

# DNA Forensic and Forensic Investigative Leads

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## 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

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# Journal Of Forensic And Investigative

**Charles R. Swanson, Neil C.  
Chamelin, Leonard Territo**



## **Journal Of Forensic And Investigative:**

**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](http://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](mailto:liugr@ucmail.uc.edu) Dr Liu will reply to you directly with the code and you can then proceed to use the software

**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

**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](http://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

**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

Fundamentals of Forensic Science Max M. Houck, Jay A. Siegel, 2006-04-24 Fundamentals of Forensic Science offers a complete look at the core topics of forensic science It represents the most realistic view of the field by including areas that while central to criminal investigation fall outside the typical definition of criminalistics These areas include pathology entomology anthropology and other areas of scientific study unique to forensic textbooks Organized by the timeline of a real case the text begins with an introduction and history of forensic science It then covers the methods of analysis used in most forensic examinations addressing the biological chemical and physical elements relevant to the field and concluding with an examination of how forensic science intersects with law Feature boxes throughout the text contain online resource listings historical events in forensic science practical issues in laboratory analysis and topics for further reading or interest This book is recommended for students in forensic science and professionals in the various forensic disciplines fire chemistry crime scene trace evidence law enforcement personnel lawyers and defense attorneys Vivid full color illustrations that diagram key concepts and depict evidence encountered in the field Straightforward unit organization that includes key terms numerous feature boxes emphasizing resources on the World Wide Web historical events in forensic science practical issues in laboratory analysis and topics for further reading Effective pedagogy including end of chapter questions paired with a clear writing style makes this an invaluable resource for professors and students of forensic science

**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 true forensics and popular media fictions Each chapter begins with an overview and ends with a summary and key terms review questions and up to date references Appropriate for any sensibility more than 350 full color photos from real cases give students a true to life learning experience Access to identical eBook version included Features Showcases contributions from high profile experts in the field Highlights real life case studies from experts personal files along with stunning full color photographs Organizes chapters into topics most popular for coursework Covers of all forms of evidence from bloodstain patterns to questioned documents Includes textboxes with historical notes myths in forensic science and advice for career advancement Provides chapter summaries key terms review questions and further reading Includes access to an identical eBook version Ancillaries for Instructors PowerPoint lecture slides for every chapter A full Instructor s Manual with hundreds of questions and answers including multiple choice Additional chapters from previous editions Two extra in depth case studies on firearms and arson photos included Further readings on entomological evidence and animal scavenging photos included

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 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

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

*Criminal Dismemberment* Sue Black,Guy Ruttly,Sarah V. Hainsworth,Grant Thomson,2017-05-18 Criminal Dismemberment is the first book to examine dismemberment as a phenomenon in the context of criminal acts While the number of such dismemberment cases in any given country is often small the notion of dismemberment captures the imagination often leading many to question the motivations as to why anyone would perpetrate such an unnatural act The act of dismemberment in its original form referred to cutting tearing pulling wrenching or otherwise separating the limbs from a living being as a form a capital punishment In today s society it has become associated most frequently with the criminal act of sectioning the remains of the dead in an attempt to conceal the death and dispose of the remains or make the process of identification of the deceased more difficult to achieve Drawing on expertise from leading forensic anthropologists pathologists and forensic materials engineers the book brings together much of the literature on criminal dismemberment viewing it from the investigative forensic and social science perspectives Key features include Psychological analysis of the perpetrator Detailed examination of case studies anonymized from recent investigations Difficulties encountered in a dismemberment investigation Tool mark analysis including knives and saws accompanied by over 120 detailed full color illustrations and photographs Serves as a unique and useful resource in the investigation of dismembered human remains The diverse backgrounds of the contributors offers a thorough account of such topics as the history of dismemberment the forensic pathology in such cases the importance of developing a common vocabulary in terminology used the legal admissibility in dismemberment cases As such *Criminal Dismemberment* will serve as a comprehensive reference for students and practitioners alike      **The Practice Of Crime Scene Investigation** John Horswell,2004-04-13 Crime scene investigation involves the use and integration of scientific methods physical evidence and deductive reasoning in order to determine and establish the series of events surrounding a crime The quality of the immediate crime scene response and the manner in which the crime scene is examined are critical to the success of the investigation Evidence that is missed or corrupted by incomplete or improper handling can have a devastating effect on a case and keep justice from being served The Practice of Crime Scene Investigation covers numerous aspects of crime scene investigation including the latest in education and training quality systems accreditation quality assurance and the application of specialist scientific disciplines to crime The book discusses a range of basic and advanced techniques such as fingerprinting dealing with trauma victims photofit technology the role of the pathologist and ballistic expert and signal processing It also reviews specialist crime scene examinations including clandestine laboratories drug operations arson and explosives      *Forensic Investigation of Explosions* Alexander Beveridge,1998-03-30 This text has been shaped by the editor s experiences on task forces set up to investigate major explosives incidents and related civil and criminal proceedings Chapters cover methods applications quality

control and significance of forensic chemistry aircraft sabotage investigation forensic pathology and presentation of expert testimony Contributors provide descriptions of the physics and chemistry of explosions and explosives the detection of hidden explosives and the procedures carried out at the scenes of gas explosions in buildings Experienced professionals from industry government and the medical and legal professionals provide accounts of the developments and techniques in each of their subject areas

*Forensic Science* Stuart H. James, Jon J. Nordby Ph.D., 2002-08-29 Criminal profiling cyberforensics accident reconstruction Forensic Science An Introduction to Scientific and Investigative Techniques is the first introductory text to present forensic science in its broadest sense encompassing classic criminalistics and beyond Packed with over 350 full color illustrations the book offers a cutting ed

Criminal and Environmental Soil Forensics Karl Ritz, Lorna Dawson, David Miller, 2008-12-23 Soils have important roles to play in criminal and environmental forensic science Since the initial concept of using soil in forensic investigations was mooted by Conan Doyle in his Sherlock Holmes stories prior to real world applications this branch of forensic science has become increasingly sophisticated and broad New techniques in chemical physical biological ecological and spatial analysis coupled with informatics are being applied to reducing areas of search by investigators site identification site comparison and measurement for the eventual use as evidence in court Soils can provide intelligence in assisting the determination of the provenance of samples from artifacts victims or suspects enabling their linkage to locations or other evidence They also modulate change in surface or buried cadavers and hence affect the ability to estimate post mortem or post burial intervals and locate clandestine graves This interdisciplinary volume explores the conceptual and practical interplay of soil and geoforensics across the scientific investigative and legal fields Supported by reviews case studies from across the world and reports of original research it demonstrates the increasing convergence of a wide range of knowledge It covers conceptual issues evidence from recovery to use in court geoforensics taphonomy as well as leading edge technologies The application of the resultant soil forensics toolbox is leading to significant advances in improving crime detection and environmental and national security

*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

## **Journal Of Forensic And Investigative** Book Review: Unveiling the Power of Words

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