

Khosit Pinmai.

Infection and immunology / Khosit Pinmai, Pongsakorn Martviset,
Chirdpan Benjakul; Khosit Pinmai, editor.

1. Infections. 2. Immunity. 3. Microbiology.

QW700

ISBN 978-616-314-958-9

Copyright by **Assistant Prof. Khosit Pinmai,**
Assistant Prof. Pongsakorn Martviset, PhD.,
Chirdpan Benjakul,
Assistant Prof. Sutiwa Benjakul, Ph.D.

All rights reserved

First edition, January 2023, 170 copies

Published and distributed by **Thammasat University Press**

Tha Prachan: The 60th Anniversary Thammasat Bldg, U1 Flr.,
Thammasat University

Prachan Road, Bangkok 10200, Thailand

Tel. 0-2223-9232

Rangsit Campus: Dome Administration Bldg, 317, 3rd Flr.,
Thammasat University, Paholyothin Road, Klong Nueng,
Klong Luang, Pathum Thani 12120, Thailand

Tel. 0-2564-2859-60 Fax 0-2564-2860

<http://thammasatpress.tu.ac.th>, e-mail: unipress@tu.ac.th

Printed by **Thammasat Printing House**

Price 2,000.- Baht

TABLE OF CONTENTS

PREFACE	(18)
ACKNOWLEDGMENTS	(19)
ABOUT THE BOOK	(19)
CONTRIBUTORS	(20)
CHAPTER I: General Microbiology and Biology of Microorganisms	1
<i>Khosit Pinmai</i>	
HISTORY	2
Koch's Postulates	5
Molecular Koch's Postulates	6
CLASSIFICATION OF MICROORGANISMS	7
Molecular Classification	8
MICROSCOPY	8
BRIGHT-FIELD OR LIGHT MICROSCOPE	9
STAINING TECHNIQUES	11
COMMON STAINING TECHNIQUES USED IN MICROBIOLOGY	12
GRAM STAIN	12
ACID-FAST STAIN	14
MICROSCOPY OF BACTERIA IN LIVING STATE	17
MORPHOLOGY OF BACTERIA	18
SHAPE OF BACTERIA	18
BACTERIAL CELL WALL	19
CELL MEMBRANE	23
CYTOPLASMIC MATRIX	23
CELL WALL APPENDAGES	24
BACTERIAL SPORES	29
PHYSIOLOGY OF BACTERIA	30
BACTERIAL GROWTH AND NUTRITION	30
FACTORS AFFECTING GROWTH OF BACTERIA	33
BACTERIAL METABOLISM	34
BACTERIAL GENETICS	37
PRINCIPLES OF BACTERIAL GENETICS	37
BACTERIAL DNA	37
BACTERIAL RNA	39
POLYPEPTIDE SYNTHESIS	39
PLASMID	40
BACTERIAL VARIATION	41
MUTATION	41
HORIZONTAL GENE TRANSFER IN BACTERIA	42
TRANSFORMATION	43
TRANSDUCTION	44
LYSOGENIC CONVERSION	46
CONJUGATION	47

BACTERIAL RECOMBINATION	49
TRANSPOSITION	50
MICROBIOLOGICAL SAFETY	51
General Laboratory Safety	51
STANDARD PRECAUTIONS	52
HAZARDOUS CHARACTERISTICS OF AN AGENT	56
BIOSAFETY LEVELS	57
Biosafety Level 1	58
Biosafety Level 2	59
Biosafety Level 3	61
Biosafety Level 4	63
HAZARDOUS WASTE	64
Miscellaneous Safety Considerations	68
COLLECTION AND HANDLING OF CLINICAL SPECIMENS	69
TECHNIQUES IN IMMUNOLOGY AND SEROLOGY	72
CHAPTER II: Bacterial Diseases of Humans	75
<i>Khosit Pinmai</i>	
STAPHYLOCOCCUS	76
STAPHYLOCOCCUS AUREUS	77
COAGULASE-NEGATIVE STAPHYLOCOCCUS (CoNS)	88
STREPTOCOCCUS, ENTEROCOCCUS AND PNEUMOCOCCUS	90
STREPTOCOCCUS PYOGENES	91
OTHER β HEMOLYTIC STREPTOCOCCI	101
Group B Streptococci (<i>S. agalactiae</i>)	101
Group C Streptococci	102
Group F Streptococci	102
Group G Streptococci	102
Group D Streptococci	102
ENTEROCOCCUS	102
VIRIDANS STREPTOCOCCI	104
PNEUMOCOCCUS	105
NEISSERIA AND MORAXELLA	112
NEISSERIA MENINGITIDIS	112
NEISSERIA GONORRHOEAE	117
COMMENSAL NEISSERIA SPECIES	121
MORAXELLA	122
AEROBIC GRAM-POSITIVE BACILLI	123
CORYNEBACTERIUM	123
CORYNEBACTERIUM DIPHTHERIAE	123
DIPHTHEROIDS OR NONDIPHTHERIAL CORYNEBACTERIA	131
BACILLUS	132
BACILLUS ANTHRACIS	132
ANTHRACOID BACILLI	138
<i>Bacillus cereus</i>	138
<i>Bacillus thuringiensis</i>	139

ANAEROBES (CLOSTRIDIUM AND NON-SPORING ANAEROBES)	140
CLOSTRIDIUM	140
CLOSTRIDIUM PERFRINGENS	141
CLOSTRIDIUM TETANI	146
CLOSTRIDIUM BOTULINUM	151
CLOSTRIDIODES DIFFICILE	153
NON-SPORING ANAEROBES	156
MYCOBACTERIUM	162
MYCOBACTERIUM TUBERCULOSIS COMPLEX	162
NONTUBERCULOUS MYCOBACTERIA	184
MYCOBACTERIUM LEPRAE	187
MISCELLANEOUS GRAM-POSITIVE BACILLI	197
ACTINOMYCES	197
NOCARDIA	199
ACTINOMADURA	203
LISTERIA MONOCYTOGENES	203
ERYSIPELOTHRIX RHUSIOPATHIAE	206
TROPHERYMA WHIPPLEI	206
ENTEROBACTERALES	207
ESCHERICHIA COLI	208
SHIGELLA	217
SALMONELLA	221
TYPHOIDAL SALMONELLA	224
NON-TYPHOIDAL SALMONELLAE	233
CITROBACTER	234
KLEBSIELLA	235
ENTEROBACTER	236
ERWINIA	236
PANTOEA	236
HAFNIA	236
EDWARDSIELLA	237
MORGANELLA	237
PROVIDENCIA	237
PROTEUS	238
SERRATIA	240
YERSINIA PESTIS	240
YERSINIOSIS	245
NEWLY INCLUDED GENERA	247
VIBRIO AND AEROMONAS	248
VIBRIO CHOLERAE	248
HALOPHILIC VIBRIOS	261
AEROMONAS	263
PSEUDOMONAS AND OTHER NON-FERMENTERS	264
PSEUDOMONAS	264
OTHER NON-FERMENTERS	268
<i>Burkholderia pseudomallei</i> (Meliodosis)	268
<i>Burkholderia mallei</i>	270

<i>Burkholderia cepacia</i> Complex	270
<i>Acinetobacter</i>	271
<i>Stenotrophomonas maltophilia</i>	272
<i>Elizabethkingia meningosepticum</i>	272
<i>Alcaligenes</i>	273
HAEMOPHILUS AND HACEK GROUP	274
HAEMOPHILUS INFLUENZAE	274
OTHER HAEMOPHILUS SPECIES	279
<i>Haemophilus ducreyi</i>	279
<i>Haemophilus aegyptius</i>	280
<i>Haemophilus parainfluenzae</i>	280
<i>H. haemolyticus</i> and <i>H. parahaemolyticus</i>	280
<i>Aggregatibacter aphrophilus</i> and <i>A. paraphrophilus</i>	281
HACEK GROUP	281
BORDETELLA	283
BORDETELLA PERTUSSIS	283
BRUCELLA	288
MISCELLANEOUS GRAM-NEGATIVE BACILLI	294
CAMPYLOBACTER	294
HELICOBACTER	296
LEGIONELLA	299
Donovanosis	302
GARDNERELLA VAGINALIS	303
RAT-BITE FEVER	304
FRANCISELLA TULARENSIS	305
PASTEUURELLA	307
CHROMOBACTERIUM VIOLACEUM	307
CAPNOCYTOPHAGA SPECIES	307
SPIROCHETES	308
TREPONEMA PALLIDUM (AGENT OF SYPHILIS)	309
NON-VENEREAL TREPONEMATOSES	322
BORRELIA	325
RELAPSING FEVER	325
LYME DISEASE	327
VINCENT'S ANGINA	332
LEPTOSPIRA	333
RICKETTSIAE, COXIELLA AND BARTONELLA	339
Rickettsia	339
Epidemic Typhus (Louse-borne)	341
Endemic Typhus (Flea-borne)	342
Rocky Mountain Spotted Fever	342
Indian Tick Typhus	343
Other Tick-borne Fever	343
Rickettsialpox	343
Scrub Typhus	345
EHRlichiosis	347

COXIELLA BURNETII (Q FEVER)	348
BARTONELLA	349
CHLAMYDIAE	352
CHLAMYDIA TRACHOMATIS	354
CHLAMYDOPHILA PSITTACI	356
CHLAMYDOPHILA PNEUMONIAE	357
MYCOPLASMA AND UREAPLASMA	361
MYCOPLASMA PNEUMONIAE	362
UROGENITAL MYCOPLASMAS	365
CHAPTER III: The Viruses, Virus-Like Agents and associated diseases	367
<i>Khosit Pinmai</i>	
GENERAL PROPERTIES OF VIRUSES	368
MORPHOLOGY OF VIRUS	368
NOMENCLATURE AND CLASSIFICATION	370
VIRAL REPLICATION	370
VIRAL GENETIC MODIFICATIONS	375
VIRUS HOST INTERACTIONS	376
VIRAL PATHOGENESIS AT CELLULAR LEVEL	379
HERPESVIRUSES	382
GENERAL PROPERTIES	382
HERPES SIMPLEX VIRUS	383
VARICELLA-ZOSTER VIRUS	390
CYTOMEGALOVIRUS	395
EPSTEIN-BARR VIRUS	398
LESS COMMON HERPESVIRUSES	402
OTHER DNA VIRUSES	404
PARVOVIRUS B19	404
PAPILLOMAVIRIDAE AND POLYOMAVIRIDAE	406
HUMAN PAPILLOMAVIRUS	407
ADENOVIRUS	409
POXVIRUS	411
SMALLPOX VIRUS (VARIOLA)	412
MONKEYPOX	414
VACCINIA VIRUS	418
MOLLUSCUM CONTAGIOSUM VIRUS	418
BACTERIOPHAGE	419
MYXOVIRUSES AND RUBELLA VIRUS	422
CLASSIFICATION	422
INFLUENZA VIRUSES	422
Avian Flu	427
PARAMYXOVIRIDAE	431
PARAINFLUENZA VIRUSES	432
MUMPS VIRUS	434
MEASLES (RUBEOLA) VIRUS	437
NIPAH VIRUS AND HENDRA VIRUS	442

RESPIRATORY SYNCYTIAL VIRUS	443
HUMAN METAPNEUMOVIRUS	445
RUBELLA	445
PICORNAVIRUSES	451
CLASSIFICATION	451
MORPHOLOGY	451
POLIOVIRUSES	451
COXSACKIEVIRUSES	457
OTHER ENTEROVIRUSES	458
ARBOVIRUSES	460
INTRODUCTION	460
Chikungunya	462
Japanese B Encephalitis (JE) Virus	464
Dengue Viruses	465
Zika Virus	470
Yellow Fever Virus	472
RHABDOVIRUSES	475
RABIES VIRUS	475
HIV AND OTHER RETROVIRUSES	482
HUMAN IMMUNODEFICIENCY VIRUS (HIV)	482
RODENT-BORNE VIRUSES	502
Hantaviruses	502
Arenaviruses	503
Old World Viruses	503
New World Viruses	504
Ebola Virus	504
Marburg Virus	506
CORONAVIRUSES	507
Human Coronaviruses	507
SARs-CoV	508
MERS-CoV	508
SARS-CoV-2	509
SLOW VIRUSES AND PRIONS	519
Slow Virus Diseases Due to Conventional Viruses Subacute Sclerosing Panencephalitis (SSPE)	520
Progressive Multifocal Leukoencephalopathy (PML)	520
Visna and Maedi	520
Slow Virus Diseases due to Unconventional Viruses/Prion Diseases	520
VIRAL GASTROENTERITIS	523
Rotavirus	523
HEPATITIS VIRUS	527
INTRODUCTION	527
HEPATITIS A VIRUS	528
HEPATITIS B VIRUS	530
HEPATITIS C VIRUS	539
HEPATITIS D VIRUS	543
HEPATITIS E VIRUS	544

HEPATITIS G VIRUS	545
ONCOGENIC VIRUSES	546
VIRAL ONCOGENESIS	547
ONCOGENIC RNA VIRUSES	548
ONCOGENIC DNA VIRUSES	550
CHAPTER IV: Fungal pathogens and associated diseases	555
<i>Khosit Pinmai</i>	
GENERAL MYCOLOGY	556
Morphological Classification	556
Life cycle of fungi	558
CLASSIFICATION OF FUNGAL DISEASES	560
SUPERFICIAL MYCOSES	565
TINEA VERSICOLOR	565
TINEA NIGRA	567
PIEDRA	567
DERMATOPHYTOSES	568
SUBCUTANEOUS MYCOSES	575
MYCETOMA	575
SPOROTRICHOSIS	578
CHROMOBLASTOMYCOSIS	581
PHAEOHYPHOMYCOSIS	583
RHINOSPORIDIOSIS	584
SYSTEMIC MYCOSES	585
HISTOPLASMOSIS	585
BLASTOMYCOSIS	587
COCCIDIOIDOMYCOSIS	589
PARACOCCIDIOIDOMYCOSIS	590
OPPORTUNISTIC MYCOSES	592
CANDIDIASIS	592
CRYPTOCOCCOSIS	598
ZYGOMYCOSIS	601
ASPERGILLOSIS	604
PENICILLIOSIS	607
PNEUMOCYSTIS PNEUMONIA	609
FUSARIOSIS	610
MYCOTOXICOSES	611
CHAPTER V: Parasitic pathogens, Medical entomology and associated diseases	615
<i>Pongsakorn Martviset</i>	
INTRODUCTION	616
Classification of Parasitic Organisms	616
Definition of Hosts	617
Mode of Transmission (Source of Infection)	617
Mode of Infection (Route of Infection)	617

UNICELLULAR PARASITES	618
General Characteristics	618
Reproduction	618
Amoebic Parasites	619
Flagellated Parasites	629
Hemoflagellates	636
Ciliated Parasites	647
Sporozoan Parasites	650
Percolozoa	663
Non-Protozoa	667
TREMATODES	671
General Characteristics	671
General Life Cycle	672
Classification of Parasitic Trematodes	673
Intestinal flukes	673
Liver Flukes	683
Lung Flukes	688
Blood Flukes	690
CESTODES	693
General Characteristics	693
Cyclophyllidian Tapeworms	694
Pseudophyllidian Tapeworms	714
ACATHOCEPHALANS	720
General Characteristics	720
Acanthocephaliasis	720
NEMATODES	721
General Characteristics	721
Small Intestinal Roundworms	722
Large Intestinal Roundworms	737
Tissue Roundworms	743
Circulatory Roundworms	750
MEDICAL IMPORTANT ARTHRODODS	753
SUMMARY TABLES OF IMPORTANT HELMINTHS	759

CHAPTER VI: Immune System 765

<i>Khosit Pinmai</i>	
ANATOMY OF THE IMMUNE SYSTEM	766
CELLS OF THE IMMUNE SYSTEM	773
Hematopoiesis	773
B-cell Development	774
T-cell Development and Education	776
Cells of the Immune System	777
IMMUNE SYSTEM	779
Innate Immunity	779
Phagocytic Responses and Acute Inflammation	787
Complement	789
Cytokines	791

Inflammation	794
Proinflammatory Cytokines	796
Interferons	797
Innate Lymphoid Cells (ILCs)	798
NK Cells	799
Acute-Phase Response	801
Bridge to Adaptive Immune Responses	802
Adaptive Immune Responses	803
Antigen Presentation	804
Major Histocompatibility Complex (MHC) I and II	805
T cells	806
Helper T cells (Activation and Differentiation)	806
CD4 T-helper Cell Functions	807
B cells	809
Humoral Immunity	810
Immunoglobulins	815
Cell-mediated Immunity	817
Cross-presentation of Antigens to CD8+ T Cells	820
Conclusions of Pathways and Stages of Adaptive Immune Responses	822
HYPERSENSITIVITIES	825
Type I Hypersensitivity	826
Type II Hypersensitivity	826
Type III Hypersensitivity	826
Type IV Hypersensitivity	827
TOLERANCE AND AUTOIMMUNITY	827
Central Tolerance	827
Peripheral Tolerance	828
Autoimmunity and Disease	829
Autoimmune Diseases	832
IMMUNODEFICIENCY	835
TRANSPLANTATION IMMUNOLOGY	838
Graft acceptance and types of rejections	838
Donor testing and tissue typing	840
Immunosuppression	840
TUMOR IMMUNOLOGY	842
Carcinogens	842
Tumor Antigens	843
Serum Tumor Markers	845
Immune Responses to Cancer	847
Immune Evasion of Tumor Cells	849
Cancer Therapy	851
CHAPTER VII: Oral Microbiology and Immunology	859
<i>Chirdpan Benjakul and Sutiwa Benjakul</i>	
INTRODUCTION	860
THE MOUTH AS A MICROBIAL HABITAT	860

The Oral Ecosystem	860
Microbiota and Oral Dysbiosis	861
The Oral Environment	861
Oral Habitats	861
Factors Modulating Microbial Growth	862
THE RESIDENT ORAL MICROFLORA	864
Gram-positive Cocci	864
Gram-positive Rods and Filaments	866
Gram-negative Cocci	867
Gram-negative Rods	867
Fungi	869
Viruses	870
Mycoplasmas	870
Protozoa	870
Biological Role of Resident Oral Microflora	871
ACQUISITION, ADHERENCE, DISTRIBUTION AND METABOLISM OF THE ORAL MICROFLORA	871
Acquisition and Adherence of the Resident Oral Microflora	871
Distribution of the Resident Oral Microflora	874
Metabolism of Oral Bacteria	875
DENTAL PLAQUE	879
Dental Plaque Composition	879
Dental Plaque Formation	879
Calculus Formation	883
Plaque-mediated Diseases - Dental Caries and Periodontal Diseases	883
ORAL IMMUNE SYSTEM	892
Components of Oral Immune System	892
Innate Immunity	892
Acquired Immunity	895
Programmed Cell Death in Response to Oral Microbes	899
OROFACIAL BACTERIAL INFECTIONS	899
Principles of Management	900
Endodontic Infection	901
Dentoalveolar Infection	901
Ludwig's Angina	902
Osteomyelitis	903
Dry Socket	903
Peri-implantitis	903
Pericoronitis	903
Antimicrobial Prophylaxis	904
ORAL FUNGAL INFECTIONS	905
Pseudomembranous Candidiasis	907
Erythematous Candidiasis	907
Hyperplastic Candidiasis	908
Diagnosis of Oral Candidiasis	908
Management of Oral Candidiasis	908

OROFACIAL VIRAL INFECTIONS	909
Antiviral Agents	909
General Traits of Viral Infections Targeting Oropharyngeal Area	910
ORAL IMPLANTATIONS OF INFECTION IN COMPROMISED PATIENTS	917
Osteoradionecrosis	917
Post-irradiation Mucositis	917
Bisphosphonate-associated Osteonecrosis	918
Xerostomia	918
Gingival Hyperplasia and Immunosuppressive Agents	918
Human Immunodeficiency Virus (HIV) and Acquired Immune Deficiency Syndrome (AIDs)	918
INFECTION CONTROL	919
CHAPTER VIII: Host-Microbial interactions	927
<i>Khosit Pinmai</i>	
INTRODUCTION	928
The Pathogenesis of Infectious Diseases	928
Host Factors	928
Composition of Microbial Biota at Different Body Sites	929
Role of Microbial Biota	936
Homeostasis and Dysbiosis	938
Classification of Infections	941
Epidemiological Pattern of Infection	943
Sources and Reservoir of Infection	944
Mode of Transmission	945
The Immune Defense Mechanisms against Pathogens	947
HOST-BACTERIAL INTERACTIONS AND PATHOGENESIS	949
Bacterial Pathogenicity	950
Mechanisms of Bacterial Pathogenesis	951
Role of Biofilm in Human Infections	964
Innate Immunity to Extracellular Bacteria	967
Adaptive Immunity to Extracellular Bacteria	969
Immunity to Intracellular Bacteria	971
Innate Immunity to Intracellular Bacteria	971
Adaptive Immunity to Intracellular Bacteria	973
HOST-VIRAL INTERACTIONS AND PATHOGENESIS	975
Implantation at the Portal of Entry	975
Viral Attachment to Host Cell	975
Innate Immune Responses to Virus	977
Adaptive Immune Responses to Virus	979
Viral Evasion of Immune Responses	981
Viral Immunopathogenesis	981
HOST-FUNGAL INTERACTIONS AND PATHOGENESIS	984
Innate Immunity to Fungi	985
Adaptive Immunity to Fungi	986
Factors Influence Development of Fungal Diseases	986
Immune Responses to Specific Fungi	990

HOST-PARASITE INTERACTIONS AND PATHOGENESIS	996
Host Defense Mechanisms	997
Immune Response to Protozoa	997
Immune Response to Helminths	998
Conclusions of Host-microbe Interactions	1002
The Consequences of host-microbe Interactions	1003
CHAPTER IX: Treatment and Control of infection	1005
<i>Khosit Pinmai</i>	
VACCINATION AND IMMUNIZATION	1006
Immunization	1007
Passive Immunization	1007
Artificial Active Immunization (Vaccination)	1008
How to Administer the Vaccine	1011
Immunization Programs	1012
PHYSICAL AND CHEMICAL CONTROL OF MICROBES	1015
Factors That Influence the Degree of Killing	1016
Methods of Disinfection and Sterilization	1020
Food and Drug Administration Regulations on Chemical Skin Antiseptics	1025
ANTIMICROBIAL THERAPY	1030
ANTIBIOTICS	1031
Mechanisms of Antimicrobial Action	1031
Spectrum of Action and Activity	1035
Prophylactic Therapy	1036
Empiric therapy	1039
Definitive Therapy	1042
Antibiotic Failure	1048
Guidelines and pitfalls in antibiotic prescribing	1049
Safety and Side Effects	1052
Drug Resistance	1054
ANTITUBERCULOUS DRUGS	1058
Isoniazid	1058
Rifampicin	1058
Ethambutol	1058
Pyrazinamide	1059
Second-line Anti-tuberculous Drugs	1059
Streptomycin	1059
ANTIVIRAL DRUGS	1060
Acyclovir, Valaciclovir and Famciclovir	1061
Idoxuridine	1062
Amantadine	1062
Zanamivir and Oseltamivir	1062
Ribavirin	1062
Interferon- α	1063
Nucleoside/nucleotide Reverse Transcriptase Inhibitors	1063
Non-nucleoside Reverse Transcriptase Inhibitors (NNRTIs)	1064

Protease Inhibitors	1065
Fusion and Entry Inhibitors	1065
Integrase Inhibitors	1066
ART Therapy for Treatment-Naive Patients from Department of Health and Human Services Adults and Adolescents Antiretroviral (DHHS) Guidelines 2019	1066
ANTIFUNGAL DRUGS	1069
Amphotericin B	1069
Flucytosine	1070
Imidazoles and Related Compounds	1070
Miconazole	1070
Other Azoles	1071
Nystatin	1071
Echinocandins (Caspofungin and anidulofungin)	1072
Griseofulvin	1072
Terbinafine	1072
ANTIPROTOZOAL DRUGS	1073
ANTIMALARIAL DRUGS	1074
ANTHELMINTIC DRUGS	1077

INDEX**1081**