Forensic Technology Center of Excellence

MICROBIAL FORENSICS WEBINAR SERIES

Final Report

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Information provided herein is intended to be objective and is based on data collected during primary and secondary research efforts available at the time this report was written. The information provided herein is intended to provide a summary of the microbial forensics webinar series; it is not intended as an exhaustive summary of the field of microbial forensics.

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The Forensic Technology Center of Excellence (FTCoE)

The FTCoE is a collaboration of RTI International and the following academic institutions, which are accredited by the Forensic Science Education Programs Accreditation Commission (FEPAC): Duquesne University, Virginia Commonwealth University, and the University of North Texas Health Science Center. In addition to supporting NIJ's research and development (R&D) programs, the FTCoE provides testing, evaluation and technology assistance to forensic laboratories and practitioners in the criminal justice community. NIJ supports the FTCoE to transition forensic science and technology to practice (award number 2011-DN-BX-K564).

FTCoE is led by RTI, a global research institute dedicated to improving the human condition by turning knowledge into practice. With a staff of more than 4,700 providing research and technical services to governments and businesses in more than 58 countries, RTI brings a global perspective. FTCoE builds on RTI's expertise in forensic science, innovation, technology application, economics, data analytics, statistics, program evaluation, public health and information science.

CONTENTS

Appendices

1. INTRODUCTION

1.1 Project Background

In 2016, the National Institute of Justice's Forensic Technology Center of Excellence (FTCoE) at RTI International hosted a three-part webinar series on Microbial Forensics in collaboration with the University of North Texas Health Science Center (UNTHSC). The objective of this webinar series was to discuss the history and basics of microbial forensic investigations, provide the viewer with an understanding of microbiology as applied to forensics, and evaluate the ways in which microbial forensics can be expanded to resolve forensic casework.

The microbial world is vast and diverse. There are more microbes on earth than there are stars in the universe. Indeed, the world as we know it would not exist without microorganisms. While some microorganisms are beneficial, there are others that cause disease. These disease causing microorganisms can and have been used as bioweapons to cause harm to people, animals, and plants in which the effects can have a serious impact on our health, economy, and general safety. Understanding basic microbiology, the indicators of development and use of bioweapons, and the associated risks for victims can be important for the forensic scientist who may be the first exposed to this type of crime scene evidence. The field of microbial forensics garnered community wide support in response to the 2001 anthrax letter attacks. In its earliest conception, the field of microbial forensics was narrowly defined to support investigations involving bioterrorism and biocrime. However, over the past few years there have been substantial technical and bioinformatic advances which enhance the capability to type microbial evidence as well as expand the characterization of microbes and their products, therefore supporting a wider range of forensic investigations. Some of these areas include using microbes for human identification, postmortem interval determination, and tracing infections in criminal and civil cases. Microbial forensics today can be broadly defined as the discipline of characterizing microbiological evidence to develop investigative leads in criminal and civil cases.

This report summarizes the content of the 2016 three-part webinar series, as well as the reception of the series by the forensics community. The project team made surveys available to all participants immediately following each webinar to obtain data metrics to assess the quality and impact of discussion content, and to gain information on the structure of the web audience. The webinar series and this document is available on the FTCoE website, www.ForensicCOE.org, therefore providing the community with a resource for future reference and sustainability.

1.2 Project Team

This project was a collaborative effort with UNTHSC, whose primary consultant and discussion leader was Dr. Bruce Budowle. Dr. Budowle is currently the executive director of UNTHSC's Institute of Applied Genetics and professor in the Department of Molecular and Medical Genetics. He was previously employed by the Federal Bureau of Investigation (FBI) for 26 years and is an expert in forensic genetics.

Representing RTI, Dr. Patricia Melton from the Center for Forensic Sciences was the FTCoE project leader responsible for project coordination and logistics. Dr. Melton is a senior research forensic scientist and has nearly a decade of experience as a forensic DNA analyst and has been on the faculty of two universities.

The speakers were an integral part of the overall goal of describing the role of microbial forensics in relationship to criminal and civil investigations. Choosing speakers with backgrounds relevant to the topics presented within each webinar ensured greater impact and more powerful discussion. The participants varied in the level of experience and application of microbial forensics. ***Table 1*** summarizes the subject content and speakers for the entire webinar series. Biographies of speakers are available in ***Appendix A***.

Table 1. Summary of Webinar Series

Broadcast Date	Speakers	Subject Content
Session 1: **May 4, 2016** Learning About Microbial Forensics	Dr. Bruce Budowle Institute of Applied Genetics, UNTHSC Sarah Schmedes Institute of Applied Genetics, UNTHSC	• Birth of the field of Microbial Forensics • History of Biocrime and Bioterrorism • Basics of Microbial Forensics • Epidemiology • Goals of Investigations • Select Agent Rule/Threat Assessment
Session 2: **May 18, 2016** Basics of Microbiology as they Apply to Microbial Forensics	Dr. Bruce Budowle Institute of Applied Genetics, UNTHSC Dr. Dana Kadavy Director of Biological Science, Signature Science, LLC	• Complexity of the Challenge • Microbiology • Pathogens • Human Microbiome • Genetic Engineering/Synthetic Biology
Session 3: **June 15, 2016** Expansion of Microbial Forensics	Dr. Bruce Budowle Institute of Applied Genetics, UNTHSC Dr. Heather Jordan Department of Biological Sciences, Mississippi State University	• Biocrime – HIV/HCV Cases • Postmortem Interval • Pathogens • Capabilities • Legal Issues • Role of the Forensic Scientist - Awareness

2. MICROBIAL FORENSICS WEBINAR SERIES

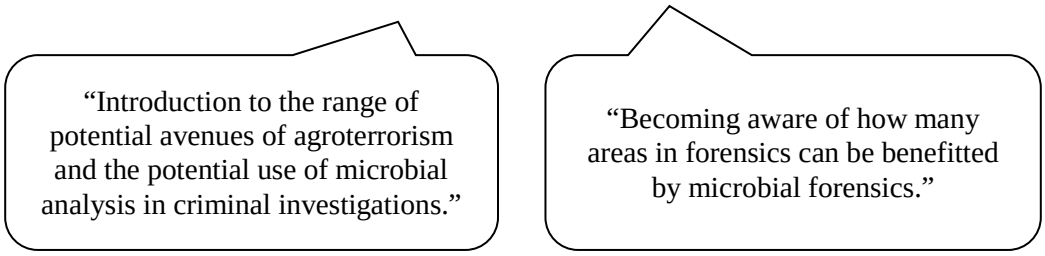
2.1 Webinar Session 1: Learning about Microbial Forensics

Objectives

- Provide a better understanding of the history of microbial forensics.
- Outline the role microbial forensics plays in combatting bioterrorism.
- Explain the basics of microbial forensics.
- Discuss epidemiologic considerations that may suggest a bioterrorist attack.
- Discuss investigation goals pertaining to biological crimes and bioterrorism.

A total of 90 registrants attended the webinar. The majority listed themselves as forensic DNA specialists (23%) or forensic practitioners (20%), with an additional 6% representing crime laboratory directors. The remaining attendees were law enforcement personnel (8%), legal representatives (6%), from academia (17%), or of other professions (20%). An event performance sheet (EPS) captured the specific demographic and impact information of this webinar. ***Appendix B*** includes the EPS for this webinar.

The project team asked webinar participants the following question: "What was the biggest benefit of attending this webinar?" Some of the feedback included the following responses:



Summary of Webinar Session 1

This session presented an overview of microbial forensics, anthrax typing, threat assessment, and select agent regulations. To illustrate the importance of the field of microbial forensics, Dr. Bruce Budowle kicked off the webinar series with a case study – the anthrax letters attack in the fall of 2001, just days after the terrorist attacks of September 11, which resulted in five deaths due to anthrax inhalation. As the first major bioterrorism investigation in the United States, the anthrax attack changed the view of the nation's security system and demonstrated the need for a coordinated national response for threat assessments countermeasures as well as forensics for biological agents. The government relied on the country's assets and scientific prowess to investigate the forensic evidence necessary to characterize the microbes in question for source attribution using existing technologies. The origin of the letters were traced to a single postal collection box and scientists were able to type the strain of *Bacillus anthracis* (anthrax) using

multiple locus variable number tandem repeat analysis (MLVA) and whole-genome sequencing technology. Scientists were also able to locate the spore stock from which the anthrax in the letters was derived. Using genetics and comparative genomics to determine the anthrax source, microbial forensics was able to complement traditional police investigative work during the aftermath of the anthrax letter attacks.

The four mission areas of bioterrorism are prevent terrorism, pursue terrorists, protect our nation, and prepare for the consequences of an attack. Microbial forensics is the analysis of evidence from a bioterrorism act, biocrime, or inadvertent microorganism/toxin release for attribution purposes and can aid in the four mission areas of bioterrorism. Essentially the same as any other forensic discipline, the objective of microbial forensic is to compare evidence to reference samples and determine source attribution.

Dr. Budowle discussed how microbial forensics is truly an intersection of disciplines, including genomics, epidemiology, microbiology, and biochemistry. For example, epidemiology, the study of the distribution and determinants of disease, plays a major role in microbial forensics. Among other factors, the occurrence of a disease caused by an uncommon agent, a number of ill persons seeking treatment at the same time, or a large number of unexplained deaths may indicate a bioterrorist attack. Stemming from epidemiology, microbial forensics as a whole goes beyond an examination of the distribution of a public health event and determines source attribution.

Dr. Budowle also discussed how microbial forensics plays a role in agroterrorism and human identification using the microbiome. Agroterrorism is the use of biological, chemical, or radiological agents against a component of agriculture to adversely impact the agriculture industry, the economy, or the consuming public. Humans carry over 90 trillion microbes and the microbiome is unique to every individual. Microbial forensics can characterize microbiological evidence to develop investigative leads in criminal and civil cases.

During the last part of this webinar session, Sarah Schmedes focused on threat assessment and select agent regulations as they pertain to microbial forensics. Threat assessment is broadly interpreted as evaluation of impending danger or harm by a person, group, circumstance, or set of conditions. The National Strategy for Countering Biological Threats (NSC) stressed the beneficial nature of advances in the life sciences and their importance in combating infectious diseases, protecting the environment, expanding energy options, and enhancing agricultural production. Public health, law enforcement, and the Federal Bureau of Investigation (FBI) all play a role in threat assessment; public health officials conduct epidemiological investigations, law enforcement investigates any actual or threatened use of a disease-causing microorganism or biological agent, and the FBI initiates a threat credibility assessment any time a potential attack occurs.

In order to limit access to unauthorized pathogenic microorganisms, U.S. legislation created the Select Agent Program in 1997. A multiagency committee was commissioned by the Secretary of the Department of Health and Human Services (HHS) to develop regulations to protect the public without impeding scientific and medical research. Since the establishment of the Select Agent Program, additional acts have placed further regulations on handling or possessing select agents and toxins; the Patriot Act, which was signed into law by President George W. Bush following the 2001 anthrax attack, and the Public Health Security and Bioterrorism Preparedness and Response Act of 2002. The U.S. Department of Agriculture (USDA) also maintains a list of each biological agent and toxin that the USDA Secretary determines has the potential to pose a severe threat to the public.

2.2 Webinar Session 2: Basics of Microbiology as they apply to Microbial Forensics

Objectives

- Provide an understanding of microbiology as applied to forensics and the role it plays in combating bioterrorism.
- Discuss the complexity of the challenges in the field of microbial forensics.
- Explain how pathogens, the human microbiome, and genetic engineering/synthetic biology relate to microbial forensics.

A total of 63 registrants attended the webinar. The majority listed themselves as forensic practitioners (32%) or from academia (29%). The remaining attendees were law enforcement personnel (18%), forensic DNA specialists (11%), crime laboratory directors (7%), or of other professions (3%). An event performance sheet (EPS) captured the specific demographic and impact information of this webinar. ***Appendix C*** includes the EPS for this webinar.

The project team asked webinar participants the following question: "What was the biggest benefit of attending this webinar?" Some of the feedback included the following responses:

"The knowledge of what is being pursued in terms of forensic microbiology. I was able to obtain an overview of several aspects being considered."

"Acquiring knowledge about forensic microbiology, identifying new challenges in this field, and identifying other areas for research."

Summary of Webinar Session 2

During this webinar session, Dr. Dana Kadavy discussed the microbial forensic process, challenges encountered within microbial forensics, and provided a brief introduction to microbiology and pathogens. Similar to other areas of forensics, the microbial forensic process involves sample collection, processing,

analysis, report writing, and expert witness testimony. Possible sample types include water, soil, food, biological samples, and agriculture materials. One of the biggest challenges faced by microbial forensics is advancing from simple sample comparison to confirmatory inferences. Since prokaryotic diversity is essentially infinite and an organism's composition can change over time, it can be difficult to reliably obtain source attribution. Another challenge microbial forensics face is that analytical methods are vast. A wide variety of technologies are available including traditional morphological approaches, massively parallel sequencing, field immunoassays, and secondary ion mass spectroscopy. In addition to the vast amount of analytical methods, many forensic targets exist including genetics, proteins, morphology, and biochemistry. Where should an analyst begin? Which methods should be validated? Do reference standards exist? There are many paths a forensic analyst can take but the correct path must be taken in order to answer the question being asked. Moving forward, microbial forensics experts must be identified, technologies must be reviewed, scientific working groups must form guidelines, and validation methods must be defined more clearly.

In the introduction to microbiology during this webinar session, Dr. Kadavy briefly discussed the differences in organism cell structure between prokaryotes and eukaryotes, the central dogma of molecular biology, genome structure and the differences between human, bacterial, and viral genomes, protein structure, plasmids, and natural mechanisms of genetic modification. An overview of bacterial, viral, and toxin detection was also presented. Biological agents can be pathogens as well as toxins. Pathogens are a specific causative agent of disease and can be classified as bacteria, viruses, and fungi. Examples of pathogens include anthrax and smallpox. Toxins are the "poison" produced by an organism and include any toxic substance of natural origin produced by an animal, plant, fungi, or bacteria. Toxins illicit an immune response and while some are helpful, such as penicillin, many can be life-threatening. An understanding of microbiology is essential within microbial forensics in order to correctly identify evidentiary samples.

An overview of the human microbiome was also discussed during this webinar session by Dr. Bruce Budowle. The human microbiome is collectively all of the microbes in or on the human body, and approximately 91% of the cells in our bodies are non-human microbial cells. Examples of microbes include fungi, bacteria, and viruses. Among others factors, our microbiome changes as we age and mature, with pregnancy, with diet, and with exposure to pets at home. The microbiome is unique to every individual and may be used for human identification. The goals of the Human Microbiome Project, a National Institute of Health (NIH) initiative, include developing a reference set of sequences and preliminary characterization of the human microbiome, developing new technologies and tools for computational analysis, and establishing a data analysis and coordinating center. Since microorganisms are shed, deposited, and

exchanged routinely, they may provide forensic signatures for identity testing purposes. Also, since different microorganisms are located in different areas of the human body, establishing a tissue source of forensic biological evidence may be possible.

During the last part of this webinar session, Dr. Budowle discussed how genetic engineering and synthetic biology relate to microbial forensics. Genetic engineering involves the addition, deletion, or manipulation of a single trait in an organism to create a desired change. Synthetic biology combines engineering with biology to manipulate living things. Synthetic biology becomes a security risk when it involves the synthesis of biological agents intended to inflict harm. In the future, a biological security strategy to recognize this reality and advances in the field of microbial forensics must occur in order to aid in investigations involving synthetic organisms.

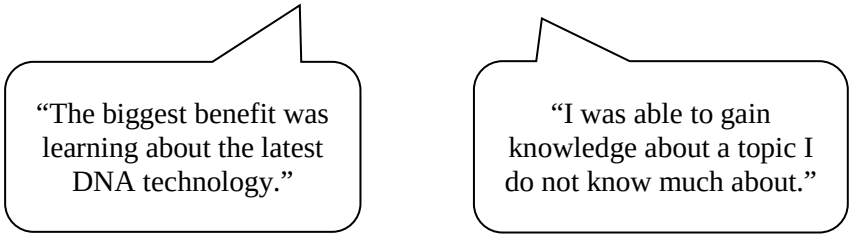
2.3 Webinar Session 3: Expansion of Microbial Forensics

Objectives

- Evaluate the ways in which microbial forensics can be expanded to resolve forensic casework.
- Provide an overview of how microbial forensics can determine the postmortem interval.
- Discuss how agroterrorism relates to microbial forensics.

A total of 45 registrants attended the webinar. The majority listed themselves as forensic practitioners (39%) or forensic DNA specialists (25%), with an additional 4% representing crime laboratory directors. The remaining attendees were law enforcement personnel (11%), from academia (18%), or of other professions (3%). An event performance sheet (EPS) captured the specific demographic and impact information of this webinar. ***Appendix D*** includes the EPS for this webinar.

The project team asked webinar participants the following question: "What was the biggest benefit of attending this webinar?" Some of the feedback included the following responses:



Summary of Webinar Session 3

The final session of the microbial forensics webinar series discussed the ways microbial forensics can be expanded to resolve forensic casework. Dr. Heather Jordan discussed how microorganisms can provide insights into time since death, cause of death, the origin of biocrimes, sexual assault, medical

malpractice, and trace evidence. Research on soil communities, animal studies, and human studies help discover how microbes can serve as indicators of the postmortem interval, or time since death. As the time since death increases, the stages of decomposition progresses. Human decomposition results in release of ammonia rich nutrients, which alters the pH and nutrient content of the surrounding area. These changes stimulate microbial activity. Animals and insects can also further increase microbial activity. By studying microbial activity present, time since death can be estimated. Factors affecting soil associated with microbial communities include temperature, moisture, soil type and texture, burial, and season. These factors should be considered when performing studies on the postmortem interval. Dr. Jordan also presented current research projects, including results obtained from a recent grant from the NIJ (2014-DN-BX-K008). Dr. Jordan, in collaboration with colleagues, is studying postmortem changes and translocation of bacterial community structure and function for use in criminal investigations. The objective of this research is to describe how the microbiome of a living host changes and transmigrates within the body after death. Another portion of Dr. Jordan's funded work involves understanding the human postmortem microbiome during death investigations. The aim of this study is to describe human bacterial communities on different areas of cadavers in relation to manner of death and postmortem interval in a major, metropolitan city (Detroit, MI).

For the final portion of this webinar session, Dr. Bruce Budowle discussed how microbial forensics can aid in the investigation of an agroterrorism attack. Agroterrorism has the potential to place food supply at risk, disrupt food production, cripple a nation's economy, and destabilize governments. Although food produced in the U.S. may be safe, food from other countries may not, and each day the average American consumes food from over 30 countries. Throughout this webinar session, many examples of public health outbreaks were discussed, including the Chilean grape scare of 1989, the deliberate and illegal importation of rabbit hemorrhagic disease virus (RHDV) into New Zealand in 1997, an outbreak of foot and mouth disease (FMD) in the United Kingdom in 2000, and an outbreak of mad cow disease in Canada in 2003. The Food and Drug Administration (FDA) and USDA are responsible for containing public health risks. Once an outbreak has occurred, suspected hazardous material will be collected and sent to a network of labs for the identification of biological or chemical pathogens. Effective epidemiological and forensic investigations must be developed to locate the origin of the outbreaks, contain the outbreak, determine if the cause is natural or manmade, and determine source attribution. In order to establish a robust microbial forensics program to aid in investigations, robust analytical methods must be developed and validated. Also, databases on pathogen genetics and other biological data need to be created in addition to a strain repository.

3. COMPLETE SESSION HIGHLIGHTS AND SUMMARY

Nearly 200 online participants from around the world attended the live FTCoE webinar series. The participants represented forensic practitioners and professionals including forensic DNA specialists, laboratory directors and managers, legal and law enforcement representatives, and academics. In this three part series, participants gained a better understanding of microbiology as applied to microbial forensics and the role it plays in combating bioterrorism. While some microorganisms are beneficial, there are others that cause disease and have been used as bioweapons to cause harm to people, animals, and plants, the effects of which may have a serious impact on our health, economy and general safety. Over the past few years there have been substantial technical and bioinformatic advances which enhance the capability to type microbial evidence as well as expand to the characterization of microbes and their products, therefore supporting a wider range of forensic investigations. Leaders in the field of microbial forensics provided participants with an overview of the history of microbial forensics, threat assessment, select agent regulations, microbiology, human identification using the microbiome, and possible avenues of bioterrorism. Participants benefited from attending the webinars by acquiring a detailed overview of microbial forensics, learning about challenges in the field, and identifying future areas for research.

Appendix A: Biographies

Bruce Budowle

Dr. Bruce Budowle received a Ph.D. in Genetics in 1979 from Virginia Polytechnic Institute and State University. From 1979-1982, Dr. Budowle was a postdoctoral fellow at the University of Alabama at Birmingham. Working under a National Cancer Institute fellowship, he carried out research predominately on genetic risk factors for such diseases as insulin dependent diabetes mellitus, melanoma, and acute lymphocytic leukemia.

In 1983, Dr. Budowle joined the research unit at the FBI Laboratory Division to carry out research, development, and validation of methods for forensic biological analyses. The positions he has held at the FBI include: Research Chemist, Program Manager for DNA Research, Chief of the Forensic Science Research Unit, and the Senior Scientist for the Laboratory Division of the FBI. Dr. Budowle has contributed to the fundamental sciences as they apply to forensics in analytical development, population genetics, statistical interpretation of evidence, and in quality assurance. Some of his technical efforts have been: 1) development of analytical assays for typing myriad protein genetic marker systems, 2) designing electrophoretic instrumentation, 3) developing molecular biology analytical systems to include RFLP typing of VNTR loci and PCR-based SNP assays, VNTR and STR assays, and direct sequencing methods for mitochondrial DNA, 4) new technologies; and 5) designing image analysis systems. Dr. Budowle has worked on laying some of the foundations for the current statistical analyses in forensic biology and defining the parameters of relevant population groups. He has published approximately 550 articles, made more than 700 presentations (many of which were as an invited speaker at national and international meetings), and testified in well over 250 criminal cases in the areas of molecular biology, population genetics, statistics, quality assurance, forensic genetics and forensic biology. In addition, he has authored or co-authored books on molecular biology techniques, electrophoresis, protein detection, microbial forensics, and forensic genetics. Dr. Budowle has been involved directly in developing quality assurance (QA) standards for the forensic DNA field. He has been a chair and member of the Scientific Working Group on DNA Methods, Chair of the DNA Commission of the International Society of Forensic Genetics, and a member of the DNA Advisory Board. He was one of the initial architects of the CODIS National DNA database, which maintains DNA profiles from convicted felons, from evidence in unsolved cases, and from missing persons.

Some of Dr. Budowle's efforts over the last 15 years also are in counter terrorism, including

identification of victims from mass disasters and in efforts involving microbial forensics and bioterrorism. Dr. Budowle was an advisor to New York State in the effort to identify the victims from the WTC attack. In the area of microbial forensics, Dr. Budowle has been the chair of the Scientific Working Group on Microbial Genetics and Forensics, whose mission was to set QA guidelines, develop criteria for biologic and user databases, set criteria for a National Repository, and develop forensic genomic applications. He also has served on the Steering Committee for the Colloquium on Microbial Forensics sponsored by American Society of Microbiology, an organizer of four Microbial Forensics Meetings held at The Banbury Center in the Cold Spring Harbor Laboratory, and on steering committees for NAS sponsored meetings.

In 2009 Dr. Budowle became Executive Director of the Institute of Applied Genetics and Professor in the Department of Molecular and Medical Genetics at the University of North Texas Health Science Center at Fort Worth, Texas. His current efforts focus on the areas of next generation sequencing, human forensic identification, microbial forensics, pharmacogenetics, and emerging infectious disease.

Patricia Melton

Dr. Patricia Melton is currently a Senior Research Forensic Scientist in the Center for Forensic Sciences at RTI International. In this capacity, she implements and procures educational courses to facilitate the knowledge transfer of current forensic DNA technology to law enforcement and judicial practitioners. She also serves as a project team member for the knowledge transfer and best practices development within the forensic community for responses to sexual assaults. Dr. Melton possesses the following specialized skills in forensic sciences: serological screening for biological fluids; nuclear DNA extraction of swabs; bloodstains, tissue, bone, hair roots, and teeth; and nuclear DNA extraction from “touch” DNA samples. In addition, she has specialized skills in short tandem repeat (STR) analysis. Dr. Melton has experience with providing courtroom testimonies and exceeds the education requirements for a DNA Forensic Casework Analyst as established by the FBI Quality Assurance Standards. Dr. Melton has been on the faculty of two universities and actively participates in the certification program for crime laboratories under the American Society of Crime Laboratory Directors/Laboratory Accreditation Board (ASCLAD/LAB) regulations and requirements (legacy and International Organization for Standardization [ISO] programs).

Sarah Schmedes

Sarah E. Schmedes, M.S., is a Ph.D. Candidate, studying under the direction of Dr. Bruce Budowle, in the Department of Molecular and Medical Genetics at the University of North Texas Health Science Center (UNTHSC), in Fort Worth, TX. She earned her Bachelor of Science in biochemistry and microbiology from Texas State University in San Marcos, TX and earned her Master of Science in forensic biology from University of Albany, State University of New York. While pursuing her master's degree, Sarah completed an internship at the McMaster Ancient DNA Centre at McMaster University in Hamilton, ON, directed by Dr. Hendrik Poinar. Prior to enrolling in the molecular genetics doctoral program at UNTHSC, she served as a forensic research assistant in the Institute of Applied Genetics at UNTHSC. She has published 9 manuscripts and 1 book chapter during her graduate career. Sarah is a student member of the American Society for Microbiology and was a recipient of the 2014 Eugene and Millicent Goldschmidt Graduate Student Award, awarded by the Texas Branch-American Society for Microbiology. Her research interests include metagenomics, microbial forensics, and emerging infectious diseases.

Dana Kadavy

Dr. Kadavy is a credentialed Project Management Professional (PMP) by the Project Management Institute and an active Crime Laboratory Director holding full membership with the American Society of Crime Laboratory Directors – ASCLD. Dr. Kadavy runs an active, accredited forensic laboratory and has supported microbial forensic investigations and Programs since 2001. Dr. Kadavy has supported the Department of Defense, Department of Homeland Security (DHS) and the Federal Bureau of Investigation (FBI) as a Program Manager and Subject Matter Expert since 2003. Dr. Kadavy served as the manager of a large, long-standing program focused on the evaluation and statistically defensible validation of collection and analytical methods for the identification of CBRNE forensic signatures for DOD. Dr. Kadavy has served as the Principal Investigator (PI) or SME across microbiological, molecular biology, and forensic research projects. She provides technical leadership and oversight for DOD programs designed to improve analytical capability (from sample collection to bioinformatics analysis and reporting) in the areas of human and microbial DNA forensics. As Director of the Signature Science Forensic Laboratory in Austin, TX, Dr. Kadavy is responsible for the oversight and technical defensibility of human DNA operations, including obtaining and retaining ASCLD-Lab/I accreditation. Dr. Kadavy served as the Lead Subject Matter Expert

(SME) in a Microbial Forensic Program for DOD where she provides technical leadership and guides the development and validation of the technical aspects of this microbial forensic initiative – including development and delivery of bioinformatics solutions. Dr. Kadavy participated in the U.S. National Academy of Sciences-sponsored "Science Needs for Microbial Forensics: Developing an International Roadmap (Zagreb, HR, Oct, 2013)" as an invited speaker and recognized expert in microbial forensics. Dr. Kadavy is an active participant in the early access program for the MinION™ next generation technology, where she is investigating and publishing in forensic applications of next-generation sequencing technology for both microbial and human identification.

Prior to her move to Austin, Dr. Kadavy served as the Chief of Bacteriology in the Division of Infectious and Parasitic Diseases at the Armed Forces Institute of Pathology in Washington, DC. Dr. Kadavy supervised and coordinated microbiology and molecular biology tasks in both BSL-2 and BSL-3 laboratories. Dr. Kadavy provided consultation to State Department-funded projects to reduce the threat of biological weapons. She was an active participant in the Laboratory Response Network (LRN) and coordinated the assay development and analysis of over 5000 environmental samples (filters and other complex matrices) for the presence of viable Bacillus anthracis and other biological threat agents in support of FBI investigations.

Heather Jordan

Dr. Jordan received her Ph.D. from the University of Tennessee, Department of Microbiology in 2008. She is currently an assistant professor in the Department of Biological Sciences at Mississippi State University. Her research focuses on microbial response in dynamic environments. She combines classical microbiology and genomics/transcriptomics involving next-generation sequencing to determine microbial community structure and function under several environmental and host niches and conditions in an effort to elucidate how each attribute contributes to individual cell signaling and overall microbial community fitness, and host health. Additionally, she is also experienced in genetic manipulation of bacterial species as well as imaging technologies, and has also published infection studies using animal models. She has published 20 peer-reviewed journal articles, 4 book chapters, and 10 conference proceedings. According to Google Scholar, she has 391 citations. She is the PI on the National Institute of Justice funded grant: "Postmortem Changes and Translocation of Bacterial Community Structure and Function for use in Criminal Investigations."

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Learning about Microbial Forensics - Microbial Forensics 1

NIJ Live Online Workshop

MAY 6
2016

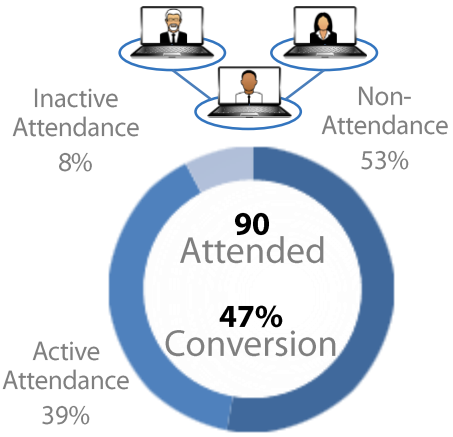
1 PM ET
Duration: 120 minutes

Format: Live Online

Dr. Bruce Budowle of the University of North Texas Health Science Center, will present on the basics of microbial forensics, epidemiology and the goals of investigation pertaining to biological crimes and bioterrorism. Participants will gain a better understanding of the history of microbial forensics and the role it plays in combating bioterrorism.

Attendee Interactivity Rate

Online Participation



Instruction Minutes: 9,015
Activity Minutes: 22,920
Registered: 191

Each event is tracked by the following:
Non-attendance rate: Those who registered but did not attend divided by registration (an indication of conversion from registration to attendance).

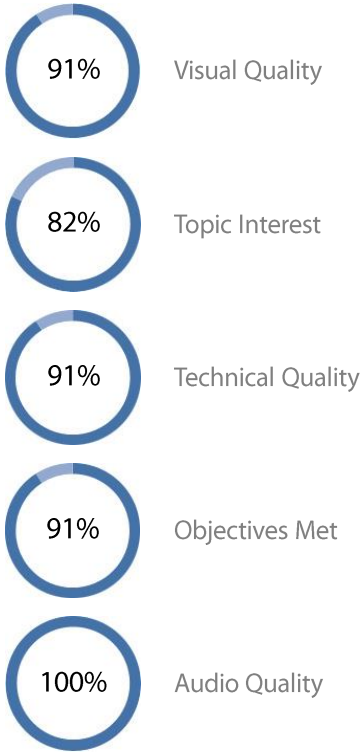
Active attendance rate: Rate at which registrants attend and interact consistently throughout the event. For a day-long event, we expect this rate to be lower because attendees will attend sessions of interest, but not necessarily the entire date. For perspective, we see inactive attendance rates for purely online, 90-minute events of ~5%.

Inactive attendance rate: Rate at which registrants attend but do not stay active for the entire event. We do not have the ability to estimate this interaction of on-site attendees.

Satisfaction

Our standard survey consists of 17 questions. The questions reflecting the overall performance are shown below.

Response Rate | Total Responded



Appendix B: Event Performance Sheet for Webinar 1 (May 4, 2016)

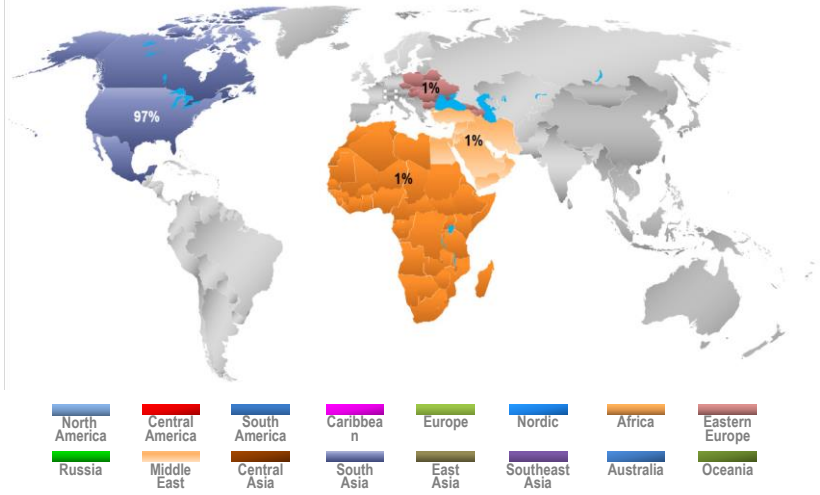
Learning about Microbial Forensics - Microbial Forensics 1

NIJ - Sponsored Event

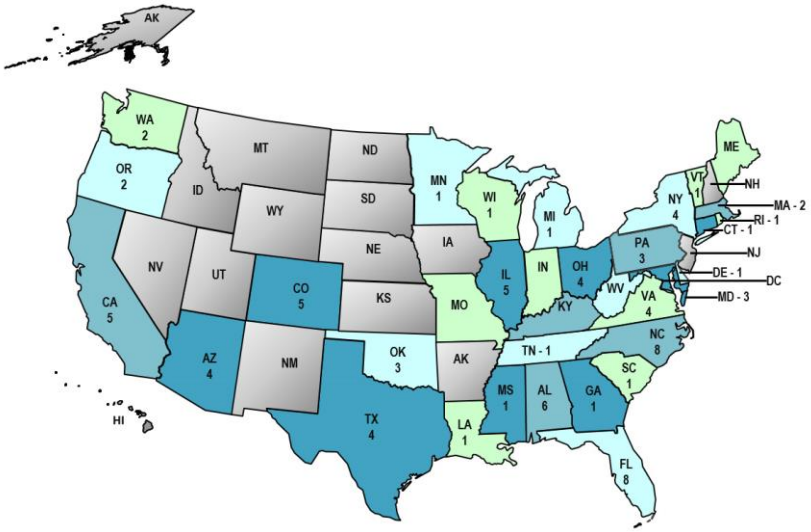
Attendance

Values are a percentage of the attendees throughout the day.

International Online Attendance

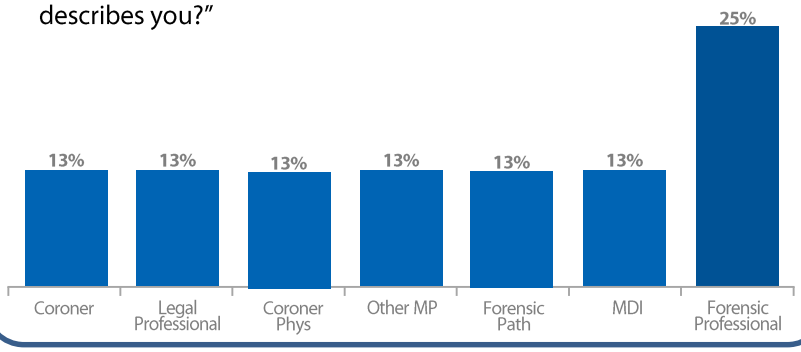


U.S. Online Attendance



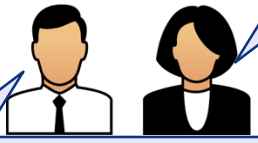
Which Best Describes You?

At the beginning of each event attendees are polled "Which best describes you?"



"This webinar was extremely informative!!"

—Online Attendee Response

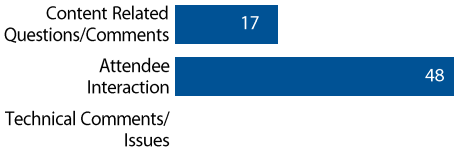


"Biggest benefit of attending was gaining knowledge about a topic I do not know much about"

—Online Attendee Response

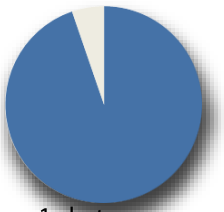
Chat Interactions

An open chat is used in each event. The host and ghost host encourage interaction from attendees to the subject matter expert. New conversation topics brought up by attendees will be extracted from the chat and further discussed.



Chatter

Based 120 minutes of content delivered



1 chat every 1.90 minutes

Contact

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Research Triangle Park, NC
27709-2194 USA

Event Performance Statement

RTI INTERNATIONAL

www.rti.org

Basics of Microbiology as applied to Microbial Forensics – Microbial Forensics 2

NIJ Live Online Workshop

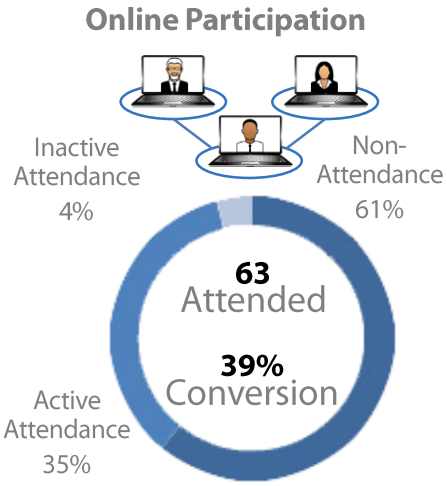
MAY 18 2016 | 1 PM ET

Duration: 120 minutes

Format: Live Online

Dr. Bruce Budowle, of the University of North Texas Health Science Center, and Dr. Dana Kadavy, Director of Biological Sciences at Signature Science, LLC, presented on microbiology, pathogens, human microbiome, and genetic engineering/synthetic biology. Participants will gain a better understanding of microbiology as applied to microbial forensics and the role it plays in combating bioterrorism.

Attendee Interactivity Rate



Instruction Minutes: 6,791
Activity Minutes: 19,320
Registered: 161

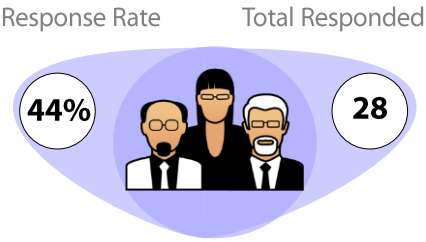
Each event is tracked by the following:
Non-attendance rate: Those who registered but did not attend divided by registration (an indication of conversion from registration to attendance).

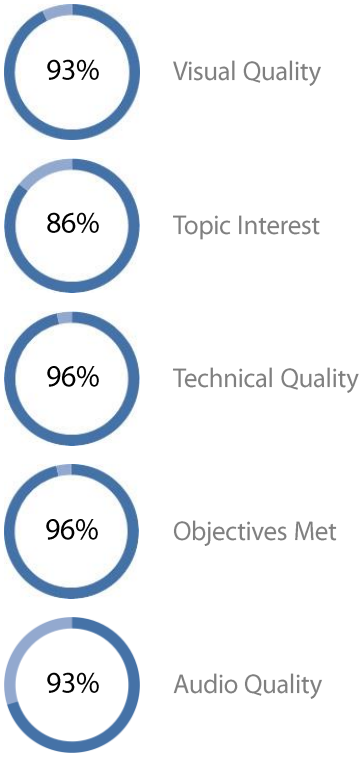
Active attendance rate: Rate at which registrants attend and interact consistently throughout the event. For a day-long event, we expect this rate to be lower because attendees will attend sessions of interest, but not necessarily the entire date. For perspective, we see inactive attendance rates for purely online, 90-minute events of ~5%.

Inactive attendance rate: Rate at which registrants attend but do not stay active for the entire event. We do not have the ability to estimate this interaction of on-site attendees.

Satisfaction

Our standard survey consists of 17 questions. The questions reflecting the overall performance are shown below.





Appendix C: Event Performance Sheet for Webinar 2 (May 18, 2016)

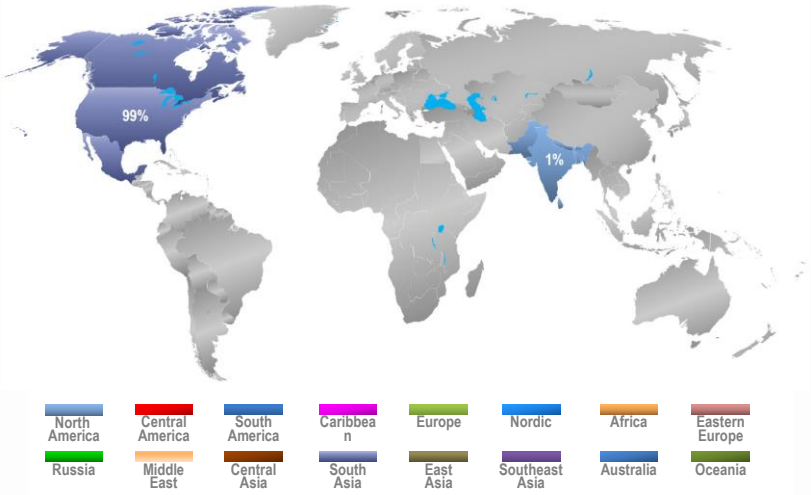
Basics of Microbiology as applied to Microbial Forensics - Microbial Forensics 2

NIJ - Sponsored Event

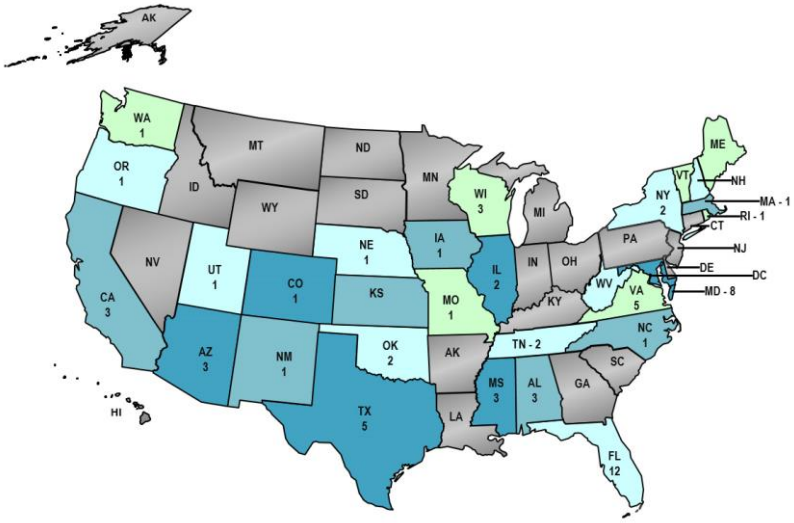
Attendance

Values are a percentage of the attendees throughout the day.

International Online Attendance

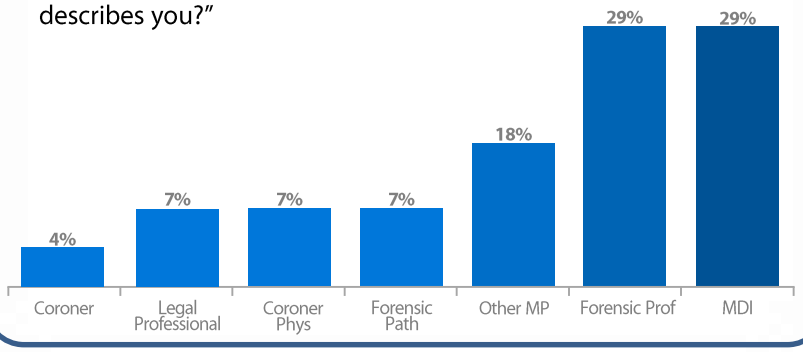


U.S. Online Attendance



Which Best Describes You?

At the beginning of each event attendees are polled "Which best describes you?"



'Biggest Benefit of Attending '"The knowledge of what is being pursued in terms of forensic microbiology. I was able to obtain an overview of several aspects being considered."

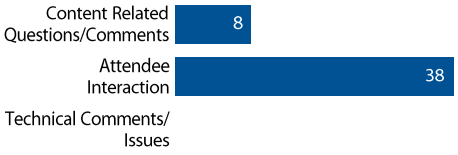
—Online Attendee Response

'Biggest Benefit of Attending '"Acquiring knowledge about forensic microbiology, identifying new challenges in this field, and identifying other areas for research."

—Online Attendee Response

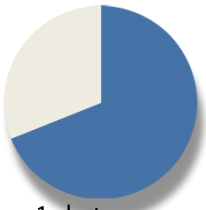
Chat Interactions

An open chat is used in each event. The host and ghost host encourage interaction from attendees to the subject matter expert. New conversation topics brought up by attendees will be extracted from the chat and further discussed.



Chatter

Based on 120 minutes of content delivered



1 chat every 2.61 minutes

Contact

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27709-2194 USA

Event Performance Statement

RTI INTERNATIONAL

www.rti.org

Expansion of Microbial Forensics - Microbial Forensics 3

NIJ Live Online Workshop

JUNE 15
2016

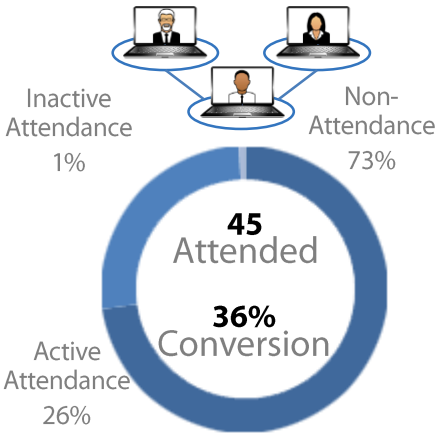
1 PM ET
Duration: 120 minutes

Format: Live Online

Dr. Bruce Budowle, of the University of North Texas Health Science Center, and Dr. Heather Jordan, Assistant Professor of Biological Sciences at Mississippi State University, presented on biocrime, postmortem interval and agroterrorism. Participants will gain a better understanding of microbiology as applied to microbial forensics and the role it plays in combating bioterrorism.

Attendee Interactivity Rate

Online Participation



Instruction Minutes: 5,400
Activity Minutes: 15,625
Registered: 125

Each event is tracked by the following:
Non-attendance rate: Those who registered but did not attend divided by registration (an indication of conversion from registration to attendance).

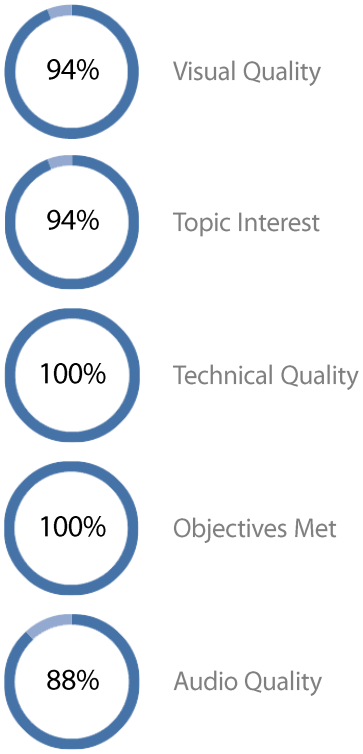
Active attendance rate: Rate at which registrants attend and interact consistently throughout the event. For a day-long event, we expect this rate to be lower because attendees will attend sessions of interest, but not necessarily the entire date. For perspective, we see inactive attendance rates for purely online, 90-minute events of ~5%.

Inactive attendance rate: Rate at which registrants attend but do not stay active for the entire event. We do not have the ability to estimate this interaction of on-site attendees.

Satisfaction

Our standard survey consists of 17 questions. The questions reflecting the overall performance are shown below.

Response Rate | Total Responded



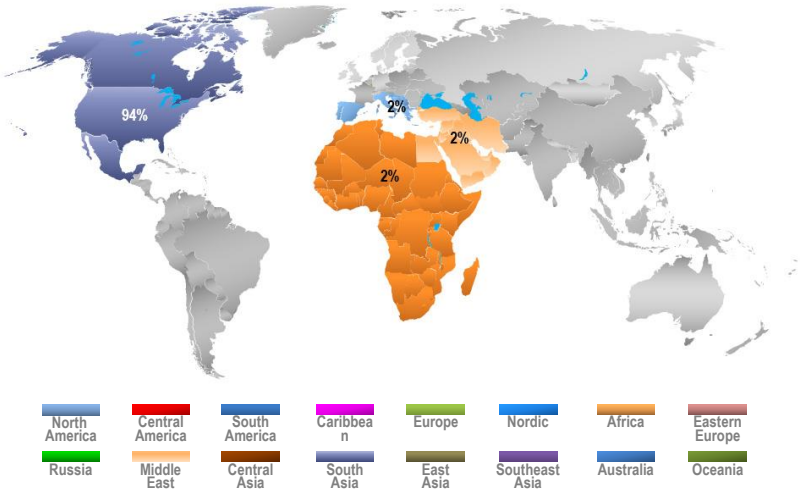
Appendix D: Event Performance Sheet for Webinar 3 (June 15 2016)

Expansion of Microbial Forensics - Microbial Forensics 3
NIJ - Sponsored Event

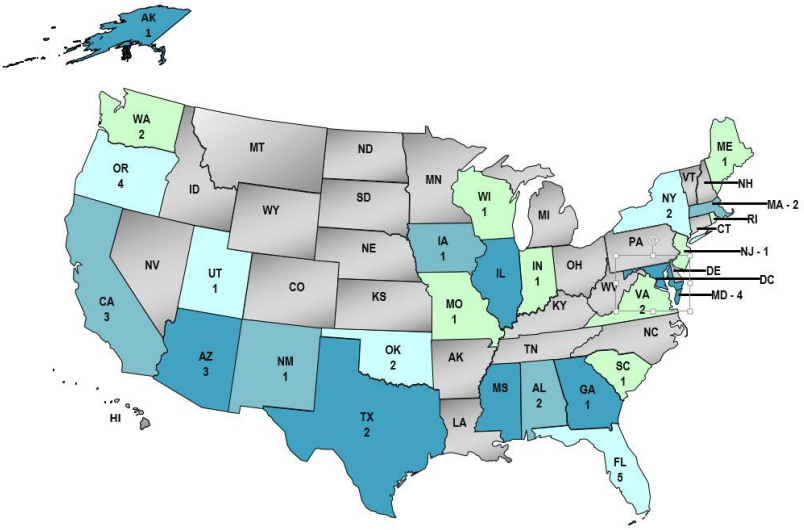
Attendance

Values are a percentage of the attendees throughout the day.

International Online Attendance

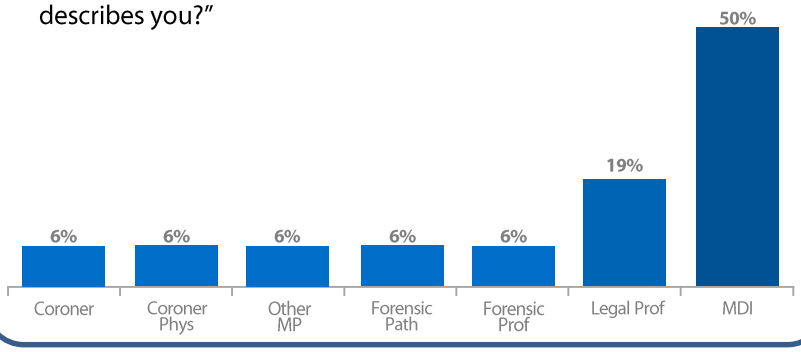


U.S. Online Attendance



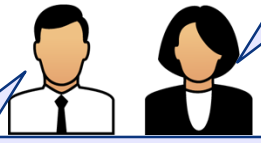
Which Best Describes You?

At the beginning of each event attendees are polled "Which best describes you?"



"The biggest benefit of this class was learning the latest DNA technology."

—Online Attendee Response

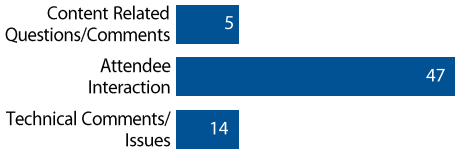


"I was able to gain knowledge about a topic I do not know much about ."

—Online Attendee Response

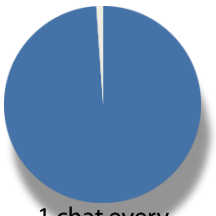
Chat Interactions

An open chat is used in each event. The host and ghost host encourage interaction from attendees to the subject matter expert. New conversation topics brought up by attendees will be extracted from the chat and further discussed.



Chatter

Based on 120 minutes of content delivered



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Event Performance Statement