

DNA Forensic and Forensic Investigative Leads

Johannes Hendrik Smith^{1*} and M. Singh²

¹Department of Forensic and Criminal Investigation Science, College of Law; School of Criminal Justice, University of South Africa (UNISA), Pretoria, Gauteng, South Africa

²Department of Genetics, University of the Free State, Free State, South Africa

Abstract

The chapter explores the fundamental principles of Deoxyribonucleic acid (DNA) in the context of forensic DNA profiling. Moreover, it explores the use of forensic DNA databases and the comparative searches carried out within them. The outcomes of these comparative searches produce Forensic Investigative Leads (FILs), which require communication with detectives for more investigation and follow-up. To successfully investigate these FILs, it is crucial to have efficient communication and engage in multidisciplinary detective work. This entails examining further corroborating evidence that could either absolve an innocent person from blame or contribute to the apprehension and compelling conviction of the perpetrator.

Keywords: Deoxyribonucleic acid • Forensic DNA database • Familial searching • Forensic investigative leads • Forensic investigative genetic geology • Criminal casework investigations

Introduction

Criminal investigations extensively depend on Deoxyribonucleic Acid (DNA) forensic investigation leads, transforming forensic science by offering crucial information for identifying suspects, connecting individuals to crime scenes and verifying or disproving criminal testimonies [1,2]. Although the act of discarding a cigarette butt in a public area may appear harmless, justifying the presence of DNA discovered in a recently burglarised residence presents a substantial difficulty for individuals who are being investigated [3].

Deoxyribonucleic Acid (DNA)

DNA, the hereditary code of all living beings, is crucial in distinguishing individuals based on biological material by examining genetic variations [4-6]. DNA, which encodes biological properties such as protein expression and physical attributes, shows significant similarities among individuals, with just a 0.5% variation in genetics [7]. Genetic information plays a fundamental role in forensic science in confirming identity and conducting criminal investigations [4,8,9].

Different patterns of repeating sequences found in DNA, such as VNTR and STR, allow for the unique identification of individuals using tandem repeat analysis [10,11]. Despite having the same genetic material, monozygotic twins have separate genetic profiles due to mutations that occur after the division of the zygote, which sets them apart [12]. Despite their widespread use, conventional length-based STR approaches cannot distinguish between monozygotic twins [4,13-15]. Ultra-deep Multiple Parallel Sequencing (MPS) has emerged as a solution for finding genomic variations, such as copy number differences and single nucleotide polymorphisms [16-18].

In creatures such as humans, DNA is found in nuclear DNA in cell nuclei

and mitochondrial DNA(mtDNA) in mitochondria. In the double helix structure of DNA, the nucleotides are coupled together - adenine with thymine and guanine with cytosine - to create base pairs [19,20]. The process of DNA replication and recombination, essential for genetic inheritance, is made possible by the complementary base pairing. During fertilisation, chromosomal pairs are separated, where each parent contributes half of the DNA to the offspring [21,22]. This separation leads to the creation of genetic variety. DNA replication, which is susceptible to mutations, results in the emergence of genetic variants as time progresses, which occur due to errors in DNA replication or repair, resulting in alterations in DNA sequences [23,24]. These changes contribute to the distinctiveness of individuals [25,26]. Forensic DNA profiles employ fragments from locations in the genome to detect alleles and heterozygosity by analysing repetitive nucleotide sequences [2,27,28]. Different alleles at each locus are distinguished by motif repetition and sequence type variations [29].

Forensic DNA profiling

Forensic DNA profiling was first introduced in the early 1980s [30]. Since then, it has been developed and established as a powerful tool. The advancements in DNA analysis have significantly improved the criminal justice system by enabling the investigation of small biological traces such as blood, saliva and skin cells to link perpetrators [31,32]. Forensic Identification Leads (FILs) play a crucial role in connecting persons to crime scenes and verifying or disproving reports of incidents [2]. In addition, a perpetrator's DNA on objects such as balaclavas can indicate an effort to hide one's identity while engaging in illegal actions [32].

Forensic DNA profiling became possible due to identifying notable discrepancies in minisatellite repeats among people [4, 33]. Southern Blotting techniques were initially used to generate distinct DNA patterns by exploiting minisatellite dispersion. This technique used restriction enzymes to generate DNA pieces of different sizes [33]. The approach, introduced by Sir Alec Jefferys in 1984, resulted in the initial successful DNA profiling in the U.K. This technology has been essential in criminal investigations and in proving innocence [34,35].

The Polymerase Chain Reaction (PCR) significantly impacted DNA analysis by enabling the amplification of small quantities of DNA [36]. The Polymerase Chain Reaction (PCR) is a DNA analysis technique that amplifies Short Tandem Repeat (STR) loci. This process produces amplicons labelled with fluorescent markers, allowing for the determination of their size. The amplicons are separated based on size using either gel or capillary electrophoresis, resulting in the generation of a STR genotype that can be compared. The PCR technique and improvements such as qualitative PCR

*Address for correspondence: Johannes Hendrik Smith, Department of Forensic and Criminal Investigation Science, College of Law; School of Criminal Justice, University of South Africa (UNISA), Pretoria, Gauteng, South Africa; E-mail: thejhsmit@gmail.com

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Journal of Forensic Sciences, 1996 Includes papers read at the Academy's annual meeting previously published separately as Proceedings of the American Academy of Forensic Sciences

Forensic Investigation of Clandestine Laboratories Donnell R. Christian, Jr., 2022-06-20 Forensic Investigation of Clandestine Laboratories Second Edition is fully updated to address all aspects of the forensic investigation of clandestine laboratories While the first edition focused on the domestic clandestine manufacture of contraband substances this edition expands the scope to more fully address the clandestine manufacture of explosives that have become a threat that is global in nature In clandestine laboratory operations equipment is often simple household chemical products are utilized and the education of the operators basic In fact most of the time these elements individually are perfectly legal to sell and possess However the combination of all these elements is what becomes the scene of illicit activity and a criminal operation In response to the increase in use of homemade explosive mixtures by terrorists both domestically and internationally the section clandestine manufacture of explosives is greatly enhanced Topics are presented in a manner which while detailed will not compromise the tactics techniques or procedures utilized by law enforcement and military personnel in their ability to combat the clandestine manufacture of contraband substances and the battle against domestic and international terrorism Key features Examines tell tale signs to look for in recognizing a clandestine lab Outlines how to safely process the site of a clandestine lab Details how to analyze collected evidence in the examination laboratory Provides guidelines as to what to derive from the physical evidence Offers specific tactics to effectively present the opinions associated with evidence that has been collected during the investigation in a written report military style briefing or to a jury in a legal proceeding Forensic Investigation of Clandestine Laboratories Second Edition guides the reader through the process of recognizing these illegal manufacturing operations Then it examines the methods as to how to compile the volume of associated evidence into a package that can be presented in a court of law or to military commanders for decisive action It is an invaluable resource that will prove useful to chemistry lab technicians forensic investigators fire and first responder professionals military personnel police investigative agencies and narcotics units and lawyer trying cases involving clandestine labs

Forensic Science and the Administration of Justice Kevin J. Strom, Matthew J. Hickman, 2014-04-04 Uniting forensics law and social science in meaningful and relevant ways Forensic Science and the Administration of Justice by Kevin J Strom and Matthew J Hickman is structured around current research on how forensic evidence is being used and how it is impacting the justice system This unique book written by nationally known scholars in the field includes five sections that explore the demand for forensic services the quality of forensic services the utility of forensic services post conviction forensic issues and the future role of forensic science in the administration of justice The authors offer policy relevant directions for both the criminal justice and forensic fields and demonstrate how the role of the crime laboratory in the American justice system is evolving in concert with technological advances as well as

changing demands and competing pressures for laboratory resources Advances in Analytical Techniques for Forensic Investigation Priyanka Chhabra, Divya Bajpai Tripathy, Anjali Gupta, Shruti Shukla, Rajeev Kumar, Kajol Bhati, 2024-09-11 This book is essential for anyone seeking to understand and apply the latest analytical techniques in forensic investigation saving time materials energy and manpower by providing guidance on the most appropriate techniques for different types of investigations Advances in Analytical Techniques for Forensic Investigation is aimed to describe the applicability of different types of analytical techniques used for the forensic investigation including FT IR chromatography mass spectroscopy NMR spectroscopy atomic absorption spectroscopy UV vis spectroscopy etc This book will focus on current and emerging developments in the latest analytical techniques and methods used in the forensic investigation and sample analysis of various physical chemical and biological samples in order to facilitate the smooth conduction of justice *Criminal Investigation* Charles R. Swanson, Neil C. Chamelin, Leonard Territo, 2003 An important contribution to the law enforcement field at every level Criminal Investigation is recognized as the most accurate comprehensive and practical book in its field This updated edition examines the latest investigative methods and technologies with new information on white collar crime drugs terrorism and homeland security The simulation CD contains interactive modules covering the investigative process

Meshfree Methods G.R. Liu, 2009-10-06 Understand How to Use and Develop Meshfree Techniques An Update of a Groundbreaking Work Reflecting the significant advances made in the field since the publication of its predecessor Meshfree Methods Moving Beyond the Finite Element Method Second Edition systematically covers the most widely used meshfree methods With 70% new material this edition addresses important new developments especially on essential theoretical issues New to the Second Edition Much more details on fundamental concepts and important theories for numerical methods Discussions on special properties of meshfree methods including stability convergence accurate efficiency and bound property More detailed discussion on error estimation and adaptive analysis using meshfree methods Developments on combined meshfree finite element method FEM models Comparison studies using meshfree and FEM Drawing on the author's own research this book provides a single source guide to meshfree techniques and theories that can effectively handle a variety of complex engineering problems It analyzes how the methods work explains how to use and develop the methods and explores the problems associated with meshfree methods To access MFree2D copyright G R Liu which accompanies MESHFREE METHODS MOVING BEYOND THE FINITE ELEMENT METHOD Second Edition 978 1 4200 8209 8 by Dr G R Liu please go to the website www.ase.uc.edu/liugr An access code is needed to use program to receive it please email Dr Liu directly at liugr@ucmail.uc.edu Dr Liu will reply to you directly with the code and you can then proceed to use the software

Contemporary Digital Forensic Investigations of Cloud and Mobile Applications Kim-Kwang Raymond Choo, Ali Dehghantanha, 2016-10-12 Contemporary Digital Forensic Investigations of Cloud and Mobile Applications comprehensively discusses the implications of cloud storage services and mobile applications on digital forensic investigations The book

provides both digital forensic practitioners and researchers with an up to date and advanced knowledge of collecting and preserving electronic evidence from different types of cloud services such as digital remnants of cloud applications accessed through mobile devices This is the first book that covers the investigation of a wide range of cloud services Dr Kim Kwang Raymond Choo and Dr Ali Dehghantanha are leading researchers in cloud and mobile security and forensics having organized research led research and been published widely in the field Users will gain a deep overview of seminal research in the field while also identifying prospective future research topics and open challenges Presents the most current leading edge research on cloud and mobile application forensics featuring a panel of top experts in the field Introduces the first book to provide an in depth overview of the issues surrounding digital forensic investigations in cloud and associated mobile apps Covers key technical topics and provides readers with a complete understanding of the most current research findings Includes discussions on future research directions and challenges The Journal of Forensic Odonto-stomatology ,2003

Encyclopedia of Forensic Sciences ,2012-12-28 Forensic science includes all aspects of investigating a crime including chemistry biology and physics and also incorporates countless other specialties Today the service offered under the guise of forensic science includes specialties from virtually all aspects of modern science medicine engineering mathematics and technology The Encyclopedia of Forensic Sciences Second Edition Four Volume Set is a reference source that will inform both the crime scene worker and the laboratory worker of each other s protocols procedures and limitations Written by leading scientists in each area every article is peer reviewed to establish clarity accuracy and comprehensiveness As reflected in the specialties of its Editorial Board the contents covers the core theories methods and techniques employed by forensic scientists and applications of these that are used in forensic analysis This 4 volume set represents a 30% growth in articles from the first edition with a particular increase in coverage of DNA and digital forensics Includes an international collection of contributors The second edition features a new 21 member editorial board half of which are internationally based Includes over 300 articles approximately 10pp on average Each article features a suggested readings which point readers to additional sources for more information b a list of related Web sites c a 5 10 word glossary and definition paragraph and d cross references to related articles in the encyclopedia Available online via SciVerse ScienceDirect Please visit www.info.sciencedirect.com for more information This new edition continues the reputation of the first edition which was awarded an Honorable Mention in the prestigious Dartmouth Medal competition for 2001 This award honors the creation of reference works of outstanding quality and significance and is sponsored by the RUSA Committee of the American Library Association Canadian Society of Forensic Science journal ,1994 Wildlife Forensic Investigation John E. Cooper,Margaret E. Cooper,2013-05-23 Wildlife forensics is the application of forensic science to the conservation and protection of non domesticated animals both in the wild and in captivity Providing an in depth introduction to this rapidly evolving field Wildlife Forensic Investigation Principles and Practice also chronicles aspects of the history of management

conservation and environmental protection with an emphasis on their global importance in the twenty first century The book examines the crucial role of wildlife forensic investigation with regard to live animals dead animals and samples and covers national regional and international legislation While the text particularly focuses on forensic science as it relates to wild animals it also includes mention of plants and habitats because of their relevance to conservation The book discusses animal welfare as well as the damage that can be inflicted on humans and property by wildlife Offering access to sound evidence based on good science and obtained using the best available practices the book is enhanced by case studies from experts who describe some of their own work This resource is essential for those involved in a range of endeavours including investigating wildlife crime identifying animal remains ascertaining the circumstances of death of wild species and other legal proceedings and activities concerning wildlife The forensic skills described in this book can be applied to a wide range of activities not necessarily involving the legal process including environmental impact assessments insurance claims governmental and other enquiries checking of trading standards and the inspection of for instance pet shops animal boarding establishments and zoological collections The authors point out that one of the most important requirements of those persons involved in wildlife forensic work is to retain an open mind Such personnel should also be conscious of new developments and evolving techniques and be able to anticipate situations where their investigative and scientific skills might be used to advantage so called horizon scanning Examples of these are given

Radionuclear Forensic Investigations K. K. S. Pillay, Samuel Harold Levine, William Andrew Jester, 1974

Investigation for Determination of Fact Richard A. Myren, Carol Henderson Garcia, 1989 Focus is on the social science of investigation Covers investigation for fact determination information collection organization and analysis of the investigative work product presentation of the facts Annotation copyrighted by Book News Inc Portland OR

Forensic Science Suzanne Bell, 2019-05-21 Covering a range of fundamental topics essential to modern forensic investigation the fifth edition of the landmark text *Forensic Science An Introduction to Scientific and Investigative Techniques* presents contributions and case studies from the personal files of experts in the field In the fully updated 5th edition Bell combines these testimonies into an accurate and engrossing account of cutting edge of forensic science across many different areas Designed for a single term course at the undergraduate level the book begins by discussing the intersection of law and forensic science how things become evidence and how courts decide if an item or testimony is admissible The text invites students to follow evidence all the way from the crime scene into laboratory analysis and even onto the autopsy table *Forensic Science* offers the fullest breadth of subject matter of any forensic text available including forensic anthropology death investigation including entomology bloodstain pattern analysis firearms tool marks and forensic analysis of questioned documents Going beyond theory to application this text incorporates the wisdom of forensic practitioners who discuss the real cases they have investigated Textboxes in each chapter provide case studies current events and advice for career advancement A brand new feature *Myths in Forensic Science* highlights the differences between

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Criminal Investigation, a Guide to Techniques and Solutions James V. Vandiver, 1983 This is a guide to techniques and solutions in criminal investigation

Current Law Index ,2007 *Institute on Homicide Investigation Techniques* Southwestern Law Enforcement Institute, 1961

The Applied Psychologist James Hartley (Ph. D.), Alan Branthwaite, 2000 Written in a clear and accessible style the book should appeal to psychology students who want to get an idea of what it is like to work in applied psychology and the skills need to do this This is especially the case as the book contains highly practical guide to pursuing career opportunities and where to find information on relevant courses Tom Merrill Psychology Student University of Leeds UK Review of the first edition a nice combination of theory and practice which should be of interest to two main audiences psychology students trying to get some ideas about their choice of career and practising psychologists who might like to dip into the book from time to time to broaden their horizons R J Ashton School Psychology International What do psychologists do What skills do psychologists have What contributions can they make to solving people s problems Are there different kinds of psychologists doing different kinds of jobs or do applied psychologists share a common set of skills to be deployed in different contexts The fully revised and updated second edition of this highly successful book takes the latter view It brings a fresh perspective by suggesting that applied psychologists have many similar skills that can be used in different ways in different circumstances The editors identify seven roles used by most applied psychologists embracing the psychologist as counsellor colleague expert tool maker detached investigator theoretician and agent for change In this book fifteen leading applied psychologists describe several aspects of their work in order to emphasise these different roles Although the content of this book is very varied covering work based counselling cancer treatment police psychology text design driving behaviour sports psychology market research fire fighter stress autism bullying and work with refugees the theme is simple applied psychologists have many similar skills in the roles they play Students of psychology everywhere will find this book to be an essential point of reference on applied psychology Its

clear and accessible style is enhanced by discussion questions and suggestions for further reading at the end of each chapter. The text also contains a useful and highly practical guide to pursuing career opportunities and where to find information on relevant courses.

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