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Microbial Forensics: An Emerging Field and a National Need

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Microbial forensics is a newly emerging discipline with an epidemiological foundation dedicated to the characterization, analysis and interpretation of evidence from the scene of acts of bioterrorism or biocrimes [1]. It is the same as other forensic disciplines except for its focus on a particular type of crime [2]. Microbial forensic scientists employ comprehensive assays to identify the origin of a pathogen or toxin using a number of techniques. The purpose of these assays specifically is to track down perpetrators, termed "high tech crime", who employ use of biological weapons. Since the 2001 anthrax attacks, members of the biosecurity community and U.S. government officials have expressed a growing sense of alarm at the threats of biological attacks. In particular, the anthrax mailings had a disastrous and devastating impact on human health, society, and economy. The threat of terrorist or criminal use of pathogenic organisms and their toxins remains of great concern in the United States and other countries in the world. The need to conduct microbial forensic analyses to combat bioterrorism and biocrime in a rigorous scientific manner is urgent. To address this challenge, we must systematically investigate the bacteria, viruses, and fungi as well as their pathogens, toxins, and disease, and the research activities should include the detection, identification, and characterization of these microbial pathogens. *Bacillus anthrax*, also named "Amerithrax," is the first example being extensively studied in microbial forensics [3]. The collection and preservation of microbial samples is one of the most important topics in microbial forensics. The main areas in microbial forensics are forensic analysis of bacteria pathogens, *rickettsia* and *coxiella* diseases, fungal pathogens, plant toxin *ricin*, influenza virus, and biological toxins Botulinum Neurotoxin (BoNT). Many of the pathogens are air and water borne diseases. Microbial forensics is highly disciplinary, relying upon microbiology, computer technology, biochemistry, and biophysics to drive the traditional criminalistics aspects of forensic examination and investigation. The different methodologies include the traditional use of host factors, genomics, proteomics, electron beam-based, high-throughput sequencing, and non-biological measurements.

As the small-subunit ribosomal RNA, such as 16S RNA, is conserved in all life forms, its sequence can provide a relatively accurate "tree of life". Previous studies on detection and identification of microbial agents are generally DNA-based analyses. The primary focus is placed on classification, detection, and identification of these microorganisms and pathogens. In the past ten years, the field of microbial forensics has expanded significantly in its ability to detect and identify the source of microorganisms and toxins, which are used in cases of bioterrorism and biocrimes. However, there is relatively limited information available on the detailed characterizations of biological pathogens including air and water borne diseases.

Future efforts should be to continue the development of the sensitive, fast, and accurate analytical methodologies for detection and identification of the pathogens including biosensors and nanotechnology, as well as detailed characterizations of these pathogens under diverse conditions. As equally important as the research activities in microbial forensics, education and training in microbial forensic is needed for the workforce that will become the qualified scientists and leaders in the field. Future investigations of bioterrorism and biocrimes will be multifaceted and demand integration and collaboration between the scientific community and government agencies. We believe that the science of microbial forensics will play a vital role and make important contributions in protecting humankind now and in the future.

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