

Contents

PART ONE

Fundamentals of microbiology

1 Meet the microbes, 2

- Foundations of the science, 2
- Terminology used and nature of the invisible world, 3
- Origin of microorganisms, 5
- Academic aspects of microbiology, 7
- Vistas in microbiology, 9
 - Microbiology and infectious diseases, 10
 - Microorganisms and the food supply, 11
 - Microbial improvement of our environment, 12
- Summary, 15

2 Major groups of microorganisms, 16

- Prokaryotes and eukaryotes, 16
- Plantlike higher organisms, 19
 - Algae, 19
 - Blue-green algae, 20
 - Fungi, 22
 - Molds, 23
 - Yeasts, 23
 - Lichens, 28
- Animal-like higher organisms, 29
 - Protozoa, 29
 - Myxomycetes, 33
 - Acrasiales or cellular slime molds, 35
- Bacteria, 35
 - The sheathed bacteria, 36
 - Budding and appendaged bacteria, 37
 - Actinomycetales, 37
 - Caryophanon, 40
 - The gliding bacteria, 40
 - Viruses, 42
- Summary, 42

3 Natural distribution of microorganisms, 43

- Common habitats rich in microbial life, 43
 - Soil, 43
 - Rotting plant materials, 44
 - Water, 45
 - Sewage, 45
 - Rumen of cattle and other ruminants, 46
 - Intestines of the horse, 47
- Human body as a microbial habitat, 47
 - The skin, 47
 - Microflora of the mouth, 48
 - The intestinal tract, 48
- Unusual habitats, 50
 - Hot springs, 50
 - Inhabitants of cold environments, 51
 - Barophilic bacteria, 52
 - Mars-like environments, 52
 - The Great Salt Lake and the Dead Sea, 53
- Role of winds in distribution of microorganisms, 54
- Summary, 55

4 Historical aspects of microbiology, 56

- Ancient ideas of disease, 56
- Development of the microscope, 57
- First reported observation of microbes, 58
- Abiogenesis or spontaneous generation, 60
- Pasteur and abiogenesis, 61
- Pasteur and fermentation, 62
- Germ theory of disease, 63
- The golden age of microbiology, 63
- Summary, 68

5 The bacteria, 69

- Taxonomy, 69
- Shape, arrangement, and size, 70
 - Cocci, 71

- Proof of the role of water as a carrier of disease, 233
- Classification of domestic water, 234
- Methods for determining safety of water supplies, 234
- Tests for bacteria in water, 234
- Quantitative estimates of numbers of coliforms in water, 236
- Fecal streptococci or enterococci, 236
- Membrane filter technique, 237
- Purification of domestic water supplies, 237
- Sewage, 237
- Sewage disposal, 238
 - Without treatment, 238
 - Primary treatment, 240
 - Secondary treatment, 240
 - Tertiary treatment, 245
- Problems involved in reuse of sewage, 248
 - Public disfavor, 248
 - High salt levels, 248
 - High nitrate levels, 248
 - Removal of intestinal viruses, 249
 - Chlorination of sewage, 249
- Special problems related to sewage disposal, 250
 - Mercury poisoning from fish, 250
 - Eutrophication, 250
 - Indirect effects of sewage on marine algae, 251
- Microbiological problems of swimming pools and bathing beaches, 251
- Summary, 254

15 Microorganisms and foods, 255

- Food spoilage—general considerations, 255
- Methods of food preservation, 257
 - Canning, 257
 - Refrigeration, 259
 - Quick freezing, 259
 - Ultralow temperatures, 260
 - Drying, dehydration, or desiccation, 260
 - Freeze-drying or lyophilization, 260
 - Irradiation, 260
 - Chemical preservatives, 262
- Fermented foods, 262
- Food infections and food poisonings, 262
 - Staphylococcus enterotoxins, 263
 - Salmonella food poisoning, 264
 - Botulism, 265
 - Clostridium perfringens* food poisoning, 266
 - Bacillus cereus* food poisoning, 266
 - Other microbial toxins, 266
 - Shellfish poisoning, 266

- Toxic metabolites from molds, 267
- Summary, 268

16 Microbiology of milk and dairy products, 269

- Composition of milk, 269
- Microorganisms in milk and its products, 270
 - Milk-borne diseases, 270
 - Bacteria and impairment of quality, 271
- Methods for ensuring safety of milk, 272
- Procedures for testing milk for quality and safety, 274
 - Standard plate count, 274
 - Direct count of bacteria in milk, 275
- Buttermaking, 276
- Desirable fermentation products, 276
- Microbiology of cheese, 278
 - Soft unripened cheeses, 278
 - Ripened cheeses, 282
- Summary, 284

17 Industrial applications of microorganisms, 285

- Scope of industrial microbiology, 286
- Alcoholic fermentations, 286
 - Beer, 286
 - Wine, 288
 - Industrial alcohol production, 288
 - Acetone and butanol production, 289
- Organic acid production, 289
 - Acetic acid production, 289
 - Gluconic acid, 290
 - Lactic acid, 291
- Microbial foods and food additives, 291
 - Use of whole cells as food, 291
 - Food from oil, 292
 - Amino acids, 293
 - Vitamins, 293
- Enzyme preparations, 294
 - Amylases, 294
 - Proteolytic enzymes, 295
- Pharmaceutical applications, 295
 - Production of antibiotics, 296
 - Steroids, 296
- Miscellaneous applications, 297
 - Uses of crude cultures, 297
 - Bacterial insecticides, 297
- Summary, 298

18 The living soil, 299

- Soil—a microbial reservoir, 299
- Historical foundation, 300

- Soil as a microbial environment, 301
 - Simple bacteria, 302
 - Higher bacteria, 302
 - Casida's soil bacteria, 303
 - Fungi—molds and yeasts, 303
 - Blue-green algae, 306
 - Green algae, 307
 - Protozoa, 307
 - Viruses in the soil, 307
- Methodology, 307
 - Estimation of numbers of microbes, 307
 - Visualization of normal growth in soil, 308
- Cycles of the elements, 309
 - Carbon cycle, 309
 - Nitrogen cycle, 311
 - Cycle of inorganic compounds, 318
- Resistant molecules, 320
 - Naturally occurring compounds, 320
 - Man-made synthetic compounds, 320
- Summary, 321

19 Microbiology of air, 322

- Experimental beginnings, 322
- Air as an environment, 323
- Methods for isolating microbes from air, 323
- Air as a carrier of microbes, 326
 - Microbiology of air masses, 327
 - Inside air, 329
- Sanitization or chemical disinfection of air, 330
 - Use of germicidal ultraviolet rays, 330
 - Use of filters for sterile air, 331
- Summary, 332

PART THREE

Microorganisms and the production of disease

20 Epidemiology, 334

- Types of disease, 334
- The chain of infection, 335
 - Organism, 336
 - Source and reservoir, 336
 - Exit, 337
 - Transmission, 337
 - Entry, 338
 - Host, 339
- Arthropods, 339
- Infection pressure and herd immunity, 340
- Epidemics are relative, 340
- Virgin soil epidemics, 341
- Summary, 342

21 Host-parasite relationships with bacteria, 343

- Initial exposure to microbes, 343
- Comparison of germ-free and normal animals, 344
- The normal flora, 345
 - Benefits, 345
 - Age, 347
 - Diet, 347
 - Hazards, 348
- Disease production mechanisms, 348
 - Invasiveness, 349
 - Toxicogenicity, 350
- Summary, 352

22 Innate immunity, 353

- Genetic influence, 354
- Cultural differences, 355
- Age, 356
- Nutrition, 357
- Sex, 358
- External defenses, 358
- Internal defenses, 360
 - Group A compounds, 361
 - Group B compounds, 361
 - Group C compounds, 361
- Cellular elements of innate immunity, 363
- Inflammation, 366
- Fever, 368
- Summary, 369

23 Acquired immunity, 370

- Genetic aspects, 370
- Active and passive immunity, 371
- Immunoglobulins, 372
 - Cellular aspects, 374
- Antigens, 376
- Cell-mediated immunity, 378
- Hypersensitivity, 380
 - Immediate hypersensitivity, 380
 - Delayed hypersensitivity, 381
- Transplantation, 381
- Autoimmunity, 383
- Immunology, aging, and cancer, 385
- Blood group systems, 385
 - ABO blood group, 386
 - Rh blood group, 388
- Summary, 389

24 Major bacterial diseases, 390

- Staphylococcus infections, 390
 - Staphylococcus aureus*, 394
 - Staphylococcus epidermidis*, 395

- Streptococcus infections, 395
 - Beta hemolytic streptococci, 397
 - Types of group A streptococcus infections, 398
 - Transmission of streptococcus infections, 398
 - Pathogenicity of alpha hemolytic streptococci, 398
- Gonorrhea, 399
 - Transmission and pathogenicity of *Neisseria gonorrhoeae*, 400
 - Diagnosis of gonorrhea, 400
 - Treatment of gonorrhea, 401
- Syphilis, 401
 - Diagnosis of syphilis, 404
- Tuberculosis, 404
 - The genus *Mycobacterium*, 405
 - Course of tuberculous infection, 405
 - The tuberculin test, 406
 - Diagnosis of tuberculosis, 407
 - Atypical bacteria causing tuberculosis-like infections, 407
 - Treatment of tuberculosis, 407
- Salmonella and Shigella infections, 408
 - Salmonellosis other than typhoid and typhoidlike diseases, 408
 - The shigellosis, 409
- Bacterial diseases of lesser importance, 410
- Summary, 412

25 Rickettsial and chlamydial diseases, 413

- The Rickettsiales, 413
 - Epidemic or louse-borne typhus, 413
 - Endemic or flea-borne typhus, 414
 - The spotted fever group, 414
 - Q fever, 415
- The Chlamydiales, 416
 - Parrot fever—ornithosis group, 416
 - Lymphogranuloma venereum, 416
 - Trachoma and inclusion conjunctivitis, 416
- Summary, 417

26 Viruses and disease, 418

- Classification of human and animal viral pathogens, 418
- Overview of the human virus diseases, 419
- Pathogenesis of viral infections, 423
 - Inapparent infection, 423
 - Localized infection, 423
 - Generalized infection, 423
 - Slow virus disease, 425
 - Congenital infection, 425

- Aspects of viral immunology, 426
 - Antibody production, 426
 - Cell-mediated immunity, 426
 - Passive immunity, 426
- Nonimmunological factors, 427
 - Interferon, 427
 - Viral chemotherapy, 428
- What is cancer? 428
- Immunity and cancer, 430
- Viruses and cancer, 430
- Viral cancer mechanisms, 432
- Summary, 434

27 Protozoan diseases, 435

- Protozoan and bacterial diseases, 435
- Intestinal protozoa, 435
 - Amebic dysentery, 437
 - Diagnosis of amebiasis, 437
- Malaria, 438
 - Species of the malaria organisms, 440
 - Treatment and control of malaria, 440
- Insect transmitted trypanosomal diseases, 441
 - Trypanosome diseases, 441
 - The leishmaniasis, 442
- Other protozoan diseases, 443
 - Chagas' disease, 443
 - Toxoplasmosis, 443
 - Trichomonas vaginalis* infections, 444
- Summary, 445

28 Fungus diseases, 446

- Fungi as the cause of diseases, 446
- The dermatophytes, 446
 - Ringworm, 447
 - Athlete's foot, 448
- Deep-seated fungus infections, 449
 - Blastomycosis, 449
 - Coccidioidomycosis, 450
 - Cryptococcosis, 451
 - Histoplasmosis, 451
- Normal flora infections, 452
 - Candidiasis, 452
- Saprophytic mold infections, 452
- Summary, 453

29 Diseases of plants, 454

- Importance and nature of plant diseases, 454
- Bacterial diseases of plants, 454
 - Major bacterial diseases, 454
 - Diseases caused by *Mycoplasma*, 455
- Fungal diseases of plants, 456
 - Diseases of plasmodial origin, 458

Viral diseases of plants, 460
 Mechanisms responsible for diseases in
 plants, 462
 Summary, 463

Appendix A Descriptions of some major groups of microorganisms, 465

The plantlike higher microorganisms, 465
 Algae, 465
 Fungi, 470
 The animal-like higher microorganisms,
 475
 Protozoa, 475
 Myxomycetes, 478
 Bacteria, 479

Appendix B Immunological methods, 483

Agglutination, 483
 Precipitation, 484
 Complement-fixation, 484
 Neutralizing antibodies, 486
 Hemagglutination, 486
 Immunodiffusion, 487
 Immunofluorescent labelling, 488
 Electrophoresis and
 immunoelectrophoresis, 489
 Radioimmunoassay, 491
 Immune electron microscopy, 491
 ELISA, 493