ADVANCES IN
BIOLOGICAL AND CHEMICAL TERRORISM COUNTERMEASURES

EDITED BY
RONALD J. KENDALL
STEVEN M. PRESLEY
GALEN P. AUSTIN
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Preface

This textbook, *Advances in Biological and Chemical Terrorism Countermeasures*, is offered as a contribution to establish the state-of-the-science of research on countermeasures to biological and chemical threat agents. Although the context of this book is heavily focused on the United States, its application should be considered global in nature. Biological and chemical terrorism are continuing threats to the United States and other nations; ironically, as we began writing this book in July 2007, the National Intelligence Council of the United States had just issued a report in which it is stated, "As a result, we judged that the United States currently is in a heightened threat environment." The July 2007 National Intelligence Report went on to state that "we assessed that al-Qa'ida will continue to try to acquire and employ chemical, biological, radiological or nuclear material attacks and will not hesitate to use them if it develops what it deems is sufficient capability." Therefore, we believe that this textbook is timely and will continue to offer strategies and perspectives to assist the United States and other nations to defend themselves from terroristic threats.

Research was begun in 1998 at Texas Tech University to develop countermeasures against biological and chemical threat agents. Subsequently, through The Institute of Environmental and Human Health (TIEHH) at Texas Tech University, the Admiral Elmo R. Zumwalt, Jr. National Program for Countermeasures to Biological and Chemical Threats (Zumwalt Program) was commissioned to further advance the university's and its collaborators' research and development of countermeasures to biological and chemical threats. Support for this research program has primarily occurred through the U.S. Army and, particularly, through the Research Development and Engineering Command, which has challenged our program to develop a multidisciplinary toxicology research program to address countermeasures to biological and chemical threat agents. Indeed, *Advances in Biological and Chemical Terrorism Countermeasures* draws heavily from the funding received through the U.S. Army and incorporates other leading scientists' research and their involvement with countermeasures against biological and chemical threats over the past few years.

Drawing upon the research data developed on countermeasures to biological and chemical threats as well as literature review, this book involved many months of planning and coordination by its authors as well as a meeting in July 2007 in Beaver Creek, Colorado, to bring all the chapters together for the book. Following months of planning, the authors met and discussed these issues for several days to coordinate this book as it relates to advances in countermeasures to both types of threats. Although the book does not attempt to completely implement all aspects of countermeasures to biological and chemical threats, it particularly addresses the research and development that has occurred through the Zumwalt Program at Texas Tech University.

The main authors of *Advances in Biological and Chemical Terrorism Countermeasures* participated fully in a collegial and multidisciplinary perspective at the

Beaver Creek meeting. Additional persons who offered input into individual chapters are noted as contributing authors to an individual chapter, even if they did not participate in the Beaver Creek meeting. The authors did participate in the Beaver Creek meeting and fully support the conclusions reached by the group, particularly those related to the conclusions and research recommendations chapter.

Countermeasures to biological and chemical threats continue to evolve as a national priority issue and we envision this issue will be before us for many years to come. We offer this book as a science-based text to improve our ability to implement countermeasures to biological and chemical terrorism. The authors believe that this book will contribute to developing the science of addressing countermeasures to biological and chemical terrorism that oftentimes challenge environmental toxicologists by virtue of the potential threats that are continuing to emerge with biological and chemical threat agents and that may require more complex experimental designs to evaluate.

We appreciated the opportunity to work together as a team in the publication of *Advances in Biological and Chemical Terrorism Countermeasures*, and we appreciate the Research Development and Engineering Command of the U.S. Army in supporting our research and the ultimate development of this textbook.

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We gratefully acknowledge and appreciate the financial support for the development of this book from the United States Army Research, Development and Engineering Command (RDECOM). In particular, we appreciate the encouragement and support of Dr. William Lagna and Dr. John White from RDECOM throughout the years of our association. They have been tireless champions of our program and research efforts and we could not have had better project officers who also supported and encouraged the production of this timely textbook. A major part of the research that was ultimately integrated into the context of this textbook resulted from research conducted through the Admiral Elmo R. Zumwalt, Jr. National Program for Countermeasures to Biological and Chemical Threats (Zumwalt Program), which is operated through The Institute of Environmental and Human Health (TIEHH), an institute within the Texas Tech University System. The Zumwalt Program is comprised of and supported by many individual investigators through out the Texas Tech University System whose research and written contributions to this book are greatly appreciated. We also want to express our sincere appreciation to the administrative staff and support personnel at TIEHH, in particular Ms. Tammy Henricks, Ms. Lori Gibler and Mr. Ryan Bounds, for their professionalism and dedication in the completion of this textbook.

About the Editors

Galen P. Austin is a senior research associate at The Institute of Environmental and Human Health, Texas Tech University. He earned his doctoral degree in animal science with an emphasis on beef cattle production from Texas Tech University in December 2003. As an animal scientist, Dr. Austin's research interests are varied regarding livestock production and the environment. He has utilized GPS/GIS technology to monitor beef cattle movement and behavior and is interested in livestock disease epidemiology, in particular, zoonotic diseases. Additionally, Dr. Austin is concerned with and has research interests in the protection from and detection of agricultural terrorism directed at both on-farm/ranch livestock and confined animal feeding operations.

Ronald J. Kendall serves as the founding director of The Institute of Environmental and Human Health (TIEHH), a joint venture between Texas Tech University and Texas Tech University Health Sciences Center at Lubbock, Texas. He is professor and chairman of the Department of Environmental Toxicology at Texas Tech University. He graduated from the University of South Carolina and received his MS degree from Clemson University and his PhD from Virginia Polytechnic Institute and State University. He received a U.S. Environmental Protection Agency (EPA) postdoctoral traineeship at the Massachusetts Institute of Technology. Dr. Kendall served on the EPA's Science Advisory Panel from June 1995 to December 2002, and was appointed chairman from January 1999 to December 2002. He has served on many other boards, including past president of the Society of Environmental Toxicology and Chemistry, Board of Directors of the SETAC Foundation for Environmental Education, the Endocrine Disrupters Screening and Testing Advisory Committee of the U.S. Environmental Protection Agency, and multiple panels of the National Research Council. He currently serves as editor of terrestrial toxicology for the journal *Environmental Toxicology and Chemistry.* In addition, he has authored more than 200 refereed journal and technical articles and has published or edited many books. He has made more than 170 public and scientific presentations in the field of wildlife and environmental toxicology and has successfully won 136 research grants from federal, state, and foreign governments, industries, and foundations. He has served as advisor for 31 students at the graduate levels, including MS and PhD degrees, and has authored 10 courses in environmental toxicology and wildlife toxicology. He has received numerous awards, addressed the U.N. Committee on Sustainable Development, and has consulted with many foreign countries on environmental issues. Dr. Kendall was awarded a Fulbright Fellowship in 1991.

Steven M. Presley is an associate professor of environmental toxicology in The Institute of Environmental and Human Health, and serves as research coordinator for the Admiral Elmo R. Zumwalt, Jr. National Program for Countermeasures to Biological and Chemical Threats at Texas Tech University. Professionally trained

as a medical entomologist, Dr. Presley also served as a U.S. Navy officer and is a graduate of the U.S. Marine Corps Command and Staff College, earning a master's of military studies degree focused on domestic terrorism, and has extensive training and practical experience in various aspects of biological, chemical, and radiological incident detection, response, and mitigation. His operational and research experience has focused upon the surveillance, prevention, and control of biological threats in the environment, and specifically vector-borne infectious diseases in tropical and semi-tropical environments. He has led malaria control operations and research efforts in Africa, Asia, and South America, as well as Rift Valley fever, Crimean Congo hemorrhagic fever, and cutaneous leishmaniasis studies in Africa and Asia. He has published more than 35 scientific and technical manuscripts, and was awarded the Rear Admiral Charles S. Stephenson Award for Excellence in Preventive Medicine for the year 2000–2001.

Philip N. Smith received his doctoral degree in environmental toxicology from Texas Tech University in May 2000, and has since advanced from senior research associate to assistant professor. Dr. Smith is an ecotoxicologist with wide-ranging interests in contaminant exposure and responses among ecological receptors. His research is focused on pathways of contaminant exposure among mammals, birds, aquatic organisms, and trophic transfer of environmental contaminants. Additionally, physiological and population-level responses to contaminant exposure are of particular interest to Dr. Smith. Dr. Smith's research is grounded in ecological relevance and is strategically aligned with his academic emphasis, which is ecological risk assessment. He is a reviewer for ten national and international journals and serves as editorial board member for two international journals, *Environmental Pollution*, and *Environmental Toxicology and Chemistry.*

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1 State of the Science
Background, History, and Current Threats

Steven M. Presley, Christopher B. Pepper, Galen P. Austin, and Ronald J. Kendall

Alas America's future enemies may not fight according to these Marquis of Queensberry rules. They might use nuclear, biological, or chemical weapons, not only on the "regional" battlefield that the Pentagon planners assign to them, but also in that unanticipated region of warfare—the United States itself.

—Former Under-Secretary of Defense for Policy Fred C. Iklé (1997)

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1.1 INTRODUCTION

1.1.1 Summary of World Situation and Perspective on Likely Future Situation

Western civilization is at war—a multifaceted, asymmetric, global war being fought in a nondelineated, undefined battle space, waged against a faceless enemy that operates from the shadows, utilizing both conventional and unconventional weapons and tactics to achieve its objectives. These 21st-century terrorists do not officially represent nation-states, but often they represent a religious ideology expressed through violence and death. They are driven by hatred and religious fanaticism, with many striving for the destruction of Western society and culture, and ultimately for the establishment of a global theocracy. The employment of unconventional weapons and weapons of mass destruction against civilian noncombatants is not novel or unique to present times. Mankind has exploited diseases, toxins, and poisons since the earliest