Contents

Preface vii

ESSENTIAL LABORATORY SKILLS

Case Study Exercise 1 Safety Considerations in the Microbiology Laboratory 1

CASE SYNOPSES

Community College Acquired Infection with Salmonella Typhimurium—38 States, 2011.

Ocular Vaccinia Infection of a Laboratory Worker—Philadelphia, 2004.

Laboratory Researcher Dies after Suffering Burns—Los Angeles, California, 2009–2014.

Case Study Exercise 2 Microscopy and Measurement of Microscopic Specimens 9

CASE SYNOPSIS

Correspondence between Anton van Leeuwenhoek and the Royal Society of London for the Improvement of Natural Knowledge.

SURVEY OF MICROORGANISMS

Case Study Exercise 3 Identification and Classification of Algae 21

CASE SYNOPSIS

Paralytic Shellfish Poisoning—Alaska, 2011.

There's More to the Story . . . Phytoplankton Monitoring Network

Case Study Exercise 4 Survey of Medically Important Protozoa 33

CASE SYNOPSIS

Primary Amebic Encephalitis—Louisiana, 2011.

Classification of Fungi 41

CASE SYNOPSIS

Histoplasmosis Outbreak Among Day Camp Attendees—Nebraska, June 2012.

Case Study Exercise 6 Ubiquity of Microorganisms 55

CASE SYNOPSIS

Engineering Infection Control Through Facility Design.
Outbreak of Multidrug-Resistant *Pseudomonas aeruginosa*Related to Intensive-Care Room Design—2009.

MANIPULATION, STAINING, AND OBSERVATION OF MICROORGANISMS

Case Study Exercise 7 Aseptic and Pure Culture Techniques 61

CASE SYNOPSIS

Neonatal Tetanus—Montana, 1998.

Case Study Exercise 8 Simple Staining, Negative Staining, and Gram Staining 75

CASE SYNOPSIS

Multistate Outbreak of Listeriosis Associated with Jensen Farms Cantaloupe—United States, August–September 2011.

Case Study Exercise 9 Capsular Staining 89

Pneumococcal Sepsis after Autosplenectomy—2005.

Case Study Exercise 10 Endospore Staining 93 CASE SYNOPSIS

Inhalation Anthrax Associated with Dried Animal Hides—London, 2008.

There's More to the Story . . . Isolation and Identification of Bacillus

Case Study Exercise 11 Acid-Fast Staining 99 CASE SYNOPSIS

Tattoo-Associated Nontuberculous Mycobacterial Skin Infections—Multiple States, 2011–2012.

ENVIRONMENTAL INFLUENCES ON THE GROWTH OF MICROORGANISMS

Case Study Exercise 12 Viable Plate Count 105 CASE SYNOPSIS

Escherichia coli 0157:H7 Infections in Children Associated with Raw Milk and Raw Colostrum From Cows—California, 2006.

Case Study Exercise 13 Cultivation of Anaerobes 113 CASE SYNOPSIS

Botulism Associated with Commercially Canned Chili Sauce—Texas and Indiana, July 2007.

Case Study Exercise 14 Temperature Effects on Bacterial Growth and Survival 121

CASE SYNOPSIS

Outbreak of Gastroenteritis Associated with Consumption of Alaskan Oysters—Multiple States 2004.

Case Study Exercise 15 pH and Microbial Growth 127 CASE SYNOPSIS

Botulism From Prepared Garlic—New York, 1989.

Case Study Exercise 16 Effects of Osmotic Pressure on Bacterial Growth 133

CASE SYNOPSIS

Vibrio vulnificus Infection Traced to Sewage Spill—Hawaii, 2006.

CONTROL OF MICROBIAL GROWTH

Case Study Exercise 17 Lethal Effects of Ultraviolet Light 141

CASE SYNOPSIS

Gastrointestinal Outbreak Traced to Interactive Fountain—New York, March 2006.

There's More to the Story . . . Effects of Environmental UV Exposure on Bacterial Populations.

Case Study Exercise 18 Evaluation of Disinfectants 149

CASE SYNOPSIS

Outbreak of Skin Infections on High School Wrestling Team—Michigan 2013.

There's More to the Story . . . Disk Diffusion Testing of Antimicrobial Chemicals.

Case Study Exercise 19 Effectiveness of Hand Scrubbing 157

CASE SYNOPSIS

Puerperal Fever—Vienna, Austria, 1847.

There's More to the Story... Comparison of Resident and Transient Microbial Populations.

Case Study Exercise 20 Antimicrobic Sensitivity Testing: Kirby-Bauer, Tube Dilution, and E-Test Methods 165

CASE SYNOPSES

Methicillin-Resistant *Staphylococcus aureus* Infections among Tattoo Recipients—Ohio, Kentucky, and Vermont, 2004–2005. New Antibiotic Discovered—Germany, 2008.

There's More to the Story . . . Isolation of Antibiotic Producing Actinomyces.

EPIDEMIOLOGY

Case Study Exercise 21 Phage Typing of Bacteria 179

CASE SYNOPSIS

Salmonella Serotype Enteritidis Infections among Workers Producing Poultry Vaccine—Maine, November–December, 2006.

Case Study Exercise 22 Simulated Epidemic 185 CASE SYNOPSIS

Import-Associated Measles Outbreak—Indiana, May–June, 2005.

Case Study Exercise 23 Morbidity and Mortality Weekly Report 193

CASE SYNOPSIS

Google Used to Predict Influenza Outbreaks—2009. There's More to the Story . . . Using Social Media to Track Disease.

MICROBIAL GENETICS

■ Case Study Exercise 24 Bacterial Transformation 203

CASE SYNOPSIS

Hospital outbreak of Carbapenem-Resistant *Klebsiella* pneumoniae—Maryland, 2011.

Case Study Exercise 25 The Ames Test 213

CASE SYNOPSIS

West Nile Virus Update—United States, January 1–December 31, 2012.

APPLIED MICROBIOLOGY

Case Study Exercise 26 DNA Extraction from Bacterial Cells 219

CASE SYNOPSIS

IKEA pulls meatballs from shelves after horse meat found—2013.

Case Study Exercise 27 DNA Profiling 223 CASE SYNOPSIS

Multistate Outbreak of *Salmonella* Infections Associated with Peanut Butter and Peanut Butter-Containing Products—United States, 2008–2013.

Case Study Exercise 28 Measures of Water Quality: Most Probable Number Procedure 235

CASE SYNOPSIS

E. coli Contamination of Water Supply—Frazier Park, California, 2007.

Case Study Exercise 29 Measures of Water Quality: Membrane Filtration Method 243

CASE SYNOPSIS

Fecal Contamination of Airline Drinking Water—2005. There's More to the Story . . . Identification of Coliforms.

Case Study Exercise 30 Measures of Milk Quality: Methylene Blue Reductase Test 251

CASE SYNOPSIS

Salmonella Typhimurium Infection Associated with Raw Milk and Cheeses Consumption—Pennsylvania, 2007.
There's More to the Story . . . The Science of Yogurt.

Case Study Exercise 31 Bacterial Counts of Food 257

CASE SYNOPSIS

Food Poisoning among Inmates at a County Jail—Wisconsin, August, 2008.

Contents

MEDICAL MICROBIOLOGY

■ Case Study Exercise 32 Isolation and Identification of Staphylococci 263

CASE SYNOPSIS

Methicillin-Resistant *Staphylococcus aureus* Skin Infections from an Elephant Calf—San Diego, California, 2008

Case Study Exercise 33 Isolation and Identification of Streptococci 273

CASE SYNOPSIS

Invasive Group A *Streptococcus* in a Skilled Nursing Facility—Pennsylvania, 2009–2010

There's More to the Story . . . Tracking Hand Hygiene.

Case Study Exercise 34 Epidemiology of Gastrointestinal Illness: Differentiation of Enterobacteriaceae 285

CASE SYNOPSIS

Outbreaks of *Escherichia coli* O157:H7 Associated with a State Fair—North Carolina, 2011.

Case Study Exercise 35 Blood Typing 293 CASE SYNOPSIS

Transfusion Reaction Leads to Death due to ABO Incompatibility—Florida, 2008

Case Study Exercise 36 Differential White Blood Cell Count 301

CASE SYNOPSIS

Screening for Parasitic Infection of Refugees—United States, 2011

Case Study Exercise 37 Slide Agglutination 309 CASE SYNOPSIS

Leptospirosis Infection—Hawaii, 2005

Case Study Exercise 38 Enzyme-Linked Immunosorbent Assay (ELISA) 313

CASE SYNOPSIS

Hepatitis C Virus Transmission at an Outpatient Hemodialysis Unit—New York, 2001–2008

IDENTIFICATION OF UNKNOWN BACTERIA

Case Study Exercise 39 Identification of Bacterial Unknowns 321

CASE SYNOPSIS

Respiratory Disease Strikes Legionnaires'
Convention—Philadelphia, Pennsylvania, 1976

PHOTOGRAPHIC ATLAS FOR LABORATORY APPLICATIONS IN MICROBIOLOGY

Staining Techniques A-7

Cultural and Biochemical Tests A-9

Bacterial Colonial Morphology A-31

Bacterial Microscopic Morphology A-37

Fungi A-45

Protists A-57

Helminths A-69

Hematology and Serology A-79

LABORATORY TECHNIQUES, REAGENTS, AND ASSAYS

Analysis of Bacterial Cultures Based on Morphological Characteristics

Exercise 40 Colony Morphology 341

Exercise 41 Growth in Solid and Liquid Media 345

Staining Techniques Used for the Microscopic Examination of Bacteria

Exercise 42 Motility Methods: Wet Mount and Hanging Drop 349

Exercise 43 Flagella Stain 353

Techniques for Inoculation of Media

Exercise 44 Streak-Plate Isolation 357

Exercise 45 Loop Dilution 365

Exercise 46 Spread-Plate 371

Commonly Used Differential and Selective Media

Exercise 47 Fluid Thioglycollate Medium 375

Exercise 48 Mannitol Salt Agar 379

Exercise 49 MacConkey Agar 383

Exercise 50 Desoxycholate Agar 387

Exercise 51 Endo Agar 391

Exercise 52 Eosin Methylene Blue Agar 395

Exercise 53 Hektoen Enteric Agar 399

Exercise 54 Xylose Lysine Desoxycholate Agar 403

Exercise 55 Blood Agar 407

Exercise 56 Motility Medium 411

Exercise 57 SIM Medium 415

Exercise 58 Kligler's Iron Agar 419

Exercise 59 Triple Sugar Iron Agar 423

Exercise 60 Lysine Iron Agar 427

Exercise 61 Litmus Milk 431

Commonly Used Biochemical Tests

Exercise 62 Oxidation-Fermentation Test 435

Exercise 63 Phenol Red Carbohydrate Broth 439

Exercise 64 Purple Carbohydrate Broth 443

Exercise 65 Methyl Red and Voges-Proskauer
Tests 447

Exercise 66	Catalase Test 451	Commercial Identification Systems
Exercise 67	Oxidase Test 455	Exercise 84 API 20E System 517
Exercise 68	Nitrate Reduction Test 459	Exercise 85 Enterotube II System 525
Exercise 69	Coagulase Test 463	Antimicrobial Susceptibility Tests
Exercise 70	Citrate Test 465	Exercise 86 Antibiotic Disk Sensitivity Tests 533
Exercise 71	Malonate Test 469	Exercise 87 β-Lactamase Test 537
	Decarboxylation Test 473 Phenylalanine Deaminase Test 477	Quantitative Techniques Exercise 88 Viable Plate Count 539
Exercise 74	Bile Esculin Test 479	Exercise 89 Direct Cell Count 545
Exercise 75	Starch Hydrolysis 483	Amounding As Construmbation at the Determination of Postanial
Exercise 76	ONPG Test 487	Appendix A: Spectrophotometric Determination of Bacterial Growth: Use of the Spectrophotometer 549
Exercise 77	Urease Test 491	Appendix B: Use of Pipettes in the Laboratory 551
Exercise 78	Casease Test 495	Appendix C: Preparation of Culture Media 555
Exercise 79	Gelatinase Test 499	Appendix D: Media, Reagents, and Stain Formulas 560
Exercise 80	DNase Test 503	Appendix E: Data Sheet for Unknown Identification 568
Exercise 81	Lipase Test 507	Glossary 569
Exercise 82	CAMP Test 511	Credits 586
Exercise 83	PYR Test 515	Index 589



Indicates a LearnSmart Lab $^{\text{TM}}$ activity is available for all or part of this exercise. For more information, visit learnsmartadvantage.com.