In memory of William A. Craig (1939-2015) and Robert C. Moellering, Jr. (1936-2014), two highly esteemed colleagues, clinicians, educators, investigators, and mentors. We thank them for their friendship, inspiration, and collective contributions to the development of nearly every new antibacterial agent in the last four decades.
Contents

Contributors ix
Foreword xv
Preface xvii
Acknowledgments xix

1 West Africa 2013: Re-examining Ebola 1
   Daniel G. Bausch and Amanda Rojek

2 Preparing for Serious Communicable Diseases in the United States: What the Ebola
   Virus Epidemic Has Taught Us 39
   Jay B. Varkey and Bruce S. Ribner

3 Ebola Virus Disease: Therapeutic and Potential Preventative Opportunities 53
   Robert Fisher and Luciana Borio

4 Middle East Respiratory Syndrome (MERS) 73
   Sonja A. Rasmussen, Amelia K. Watson, and David L. Swerdlow

5 The Emergence of Enterovirus D-68 105
   Kevin Messacar, Mark J. Abzug, and Samuel R. Dominguez

6 The Role of Punctuated Evolution in the Pathogenicity of Influenza Viruses 121
   Jonathan A. McCullers

7 Measles in the United States since the Millennium: Perils and Progress in the
   Postelimination Era 131
   Anne Schuchat, Amy Parker Fiebelkorn, and William Bellini

8 Chikungunya Virus: Current Perspectives on a Reemerging Virus 143
   Clayton R. Morrison, Kenneth S. Plante, and Mark T. Heise

9 Zika Virus Disease 163
   Werner Slenczka

10 West Nile Virus Infection 175
    James J. Sejvar

11 Mobilization of Carbapenemase-Mediated Resistance in Enterobacteriaceae 201
    Amy Mathers

12 Antimicrobial Resistance Expressed by Neisseria gonorrhoeae: A Major Global Public
   Health Problem in the 21st Century 213
    Magnus Unemo, Carlos del Rio, and William M. Shafer
13  **Bordetella holmesii: Still Emerging and Elusive 20 Years On**  239  
Laure F. Pittet and Klara M. Posfay-Barbe

14  **Cronobacter spp.**  255  
Brian P. Blackwood and Catherine J. Hunter

15  **Clostridium difficile Infection**  265  
Jae Hyun Shin, Esteban Chaves-Olarte, and Cirle A. Warren

16  **Emerging Tick-Borne Bacterial Pathogens**  295  
Tahar Kernif, Hamza Leulmi, Didier Raoult, and Philippe Parola

17  **Bordetella pertussis**  311  
Delma J. Nieves and Ulrich Heininger

18  **Invasive Infections with Nontyphoidal Salmonella in Sub-Saharan Africa**  341  
Barbara E. Mahon and Patricia I. Fields

19  **Fungal Infections Associated with Contaminated Steroid Injections**  359  
Carol A. Kauffman and Anurag N. Malani

20  **Emerging Fungal Infections in the Pacific Northwest: The Unrecognized Burden and Geographic Range of Cryptococcus gattii and Coccidioides immitis**  375  
Shawn R. Lockhart, Orion Z. McCotter, and Tom M. Chiller

21  **The Emerging Amphibian Fungal Disease, Chytridiomycosis: A Key Example of the Global Phenomenon of Wildlife Emerging Infectious Diseases**  385  
Jonathan E. Kolby and Peter Daszak

22  **Artemisinin-Resistant Plasmodium falciparum Malaria**  409  
Rick M. Fairhurst and Arjen M. Dondorp

Index  431
Contributors

Mark J. Abzug
University of Colorado School of Medicine
Department of Pediatrics
Section of Infectious Disease
Aurora, CO 80045

Daniel G. Bausch
Tulane School of Public Health and Tropical Medicine
Department of Tropical Medicine
New Orleans, LA 70112

William Bellini
Division of Viral Diseases
The National Center for Immunization and
Respiratory Diseases
Centers for Disease Control and Prevention
Atlanta, GA 30329

Brian P. Blackwood
Ann and Robert H. Lurie Children's Hospital of Chicago
Chicago, IL 60611

Luciana Borio
Food and Drug Administration
Office of the Chief Scientist
Silver Spring, MD 20993

Esteban Chaves-Olarte
Universidad de Costa Rica
San Pedro, Costa Rica

Tom M. Chiller
Mycotic Diseases Branch
Centers for Disease Control and Prevention
Atlanta, GA 30333

Peter Daszak
EcoHealth Alliance
New York, NY 10001
Contributors

Carlos del Rio
Hubert Department of Global Health
Rollins School of Public Health of Emory University
and Department of Medicine
Division of Infectious Diseases
Emory University School of Medicine
Atlanta, GA 30322

Samuel R. Dominguez
University of Colorado School of Medicine
Department of Pediatrics
Section of Infectious Disease
Aurora, CO 80045

Arjen M. Dondorp
Mahidol-Oxford Tropical Medicine Research Unit
Faculty of Tropical Medicine
Mahidol University
Bangkok 10400, Thailand;
Centre for Tropical Medicine
Nuffield Department of Medicine
University of Oxford
Oxford OX3 7BN, United Kingdom

Rick M. Fairhurst
Laboratory of Malaria and Vector Research
National Institute of Allergy and Infectious Diseases
National Institutes of Health
Rockville, MD 20852

Patricia I. Fields
Division of Foodborne, Waterborne, and Environmental Diseases
National Center for Emerging and Zoonotic Infectious Diseases
Centers for Disease Control and Prevention
Atlanta, GA 30329

Robert Fisher
Food and Drug Administration
Office of Counterterrorism and Emerging Threats
Silver Spring, MD 20993

Ulrich Heininger
Universitäts-Kinderspital beider Basel (UKBB)
CH-4031 Basel, Switzerland

Mark T. Heise
Department of Genetics
The University of North Carolina
Chapel Hill, NC 27599
Catherine J. Hunter
Ann and Robert H. Lurie Children’s Hospital of Chicago
Chicago, IL 60611

Carol A. Kauffman
Division of Infectious Diseases
Department of Internal Medicine
Veterans Affairs Ann Arbor Healthcare System;
University of Michigan Medical School
Ann Arbor, MI 48105

Tahar Kernif
Aix Marseille Université
Unité de Recherche sur les Maladies Infectieuses Transmissibles et Emergentes (URMITE)
UM63, CNRS 7278, IRD 198,
Inserm 1095, Faculté de Médecine,
13385 Marseille cedex 5, France;
Institut Pasteur d’Algérie
Algiers, Algeria

Jonathan E. Kolby
One Health Research Group, College of Public Health, Medical, and Veterinary Sciences
James Cook University, Townsville
Queensland, Australia

Hamza Leulmi
Aix Marseille Université
Unité de Recherche sur les Maladies Infectieuses Transmissibles et Emergentes (URMITE)
UM63, CNRS 7278, IRD 198,
Inserm 1095, Faculté de Médecine,
13385 Marseille cedex 5, France;
Ecole Nationale Supérieure Vétérinaire d’Alger
El Aliya Alger, Algérie

Shawn R. Lockhart
Mycotic Diseases Branch
Centers for Disease Control and Prevention
Atlanta, GA 30333

Barbara E. Mahon
Division of Foodborne, Waterborne, and Environmental Diseases
National Center for Emerging and Zoonotic Infectious Diseases
Centers for Disease Control and Prevention
Atlanta, GA 30329
Anurag N. Malani  
St. Joseph Mercy Hospital;  
University of Michigan Medical School  
Ann Arbor, MI 48105

Amy Mathers  
Division of Infectious Diseases and International Health  
Department of Medicine  
University of Virginia Health System;  
Clinical Microbiology  
Department of Pathology  
University of Virginia Health System  
Charlottesville, VA 22911

Orion Z. McCotter  
Mycotic Diseases Branch  
Centers for Disease Control and Prevention  
Atlanta, GA 30333

Jonathan A. McCullers  
Department of Pediatrics  
The University of Tennessee Health Sciences Center  
Memphis, TN 38103

Kevin Messacar  
University of Colorado School of Medicine  
Department of Pediatrics  
Sections of Infectious Disease and Section of Hospital Medicine  
Aurora, CO 80045

Clayton R. Morrison  
Department of Genetics  
The University of North Carolina  
Chapel Hill, NC 27599

Delma J. Nieves  
Pediatric Infectious Diseases  
CHOC Children’s  
Orange, CA 92868

Amy Parker Fiebelkorn  
Division of Viral Diseases  
The National Center for Immunization and Respiratory Diseases  
Centers for Disease Control and Prevention  
Atlanta, GA 30329
Philippe Parola
Aix Marseille Université
Unité de Recherche sur les Maladies Infectieuses Transmissibles et Emergentes (URMITE)
UM63, CNRS 7278, IRD 198,
Inserm 1095, Faculté de Médecine,
13385 Marseille cedex 5, France

Laure F. Pittet
Pediatric Infectious Diseases Unit
Children’s Hospital of Geneva
University Hospitals of Geneva
1211 Geneva 14, Switzerland

Kenneth S. Plante
Department of Genetics
The University of North Carolina
Chapel Hill, NC 27599

Klara M. Posfay-Barbe
Pediatric Infectious Diseases Unit
Children’s Hospital of Geneva
University Hospitals of Geneva
1211 Geneva 14, Switzerland

Didier Raoult
Aix Marseille Université
Unité de Recherche sur les Maladies Infectieuses Transmissibles et Emergentes (URMITE)
UM63, CNRS 7278, IRD 198,
Inserm 1095, Faculté de Médecine,
13385 Marseille cedex 5, France

Sonja A. Rasmussen
Centers for Disease Control and Prevention
Atlanta, GA

Bruce S. Ribner
Emory University School of Medicine
Atlanta, GA 30307

Amanda Rojek
University of Oxford
Epidemic Diseases Research Group, Centre for Tropical Medicine and Global Health
Oxford, United Kingdom

Anne Schuchat
The National Center for Immunization and Respiratory Diseases
Centers for Disease Control and Prevention
Atlanta, GA 30329
James J. Sejvar
Division of High-Consequence Pathogens and Pathology
National Center for Emerging and Zoonotic Infectious Diseases (NCEZID)
Centers for Disease Control and Prevention (CDC)
Atlanta, GA 30333

William M. Shafer
Department of Microbiology and Immunology
Emory University School of Medicine
Atlanta, GA 30322;
Veterans Affairs Medical Center (Atlanta)
Decatur, GA 30033

Jae Hyun Shin
Department of Medicine
University of Virginia
Charlottesville, VA 22908

Werner Slenczka
Philipps-University Marburg
Institute of Virology
35037 Marburg, Germany

David L. Swerdlow
Centers for Disease Control and Prevention
Atlanta, GA 30602

Magnus Unemo
WHO Collaborating Centre for Gonorrhoea and Other STIs
Department of Laboratory Medicine, Microbiology
Örebro University Hospital
SE-701 85 Örebro, Sweden

Jay B. Varkey
Emory University School of Medicine
Atlanta, GA 30307

Cirle A. Warren
Department of Medicine
University of Virginia
Charlottesville, VA 22908

Amelia K. Watson
The University of Georgia
Athens, GA 30602
The field of emerging and re-emerging infectious diseases has traveled from A (anthrax) to Z (Zika) in less than 15 years. Fortuitously, over that same interval, the insights, tools, and investments needed to address these challenges to medicine and public health have kept pace. The One Health Initiative has its roots in antiquity but only began to gather momentum with the appearance of West Nile virus in the Americas in 1999. Investigators now prospect wildlife and domesticated animals worldwide looking for novel agents and hints for origins of the next pandemic.

Molecular strategies for microbial surveillance, diagnosis and discovery have largely supplanted more laborious and expensive classical methods, resulting in an explosive expansion of genetic data that require increasingly complex and powerful resources for bioinformatic and biostatistical analysis. Discovery, an activity once focused in the West, is becoming decentralized as costs and expertise required for sequencing decrease. Governments and foundations invest in support of the United Nations International Health Regulations of 2005—a document signed by all member states “designed to prevent, protect against, control and provide a public health response to the international spread of disease in ways that are commensurate with and restricted to public health risks, and which avoid unnecessary interference with international traffic and trade.” The importance of this document and of the commitment of the scientific and communities to transparency has been underscored by the emergence of pandemic strains of influenza, antibiotic-resistant bacteria, Nipah, SARS, chikungunya, MERS, Ebola, and most recently Zika, which threaten regional and global public health as well as economic security.

The U.S. Supreme Court decision in the Association for Molecular Pathology v. Myriad Genetics that challenged the patentability of sequences existing in nature had ramifications far beyond the field of diagnostic oncology that prompted the initial litigation. It effectively ended the race to simply recover, claim and license microbial sequences of emerging pathogens. The result has been to encourage more mechanistic science. The number of laboratories focused on work in high-level biocontainment has dramatically increased. This has enabled more investigators to contribute to research into the biology, pathogenesis, diagnosis, prevention and treatment of emerging infectious diseases. It has also driven concerns about gain-of-function and dual use research as well as inadvertent release of high threat agents. An appropriate balance will be essential if the needs of all stakeholders are to be met.

Emerging Infections 10 is the latest in an American Society for Microbiology series initiated in 1998. My dear friend and mentor, the late Josh Lederberg, who
wrote the foreword to *Emerging Infections* 1, would be pleased to see that the series is alive and well and that the authors include an international cast of veterinarians, physicians, basic scientists, and public health practitioners. He would have anticipated the emergence of novel agents and the re-emergence of old foes like measles. In channeling Josh and his propensity for driving the field with predictions, I expect that volume 11 will feature chapters on modeling and the role of social media in biosecurity.

W. Ian Lipkin  
New York, NY  
2016
Preface

Despite progress in the prevention and control of infectious diseases during the past several decades, the first 15 years of the 21st century continue to provide evidence of the persistence and tenacity of emerging microbial threats. The interplay of rapid globalization, demographic shifts, ecological changes, environmental degradation, climate change, and unprecedented movement of people, animals, and commodities yield unexpected risks to health, often with attendant social, economic, and political repercussions. The emergence and rapid global spread of diseases such as MERS, Ebola virus disease, chikungunya, and Zika virus disease provide dramatic evidence of the continued ability of microbes to emerge, spread, adapt, and challenge the global infectious diseases, microbiology, and public health communities. In addition, the resurgence of long recognized diseases such as measles and pertussis and the spread of diseases such as coccidioidomycosis beyond endemic areas pose additional challenges.

Since 1995, annual infectious diseases meetings including those organized by the Infectious Diseases Society of America and the American Society for Microbiology have included updates on emerging infectious diseases. The 22 chapters in Emerging Infections 10 provide important updates on a broad range of emerging and re-emerging bacterial, viral, parasitic, and fungal infectious diseases in the United States and globally. Highlights include timely chapters on MERS, Ebola virus disease, chikungunya, and Zika virus disease which have recently been the focus of clinicians, researchers, and public health officials around the world and have received extensive media attention. The global threat of antimicrobial resistance is addressed in chapters on carbapenem-resistant Enterobacteriaceae, multiply-resistant gonococcal infections, non-typhoidal Salmonella infections in sub-Saharan Africa, and artemisinin-resistant Plasmodium falciparum malaria. Topics range from recently recognized diseases to long-recognized diseases posing current challenges to the clinical, laboratory, research, public health, and animal health communities.

Our experiences in responding to recent outbreaks, many of which are of vectorborne or zoonotic origin, provide important lessons for the future and highlight the relevance and importance of the One Health concept which emphasizes the importance of closer collaboration among the human, animal (both domestic and wildlife), and environmental and ecosystem health sectors. Recent experience emphasizes the importance of preparedness to respond to domestic and global threats with a co-ordinated, evidence-based, interdisciplinary response guided by strong, effective leadership at the national and global levels and accelerated implementation of a research agenda to provide tools to support diagnostic, therapeutic, and prevention strategies.
Because weak health systems in many areas of the world pose threats to all, investments in health system strengthening, national public health institutions, response capacity, and workforce development can yield substantial returns for the health and security of the global community. Recent experiences with and lessons learned from MERS, Ebola virus disease, chikungunya, and Zika virus disease have highlighted the importance of strengthening national capacities in support of the International Health Regulations and the Global Health Security Agenda. Fortunately, important scientific and prevention opportunities in the future are likely to result from advances in molecular diagnostics, next generation sequencing, utilization of big data, microbiome research, pathogen discovery, and epidemic modeling.

Future infectious disease challenges are difficult to predict but certainly include antimicrobial-resistant infections in healthcare and community settings, foodborne and waterborne diseases, influenza and other respiratory diseases, and vectorborne and zoonotic diseases, as well as new threats for immunocompromised and disadvantaged populations. Additional links between chronic diseases and infectious agents and between the microbiome and human health and disease will certainly be identified, providing new prevention and treatment opportunities. We hope the tenth volume in the Emerging Infections series will serve as a valuable resource for those currently working to address emerging infectious disease threats to national and global health and security as well as for the next generation of talented, committed professionals needed to confront these threats in the future.

W. Michael Scheld
James M. Hughes
Richard J. Whitley
We thank all of our colleagues who have helped us in preparing this volume. Most importantly, we thank all of the authors for their outstanding contributions. As editors, we are particularly grateful to the members of the Interscience Conference on Antimicrobial Agents and Chemotherapy (ICAAC) and the Infectious Diseases Society of America (IDSA) Program Committees who assisted us in coordinating topic and speaker selection for and/or moderating the joint symposia on emerging infections during previous ICAAC and IDSA meetings. As past presidents of IDSA, we would especially like to thank Mark Leasure, the soon to retire CEO of IDSA, for nearly 20 years of outstanding service to the Society and the infectious diseases profession. Numerous other colleagues provided helpful discussion, advice, and criticisms. We are also grateful to our assistants, Lisa Cook, Dianne Miller, and Dunia Ritchey. We also want to thank Lauren Luethy, Megan Angelini, and their colleagues at ASM Press for their superb work in coordinating production of the book. And finally, we thank our families for their understanding and support during this undertaking.
16S ribosomal RNA, *Bordetella holmesii*, 246
Acellular vaccines, *Bordetella pertussis*, 322
Acute flaccid myelitis (AFM) enterovirus-D68, 110–112, 111, 113
West Nile virus-associated, 180–181, 184–186, 187, 189
Acute flaccid paralysis, Chikungunya virus (CHIKV), 148
Ad26.ZEBOV vaccine, Ebola virus disease, 62
Advisory Committee on Immunization Practices (ACIP)
*Bordetella pertussis*, 322–326
measles, 132–133, 137
*Aedes aegypti* mosquitoes
Chikungunya virus, 143–146, 150
Zika virus, 165, 167, 170
*Aedes albopictus* mosquitoes, 144, 150, 170
*Aedes apicoargenteus*, 167
*Aedes furcifer*, 167
*Aedes luteocephalus*, 167
*Aedes* [*Stegomyia*] *africana*, Zika virus, 163, 167
*Aedes vittatus*, 167
Africa, see also West Africa
*Clostridium difficile* infection (CDI), 271–272
nontyphoidal *Salmonella* (NTS) infection, 341–342, 350–351
Zika virus, 163–164, 166–168, 170
AIDS (acquired immunodeficiency syndrome), see HIV/AIDS
American Academy of Pediatrics, 324
American Society for Microbiology, 46
Amphibian fungal disease, see also Batrachochytrium dendrobatidis; Chytridiomycosis
*Batrachochytrium dendrobatidis* and amphibian population, 387–388
global amphibian decline, 385, 401
global distribution map, 391
Amphotericin B, fungal infections, 368
*Anaplasma* capra, 301–302
*Anaplasmataceae* family, 301, 302, 304
*Anaplasmosis*, 295, 301–302
Animal models
Chikungunya virus (CHIKV), 147, 150, 153, 155
Middle East respiratory syndrome (MERS), 87–88
Animal reservoir
*Bordetella holmesii*, 248
Middle East respiratory syndrome (MERS), 84–85
*Anopheles* mosquitoes, artemisinin-resistant parasites, 409, 415, 417–419
Antibacterial agents, *Clostridium difficile* infection (CDI), 276–278
Antibiotics
*Bordetella holmesii*, 246–248
*Bordetella pertussis*, 319–320
*Cronobacter* infection, 258–259
Antibodies
Chikungunya virus (CHIKV), 153–154
*Clostridium difficile* infection (CDI), 278
Ebola virus disease (EVD), 56–58
medical countermeasures, 56–58
Antifungal chemotherapy, amphibian, 395
Antimalarials, see also Artemisinin-resistant *Plasmodium falciparum* malaria
parasite clearance, 410–411, 412
Antimicrobial resistance
*Neisseria gonorrhoeae*, 215–220
nontyphoidal *Salmonella* (NTS), 341–343, 345, 348–350
World Health Organization, 208, 221
Antimicrobials
*Bordetella pertussis*, 319–320
Global Gonococcal Antimicrobial Surveillance Programme (Global GASP), 221–222
Gonococcal Isolate Surveillance Project (GISP) testing panel, 223–224
gonorrhea treatment, 226–228
Antitoxin, *Clostridium difficile* infection (CDI), 278–279
Antivirals
Chikungunya virus (CHIKV), 152–155
tyrovidivirus, 113–114
host-targeted, for CHIKV, 154–155
influenza viruses, 126, 128, 129
Middle East respiratory syndrome coronavirus (MERS-CoV), 93
Virus-targeted, for CHIKV, 153
Arabian Peninsula, Middle East respiratory syndrome (MERS), 75, 77, 82–83, 86, 90, 94
Arboviruses, see also West Nile virus (WNV)
arthropod-borne viruses, 175, 176
Argasidae (soft ticks), 295
Artemisinin-resistant Plasmodium falciparum malaria
artemisinin and artemisinin combination therapies (ACT), 409–410
artemisinin resistance, 411–419
clinical impact of artemisinin resistance, 419–421
clinical phenotype, 411–412
failures with ACTs, 421–422
future research, 422
genetic determinants, 413–415
K13-propeller mutations, 418
laboratory phenotype, 412–413
molecular epidemiology, 416–417
molecular mechanisms, 415–416
mosquito transmission, 417–419
parasite clearance by artemisinins and antimalarials, 412
parasite clearance half-life, 410–411
P. falciparum kelch13 protein, 414
redefining artemisinin resistance, 419
Treatment options, 420
Asia, Clostridium difficile infection (CDI), 268–271
Assessment-Feedback-Incentives-exchange of information (AFIX) system, 133
Australia
Clostridium difficile infection (CDI), 270–271
treatments for uncomplicated Neisseria gonorrhoeae infections, 221
Automated microbial identification devices, Bordetella holmesii, 246
AVI Biopharma (Sarepta) molecules, Ebola virus disease, 58–59
Azoles, fungal infections, 370
Bacteremia, Bordetella holmesii, 243–244, 247
Bacteriotherapy, Clostridium difficile infection (CDI), 279–281
Batrachochytrium dendrobatidis
amphibian populations, 387–388
anthropogenic-assisted spread, 392–393
detection of, infection vs. disease, 387
detection of amphibian chytrid fungus, 389
discovery of, 385–386
emergence of, and global amphibian decline, 388–389
global distribution, 389
global origin of, 390–391
infection with, 386
modes of dispersal, 392–394
multiple strains of, 389–390
nonanthropogenic-assisted spread, 393–394
questions and uncertainties, 399
timeline of emergence, 391–392
Batrachochytrium dendrobatidis dispersal
anthropogenic-assisted spread, 392–393
environmental forces, 393–394
fomites, 393
international amphibian trade, 392
international nonamphibian trade, 393
nonanthropogenic-assisted spread, 393–394
wildlife, 393
Batrachochytrium dendrobatidis mitigation
amphibian antifungal chemotherapy, 395
amphibian probiotics, 396
amphibian selective breeding for resistance, 396–397
amphibian temperature and desiccation, 395
amphibian vaccination, 395–396
attempts and opportunities, 394–399
government intervention, 394
habitat biological control, 398
habitat-level, 397–399
habitat physical modification, 398–399
habitat site-level treatment, 397–398
mitigation of B. dendrobatidis’s impact, 394–397
Batrachochytrium salamandrivorans, 400–401
Bat white nose syndrome, 399–400
Bavarian Nordic, 62
BCX4430 (Biocryst), Ebola virus disease, 59
Biomedical Advanced Research and Development Authority (BARDA), 57, 59, 61
Bordetella bronchiseptica, 245
biochemical characteristics, 240, 241
infections, 317
Bordetella genus, 239
biochemical characteristics, 240, 241
infections, 314–317
organism, 312–314
Bordetella holmesii, 239–240
16S ribosomal RNA sequencing, 246
antibiotic prophylaxis, 248
automated microbial identification devices, 246
bacteremia, 243–244, 247
biochemical characteristics, 240, 241
clinical features, 243–244
colonies on sheep blood agar plate, 241
culture, 245
diagnosis, 244–246
epidemiology, 248–249
genome, 240–241
genome map, 242
gram stain of, 240
incidence, 248–249
infections, 317
invasive infections, 244, 247
loop-mediated isothermal amplification assay, 245–246
management, 248
microbiology, 240–243
morphological characteristics, 240
pathogenic factors, 242–243
pertussis-like respiratory infections, 243
polymerase chain reaction (PCR), 245
prevalence, 248–249
prevention, 247–248
reservoir, 248
respiratory infections, 247
spectrometry, 246
systematic misidentification as B. pertussis, 239, 248, 249
transmission, 248
treatment, 246–247
vaccination, 247–248
Bordetella parapertussis
biochemical characteristics, 240, 241
Bordetella pertussis
antibiotics, 319–320
antimicrobial treatment, 320
biochemical characteristics, 240, 241
clinical syndrome, 314–316
diagnosis, 318–319
differential diagnosis, 318
epidemiology, 317–318
genome map, 242
immunization, 321–324
immunization schedule, recommendations and contraindications, 322–324
infections, 314–316
pathogenesis, 313–314
pathogenic factors, 242–243
pertussis, 311–312
polymerase chain reaction (PCR), 245
post-exposure prophylaxis, 320
prevention, 321–324
respiratory infection, 243, 247
resurgence of pertussis, 324–326
supportive care, 320–321
systematic misidentification of B. holmesii as, 239, 248, 249
treatment, 319–321
vaccines, 321–324
virulence factors, 313–314
Borrelia, 295, 302–304
Brincidofovir, Ebola virus disease, 20, 21
Bundibugyo ebolavirus, 41
California, measles, 136–139
Cambodia, artemisinin-resistant Plasmodium falciparum malaria, 411, 413–414, 416–417, 420
Canada
treatments for uncomplicated Neisseria gonorrhoeae infections, 221
West Nile virus (WNV), 177
Candidatus Neoehrlichia mikurensis (C. N. mikurensis), 299, 301, 302
Carbapenemases
clinical context of, 202–203
detection challenges, 205–206
epidemiologies of major, 203, 205
global epidemiology of KPC, OXA–48 and NDM, 204
impact of genetic context on mobility, 206–208
KPC (Klebsiella pneumoniae carbapenemase), 202, 203, 208
NDM (New Delhi metallo-ß-lactamase), 202, 203, 205, 208
OXA-48-like (oxacillinase-48-like), 202, 203, 205, 207–208
schematic of mechanisms of mobility, 207
Caribbean, Chikungunya virus (CHIKV), 144–145
Case fatality rate (CFR), Ebola virus disease, 3–4, 10, 13, 15, 19
Case management, Ebola virus disease, 26
CDC (Centers for Disease Control and Prevention), 6, 17, 24
Bordetella holmesii, 239
Ebola virus disease, 6, 17, 24, 47
enterovirus-D68, 106–107
fungal infections, 359–360
Gonococcal Isolate Surveillance Project (GISP), 222–225
gonorrhea as public health concern, 214–215
Sexually Transmitted Diseases (STD) Treatment Guidelines, 222–223
West Nile virus (WNV), 178, 179
CDI, see Clostridium difficile infection (CDI)
Cephalosporin resistance, Neisseria gonorrhoeae, 216, 219–220
ChAd3-EBOZ vaccine, Ebola virus disease, 61–62
Chikungunya virus (CHIKV)
Aedes aegypti mosquitoes, 143–146, 150
antibody therapies, 153–154
antivirals against, 152–155
CHIKV disease, 146–148
emergence, 143–146
host-targeted antivirals, 154–155
joint and muscle disease, 146–148
mortality associated with infection, 148
neurologic involvement, 148
reemergence, 143–146, 155
therapeutics, 148–155
therapies for chronic CHIKV disease, 155
vaccines, 214, 149–152
virus-targeted antivirals, 153
Children
nontyphoidal Salmonella (NTS) infection, 343–344
pediatric West Nile virus infection, 186–187
Children's Mercy Hospital, enterovirus-D68, 106, 114–115
Chytridiomycosis, see also Batrachochytrium dendrobatidis

Batrachochytrium dendrobatidis infection, 386
detection of B. dendrobatidis infection vs. disease, 387
global emergence of, 390–391, 401–402
resistance in nature, 386–387
salamander fungus, 400–401
susceptibility to, 397
World Organization for Animal Health (OIE), 392
yellow-legged frog (Rana muscosa), 388, 396

Clinical and Laboratory and Standards Institute (CLSI)
carbapenemase detection, 205
Gonococcal Isolate Surveillance Project (GISP) antimicrobial testing, 223–224

Clostridium difficile infection (CDI)
Africa, 271–272
antibacterial agents, 276–278
Asia, 268–271
Australia, 270–271
bacteriotherapy, 279–281
clinical presentation, 272–274
colecotomy, 282
diagnosis, 274–276
diverting loop ileostomy with lavage, 282
East Asia, 268–269
epidemiology, 266–272
Europe, 267
fecal microbiota transplant, 279–280
fidaxomicin, 277–278
immunoglobulin (IG), 279
Latin America, 267–268
management, 276–283
metronidazole, 276–277
monoclonal antibodies, 278
mortality, 274
nontoxigenic C. difficile (NTCD), 281
North America, 267
pathophysiology, 265–266
probiotics, 280–281
recurrent disease, 274
risk factors, 272–273
severity of disease, 273–274
South Asia, 270
Southeast Asia, 269–270
surgical interventions, 281–282
tolevamer, 278–279
vaccine, 282–283
vancomycin, 277

Coccidioides immitis, geographic distribution, 380, 381
Coccidioidomycosis
geographic range, 378–380
map of United States and Mexico, 379
range of endemcity in U.S., 378–380
in soil, 380–381
Colecotomy, Clostridium difficile infection (CDI), 282
Community preparedness, emerging infectious diseases, 46–48
Convalescent blood and plasma, Ebola virus disease, 20, 57–58
Coronavirus antivirals, 93
human coronavirus-Erasmus Medical Center (HCoV-EMC), 73, 76
MERS (Middle East respiratory syndrome), 76, 78–80
MERS-CoV case definition, 89, 90, 91
severe acute respiratory syndrome (SARS), 75

Countermeasures, see Medical countermeasures (MCMs)
Cronobacter genus, 255–256
antibiotic susceptibility, 258–259
classification, 256
clinical associations, 257–258
environmental sources, 256–257
epidemiology, 256–257
pathogenesis, 258
virulence, 258

Crucell subsidiary (Johnson & Johnson), 62
Cryptococcus gattii, 375, 381
emergence in North America, 376–378
Culex pipiens, West Nile virus (WNV), 176
Culex quinquefasciatus, West Nile virus (WNV), 176
Culex tarsalis, West Nile virus (WNV), 176
Culture, Bordetella holmesii, 245

Disney amusement parks, measles, 132, 137, 139
Diverting loop ileostomy with lavage, Clostridium difficile infection (CDI), 282
Drug Quality and Security Act (2013), 371
DTaP vaccine (diphtheria-tetanus-acellular pertussis), Bordetella pertussis, 311–313, 322–324
DTP vaccine (diphtheria-tetanus-pertussis), Bordetella pertussis, 311–312, 322, 324

East Asia, Clostridium difficile infection (CDI), 268–269
Ebola virus disease (EVD)
case fatality rate (CFR), 3–4, 10, 13, 15, 19
case management, 26
clinical management, 13–14
clinical presentation, 12–13
Ebola treatment units (ETUs), 6, 8, 10–11, 13, 17–18, 21–22, 24, 26
experimental therapeutics, 18–22, 41–42
experimental vaccines, 22–23, 42–43
factors contributing to 2013–2015 outbreak, 47
field surveillance, 26
funding for global preparedness and response, 11
future challenges, 26–27
health-care worker infections, 16–18
infection prevention and control, 5, 16–18
information technology, 26
international community response, 5–6
laboratory-confirmed outbreaks (1976–2016), 3–4
patient bed capacity and requirements, 8
patient care, 40–41
personal protective equipment (PPE), 5, 16–18, 44–46
population density, 8–9
registered clinical trials, 20
resource-poor countries, 5
response to control measures, 8–11
sequelae, virus persistence and recrudescence, 14–16
treatment and prevention, 113–115
travel frequency, 8–9
virus persistence after onset, 16
West Africa 2013 outbreak, 1–2, 5–12
Ehrlichia muris-like (EML), 299, 301
Ehrlichioses, 295, 301
Elders, 295, 301
Elderly patients, Cronobacter spp., 255–259
Enterobacteriaceae, see also Carbapenemases
Enteroviruses, 105
Enteroviruses, 105
changes in, United States, 136–138
Ehrlichia muris-like (EML), 299, 301
Ehrlichioses, 295, 301
Elders, 295, 301
Elderly patients, Cronobacter spp., 255–259
Enterobacteriaceae, see also Carbapenemases
clinical context of carbapenemase enzymes, 202–203
Cronobacter as member, 255
epidemiologies of carbapenemases, 203, 205
mechanisms of mobility of carbapenemase genes
in, 206–208
Enteroviruses, 105
biological characteristics, 105–106
pathogenesis, 105–106
Environmental Protection Agency (EPA), 46, 170
Epidemiology
Bordetella holmesii, 248–249
Bordetella pertussis, 317–318
changing, in United States, 136–138
Clostridium difficile infection (CDI), 266–272
Coccidioides species, 378
Cronobacter spp., 256–257
Ebola virus disease (EVD), 7, 15, 25–27
enterovirus-D68 (EV-D68), 106–108, 109
fungal infections, 360–362
KPC (Klebsiella pneumoniae) carbapenemase, 203, 204
Middle East respiratory syndrome coronavirus (MERS-CoV), 75, 82–85, 90, 93–94
NDM (New Delhi metallo-β-lactamase), 204, 205
nontyphoidal Salmonella (NTS) disease, 342
OXA-48-like (oxacillinase), 203, 204, 207–208
Plasmodium falciparum mutations, 416–417
West Nile virus (WNV), 177, 179
WNV infection in humans, 180–181
Zika virus, 164, 165–166, 170
Escherichia coli, 202, 206–208
Europe
Clostridium difficile infection (CDI), 267
treatments for uncomplicated Neisseria gonorrhoeae infections, 221
West Nile virus (WNV), 176–177, 179–180
EVD, see Ebola virus disease (EVD)
EV-D68 (enterovirus-D68), 106
acute flaccid myelitis, 110–112, 113, 114
clinical features, 108, 110–112
diagnostics, 112–113
epidemiology, 106–108, 109
lessons learned from 2014 outbreak, 114–115
potential neurologic disease, 110–112
respiratory disease, 108, 110, 113
treatment and prevention, 113–114
Exophiala dermatitidis, 361
Experimental therapeutics, Ebola virus disease (EVD), 18–22, 41–42
Experimental vaccines, Ebola virus disease, 22–23
Exserohilum rostratum, see also Fungal infections
azoles for treatment, 370
cerebrospinal fluid (CSF), 366, 367
growth in culture, 366
histopathology, 366
infection, 359–360, 371
mycology, 362
voriconazole, 368
Favipiravir (Toyama Chemical), Ebola virus disease, 20, 21, 59
Fecal microbiota transplant, Clostridium difficile infection (CDI), 279–280
Fidaxomicin, Clostridium difficile infection (CDI), 277–278
Fire salamanders, 400–401
Flavivirus, see Zika virus
Fluoroquinolone resistance, Neisseria gonorrhoeae, 216, 218
Food and Drug Administration (FDA)
carbapenemase detection, 205
carbapenemase detection, 205
carcinogenic infections, 360, 371
Fungal infections
amphotericin B, 368
azoles, 370
cerebrospinal fluid (CSF) (1,3) beta-D-glucan, 367
clinical aspects, 363–366
Coccidioides immitis, 378–381
contaminated methylprednisolone, 359
Cryptococcus gattii, 376–378
culture, 366
diagnosis, 366–367
epidemiology, 360–362
histopathology, 366–367
long-term outcomes, 365–366
Fungal infections (continued)
meningitis, 363–364
mycological aspects, 362
peripheral osteoarticular infections, 365
polymerase chain reaction (PCR), 366
recurrence risk, 370–371
spinal and paraspinal infections, 364–365
treatment, 367–370
voriconazole, 368–370
Gabon, Ebola virus disease outbreaks, 3–4
GlaxoSmithKline (GSK), 62
Global Gonococcal Antimicrobial Surveillance Programme (Global GASP), 221–222
Gonococcal Isolate Surveillance Project (GISP), 222–225
Gonorrhea, see also Neisseria gonorrhoeae
antimicrobials for treating, 226
current treatment for, 225–226
future treatments for, 226–228
international responses to difficult-to-treat or untreatable, 220–222
Neisseria gonorrhoeae and, 213–215
public health concern, 214–215, 228
GS-5734 (Gilead), Ebola virus disease, 60
Guinea
bush taxis in, 10
Ebola virus disease, 1, 4, 5–10, 15, 19–23, 25
population density and size, 9
H1N1 influenza virus, 5, 46, 124–125, 128
H2N2 influenza virus, 124, 125
H3N2 influenza virus, 125, 125, 127
Habitat treatment, Batrachochytrium dendrobatidis eradication, 397–399
Haemophilus influenzae, 342
Haemophilus influenzae type b, 133
Hemagglutinin (HA), influenza A virus, 122, 126–127
HIV/AIDS
Clostridium difficile infection (CDI), 272, 280
Cryptococcus gattii, 376
Ebola virus, 2, 11, 15
gonorrhea, 214, 221, 224
nontyphoidal Salmonella, 342–346, 349–351
respiratory infections, 317
Hospital preparedness, emerging infectious diseases, 46–48
Human coronavirus-Erasmus Medical Center (HCoV-EMC), 73, 76
Human immunodeficiency virus, see HIV/AIDS
Immune response, Middle East respiratory syndrome coronavirus (MERS-CoV), 92
Immunization, see also Vaccination; Vaccines
Advisory Committee on Immunization Practices (ACIP), 132–133, 137, 322–326
Bordetella pertussis, 321–324
B. pertussis schedule, recommendations and contraindications, 322–324
measles program, 139–140
measles surveys, 133
National Immunization Survey, 133, 136
Immunoglobulin (IG), Clostridium difficile infection (CDI), 279
Infection control
Ebola virus disease (EVD), 5, 16–18
Middle East respiratory syndrome (MERS), 85–86
Infectious diseases
Ebola virus disease, 39–40, 48–49
experimental therapeutics, 41–42
hospital and community preparedness for emerging, 46–48
infection control, 43–46
patient care, 40–41
schematic of Serious Communicable Diseases Unit (SCDU), 45
vaccines, 42–43
Infectious Diseases Society of America (IDSA), Clostridium difficile infection (CDI), 273–275
Influenza A virus
adaptation, 125
biology, 122–123
ecology, 123–124
gene functions, 122
impact of adaptation on pathogenicity, 126–128
life cycle in cells, 123
neuraminidase (NA), 127
non-structured protein 1 (NS–1), 128
pandemics, 124–125
pandemic timeline, 125
PBI-F2 protein of, 127–128
rapid evolution, 125–126
Influenza viruses
biology and ecology of, 121–124
pandemic threat, 121, 128–129
International Committee on the Taxonomy of Viruses, 76, 106
International Community, response to Ebola virus disease, 5–6
Invasive infections
Bordetella holmesii, 244, 247
nontyphoidal Salmonella (NTS) in adults, 344
NTS infection in children, 343–344
West Nile neuroinvasive disease, 179, 182–186
Itraconazole, amphibian treatment, 395, 396, 397
Ixodidae (hard ticks), 295, 297, 300–303
Japanese encephalitis, 175, 189–190
Joint disease, Chikungunya virus (CHIKV), 146–148
Kawasaki’s disease, 138
Klebsiella pneumoniae, 201, 203, 206–208
Kunjin virus, 175, 179–180

Lacey Act, 394, 401
Laos, artemisinin-resistant Plasmodium falciparum malaria, 411, 416, 420
Latin America, Clostridium difficile infection (CDI), 267–268
Liberia, Ebola virus disease, 1, 4–7, 8–11, 13–14, 23, 25
Loop-mediated isothermal amplification assay, Bordetella holmesii, 245–246

MabWorks, 57
Macrolides
Bordetella holmesii, 246–248
Neisseria gonorrhoeae, 216, 218–219
Malaria, see also Artemisinin-resistant Plasmodium falciparum malaria
artemisinin resistance, 411–419
artemisinins and combination therapies, 409–410
DHA-piperaquine treatment, 420–421
nontyphoidal Salmonella (NTS) infection, 343–344, 350
parasite clearance half-life, 410–411
Marburg virus, 53–54, 59, 62, 167
Matrix-assisted laser desorption ionization-time-of-flight mass spectrometry (MALDI-TOF MS), Bordetella holmesii, 246

Measles
characteristics of recent outbreaks, 136
comparing key variables, 137
epidemiological context, 138–139
immunization program, 139–140
immunization surveys, 133
policy changes, 139
public opinion, 139
road to elimination, 132–133
safety of vaccines, 135–136
transmission, 131–132
United States (1962–2014), 132
United States after elimination of, 133–135
Measles-mumps-rubella (MMR) vaccine, 131–133, 135–137, 139

Medical countermeasures (MCMs)
Ad26.ZEBOV (Crucell/Johnson & Johnson), 62 antibodies, 56–58
AVI–7537, AVI–7539 and AVI–6002 (Sarepta), 58–59
BCX4430 (Bioryst), 59
ChAd3-EB0Z, 61–62
convalescent blood and plasma, 57–58
development during 2014–2015 epidemic, 54–62
everging infectious diseases, 62–63
favipiravir (Toyama Chemical), 59
GS-5734 (Gilead), 60
MIL-77, 57
MVA-BN Filo (Bavarian Nordic), 62
MVA-BN Filo (Bavarian Nordic), 62

INDEX
Peripheral osteoarticular infections, 365
Pertussis, 311–312, see also Bordetella pertussis
reported cases, 312
resurgence, 324–326
Plasmodium falciparum, see also Artemisinin-resistant Plasmodium falciparum malaria
mechanisms of artemisinin sensitivity and resistance, 415–416
treatment failures, 421–422
Polymerase chain reaction (PCR)
Bordetella holmesii, 245
Clostridium difficile infection (CDI), 269–271, 274–276
Ebola virus disease, 24–26
fungus detection, 366
Pregnancy, Zika virus, 167–168, 170
Pregnancy Risk Assessment Monitoring System (ProMED), 73, 75
Prophylaxis
Bordetella pertussis, 320
Bordetella holmesii, 248
Zika virus, 170
Pseudogymnoascus destructans, 399–400
Pseudomembranous colitis (PMC)
clinical presentation, 272–273
Clostridium difficile infection (CDI), 265–266
fetal microbiota transplant (FMT), 279
pathology of, 266
South Korea, 269
vancomycin, 277
Public Health Agency of Canada, 56, 61, 107
Registered clinical trials, Ebola virus disease, 20
Repellents, West Nile virus (WNV), 190
Republic of Korea, Middle East respiratory syndrome (MERS), 75, 77, 80–81, 83, 94
Respiratory disease, enterovirus-D68, 108, 110, 113
Respiratory infections, Bordetella holmesii, 243, 247
Reverse transcription PCR (RT–PCR)
Middle East respiratory syndrome coronavirus (MERS-CoV), 75, 89–90, 92
Zika virus, 169
Rickettsiaceae family, 299, 304, see also Tick-borne bacterial pathogens
Candidatus Rickettsia tarasevichiae, 299, 300
emerging tick-borne rickettsioses, 299–301
Rickettsia sp. Atlantic rainforest or Bahia strain, 296, 300–301
Tick-borne spotted fever group, 296–299
Salamandra salamandra, 400–401
Salmonella, 341–343, see also Nontyphoidal Salmonella (NTS)
  Enteritidis serotype, 342, 344–347, 349, 351
  infection, 341–343
  microbiology, 344–346
  serotypes, 344–346
  sources, 346–348
  transmission, 346–348
  Typhimurium serotype, 344–347, 349, 351
SARS (severe acute respiratory syndrome), 46
Saudi Arabia, Middle East respiratory syndrome (MERS), 73, 75, 76, 77
Selective breeding, amphibians, 396–397
Serious Communicable Diseases Unit (SCDU), 44–46
Severe acute respiratory syndrome (SARS), 74, 75
Sexual transmission
  Marburg virus disease, 167
  Zika virus, 166, 167, 167–170
Sierra Leone, Ebola virus disease, 1, 4–10, 21, 24
Snake fungal disease, 400
Society for Healthcare Epidemiology of America, 273, 275
Soil, coccidioides in, 380–381
South Asia, Clostridium difficile infection (CDI), 270
Southeast Asia, Clostridium difficile infection (CDI), 269–270
Spectinomycin resistance, Neisseria gonorrhoeae, 216, 217–218
Spinal infections, fungal, 364–365
Staphylococcus aureus, 201, 206
Stevens-Johnson syndrome, 138
Sudan, Ebola virus disease outbreaks, 3–4, 53–54
Sulfonamide resistance, Neisseria gonorrhoeae, 215–216
Surgical interventions, Clostridium difficile infection (CDI), 281–282
Swine flu, 5

Tanzania, Chikungunya virus (CHIKV), 143–144
Tdap vaccine (reduced-dose acellular pertussis), Bordetella pertussis, 312, 313, 322–326
Tekmira Pharmaceuticals, Ebola virus disease, 60
Tetracycline resistance, Neisseria gonorrhoeae, 216, 217
Thailand
  artemisinin-resistant Plasmodium falciparum malaria, 411, 416–417, 420
  Chikungunya virus (CHIKV), 144
  Therapeutics, see also Medical countermeasures (MCMs)
  Chikungunya virus (CHIKV), 148–155
  Ebola virus disease (EVD), 18–22, 41–42, 56–60
  Zika virus, 170
  Tick-borne bacterial pathogens
    anaplasmosis, 295, 301, 301–302, 303
  Borrelia miyamotoi, 303
  borrelioses, 302–304
  ehrlichioses, 301
  EML (Ehrlichia muris-like), 299, 301
  neoehrlichiosis, 301, 302
  new Borrelia spp., 303–304
  Rickettsiae agents of human disease, 296–299
  Rickettsia sp. Atlantic rainforest or Bahia strain, 296, 300–301
  rickettsioses, 299–301
  Ticks, 295, 299
  TKM-100802, Ebola virus disease, 42, 60
  TKM 130803, Ebola virus disease, 20, 21
  TKM-Ebola, Ebola virus disease, 60
  Tolevamer, Clostridium difficile infection (CDI), 278–279
Toyama Chemical, favipiravir, 59
Transmission
  Artemisinin-resistance Plasmodium falciparum, 417–419
  Batrachochytrium dendrobatidis, 390, 392, 398
  Bordetella holmesii, 248
  Marburg virus disease, 167
  measles, 131–132
  Middle East respiratory syndrome (MERS), 82–84
  Neisseria gonorrhoeae, 213–214, 220
  nonmosquito routes for West Nile virus, 176–177
  nontyphoidal Salmonella, 346–348
  Zika virus, 165–170
Travelers
  Chikungunya virus (CHIKV), 144–145, 152
  Coccidioides immitis, 380
  Ebola virus disease, 8–9
  Middle East respiratory syndrome (MERS), 86–87
  Zika virus, 165, 170
Uganda
  Ebola virus disease outbreaks, 1, 3–4
  Zika virus, 163, 164
United States
  acute flaccid myelitis (AFM), 111–112
  antimicrobials for treating gonorrhea, 225–226
  changing epidemiology in, 136–138
  characteristics of recent measles outbreaks, 136
  Cryptococcus gattii, 376–378
  decade following measles elimination, 133–135
  enterovirus-D68 (EV-D68) outbreak, 106–108, 109, 114–115
  measles (1962–2014), 132
  reported cases, 134
  treatments for uncomplicated Neisseria gonorrhoeae infections, 221
  West Nile virus (WNV), 177–179
  Zika virus, 165
U.S. Environmental Protection Agency (EPA), 46, 170
U.S. Fish and Wildlife Service (USFWS), 394, 400–401

Vaccination, see also Immunization
amphibian, 395–396
public opinion and policy changes, 139

Vaccine Preventable Disease Public Health Laboratory Reference Centers (VPD RCs), 138

Vaccines, see also Immunization
Bordetella holmesii, 247–248
Bordetella pertussis, 321–324
Chikungunya virus (CHIKV), 148, 149–152
Clostridium difficile infection (CDI), 282–283
Ebola virus disease, 22–23, 42–43, 60–62
Haemophilus influenzae, 342
influenza A virus, 126, 129
malaria, 344, 350
Middle East respiratory syndrome coronavirus (MERS-CoV), 93–94
Middle East respiratory syndrome (MERS), 93–94
nontyphoidal Salmonella (NTS), 350–351
quest for gonococcal, 221, 228
safety and efficacy, 64
safety of, 135–136
Streptococcus pneumoniae, 342
West Nile virus, 190

Vaccines for Children (VFC), measles, 132, 133, 139
Vancomycin, Clostridium difficile infection (CDI), 277
Vesicular stomatitis virus (VSV), Ebola virus, 43
Vietnam, artemisinin-resistant Plasmodium falciparum malaria, 411, 414, 416–417, 420
Voriconazole, fungal infections, 368–370
VSV-ZEBOV vaccine, 60–61

West Africa, see also Africa; Ebola virus disease (EVD)
Ebola virus disease (EVD) outbreak, 5–12
map, 2
West Nile encephalitis (WNE), 181, 182–184, 187–189
West Nile meningitis (WNM), 181, 182–183, 188
West Nile virus neuroinvasive disease (WNND), 178, 180–181, 186
West Nile virus (WNV)
clinical manifestations of human infection, 181–186
diagnosis, 187–188
ecology, 176–180
epidemiology of human illness, 180–181
genome, 175
genomic sequencing, 175–176
geographic distribution, 177–180

incidence reported to CDC, 178
lineage 1 virus, 176, 179
lineage 2 virus, 176, 179
long-term outcomes, 187
magnetic resonance imaging of cervical spinal cord, 185
magnetic resonance imaging of patient’s brain with WNE, 183
management, 188–189
neuroinvasive disease, 179, 182–186
nonmosquito transmission routes, 176–177
pathogenesis of human infection, 180
pediatric infection, 186–187
prevention, 189–190
reported cases in United States, 178
risk factors for severe disease and death, 180–181
vaccines, 190
virology, 175–176
weakness and paralysis, 184–186
WMV-associated acute flaccid myelitis, 180–181, 184–186, 187, 189
Whole-cell vaccines, Bordetella pertussis, 321

Wildlife emerging infectious diseases, see also Batrachochytrium dendrobatidis; Chytridiomycosis
amphibians and Batrachochytrium dendrobatidis, 385–392
fungus Pseu
dogymnoascus destructans, 399–400

World Health Organization (WHO)
agenda for change, 48
antimicrobial resistance, 208
Ebola virus disease, 5, 7
Global Gonococcal Antimicrobial Surveillance Programme (Global GASP), 221–222
global health preparedness and response, 11
global plan for antimicrobial resistance in Neisseria gonorrhoeae, 221
gonorrhea as public health concern, 214–215, 228
malaria recommendations, 409, 419, 421–422
measles, 135
Middle East respiratory syndrome (MERS), 76–77

World Organization for Animal Health (OIE), 392

Zaire, Ebola virus disease outbreaks, 3–4, 53–54
Zaire ebolavirus, 41
Zaki, Ali Mohamed, 73, 75
Zika virus
clinical manifestations, 167–168
complications of disease, 168–169
diagnosis, 169
differential diagnosis, 169–170
disease, 163–164
epidemiology, 164, 165–166, 170
etiology, 164
flavivirus, 163, 170–171
intrauterine transmission, 166
occurrence of infection, 164–165
pathogenesis, 169
prophylaxis, 170
sexual transmission, 166, 167–170

therapy, 170
transmission, 165–167
vertical transmission, 167
ZMapp, Ebola virus disease, 19, 20, 21, 42, 56–57