FORENSICS & CRIMINAL JUSTICE

# DNA Analysis for Missing Person Identification in Mass Fatalities

Advances in DNA technology have expanded such that forensic DNA profiling is now considered a routine method for identifying victims of mass fatalities. Originating from an initiative funded by a grant from the U.S. Department of State, ***DNA Analysis for Missing Person Identification in Mass Fatalities*** presents a collection of training modules that supply comprehensive instruction in these complex techniques. The book begins with a concise overview of DNA analysis methods and their use in identifying victims of mass fatalities. It then goes on to explore:

- Mass fatality response operations, including body recovery, mortuary operations, family assistance, the identification of human remains, and psychosocial support for families
- Best practices in DNA sample collection and the different types of reference samples that can be used to identify a reported missing (RM) individual
- Autosomal short tandem repeat (STR) DNA profile analysis and interpretation, and procedures to ensure data accuracy
- Major steps involved in generating a DNA profile and the complex aspects of data analysis and interpretation
- The importance of data management using information technology tools, and tips for maintaining quality operations
- Accreditation and standards and the major elements of a DNA quality program
- Setting up a laboratory operation, including planning, staffing, identifying types of equipment and supplies, and the procedures for ensuring that laboratory equipment performs appropriately

The book includes a discussion of the key steps in the preparation, delivery, and evaluation of training sessions for personnel responding to a mass fatality human identification event. It also provides a comprehensive vocabulary list with terms related to mass fatality DNA identification. This text is a must-read for organizations contemplating the use of DNA in human identification initiatives following mass fatalities. It is also a tremendous value to emergency manager/planners, medical legal authorities, and forensic DNA laboratories.

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# Preface

*DNA Analysis for Missing Person Identification in Mass Fatalities* was initially started in 2008 as short individual training chapters. As part of an initiative supported by a U.S. Department of State grant, the chapters were originally designed as background information to accompany a 20-day instruction for Iraqi scientists on mass fatality response operations and forensic DNA's critical role. These university scientists from across Iraq were tasked with the responsibility of increasing awareness for the use of forensic DNA to identify victims of mass fatalities. Forensic DNA profiling is an important technology used in the identification of victims of mass fatalities and supports human rights and rule of law initiatives.

In teaching these most amazing, dedicated, and inquisitive Iraqi scientists, it was quickly apparent that a subject as complex as mass fatality response operations and the role of forensic DNA was difficult to capture in 100 pages. As such, this document grew in length outside the scope of the original project. Additionally, new DNA technologies have posed an added challenge of keeping the document up to date scientifically. Regardless, this document became what I consider to be the most comprehensive general text on mass fatality response and the use of DNA for identifications written to date and holds tremendous value to organizations contemplating the use of DNA in human identification initiatives following mass fatalities.

**Amanda Sozer**
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# Acknowledgments

This book was written with the help and input of a number of individuals. I would especially like to thank Shelly Beckwith for her help with organizing the interpretation of DNA data (one of the most complex issues in the use of DNA following mass fatalities), Susan Peters for her expertise in de-convoluting complex issues, program development, and training, Arbie Goings for his input on mass fatalities, body recovery, and family assistance center operations, Julia Powers for her help in the identification of human remains, Dave Boyer for his proficiency in sample collection, Jamie Handelsman for her innovative approaches to training, William Watson for his creativity in generating diagrams to express complex DNA processes, the staff of Future Technologies Inc., for their help with data-tracking, George Riley for his input on quality systems, and Brendan Sozer, Kaitlyn Andrews-Rice, Kaitlyn French, and Web Bist for their help in getting the document ready for publication.

This book is in honor of the many scientists, educators, and human rights organizations that are dedicated to bringing truth and understanding to family and friends following a mass fatality.

# About the Author

**Amanda Sozer, Ph.D.**, president of SNA International, received her B.A. from Rutgers University and her Ph.D. from the University of Tennessee–Oak Ridge Graduate School of Biomedical Sciences at Oak Ridge National Laboratory. Sozer has worked in forensics for over 20 years directing forensic laboratories and programs. In addition to directing forensic DNA laboratories she served as a technical contractor to the U.S. National Institute of Justice (NIJ) and worked on the DNA backlog reduction programs for no-suspect forensic cases and convicted offender outsourcing programs, which resulted in the processing of millions of samples. Following 9/11 Sozer served on and facilitated the NIJ Kinship and Data Analysis Panel for the World Trade Center victim identification effort and was instrumental in writing NIJ's *Lessons Learned from 9/11: DNA Identification in Mass Fatality Incidents.*

Sozer managed the Hurricane Katrina victim DNA identification effort, overseeing the collection, testing, analysis, and matching of thousands of samples. She facilitated the writing of the *AABB Guidelines for Mass Fatality DNA Identification Operations.* Sozer has also written strategic plans and mass fatality response plans for a number of organizations in the United States, and recently led a subject matter expert group developing guidelines for scientists working on human rights projects for the American Academy for the Advancement of Science.

Sozer was the technical lead on a U.S. State Department project to strengthen forensic DNA capabilities in Iraq and spearheaded the DNA technical portion of a State Department forensic DNA needs assessment in Afghanistan. She has worked on numerous local, state, and federal forensic projects in the United States and human identification forensic projects and human identification initiatives in Guatemala, Cyprus, Iraq, Afghanistan, Jordan, Dominican Republic, Colombia, Lebanon, the Phillipines, and Libya.

# DNA Analysis for Missing Person Identification in Mass Fatalities

# Contents

# Chapter 1

# Human Identification through DNA Analysis

Following a mass fatality, human remains are identified for the purpose of repatriation, the certification of death, the issuance of legal documents, and for providing truth and understanding to families. The use of DNA in the identification process is becoming increasingly common. This chapter reviews the basics of DNA and provides an overview of the DNA profiling process.

## 1.1 DNA

Deoxyribonucleic acid (DNA) contains the genes, or instructions, for cell growth and function. It is found in all nucleated cells in the body. DNA strands are quite long, approximately 3 billion base pairs. These long strands are packaged into bundles, called chromosomes, inside the nucleus, as shown in Figure 1.1.

In addition, DNA is found in the mitochondria, organelles found in cells responsible for cellular energy production. Mitochondria, as seen in Figure 1.2, are present in high numbers (100–1,000) in each cell. The mitochondrial genome is a relatively small, single, circular DNA chromosome of only about 16,500 base pairs. However, within each mitochondrion there are multiple copies of its chromosome (2–10). Therefore each cell potentially contains hundreds to thousands of copies of the mitochondrial chromosome.

Regardless of where the DNA is found in the cell, DNA has a double helix structure similar to a twisted ladder, with the legs of the ladder consisting of two antiparallel sugar phosphate backbones. The "rungs" of the ladder are composed of four different nucleotide bases (adenine, thymine, guanine, and cytosine) that hydrogen bond into set base pairs. Figure 1.3 illustrates the base pairing in DNA.

Encoded within the sequence of the three billion base pairs that make up the DNA of the human genome are the individual genes or instructions necessary for producing and regulating the processes responsible for life. Since all humans are structurally and functionally similar (one head, two arms, one heart, etc.), the majority of their DNA is identical. However, there are areas in the DNA where genetic differences between individuals can be detected.