

Contents

<i>Preface to Second Edition</i>	.....(xxi)
<i>Preface to First Edition</i>	.....(xxiii)
<i>Acknowledgement</i>	.....(xxv)
Chapter 1	
Introduction	
1.1 Significance of Micro-organisms	.....2
1.1.1 Endosymbiosis	.....3
1.2 Structure of Eukaryotic and Prokaryotic Cells	.....4
1.3 Evolution of Micro-organisms on Earth	.....4
1.4 Microscopy	.....5
1.4.1 Light or Optical Microscopes	.....6
1.4.2 Electron Microscope	.....12
1.5 Contribution of Scientists	.....18
1.5.1 Antony Van Leeuwenhoek	.....18
1.5.2 Alexander Fleming	.....20
1.5.3 Louis Pasteur	.....21
1.5.4 Robert Koch	.....24
1.5.5 Joseph Lister	.....25
1.5.6 Spontaneous Generation Theory	.....26
1.6 Branches in Microbiology	.....31
1.6.1 Branches of Pure Microbiology	.....32
1.6.2 Branches of Applied Microbiology	.....32
<i>Essay Questions</i>	.....34
<i>Multiple Choice Questions</i>	.....34
<i>Answers</i>	.....34

Chapter 2

Diversity of Micro-organisms

2.1	Introduction to Microbial Classification and Taxonomy	.....35
2.1.1	Features of Phylogenetic Tree	.....36
2.1.2	Assessing Microbial Phylogeny	.....37
2.2	Archaea Resembles Eucarya in many Ways	.....38
2.2.1	Relation and Difference between Three Domains	.....38
2.2.2	Techniques for Determining Microbial Taxonomy and Phylogeny	.....39
2.2.3	Classical Approaches	.....40
2.2.4	Molecular Characteristics	.....41
2.3	Kingdoms	.....42
2.3.1	Taxonomy and Classification of Microbes	.....42
2.3.2	Alternatives	.....43
2.3.3	Higher Level-Classification of Eucarya	.....44
2.3.4	Bergy's Manual of Systematic Bacteriology (BMSB)	.....45
2.4	Types of Micro-organisms	.....47
2.5	Bacteria	.....48
2.5.1	Morphology of Bacteria	.....48
2.5.2	Structure of Bacterial Cell	.....53
2.5.3	Reproduction in Bacteria	.....66
2.5.4	Some Special Groups of Bacteria	.....69
2.6	Fungi	.....81
2.6.1	Characteristics of Fungi	.....81
2.6.2	Cell Biology of the Fungi (Hyphal Tip Structure)	.....83
2.6.3	Structure and Physiology of Fungi	.....84
2.6.4	Fungal Metabolism	.....85
2.6.5	Classification Taxonomic Groups in Fungi	.....85
2.6.6	Reproduction in Fungi	.....88
2.6.7	Economic Importance of Fungi	.....92

2.7	Algae	.....95
	2.7.1 Major Classification of Algae	.....97
	2.7.2 Identification of Algae	.....104
	2.7.3 Economic Importance of Algae	.....106
2.8	Protozoa	.....108
	2.8.1 Morphology of Protozoa	.....110
	2.8.2 Intracellular Structures	.....110
	2.8.3 Classification of Protozoa	.....112
	2.8.4 Protozoan Diseases	.....113
2.9	Viruses	.....114
	2.9.1 Morphology of Viruses	.....118
	2.9.2 Classification	.....123
	2.9.3 Virus Cultivation	.....129
	2.9.4 Viruses Replication	.....133
	2.9.5 Bacteriophages	.....136
	2.9.6 Plant Viruses	.....140
	2.9.7 Viroids	.....140
	2.9.8 Prions	.....142
2.10	Identification of Micro-organisms	.....143
	2.10.1 Simple Staining	.....144
	2.10.2 Differential Staining	.....145
	2.10.3 Acid Fast Staining	.....148
	2.10.4 Kinyoun's Stain	.....151
	2.10.5 Feulgen Staining Protocol	.....152
	2.10.6 Staining of <i>Corynebacterium Diphtheriae</i>	.....152
	2.10.7 Miscellaneous Staining Methods	.....153
2.11	Bio Chemical Tests for Identifying unknown Micro-organisms	.....153
	<i>Essay Questions</i>	.....176
	<i>Multiple Choice Questions</i>	.....176
	<i>Answers</i>	.....176

Chapter 3

Nutrition and Growth

3.1	Nutritional Requirements	.....177
3.2	Nutritional Types of Bacteria	.....179
3.3	Types of Nutrient Media	.....180

3.4	Bacteriological Media	.....182
3.4.1	Fungal Media	.....183
3.4.2	Classification of Media Basing on the Consistency	.....183
3.4.3	Preparation of Media	.....184
3.4.4	Physical Conditions required for Growth	.....185
3.5	Pure Culture	.....191
3.5.1	Methods of Isolating Pure Cultures	.....191
3.5.2	Maintenance and Preservation of Pure Cultures	.....194
3.5.3	Methods of Maintenance and Preservation	.....195
3.6	Physiology of Growth	.....198
3.6.1	Growth	.....198
3.7	Reproduction	.....202
3.8	Continuous Culture	.....203
3.9	Bacterial Counts	.....206
3.9.1	Methods for Bacterial Count	.....207
	Essay Questions	.....209
	Multiple Choice Questions	.....210
	Answers	.....210

Chapter 4

Disinfectants, Antiseptics and Control of Micro-organisms

4.1	Introduction	.....211
4.2	Some Important Definitions	.....212
4.2.1	Desirable Properties of Disinfectant	.....213
4.2.2	Factors Affecting Disinfectants	.....213
4.2.3	Major Groups of Disinfectants and Antiseptics	.....215
4.3	Phenol and Phenolic Compounds	.....215
4.3.1	Alcohols	.....217
4.3.2	Halogens	.....218
4.3.3	Heavy Metals and Compounds	.....220

4.3.4	Dyes	.....222
4.3.5	Synthetic Detergents	.....223
4.3.6	Quaternary Ammonium Compounds	.....223
4.3.7	Aldehydes	.....224
4.3.8	Gaseous Agents	.....225
4.3.9	Hydrogen Peroxide and Peracetic Acid	.....227
4.4	Evaluation of Disinfectants	.....228
4.4.1	Rideal-Walker (RW) Test	.....228
4.4.2	Use-Dilution Test	.....230
4.4.3	Chick-Martin Test	.....231
4.4.4	Kelsey-Sykes Test	.....232
4.5	Dynamics of Disinfection	.....232
4.6	Sterilization	.....234
4.6.1	Methods and Equipment Used for Sterilization Purposes	.....235
4.7	Large Scale Sterilization Equipments	.....248
4.7.1	Moist Steam Sterilizer	.....248
4.8	Industrial Large Scale Autoclave	250
4.8.1	Fully Automatic Horizontal Cylindrical High Pressure Steam Sterilizer (Class-B Autoclave)	.....250
4.8.2	Fully Automatic Steam Storage Vertical High Pressure Steam Sterilizer with Drying System - Triple Walled	.....252
4.8.3	Fully Automatic Vertical High Pressure Steam Sterilizer – Triple Walled	.....253
4.8.4	Dry Heat Sterilizer	.....254
4.9	Sterilization Indicators	.....261
4.9.1	Validation of Sterilization Process	.....261
4.10	Biological Indicators	.....263
4.11	Quality Control of Microorganism: Sterility Testing	.....264
4.11.1	Definitions	.....265
4.11.2	Sterility Test Facilities	.....265
4.11.3	Tests for Sterility	.....266

(xii) Contents

4.12	Design of Aseptic Area	.....276
4.12.1	Contamination sources in Aseptic Area and Prevention Methods	.....278
4.13	Chemotherapy and Chemotherapeutic Agents	.....283
4.13.1	Chemotherapy	.....283
4.13.2	Chemotherapeutic Agents	.....283
4.14	Action of Antimicrobial Drugs	.....284
4.15	Drug Resistance	.....286
4.16	Biosafety Measures/Procedures	.....287
	Essay Questions	.....290
	Multiple Choice Questions	.....290
	Answers	.....290

Chapter 5

Immunology

5.1	Introduction	.....291
5.1.1	Acquired Immunity	.....292
5.1.2	Passive Immunity	.....293
5.2	Immune Tolerance	.....294
5.2.1	Immune Response	.....294
5.3	Factors Influencing Infection	.....295
5.4	General Resistance of the Host against Infection or Host Defense	.....296
5.5	Requirements for Immunogenicity	.....298
5.6	Non-Specific Immunity	.....299
5.6.1	Cell Tissues and Organs	.....299
5.6.2	Phagocytosis (Macrophage Activation)	.....300
5.6.3	Inflammation	.....301
5.7	Physical and Mechanical Barriers	.....301
5.8	Chemical Mediators	.....302
5.9	Specific Immunity	.....304
5.9.1	Antigens (Ags)	.....304
5.9.2	Structure of Antigen	.....305
5.9.3	Classification of Antigens	.....305
5.9.4	Important Antigens in Medicine	.....306
5.10	Haptens	.....306

5.11	Immunogenicity	.....306
5.11.1	Recognition of Foreignness	.....306
5.11.2	Class I MHC	.....307
5.11.3	Class II MHC	.....307
5.11.4	T-cells (T-lymphocytes)	.....307
5.11.5	Cellular Immune Response	.....308
5.11.6	Mechanism of Cell Mediated Immunity	.....308
5.11.7	Cytotoxic T-cells	.....309
5.11.8	Killer Cells	.....309
5.12	Chronology of Discoveries that Contributed to Immunological Techniques	.....310
5.13	Antibodies (Abs)	.....310
5.13.1	Antibody Mediated Immunity	.....311
5.13.2	Chemical Nature of Antibodies	.....311
5.13.3	Structure of Antibody	.....312
5.13.4	Production of Antibodies	.....315
5.13.5	Primary and Secondary Responses	.....315
5.13.6	Immunoglobulin Classes	.....316
5.14	Antigens-Antibody Reactions	.....320
5.14.1	Precipitation Reactions	.....321
5.14.2	Electroimmunodiffusion	.....324
5.14.3	Agglutination Reaction	.....325
5.14.4	Complement Fixation Test (CFT)	.....326
5.14.5	Opsonisation	.....329
5.14.6	Radioimmuno Assay (RIA)	.....330
5.14.7	Neutralization Reaction	.....331
5.14.8	Enzyme Immuno Assays (EIA)	.....332
5.14.9	Enzyme Linked Immunosorbent Assays (ELISA)	.....332
5.15	Classification of Vaccines	.....335
5.15.1	The following is the fate of most Vaccines Injected Directly into Muscle Tissue	.....335
5.15.2	There are Two Basic Types of Vaccines based on the Properties of Antigens	.....336
5.16	Vaccine Preparations	.....339
5.16.1	Polio Vaccine	.....339
5.16.2	BCG Vaccine	.....340

(xiv) Contents

5.17	Bacterial Toxins	.....341
5.17.1	Exotoxins	.....341
5.17.2	Endotoxins	.....343
5.17.3	Toxoids	.....344
5.18	General Methods of Immunization	.....348
5.19	Immunological Diagnostic Tests	.....349
5.19.1	Mantoux Test	.....349
5.19.2	Schick Test	.....349
5.19.3	Dick Test	.....350
5.19.4	Schultz-Charlton Test	.....350
5.19.5	Widal Test	.....350
5.20	Hypersensitivity	.....350
5.20.1	Type I Hypersensitivity	.....350
5.20.2	Type II Hypersensitivity	.....351
5.20.3	Type III Hypersensitivity	.....352
5.20.4	Type IV Hypersensitivity	.....353
5.21	Allergenic Extracts	.....354
5.21.1	Examples of Allergenic Extracts	.....355
	Essay Questions	.....356
	Multiple Choice Questions	.....356
	Answers	.....357

Chapter 6

Bacterial Genetics

6.1	Introduction	.....358
6.2	Criteria for Determining the Mode of Recombination in Bacteria	.....359
6.2.1	Transformation (Gene Exchange between Bacteria)	.....359
6.2.2	Bacterial Conjugation	.....363
6.2.3	Transduction	.....365
6.3	Bacterial Genetics	.....369
6.3.1	Mutagenesis	.....369
6.3.2	Chemical Mutagens	.....371
6.3.3	Physical Mutagens	.....372

6.3.4	Occurrence of Mutations	.....372
6.3.5	Features of Spontaneous Mutations	.....373
6.3.6	DNA Repair Mechanisms	.....373
6.3.7	Types of Mutations	.....374
6.3.8	Detection and Isolation of Mutants	.....376
6.4	DNA Replication	.....379
6.5	Transcription (RNA Synthesis)	.....382
6.6	Translation	.....384
6.6.1	Steps of the Synthesis of a Protein Chain on a Ribosome	.....385
6.7	Gene Regulation	.....385
6.7.1	The Lac Operon	.....385
6.7.2	Tryptophan Operon	.....388
6.8	Phase Variation	.....391
	<i>Essay Questions</i>	.....392
	<i>Multiple Choice Questions</i>	.....392
	<i>Answers</i>	.....392
Chapter 7		
Epidemiology of Diseases		
7.1	General Principles of Infection	.....393
7.1.1	Transmission of Diseases	.....395
7.1.2	Contact Transmission of Disease	.....395
7.1.3	Vehicle Transmission of Disease	.....396
7.1.4	Vectors Transmission of Disease	.....396
7.2	Carrier, Vectors, Reservoirs	.....397
7.3	Microbial Attack	.....399
7.3.1	Entry of Micro-organisms	.....399
7.4	Events in Infection following Penetration	.....402
7.5	Different Diseases	.....403
7.5.1	Amoebiasis	.....403
7.5.2	Influenza (Viral Disease)	.....406
7.5.3	Diphtheria (Bacterial Disease)	.....409
7.5.4	Infective Hepatitis	.....410
7.5.5	Hepatitis B Virus (HBV)	.....411
7.5.6	Tuberculosis	.....413

7.5.7	Gonorrhoea	....415
7.5.8	Bacillary Dysentery	....417
7.5.9	Tetanus	....419
7.5.10	Polio (Poliomyelitis)	....421
7.5.11	Typhoid	....422
7.5.12	Cholera	....423
7.5.13	Filariasis	....425
7.5.14	Food Poisoning	....427
7.5.15	Leprosy	....429
7.5.16	Syphilis	....432
7.5.17	Malaria	....434
7.5.18	AIDS	....435
7.5.19	Whooping Cough	....440
7.5.20	Rabies	....441
7.5.21	Plague	....446
	<i>Essay Questions</i>	....447
	<i>Multiple Choice Questions</i>	....447
	<i>Answers</i>	....448
 Chapter 8		
Micro-organisms and their Environment		
8.1	Microbial Growth in Natural Environments	....449
8.2	Different Factors that Affect the Microbial Growth	....450
8.2.1	Temperature	....451
8.2.2	Hydrostatic Pressure	....453
8.2.3	Desiccation	....454
8.2.4	Osmotic Pressure	....455
8.2.5	Oxygen	....456
8.2.6	Effect of Vibration	....458
8.2.7	Ionic Effect	....458
8.2.8	Radiant Energy	....459
8.2.9	Extreme Cold Environment	....461
8.2.10	Effects and Microbial Adaptations to Environmental Conditions	....462

8.2.11 Electricity	.....465
8.2.12 Mechanical Impact	.....469
8.3 Bioindicators	470
8.3.1 Introduction	470
8.3.2 Pharmaceutical Applications of Bioindicators	470
Essay Questions	.....476
Multiple Choice Questions	.....476
Answers	.....476

Chapter 9

Applications of Microbes in Pharmacy

9.1 Introduction	.....477
9.1.1 Pharmaceuticals produced by Micro-organisms	.....478
9.1.2 Vitamins, Amino Acids and Organic Acids	.....478
9.1.3 Enzymes	.....479
9.2 Pharmaceutical Significance of Bacteria	.....481
9.2.1 Uses of Bacteria	.....481
9.2.2 Idli Fermentation	.....482
9.2.3 Cabbage Fermentation	.....482
9.2.4 Swiss Cheese	.....482
9.2.5 Cyanocobalamin (Vitamin B-12)	.....482
9.2.6 Riboflavin (Vitamin B ₂)	.....483
9.2.7 β- carotene	.....483
9.2.8 Food-grade Lactic Acid Bacteria	.....483
9.2.9 Yogurt	.....483
9.2.10 Nystatin	.....483
9.2.11 Bacteriocins (Nisin)	.....484
9.3 Pharmaceutical Significance of Fungi	.....484
9.4 Pharmaceutical Significance of Protozoa	.....485
9.5 Pharmaceutical Significance of Algae	.....486
9.6 Some of the Products Derived from Algae	.....487
Essay Questions	.....487
Multiple Choice Questions	.....487
Answers	.....488

Chapter 10

Microbiological Assays

10.1	Introduction	.....489
10.2	Requirements of Antibiotic Assay	.....491
10.2.1	Methods	.....494
10.2.2	One-level Assay with Standard Curve	.....495
10.2.3	Two-Level Factorial Assay	.....498
10.2.4	Turbidimetric or Tube Assay Method	.....499
10.2.5	Precision of Microbiological Assays	.....502
10.2.6	Microbiological Assay of Streptomycin	.....502
10.3	Microbiological Assay of Vitamin-B ₁₂	.....503
10.4	Microbial Assay of Niacin (Vitamin B ₃)	.....508
10.5	Microbial Assay of Amino Acids	.....512
10.6	Biosensors	.....523
10.6.1	Calorimetric Biosensors	.....525
10.6.2	Potentiometric Biosensors	.....526
10.6.3	Amperometric Biosensors	.....529
10.6.4	Optical Biosensors	.....531
10.6.5	Piezo-Electric Biosensors	.....532
10.6.6	Immunosensors	.....532
10.6.7	Microbial Biosensors	.....535
10.6.8	Summary	.....541
10.7	Assessment Methods of New Antibiotics	.....543
10.8	Microbial Limit Tests	.....546
10.8.1	Preliminary Testing	.....546
10.8.2	Methods	.....547
10.9	Some of the Media used in the Microbial Limit Tests	.....554
	Essay Questions	.....558
	Multiple Choice Questions	.....558
	Answers	.....558

Chapter 11

Microbial Spoilage and Preservation of Pharmaceutical Products

11.1	Microbial Spoilage Introduction	.....559
11.2	Spoilage - Chemical and Physicochemical Deterioration of Pharmaceuticals	.....560
11.2.1	Pharmaceutical Ingredients Susceptible to Microbial Attack	.....560
11.2.2	Manifestations and Mechanism of Action	.....564
11.2.3	Observable Effects of Microbial attacks on Pharmaceutical Products	.....566
11.2.4	Factors Affecting Microbial Spoilage of Pharmaceutical Products	.....566
11.3	Sources and Control of Contamination	.....571
11.4	Microbial Standards for Non-Sterile Pharmaceutical Products	.....574
11.5	Preservation of Pharmaceutical Products	.....578
11.6	Useful method for Fast and High thorough put Preservative Efficacy Testing	.....579
11.7	Microbial Assessment	.....580
	<i>Essay Questions</i>	.....583
	<i>Multiple Choice Questions</i>	.....583
	<i>Answers</i>	.....583

Chapter 12

Miscellaneous Topics

12.1	Soil Microbiology	.....584
12.1.1	Rhizosphere and Rhizoplane Micro-organisms	.....585
12.1.2	Organic Matter Decomposition	.....587
12.2	Biogeochemical Cycling	.....589
12.3	Food Microbiology	.....597
12.3.1	Food Preservation Methods	.....598
12.3.2	Micro-organisms as Food – Single – Cell Protein	.....600

(xx) Contents

12.4	Microbiology of Air (Aeromicrobiology)	.....601
12.5	Microbiology of Water	.....606
12.6	Microbiology of Milk	.....615
12.7	Industrial Microbiology	.....620
	12.7.1 Fermenters and Fermentative Microbes	.....621
	12.7.2 Penicillin Fermentation (fed-batch) Method	.....625
	12.7.3 Immobilized Enzyme Technology	.....627
	12.7.4 Hybridomas and Monoclonal Antibodies	.....628
	12.7.5 Industrial Aspects of Microorganisms	.....628
12.8	Cell Culture	.....629
12.9	Industrial Micro-organisms and their Products	.....640
	12.9.1 <i>Escherichia E.coli</i>	.....640
	12.9.2 Industrial Applications of Penicillium Species	.....643
	12.9.3 Industrial Applications of Streptomyces species	.....649
	12.9.4 Tetracyclines	.....651
	12.9.5 Saccharomyces Species	.....652
	12.9.6 Future Prospects	.....654
	Essay Questions	.....654
	Multiple Choice Questions	.....654
	Answers	.....654
	Index	.....655