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As the field of microbial forensics evolves, substantial developments in technology and analytical capabilities have occurred. An equally important aspect of preparedness involving microbial forensics that needs a similar commitment is education and training. The scientific bases, applications, interpretations, and lessons learned by those who have been intimately involved in the early years of microbial forensics need to be documented and transferred to the next generation of scientists and decision makers so that we can protect society from potential harm resulting from bioterrorism and biocrime. Thus, the burgeoning field of microbial forensics should be accompanied by a parallel development of educational infrastructure and resources targeted at the next generation of practitioners, as well as diverse elements for the policy, research, and law enforcement communities. A microbial forensics education program can be broad, providing information encompassing all aspects of the field from science to policy, or more focused depending on its purpose and target audience. On one end of the target audience spectrum is the student at an academic center who desires to enter into the discipline of microbial forensics and would like to have options for a career choice. This student may become a forensic scientist analyzing crime scene evidence for a law enforcement or intelligence agency. Alternatively, the student may become an investigator who employs traditional law enforcement approaches merged with those of epidemiology for attribution purposes or crime investigation. An individual may become a law enforcement official whose responsibility is to understand the scope of an investigation and what tools are available to generate investigative leads. Policy makers must have a general understanding of microbial forensics results and better appreciation of their implications in order to effect sound and defensible policy decisions. Finally, an important
group that informs the public and government is the news media. They are frequently the primary interface between the scientist and the public, making their observations, insights, or inaccuracies of great importance and impact. Educational efforts will better prepare such individuals to be informed and responsible and must be varied in depth and scope to match the target audience of various entities involved in microbial forensics.

There can be many formats and venues for microbial forensics education. Full academic-style programs should be developed at universities to comprehensively educate individuals in this applied science. Microbial forensics will necessarily cover a broad range of topics (microbiology, epidemiology, evolution, statistics, infectious diseases, etc.) and no one can be an expert in all aspects. However, all interested parties need to have some requisite knowledge in the various aspects of the discipline. A full academic program likely is not practical for working professionals; more abbreviated educational/training activities, similar to that of a continuing education course format, could be very effective at integrating professionals into the microbial forensics discipline. Shorter courses or symposia will be useful for expanding the knowledge base of trained professionals. Microbiologists, epidemiologists, public health, and law enforcement officials are highly trained in relevant aspects of microbial forensics, but may need additional training to integrate effectively their expertise with the demands of this new discipline. To broadly educate as well as to specifically educate those involved in the widely varied aspects of microbial forensics represents an educational challenge that must be met to develop the experts and expertise that we desperately need to combat bioterrorism and biocrime.

Topics in Table 39.1 cover the spectrum of educational opportunities in microbial forensics and could form the template for a comprehensive education and training program. Clearly some areas are more relevant to scientists, others to crime scene investigators, and others to decision makers. Many of the subjects naturally overlap. We briefly identify some general areas and discuss why these should be considered as part of the core curriculum for scientists. Most of these topics are addressed in greater detail in other chapters of this book.

**MICROBIAL FORENSICS CURRICULA AND TRAINING**

Microbial forensics is defined as a scientific discipline dedicated to analyzing evidence from a bioterrorism act, biocrime, or inadvertent release of a microorganism/toxin for attribution purposes (1). It is the same as other forensic disciplines except for its focus on a particular type of crime (1,2). Based on
| Table 39.1 Overview and Origins of Microbial Forensics |
|------------------------------------------------------|
| Basic epidemiology                                   |
| Molecular epidemiology                               |
| Microbial forensics curricula and training           |
| Basic and advanced                                   |
| Microbes and their products                          |
| a. Viruses                                           |
| b. Bacteria                                          |
| c. Fungi                                             |
| d. Eukaryotic parasites                              |
| e. Toxins                                            |
| The host target—how does a person or animal become ill?|
| Immunology                                           |
| The plant as a target—how does a plant or crop get damaged?|
| The host response as a forensic indicator            |
| a. Immune system                                     |
| b. Pharmacokinetics                                  |
| c. Antibiotics                                       |
| Processes and technology                             |
| a. Sample collection                                 |
| b. Forensic handling                                 |
| c. Preservation                                      |
| d. Extraction                                        |
| e. Advanced microscopy                               |
| f. Proteomics                                        |
| g. Genomics                                          |
| h. Bioinformatics                                    |
| i. Statistical analysis and confidence estimations   |
| j. Indicators of engineering                         |
| k. Synthetic biology                                 |
| l. Population genetics                               |
| m. High-throughput sequencing                        |
| n. Nonbiologic tools                                 |
| o. Sensitive signature detection and characterization |
| p. Evolving, nascent technology                      |
| Quality assurance and quality control                |
| Investigative genetics (i.e., forensic genetics)     |
| a. Interpretation                                    |
| b. Forensic science in general                       |
| Crime scene investigation                            |
| a. Identify crime scene                              |
| b. Evidence collection                               |
| c. Sampling strategies                               |
| d. Sample storage and transportation                 |
| e. Trial preparation including moot court            |
| Case histories                                       |
| a. Civilian                                          |
| i. Food safety and public health                     |
| 1. Food borne—Shigella, Salmonella (spinach)         |
| 2. Anthrax                                           |
| 3. Ricin                                             |

(Continued)
Table 39.1 Overview and Origins of Microbial Forensics (Continued)

| Category                          | Example                                                                 |
|----------------------------------|-------------------------------------------------------------------------|
| ii. Agriculture                  | 1. Foot-and-mouth UK 2007                                                |
|                                  | 2. Mad cow disease US 2003 (attribution by host genetics)                |
| iii. Environmental science       | Poultry industry water contamination Arkansas                            |
| iv. Emerging infections          | 1. H1N1                                                                  |
|                                  | 2. Severe acute respiratory syndrome                                     |
|                                  | 3. Monkey pox                                                           |
|                                  | 4. HIV                                                                  |
| b. Criminal                      | i. U.S. anthrax 2001 with focus on technology and investigation HIV     |
|                                  | ii. Ricin                                                               |
| c. Biodefense                    | Terrorism and biocrimes                                                  |
| Legal issues                     | a. United States                                                        |
|                                  | b. International                                                        |
| Select Agent rules               |                                                                         |
| Operational and intelligence issues |                                                          |
| National-level capabilities and resources |                                                      |
| a. Country capabilities          |                                                                         |
| i. What and how should any country be prepared? |                                                      |
| ii. What strategies make sense?  |                                                                         |
| iii. Planning, implementing, and measuring effectiveness |                                                      |
| iv. Exercises                   |                                                                         |
| v. Where can additional support be sought? |                                                      |
| vi. Epidemiologic investigation as a basic country skill |                                                      |
| Public information (media and public) |                                                          |
| Dissemination of accurate information in timely manner |                                                      |
| Entertainment industry           |                                                                         |
| Depiction of accurate information |                                                                         |

past history and with current technology capabilities, the potential use of biological weapons is greater than at any other time in history. Only a few semiexpert individuals are needed with access to dual-use equipment (e.g., equipment used in the pharmaceutical or food industries) to produce bioweapons inexpensively. These bioweapons will contain signatures that might be exploited to help identify the perpetrators. One may consider attribution solely to be the “DNA fingerprinting” of a pathogenic agent, but unique genomic identification of a microorganism may not always be possible because of the clonal nature of many microorganisms and, on a case-by-case basis, lack of population and phylogenetic data. Microbial forensics employs the same general practices as other forensic disciplines. Recognizing a crime scene, preserving a crime scene, chain of custody practices, evidence collection and handling, evidence
shipping, analysis of evidence, and interpretation of results are carried out in the same general manner as other forensic evidence. A common exception is that evidence will be handled as a biohazard (even more so than, for example, HIV-infected blood). It is anticipated that the majority of microbial forensic evidence will fall into a category with shared characteristics, with some data being very informative and some being less informative. An understanding of the field is essential to determining what type of evidence is collected, how it is analyzed, what the significance of a result is, and what is supportive in identifying a perpetrator and for prosecution.

To support a career in microbial forensics, a university microbial forensics curriculum will necessarily cover a broad range of disciplines, which may include microbiology, chemistry, statistics, epidemiology of infectious diseases, evolution, genetics, genomics, and forensics. These courses could be taught individually or merged into a few dedicated microbial forensic courses. From a practical standpoint, many microbial forensic training programs will be based in other majors or minors in epidemiology, genetics, molecular biology, or microbiology. A major in epidemiology or microbiology could easily become a training platform for microbial forensics with the addition of select courses to include fundamentals in forensics. Alternatively, a forensics science program with additional training in basic sciences such as microbiology and epidemiology could serve to educate microbial forensic scientists. It will be important to emphasize integration of the material toward a specific microbial forensic profession. Concurrent enrollment in microbial forensics seminars, capstone courses, and internships will be needed to provide students the contextual importance of the basic material toward their chosen discipline that will often be taught more generically or under an unrelated discipline.

The depth of the curriculum will vary depending on the level and occupation of the student. High school students may have abbreviated versions that can pique their appetites to learn more. College students will need comprehensive training to prepare them for graduate school or for entering the workforce. Legal experts will require an overview to understand the limitations of the field and how to support or refute scientific findings.

**BASIC EPIDEMIOLOGY**

Epidemiology is a cornerstone of public health and is critical to microbial forensics. The goal of epidemiology is to recognize infectious disease outbreaks and to attribute the outbreak to a source in order to prevent additional cases (see Chapter 15). In many aspects, microbial forensics employs the same tools as those used in epidemiology. A training program in microbial forensics will parallel many parts of current programs in epidemiology. Models can be
obtained from epidemiology curricula and experience from natural outbreaks will help guide how microbial forensic scientists will perform investigations of biocrimes. Tracing the course of a disease will assist in identifying the index case, cause, and/or time of the outbreak. With many disease outbreaks as well as cases of unusual infections (e.g., monkey pox), the recurring question will be: Is this a natural event or an intentional attack? Epidemiological factors will help distinguish between natural or intentional events and enable more effective responses in either event. A biocrime may only be recognized through surveillance linking multiple unusual disease occurrences in contiguous or noncontiguous geographic areas. Often microbial forensic investigations will be based on initial public health findings and proceed further to address attribution as it applies to identify the perpetrator(s) of a biocrime or bioterrorist act.

MOLECULAR EPIDEMIOLOGY

Molecular epidemiology focuses on the contribution of potential genetic and environmental risk factors, identified at the molecular level, to the etiology, distribution, and prevention of disease within families and across populations. Molecular epidemiology can be expanded to include the investigation of microbes at their molecular level (3). The field also provides a good example where application of newer technologies may help overcome many of the same problems encountered with traditional epidemiology with respect to study design and interpretation (4). Molecular tools can be employed to characterize and potentially individualize samples and isolates to address forensically relevant questions. This subdivision of epidemiology has special importance in microbial forensics because it is desirable to determine the source of a particular microbe used in a crime. Highly discriminating assays can precisely identify strains and isolates, resulting in a more focused and effective investigation. These types of data could associate a sample with a single geographic area, even possibly a particular laboratory or flask, or with the specific conditions and nutrients used to culture the microorganism. Some of these aspects are discussed in the chapters on anthrax.

MICROBES AND THEIR PRODUCTS AS BIOLOGICAL WEAPONS

Agents that can be used in biocrimes span the microbial world of viruses, bacteria, fungi, eukaryotic parasites, and toxins. It is important to have a basic understanding of each type of microorganism to appreciate the parameters that make a particular microbe a serious threat as a weapon. These parameters will include accessibility, stability, transmissibility, associated history with weapons programs, and the capacity to produce disease with transient or sustained
consequences, including death. Different technologies are needed to culture bacteria and viruses, as they differ greatly in growth requirements. Indeed, some microbes are difficult or impossible to culture. Such information may help an investigator understand what microbes would be considered and how they might have been used in a particular circumstance. A basic understanding of different microbial classes and their products would include human, animal, and plant pathogens.

**HOST FACTORS INCLUDING IMMUNE RESPONSES**

It is important to understand how the host responds to microbes and how this can provide unique signatures, including those for a particular microbe or for timing the exposure to a pathogen. For forensic purposes, an immediate goal is to distinguish a potential victim from a perpetrator and to distinguish between a natural or intentional event. A basic understanding of the immune system, how antibodies are generated, and when different classes of antibodies appear may assist in criminal investigations.

**PROCESSES AND TECHNOLOGY**

Sophisticated instruments (technology) that reside in the laboratory are only part of the process for obtaining reliable and meaningful information. The process begins with sample acquisition and proceeds with packaging, storage, and analysis and ultimately ends up with interpreting the results. All aspects are important and must be integrated effectively to have high confidence in results.

**Crime Scenes and Chain of Custody**

After recognizing that a bioterrorist act or biocrime has occurred, defining the crime scene is the first important part of an investigation. Once the crime scene has been identified and delimited, a plan is needed to properly collect and maintain integrity of the evidence that may be subsequently analyzed. Practices are needed that minimize contamination of the evidence. Microbial contamination may be somewhat different from other types of contamination because the contaminating organisms can replicate confounding results. The nuances of a microbial forensic investigation add a layer on top of traditional crime scene investigations, particularly because of the hazardous nature of the evidence. The need for proper documentation may seem obvious but it is a very important part of maintaining the integrity of the evidence. Crime scenes are chaotic and missteps can occur. To minimize missteps in handling documentation procedures should be established so the crime scene can be reconstructed at a later date for investigators or in a court of law. It is likely that biocrimes and acts of bioterrorism will add another dimension of complexity
because (i) there is less experience in crime scene collection due to (unfortunately) fewer cases, (ii) addressing the safety of victims will not be trivial, (iii) investigators will be wearing cumbersome but absolutely necessary protective gear, and (iv) the best approaches for collection and preservation of evidence may have to be determined at the scene given the limited extant information available. Thus, preparing for a crime scene investigation and defining the processes of chain of custody should be essential parts of any curriculum.

The first responder community needs to be aware of the safety issues and the methods of collection because they may become involved in performing evidence collection. Laboratorians must understand these processes because better decisions can be made as to what evidence is pertinent for analysis. Lawyers and judges will want to understand the basics of chain of custody to be assured that acceptable handling methods have been exercised to maintain the integrity of the evidence. Those who will have contact with the crime scene, as well as those in the laboratory who require downstream interoperability of collected evidence, will have to learn basic do’s and don’ts of crime scene investigation to effect a better systems-based process. Education about crime scene investigation will help ensure use of validated microbial identification practices that will collect the most pertinent evidence and will best preserve the integrity of the evidence for analysis in a forensic laboratory.

**Sample Collection**

One must understand the tools available to collect the sample as well as the limitations posed with a collection process or tool. While most approaches focus on collection tools, it is very important to consider sampling strategies to obtain the most relevant data. This involves strategic planning, logistics, and statistics. Conditions that are proper for collection and/or preservation of one microbe may be deleterious for another and, for that matter, to traditional forensic materials such as human DNA, fingerprints, and trace materials. For example, food-borne pathogens are particularly vexing; conditions that are intended to preserve the material may promote growth of natural bacteria in a food product and this overgrowth may destroy or obscure the initial bio-weapon. Tools for collection need to be validated for efficient collection and for determining that they do not react with the target of interest. Tools developed for powder collection may be inefficient or ineffective for collecting plant material. Sample collection is not trivial and requires substantial consideration.

**Preservation of Forensic Evidence**

The same issues about evidence collection will need to be applied to preservation processes. It is imperative to prevent further degradation of the evidentiary target once collected. Conditions for preservation apply for packaging and shipping, for maintaining of the evidence in the laboratory, and for postanalysis storage.
Extraction
Extraction efficiency, particularly of interest to the scientist, pertains to obtaining the highest quality and quantity yield as possible of the target of interest. Yield is related to the target and removal from the collection matrix. Targets can include cells, nucleic acids, proteins, nutrients, growth materials, and elements.

Advanced Microscopy
Various forms of microscopy may be used to visualize the evidence. These may range from basic to electron microscopy to atomic force microscopy and are available for characterization of a microbe. These approaches are rapid and can be used to identify candidate threats as well as to dismiss hoaxes.

Proteomics
Defining chemical and physical properties of a biological agent can provide information on how and when the agent was produced and can be used to determine if two microbial samples were produced by the same process. Proteomics is a comprehensive study of the protein composition of biological systems at a moment in time or at different stages of the microbe. Many proteins are conserved and can be used for general identification, while other proteins may be expressed based on environmental stimuli, growth state, or growth conditions. Protein profiling can provide information beyond genomic analysis about the conditions of the bioweapon prior to host exposure. Proteomics is a complement to genomics described next.

Genomics
One of the fastest growing areas with implications for microbial forensics is genomics. More rapid and in-depth sequencing of microbes is possible than was a decade ago; methods such as those used in the anthrax-letter attack seem almost antiquated today. Genomic analyses will continue to be essential in identifying species, strains, isolates, and individual samples to assist in a microbial forensic investigation. The rapid expansion of sequencing capabilities, to where sequencing some microbes within a day at very deep coverage, has raised the importance of genetic identification. It will likely be a mainstay of microbial forensics in another attack with any microbe. The cost of whole genome sequencing has decreased at least 100-fold in just a few years. This technology will be one of the methods of choice to examine the genetic structure of a particular pathogen and to identify those signatures of forensic relevance. Likewise, proteomic analysis can comprehensively determine which proteins are present in a sample and will grow in importance to forensics. The legal profession has to have a basic understanding of the capabilities and limitations to be successful in the courtroom, just as has been necessary for human DNA forensics. Several chapters in this book expand on this technology in detail.
Statistical Analysis, Interpretation, and Confidence

Central to interpretation is, when possible, a statistical analysis of the findings. These should be performed to provide significance of the result or to convey the strength of the evidential results. A variety of statistical approaches exist and it is imperative to understand which ones apply to particular analyses and interpretations. Interpretation could be as simplistic as positive or negative to very complex evaluations using limits of detection and to complex algorithms for identifying and characterizing protein moieties. A host of answers and additional questions can arise from data interpretation.

Both scientists and legal analysts need to understand (or at least appreciate) the results and their significance. Moreover, the degree of confidence that can be placed on a result must be understood so that the weight of a comparative analysis is not overstated. Basic statistics, probability, and population genetics are essential requirements of any curriculum involving the analysis of forensic biological evidence.

Bioinformatics

The term “bioinformatics” was developed as a result of the Human Genome Project. Because of the immense amount of data generated, it became necessary to apply more sophisticated computational techniques beyond what the average bench biologist had available. Bioinformatics requires a combination of data handling and analysis skills (including standard statistics) that connect routine biology with high-powered computation. As scientific investigations and data generation expand using high-resolution, deep sequencing of genomes of microbes, and large-scale proteomics, computational analyses will be more critical than ever. This subject can be of value in a simplistic form for the biologist or a more complex form for the computationally inclined scientist. All scientists and individuals with interest in microbial forensic sciences will need to have basic training in statistics and bioinformatic tools.

Indicators of Engineering

With rapid developments in molecular biology to benefit humankind also comes a great potential for manipulating a microorganism for nefarious purposes. Microbes could be engineered to be more potent, and difficult-to-obtain microbes may be synthesized de novo in a laboratory. There is a need to detect not only the microbe but to determine if it was genetically engineered or perhaps is a novel chimera. Synthetic biology is a frontier arena, in some respects, and manipulations or synthesis signatures may be detected through sequencing and bioinformatics. The skills and materials needed to manipulate a microbial genome may provide clues about the perpetrator and degree of sophistication used to develop the biothreat agent. This capability should
be of interest to law enforcement and the intelligence community for supporting investigative leads.

**Population Genetics**
Population genetics is essential for understanding the rarity of a genetic (and sometimes protein) profile derived from an evidence sample. Molecular epidemiology is increasingly applying the principles of evolutionary and population genetics to pathogens. It is important to understand what constitutes a sample population as opposed to a sample collection, the mode of inheritance related to a genetic marker, what significance or weight to apply to a genetic marker, what the mutation rate of a marker is, and how to combine the weight of multiple markers. Training of the student in this discipline will require basic genetics courses and more advanced courses in phylogenetic analyses. Such educational material will be found in population genetics and systematic and evolutionary biology programs. The population genetics of pathogens and its importance for microbial forensics are covered elsewhere in this book.

**Nonbiological Tools**
This topic is broad and can encompass tools that characterize a microbe morphologically or chemically. These will range from microscopy to basic chemistry to analytical chemistry applications. The Amerithrax investigation demonstrated the importance of nonbiological measurements on samples of biological agents. A variety of mass spectral, spectroscopic, and other instrumental methods were used in an attempt to answer questions related to how, when, and what materials were used to produce the anthrax powders. Such information can be used to compare evidence directly to a reference sample or, indirectly, to infer something about the processes used to culture, stabilize, and/or disseminate the biothreat agent.

**FORENSIC SCIENCE**
Forensic science is the application of science to answer questions of interest to a legal system as well as for military or state decisions (1,6,7). While science may not offer definitive solutions to the problems of society, it does serve a special investigative role, particularly in the criminal justice system. The areas of science that have been traditionally exploited are diverse, but typically include the major disciplines of biology, chemistry, physics, and geology. Within each discipline are many scientific subcategories that may be used in a forensic science investigation. For example, within the discipline of biology are the subdisciplines of medicine, pathology, molecular biology, immunology, odontology, serology, psychology, and entomology. The specific discipline(s) applied
depends on the circumstances of the crime. Mathematics, especially statistics, is used to place weight or significance on observations or data retrieved from crime scene evidence. The ultimate question addressed by forensic science is usually “who committed the crime?” (i.e., attribution), and crime scene evidence can play a role in answering that question. Evidence can be any material, physical or electronic, that can associate or exclude individuals, victim, and/or suspect with a crime. It typically comprises materials specific to the crime and to control samples for background information. Types of evidence may be fingerprints, blood, semen, saliva, hair, fibers, documents, photos, computer files, videos, firearms, glass, metals, plastics, paint, powders, explosives, tool marks, and soil. The student needs to be cognizant of the types of evidence, how these different forms of evidence interplay, and how they can be used to help reconstruct the crime and/or identify the perpetrator.

**CASE HISTORIES**

A case history is a detailed account of a person or event. Studies of case histories are instructive because they provide analysis of information in the relevant context, including real complexities. The study of each incident can be tailored to the particular group learning about them. The Amerithrax case is likely to be studied for years by many different groups ranging from scientists to law enforcement to lawyers. In addition to this case, many other cases are described in chapters of this book and the previous edition (6), as well as in specific publications (8). Among these threats are food-borne illnesses from bacteria, such as *Shigella* and *Salmonella*, and toxins such as ricin. In addition, there have been events directed at agriculture, including foot-and-mouth outbreaks in the United Kingdom and mad cow disease in the United States in 2003. Environmental contamination is also an area of interest, such as water contamination by the poultry industry in Arkansas. Perhaps the most common area where issues of natural versus intentional events arise is related to emerging infections. This question has arisen with the outbreaks of influenza H1N1, severe acute respiratory syndrome, monkey pox, and specific cases of HIV infection.

**LEGAL ISSUES**

Legal issues are of obvious importance to the legal community but are also important to the scientific community. There will be times when the evidence will be used in a court of law to prosecute an individual who has been arrested for a biocrime. There are standards for admissibility of scientific evidence in a legal setting. The scientist may be asked to provide expert
testimony. These need to be known and appreciated so that the burden of admissibility of evidence can be achieved. The government will use forensic scientists and their results, other experts, and the scientific literature to support its position. The defense will defend its client vigorously to attempt to achieve an acquittal. Because of the adversary system in the United States and other English-based law countries there will be challenges to the credibility of the science and the practitioners (7,9). Studying the science behind headlines can be a very instructive and creative way to interest students. A current controversy in forensics, which can be used instructively, involves the use of low copy number of DNA (10,11). News headlines have revolved around this topic in relationship to its use in court trials.

The standards and court proceedings, however, will vary for each country. For example, in the United States, possession of unauthorized material can be considered a crime by itself.

**OPERATIONAL AND INTELLIGENCE ISSUES**

Evidence derived from a microbial forensic investigation may not necessarily end up in court. For example, such evidence can be used for intelligence purposes. Information can be gathered to determine risk or probability of an individual, a group, or a state that may plan to use (or has used) a bioweapon in an attack. The primary goal is to intercede and thwart the attack before it can happen. Alternatively, if an attack has occurred, a head of state may require some evidence to determine whether to retaliate and to whom retaliation should be directed. Use of microbial evidence is far reaching and has consequences. Training individuals in understanding the strengths and limitations of scientific evidence is essential so that proper decisions and responses can be made. Understanding how information is gathered, analyzed, and acted upon is likely to be of interest to any level of student.

**NATIONAL-LEVEL CAPABILITIES AND RESOURCES**

Policy and decision makers need to learn about and support advances in microbial forensic strategies and capabilities, such as was described in the “National Science and Technology Council, National Research and Development Strategy for Microbial Forensics, Office of Science and Technology Policy, 2009.” The following should be addressed: (i) What and how should a country be prepared? (ii) What strategies make sense? (iii) Planning, implementing, and measuring effectiveness. (iv) Training and evaluation exercises. (v) Where can additional support be sought? (vi) Leveraging of epidemiological tools.
CONCLUSION

Disciplines related to microbial forensics are evolving rapidly. This evolution includes technology, analytical capabilities, and, equally as important, education and training. This book is one form of education that should accompany advances in the field of microbial forensics. Other forms of education should include didactic lectures, practical demonstrations, and discussions at specialty societies. The target audience may include college students, bench scientists, law enforcement agents, medical care and first responder personnel, lawyers, and judges. Those who fulfill teaching roles, whether by profession or indirectly as reporters and even entertainment writers, can become informed so that their writings are founded in facts.

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