prevention and control of diseases caused by Staphylococci:	129
3.4.1 Staphylococcal (Staph) Infections:.....	129
3.4.2 Streptococci:.....	131
3.5 Bacillus:.....	131
3.6 Clostridium:.....	133
3.7 Corynebacterium:	136
3.8 Escherichia:	139
3.9 Salmonella (Salmonellosis):.....	140
3.9.1 Salmonella Causes:	141
3.9.2 Salmonella Risk Factors:.....	142
3.9.3 Salmonella Poisoning Symptoms:.....	142
3.9.4 Salmonella Complications:	143
3.9.5 Salmonella Treatment:	143
3.9.6 Salmonella Prevention:	143
3.10 Shigella:.....	144
3.10.1 Symptoms of Shigella:	145
3.11 Klebsiella:.....	146
3.12 Proteus:.....	147
3.13 Vibrio:	148

3.14 Pseudomonas:.....	151
3.14.1 Symptoms of Pseudomonas Infections:	153
3.14.2 Pseudomonas Infection Prevention:	154
3.15 Mycobacteria:.....	154
3.16 Spirochaetes:	156
3.17 Rickettsia:.....	158
3.18 References:	161

Chapter 4: Mycology 162

4.1 Mycotic Infections:.....	165
4.1.1 Scope and Distribution:	166
4.1.2 Characteristics, and Transmission:.....	166
4.2 Dermatophyte Infection:.....	167
4.2.1 Causes of Dermatophyte Infection:	168
4.3 Histoplasma:.....	168
4.3.1 Types of Histoplasmosis:	169
4.3.2 Symptoms of Histoplasma:	171
4.3.3 Risk & Prevention of Histoplasmosis:	171
4.3.4 Complications:.....	172
4.4 Cryptococcus:.....	173
4.4.1 Causes of Cryptococcus:	175
4.4.2 Symptoms of Cryptococcus:	175
4.4.3 Treatment of Cryptococcus:	176
4.5 Candida:.....	176
4.5.1 Types of Candida:	177
4.5.2 Causes and Risk Factors of Candida:	179
4.5.3 Medically Important Candida:.....	179
4.5.4 Treatment of Candida:.....	180
4.5.5 Candida Infections in Children:	181
4.6 Opportunistic Mycoses:.....	181
4.7 Mycotoxins:.....	183
4.7.1 Minimization the Risk from Mycotoxins:	185
4.7.2 Prevention and Control:.....	186
4.8 References:	186

Chapter 5: Parasitology 188

5.1 Entamoeba:.....	189
5.1.1 Life Cycle of Entamoeba:.....	191
5.2 Giardia:.....	193
5.2.1 Symptoms of Giardiasis:	194
5.2.2 Giardiasis and how is it Spread:	194
5.2.3 Diagnosed of Giardiasis:	195
5.2.4 Treatment of Giardiasis:	195
5.2.5 Prevention of Giardiasis:	195

5.3 Plasmodium:.....	196
5.3.1 Morphology of Plasmodium Falciparum:	199
5.3.2 Morphology of Plasmodium Vivax:.....	200
5.3.3 Life Cycle of Malarial Parasite:	201
5.4 Taenia:.....	205
5.4.1 Life Cycle:.....	206
5.4.2 Symptoms of Taeniasis:	208
5.4.3 Risk Factors for Taeniasis:.....	208
5.5 Ascaris:.....	208
5.5.1 Life cycle of Ascaris Lumbricoides:	209
5.5.2 Symptoms of Ascaris:	210
5.5.3 Causes of Ascaris:	211
5.5.4 Complications of Ascaris:	211
5.5.5 Risk for Ascariasis:	212
5.6 Wuchereria:	212
5.6.1 Life Cycle of Wuchereria:.....	214
5.7 References:	220

Chapter 6: Virology 221

6.1 History of Virology:.....	221
6.2 Viral taxonomy (ICTV Classification):.....	222
6.2.1 Taxonomic Classification:.....	222
6.2.2 Virus Classification:.....	223
6.2.3 ICTV:	223
6.2.4 Working of the ICTV:.....	224
6.3 Virus Structure and Morphology:	224
6.3.1 Virus Structure:	224
6.3.2 Morphology:.....	227
6.4 Cultivation and Overview of Plant and Animal Viruses:.....	229
6.5 Purification and Maintenance of Viruses:.....	231
6.5.1 Types of Sedimentation Medium:	231
6.6 Quantitation of Viruses (Viral Assays):	231
6.7 Viral structure:.....	235
6.8 Medical Importance of DNA Viruses:	238
6.8.1 Poxviruses:	239
6.8.2 Herpesviridae:	240
6.8.3 Adenoviruses:.....	241
6.9 RNA Viruses:	242
6.9.1 Picorna:.....	242
6.9.2 Orthomyxo:	242
6.9.3 Paramyxo:.....	243
6.9.4 Rhabdo:	243
6.9.5 HIV:.....	244
6.9.6 Hepatitis Viruses:	251
6.9.7 Oncoviruses:.....	253

6.9.8 Coronaviruses:.....	255
6.9.9 Molecular Structure of Coronavirus and Transmission:	256
6.10 General Idea about Bacteriophages:.....	273
6.10.1 Bacteriophage – Structure and Function:	273
6.10.2 Cyanophages:	274
6.10.3 Viruses of Insects:	277
6.11 Life Cycle of Insect Viruses:.....	277
6.12 Baculoviruses System for Insect Cell lines Subviral Particles:.....	279
6.12.1 Insect Cell Lines:.....	279
6.12.2 Prions:.....	280
6.12.3 Virusoids:	282
6.12.4 Satellite Viruses:.....	282
6.13 Viral vaccines and Antiviral Agents:	282
6.13.1 Antiviral Agent:.....	282
6.14 Nature and Source of Interferon’s:	284
6.15 Classification of Interferon:.....	285
6.15.1 Type I interferon:.....	285
6.15.2 Type II Interferon:	286
6.15.3 Type III Interferon:.....	286
6.16 Concepts of Bacterial and Viral Vaccines:.....	286
6.16.1 Bacteria:.....	286
6.16.2 Viral Vaccines:	287
6.17 New Vaccine Production:.....	290
6.17.1 DNA Vaccines:.....	290
6.17.2 Synthetic Peptide Vaccines:	292
6.17.3 Subunit Vaccine:	294
6.17.4 Edible Vaccines and their Trials:	295
6.18 Nano Vaccines:.....	298
6.19 References:	300
6.19.1 Box Item References:	301

About the Authors



Dr. Ishan Y. Pandya

Dr. Ishan Y. Pandya (DSc.hc., PhD., FBSS, FISCA), has served as Ecologist researcher in at Gujarat Ecological Education and Research (GEER) Foundation, Govt. of Gujarat. He has collectively 10 plus years of research and teaching experience of human physiology, Biotechnology, and Ecology. Currently, he is an academic Director, iClonexon Science Institute, a digital platform for developing scientific education to undergraduates and graduates in India. He is an International Author of 15 plus research papers, and 7 academics books in life sciences. His invention and ideas are published in Intellectual Property Rights (IPR), India. He has 2 national patents on CoViD-19, and 3 international Australian Patents on neural networks, blockchain technology for healthcare sectors, and security of medical cloud data. He awarded with **18 plus academic or research awards** including 'Gold medal-Indian Book of Records', Best Scientist Award-IMRF, **Hargobind Khorana Young Scientist award**, **Dr. Sarvepalli Radhakrishnan Teaching Excellence Award**, **ISSN-international Award**, Young Scientist Award-Western Sydney University-IZOR, Best Senior Faculty Award- NRA, and many others. He is fellow and life member of ISCA, Indian Virological Society-IVS, ISEBNBRI, Bose Science Society-TNSRO, IBRF.



Dr. Renuka Sharma

Dr. Renuka Sharma is Asst. Professor of Virology in Department of Research, Chandigarh Group of Colleges, Mohali, India. She awarded Ph.D. (Virology) from Amity University and worked with international and national eminent virologists. She is elected as fellow of Indian Virological Society. She conferred with many **travel grants awards** from ICAR for participating in national conferences and invited as speaker in USA, Paris and many other countries. She has also done R&D work in biotech and stem cell industries. Dr. Renuka is also a part of '**Atal Community Innovation Centre**'. She has submitted number of research projects in national agencies including **DST, DBT, INSA, SERB, ICMR**. She has delivered many free trainings and webinars for students during pandemic COVID-19.



Dr. C. Ravinder Singh

Dr. C. Ravinder Singh (Ph.D., CLAS, PDF) is a Chief Scientist & Head, Research & Innovation Department, Aakash Green Research Pvt. Limited, Dubai, UAE. Particularly, He has 10+ years of academic cum research experience in microbiological studies and fundamental experiment skills like pathogen culture and staining processes etc. He is a proud recipient of scientific research awards including **Dr. A.P. J. Abdul Kalam Researcher award**, **Dr. M. S. Swaminathan Research Excellence award**, and **Har Govind Khorana award** etc., He holds Lifetime membership in various Science Societies, Research Institutions and Professional Bodies. He has published over 35 research articles in national and international Journals of high impact. He has also presented more than 30 research findings in National/ International Level Conferences and organized various seminar/Workshops and training programs.



Kripa-Drishti Publications
A-503 Poorva Heights, Pashan-Sus Road, Near Sai Chowk,
Pune - 411021, Maharashtra, India.
Mob: +91 8007068686
Email: editor@kdpublications.in
Web: <https://www.kdpublications.in>

Price: ₹ 899

ISBN: 978-93-90847-58-7

