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## Scientific Rigor in Legal Practice: The Influence of Forensic Science

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*Law traditionally perceived as a means to maintain societal order and justice, forms an essential partnership with forensic science. Forensic science plays a crucial role in uncovering truths and ensuring equitable justice. Examining legal principles underscores that the legitimacy of the law depends on its alignment with moral values. In this context, forensic science aids in pursuing justice by revealing the truth and upholding ethical standards.<sup>1</sup> This essay extensively explores their intricate relationship, encompassing historical context, various facets of forensic science (evidence collection, expert testimony, etc.),<sup>2</sup> their shared foundations, and jurisprudential perspectives. It also contemplates whether law qualifies as the ultimate science, highlighting the profound alliance between law and forensic science in their broader quest for justice. In Paul Giannelli's words, the pursuit of truth is central to the criminal justice system, with evidence playing a pivotal role in bringing cases to judgment.<sup>3</sup>*

**Keywords:** *forensic science, justice, evidence collection, expert testimony, digital forensics.*

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<sup>1</sup> Lon L Fuller, *The Morality of Law: Revised Edition* (Yale University Press 1969)

<sup>2</sup> 'Forensic Science Plays a Pivotal Role in the Legal System' (*Incognito*) <<https://ifflab.org/the-importance-of-forensic-science-in-criminal-investigations-and-justice/>> accessed 02 December 2023

<sup>3</sup> Paul C. Giannelli, 'The Admissibility of Novel Scientific Evidence: *Frye v. United States*, a Half-Century Later' (1980) 80(6) *Columbia Law Review* <<https://www.jstor.org/stable/1122061>> accessed 02 December 2023

## INTRODUCTION

The question 'Is Law the Ultimate Science?' sparks an exploration of law's nature and its connection with scientific methods, considering legal studies as a systematic examination of principles, regulations, and their empirical application akin to natural and social sciences. This inquiry accentuates the interdisciplinary character of law, often intersecting with fields such as sociology, psychology, economics, and political science, blurring the boundaries of its domain which may either align (eg. forensic science) or deviate (eg. metaphysics) from the scientific methodology.

In the broader context of the theme, 'Is Law the Ultimate Science?' the sub-theme, 'Law and Forensic Science' offers insights into forensic science's role as the practical application of scientific principles to criminal and civil legal matters. It is inherently multidisciplinary, drawing from a range of scientific fields such as biology, chemistry, physics, and mathematics to analyze physical evidence. In doing so, it serves as a bridge between the realms of law and science, introducing a scientific approach into the legal framework.<sup>4</sup>

The legal system provides the procedural framework for legal proceedings, relying on interpretation, argumentation, and the context-specific application of principles. In contrast, forensic science operates within a framework that demands a high degree of objectivity, engaging with empirical data and scientific methodologies to unveil the truth, thus effectively harmonizing subjectivity and objectivity within the legal arena. This synergy reaffirms their dedication to justice, with forensic evidence playing a pivotal role in establishing facts, connecting individuals to criminal activities, and serving as a cornerstone for proceedings. Despite the potential for compromise and errors in highly scientific methods, as noted by Barry Scheck, this relationship reflects a blend of cooperation and tension, underscored by shared objectives and inherent challenges.<sup>5</sup>

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<sup>4</sup> 'Theoretical Approaches to Law and Criminal Justice' (*Law Explorer*, 07 October 2015)

<<https://lawexplores.com/theoretical-approaches-to-law-and-criminal-justice/>> accessed 04 December 2023

<sup>5</sup> 'The Theory of State and Law' (*ВикиЧтение*) <<https://law.wikireading.ru/72594>> accessed 04 December 2023

## **METHODOLOGY**

The research employs a multifaceted approach. It begins with a Literature Review, encompassing academic literature and legal texts to establish a foundational understanding of the relationship between law and forensic science. This is followed by a Case Study Analysis, using high-profile Indian cases to demonstrate practical applications. The study explores Jurisprudential Considerations, delving into philosophical aspects, and examines ethical standards in both fields. Legal Framework Analysis evaluates Indian legal systems regarding forensic evidence. Empirical Analysis involves both qualitative and quantitative research on how forensic evidence affects real-world legal outcomes. The essay then synthesizes findings, offering a comprehensive understanding of the intricate relationship between law and forensic science.

## **OBJECTIVE**

This essay's objective is to explore the relationship between law and forensic science, particularly to determine if law can be considered the ultimate science of forensic science. The question addressed is whether law's ability to encompass multiple scientific disciplines through forensic science makes it the ultimate science while recognizing the unique identities of these scientific fields.

## **HISTORICAL CONTEXT**

Globally, ancient legal traditions in Mesopotamia, Egypt, Greece, and Rome relied on custom and tradition, operating primarily on established norms and lacking substantial scientific underpinnings. In contrast, ancient China stood out during the 13th century when Song Ci authored a groundbreaking book, 'The Washing Away of Wrongs' outlining methods for examining bodies and determining the cause of death, marking it as one of the earliest known works in forensic science by recounting a murder investigation employing forensic techniques.

During the Scientific Revolution in the 16th and 17th centuries, figures like Galileo, Newton, and Descartes laid the foundation for systematic scientific methodologies, albeit with a gradual

integration into legal systems, marking the inception of a more scientific approach to law. The 19th century saw the emergence of forensic science, bridging the gap as techniques like fingerprint analysis and toxicology provided a tangible link between scientific methods and legal investigations, with the 20th century witnessing the rise of expert witnesses and scientific testimony, further solidifying the role of scientific evidence in the legal arena.

The British colonial era left a significant imprint on Indian legal systems, with English common law influencing the jurisprudential landscape, although it had limited scientific foundations. However, post-independence legal reforms brought a significant shift, with the Indian Constitution adopted in 1950 enshrining fundamental rights, including the right to equality (Article 14)<sup>6</sup> and the right to life and personal liberty (Article 21)<sup>7</sup>, fortified through legal precedents and scientific evidence. In the post-independence era, India prioritized legal reforms and integrated forensic science into criminal investigations, establishing forensic laboratories, introducing modern forensic techniques, and incorporating them into legal proceedings, demonstrating the country's commitment to blending scientific principles with legal practice.

## INTERSECTION BETWEEN LAW AND FORENSIC SCIENCE

**Evidence Collection:** Forensic scientists collaborate with law enforcement to collect, preserve, and analyse diverse physical evidence from crime scenes, encompassing fingerprints, bloodstains, DNA, and firearms, ensuring the evidence's admissibility in court through proper collection and handling of evidence. In the Aarushi Talwar Murder Case (2008), forensic scientists played a vital role in solving the mystery as they carefully analysed bloodstains<sup>8</sup> and fingerprints from the crime scene, connected potential suspects, and conducted comprehensive examinations of the victims' bodies to determine causes and time of death and gather crucial crime-related evidence. This collaborative effort was instrumental in revealing the case's details, identifying the murder weapon, and ultimately securing the conviction of Aarushi's parents.

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<sup>6</sup> Constitution of India 1950, art 14

<sup>7</sup> Constitution of India 1950, art 21

<sup>8</sup> Stella Tan et al., 'Blood Spatters: Messy Smears or Inconspicuous Clues?' (*Nuscrimnaljustice*, 19 October 2020) <<https://nuscrimnaljustice.com/blood-spatters-messy-smears-or-inconspicuous-clues/>> accessed 04 December 2023

**Expert Testimony and Consultation:** Forensic experts played a pivotal role in the aftermath of the 2008 Mumbai terror attacks, offering specialized knowledge in firearm and explosive analysis, including gunshot residue and bullet trajectory analyses, firearm types, ammunition sources, and explosive details. Similarly, in the 2001 Indian Parliament Attack, expert testimonies in ballistics and explosives played a significant role in analysing evidence. Following the Bhopal Gas Tragedy (1984), experts in chemical analysis and toxicology examined samples from the gas leak site, including soil, water and human tissues, to assess the gas's characteristics and its impact on the environment and affected individuals.

In legal proceedings, forensic experts serve as expert witnesses, presenting specialized insights to assist judges and juries in comprehending complex scientific evidence, especially in criminal trials where forensic evidence is central. Lawyers often consult forensic experts to grasp the scientific aspects of a case and develop effective legal strategies, and this practice is relevant in various cases where forensic evidence holds substantial importance.

In the ever-evolving landscape of forensic science and its role within the legal system, the critical issue of the reliability and credibility of expert testimony remains a significant point of discussion and concern. The persistent issue of judicial review concerning expert testimony lacks a coherent doctrinal foundation, making the admission or exclusion of such evidence unsatisfactory, as noted by David L. Faigman.<sup>9</sup> This challenge highlights the ongoing struggle to establish a consistent framework. Valerie P. Hans emphasizes that while expert testimony is vital for an accurate verdict, it must also be presented accurately, transparently, and equitably, underlining the importance of fairness and transparency in the pursuit of justice.<sup>10</sup>

**Crime Scene Investigation:** Forensic investigators operate at crime scenes, engaging in careful observation, documentation, and the utilization of various techniques and technologies to

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<sup>9</sup> Nicholas Scurich et al., 'Scientific Guidelines for Evaluating the Validity of Forensic Feature-Comparison Methods' (2023) 120(41) Proceedings of the National Academy of Sciences <<http://dx.doi.org/10.1073/pnas.2301843120>> accessed 04 December 2023

<sup>10</sup> Sanja Kutnjak Ivković and Valerie P. Hans, 'Jurors Evaluations of Expert Testimony: Judging the Messenger and the Message' (2006) 28(2) Law & Social Inquiry <<https://doi.org/10.1111/j.1747-4469.2003.tb00198.x>> accessed 04 December 2023

collect and preserve physical evidence potentially linking suspects to crimes.<sup>11</sup> In this process, the Criminal Procedure Code (CrPC), particularly Section 154,<sup>12</sup> governing the filing of First Information Reports (FIRs), plays a pivotal role. It directs the crime scene investigation, with forensic experts ensuring the proper collection and maintenance of evidence outlined in FIRs. Concurrently, Section 161,<sup>13</sup> involving the examination of witnesses by the police, becomes pertinent when law enforcement gathers statements from witnesses, with forensic experts collaborating to validate these testimonies through physical evidence analysis. Moreover, in cases related to Section 437,<sup>14</sup> addressing bail proceedings, forensic evidence significantly influences the court's assessment of the evidence against the accused. Additionally, under Section 482,<sup>15</sup> concerning the quashing of FIRs, forensic experts may scrutinize the collected or presented evidence, potentially serving as the basis for seeking the dismissal of the FIR if it is found to be flawed or unreliable. The initial crime scene investigation is of paramount importance as it lays the foundation for the entire legal and forensic process, impacting the quality of evidence, its admissibility, and the ultimate pursuit of justice.<sup>16</sup>

**Trace Analysis:** Microscopy is a crucial tool for trace analysis, empowering forensic scientists to closely inspect materials and identify their characteristics, potentially linking them to known samples. These tiny, often overlooked fragments at crime scenes offer valuable connections between suspects, victims, and crime scenes, as seen in hit-and-run cases, where analysing paint chips from the victim's vehicle can determine if they match the suspect's vehicle's paint. On the other hand, spectroscopy examines matter's interaction with electromagnetic radiation, aiding in pinpointing substance compositions, particularly valuable for analysing chemical substances in trace evidence, including unique soil compositions in specific geographic areas or gunshot residue, which provides critical insights into recent firearm discharges.

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<sup>11</sup> Deborah A. Kleypas and Ashish Badiye, 'Evidence Collection' (*National Library of Medicine*, 8 May 2023) <<https://www.ncbi.nlm.nih.gov/books/NBK441852/>> accessed 04 December 2023

<sup>12</sup> Code of Criminal Procedure 1973, s 154

<sup>13</sup> Code of Criminal Procedure 1973, s 161

<sup>14</sup> Code of Criminal Procedure 1973, s 437

<sup>15</sup> Code of Criminal Procedure 1973, s 482

<sup>16</sup> 'What Is Forensic Investigation? Crime Scene Investigation in Forensic Science' (*Financial Crime Academy*, 07 September 2023) <<https://financialcrimeacademy.org/what-is-forensic-investigation/>> accessed 04 December 2023

A notable case highlighting the significance of trace analysis is found in wildlife forensics, particularly concerning hair evidence from mammals, which is frequently encountered in wildlife-related crimes. This technique enables forensic scientists to scrutinize hair samples extensively, facilitating species identification through the examination of various characteristics, such as the hair's shape, cuticle, cortex, medulla, and cross-section. Advanced methods like scanning electron microscopy (SEM) have also been utilized to explore hair surface morphology, offering supplementary data for species characterization.<sup>17</sup>

**Fingerprint and DNA Analysis:** Ancient India, with its enduring legal traditions, notably exemplified by 'Kautilya's Arthashastra' dating back about 2300 years, embraced scientific methodologies in crime investigation. Scholars of that era laid the groundwork for modern forensic techniques such as fingerprint analysis and DNA profiling by recognizing the uniqueness and permanence of fingerprints, which have become invaluable in identifying individuals and connecting them to criminal activities, especially in cold cases involving homicides and sexual assaults. The use of DNA analysis has not only been instrumental in exonerating wrongfully convicted individuals but has also led to the establishment of national Fingerprint and DNA databases in many countries, aiding law enforcement in matching crime scene evidence to known offenders and apprehending serial criminals, with over 400 exonerations in the United States as of 2021, indicating the far-reaching impact of forensic science, a trend likely observed in India with specific variations in statistics.<sup>18</sup>

**Ballistics and Firearms Analysis:** Forensic specialists, especially those specializing in ballistics and firearm analysis, play a pivotal role in cases like murder, terrorist acts, armed robberies, drive-by shootings, officer-involved shootings, and more. Their expertise establishes the crucial link between the weapon and the crime itself through the examination of firearms, bullets, cartridge cases, trajectory analysis, gunshot residue, and firearm markings. An illustrative case

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<sup>17</sup> Vivek Sahajpal, 'Forensic Analysis in Wildlife Crime Cases: Microscopy, DNA Profiling and Isotope Analysis' in Ian Freckelton (ed), *Forensic Analysis - Scientific and Medical Techniques and Evidence under the Microscope* <<http://dx.doi.org/10.5772/intechopen.98252>> accessed 04 December 2023

<sup>18</sup> Gerald Laporte, 'Wrongful Convictions and DNA Exonerations: Understanding the Role of Forensic Science' (2018) National Institute of Justice Journal <<https://nij.ojp.gov/topics/articles/wrongful-convictions-and-dna-exonerations-understanding-role-forensic-science>> accessed 04 December 2023

exemplifying their significance is the Jessica Lal Murder Case of 1999, where these experts were instrumental in identifying the specific weapon used and connecting it to the crime, ultimately resulting in the conviction of the accused.<sup>19</sup>

**Toxicology and Drug Analysis:** Forensic toxicologists play a pivotal role in detecting drugs or toxins in bodily fluids and tissues by meticulously analysing samples such as blood, urine, and tissues, utilizing sophisticated techniques like gas chromatography and mass spectrometry. The results of these analyses can be critical in linking a suspect to a crime, explaining the cause of death, or revealing any foul play. This expertise has been instrumental in several high-profile Indian cases, including the Sheena Bora Murder Case (2015), Uphaar Cinema Tragedy (1997), and the Sunanda Pushkar Case (2014), and many more, involving drug-related crimes, poisoning incidents, and suspicious deaths. The legal framework which helps to regulate and guide the examination and analysis of toxins and drugs in the context of criminal investigations is governed by various laws, including the Poison Act (1919), the Drugs and Cosmetics Act (1940), and the Narcotic Drugs and Psychotropic Substances (NDPS) Act (1985).

**Digital Forensics:** In the Aarushi Talwar-Hemraj double murder case, digital forensics scrutinized electronic evidence, including call records, messages, and emails, reconstructing the events and communication among involved parties. Similarly, in the Sheena Bora murder case, digital forensics played a critical role in unearthing evidence from electronic devices spanning text messages, emails, and call logs, providing insights into the sequence of events and establishing culpability.

In the contemporary digital era, forensic science is pivotal in electronic evidence analysis, especially in cybercrime cases, facilitated by the Information Technology Act of 2000, which offers a legal framework and defines crucial terms. Beyond physical evidence, forensic accounting is essential for uncovering financial fraud and embezzlement, while cyber forensics investigates digital evidence in cases of cybercrimes, data breaches, and digital fraud. This

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<sup>19</sup> Jesenia M. Pizarro et al., 'Firearm Use in Violent Crime: Examining the Role of Premeditation and Motivation in Weapon Choice' (2021) 42 The Journal of Primary Prevention <<https://doi.org/10.1007/s10935-020-00595-z>> accessed 08 December 2023



evolving landscape necessitates anticipatory legislative amendments to align with dynamic criminal methods and technological advancements.<sup>20</sup>

**Crime Reconstruction:** Forensic scientists significantly contribute to reconstructing the sequence of events leading up to crimes, employing techniques such as bloodstain pattern analysis and accident reconstruction. In the crime scene investigation of the 2012 Nirbhaya case, which involved the horrific gang rape and murder of a young woman in Delhi, forensic investigators meticulously examined the interior of the moving bus where the crime transpired. They methodically documented the scene with photographs and videos from various angles to create a comprehensive visual record, painstakingly recording every detail, from the positioning of the victim and the accused to the condition of the bus's interior. The primary focus was on physical evidence, encompassing DNA samples collected through swabs from the victim's body, clothing, and the bus interior, intended for detailed analysis. Fingerprint experts scrutinized the bus for latent prints that could provide clues about the suspects, while personal effects, clothing, hair, fibers, and other biological materials were collected and preserved for analysis. Forensic pathologists conducted a thorough examination of the victim's body to determine the cause of death, and injuries, and collect pertinent evidence. Once gathered, all physical evidence was meticulously packaged, labelled, and securely transported to forensic laboratories, maintaining the chain of custody for admissibility in court. In the subsequent trial, the findings of the forensic investigation, including DNA analysis and insights from forensic pathologists, played an instrumental role in aiding judges and juries in comprehending the significance of the evidence and its implications. The comprehensive approach to crime scene investigation in the Nirbhaya case was not only crucial in bringing the perpetrators to justice but also underscored the pivotal role of forensic science in ensuring justice and upholding the rule of law in one of India's most notorious and tragic criminal cases in recent history.

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<sup>20</sup> Abati Bose, 'Relationship between law, science, and technology in modern society' (*iPleaders*, 03 March 2021) <<https://blog.iplayers.in/relationship-law-science-technology-modern-society/>> accessed 08 December 2023

## JURISPRUDENTIAL DIMENSIONS OF FORENSIC SCIENCE IN THE LEGAL SYSTEM

Jurisprudential perspectives, specifically natural law and legal positivism, contribute to the ongoing debate regarding the relationship between law and forensic science. Natural law theory asserts that law is based on inherent moral principles, while legal positivism contends that law is a social construct rooted in societal conventions. The incorporation of forensic science into legal processes has prompted questions about how it aligns with these jurisprudential theories, with considerations about whether forensic evidence upholds principles of justice or is a societal construct designed to meet specific needs, providing a framework for understanding forensic science's status within the legal system.<sup>21</sup>

The interaction between science and law is central to this jurisprudential exploration, as the integration of forensic science has challenged traditional notions of law's sources and foundations by introducing empirical and scientific methods into legal proceedings. This has altered how legal professionals establish facts and truths, with legal scholars exploring how the use of scientific evidence shapes jurisprudential debates and influences the nature and practice of law while considering its alignment with or challenge to established jurisprudential theories.

The epistemological aspect of forensic science is another critical component of this discussion, as the legal system grapples with questions about the reliability and validity of scientific evidence, exploring how the law evaluates the knowledge produced by forensic science and its impact on legal decision-making.<sup>22</sup> For example, in the Aarushi Talwar-Hemraj Double Murder Case (2008), forensic evidence, including fingerprint analysis and DNA profiling, faced scrutiny regarding its reliability and interpretation, emphasizing the ongoing need to harmonize forensic science with jurisprudential considerations to ensure fair legal decisions.

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<sup>21</sup> 'Introduction to Law and Legal Systems' (*GitHub.io*) <[https://saylordotorg.github.io/text\\_introduction-to-the-law-of-property-estate-planning-and-insurance/s04-introduction-to-law-and-legal-.html](https://saylordotorg.github.io/text_introduction-to-the-law-of-property-estate-planning-and-insurance/s04-introduction-to-law-and-legal-.html)> accessed 08 December 2023

<sup>22</sup> 'Law and Morality: Relationship, Definition & Differences' (*StudySmarter*, 2023) <<https://www.studysmarter.co.uk/explanations/law/uk-legal-system/law-and-morality/>> accessed 08 December 2023

Incorporating legal realism and empirical analysis, we delve into the practical application of law in society, with legal realism underscoring the significance of observing how the law is practiced and its real-world consequences. Empirical research has shed light on the effectiveness of forensic science in the legal system, with legal scholars conducting empirical studies to understand how the use of scientific evidence influences case outcomes, judicial decisions, and the pursuit of justice, offering insights into the interaction between law and forensic science from a practical jurisprudential standpoint.

In the context of Indian law, the Indian Evidence Act (IEA) contains numerous provisions related to forensic science, emphasizing the admissibility of scientific evidence. The IEA is structured into three parts and eleven chapters, each addressing different facets of evidence, and forensic science is deemed admissible within four primary categories: Witness, Admission, Facts, and Circumstantial evidence, with guidelines for expert opinions listed in the CrPC.<sup>23</sup> Section 45<sup>24</sup> further grants relevancy to expert opinions in various forensic fields for complex and technical matters, and multiple legislations address different aspects of forensic science, including forensic psychology, covered by specific laws like Section 84<sup>25</sup>, the Indian Lunacy Act, and the Mental Health Act. Wildlife crimes fall under the Wildlife Protection Act, which includes provisions for wildlife forensics. Forensic science, encompassing various scientific disciplines applied to legal matters, plays a crucial role in providing factual evidence for courts to determine the guilt or innocence of suspects and offenders. Despite its efficiency, the legal system often prioritizes non-scientific and non-factual evidence, with admissible evidence needing to meet specific criteria to be authentic, complete, reliable, and believable.

## IS LAW THE ULTIMATE SCIENCE?

Forensic science includes a diverse range of disciplines applied to various fields, and many of these disciplines can have legal applications, even beyond their primary non-legal purposes.

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<sup>23</sup> 'Navigating the Maze: How the Judge Deciphers the Evidence' (*Legal Vidhiya*, 03 June 2023) <<https://legalvidhiya.com/navigating-the-maze-how-the-judge-deciphers-the-evidence/>> accessed 08 December 2023

<sup>24</sup> Indian Penal Code 1860, s 45

<sup>25</sup> Indian Penal Code 1860, s 84

Initially centred on historical and evolutionary research, forensic archaeology and anthropology utilize the analysis of human remains and artifacts to provide insights into ancient civilizations, historical events, and human evolution. These disciplines are also instrumental in legal contexts, especially in cases related to mass graves, war crimes and human rights violations, where they offer vital evidence and expertise for investigations and legal proceedings. Disaster victim identification, which aids in natural disaster response, also supports legal investigations involving human remains. Forensic entomology plays a pivotal role in estimating the time of death in criminal cases by analysing insect interactions with decomposing bodies. Forensic botany identifies plant materials at crime scenes, connecting suspects to specific locations. In forensic pathology experts perform autopsies and provide crucial evidence when a death is suspicious or related to a crime, helping establish the circumstances of a person's demise.<sup>26</sup>

Forensic engineering examines structural and machinery failures, aiding in legal cases involving accidents and disasters, while forensic fire investigation determines the cause and origin of fires and explosions. Additionally, aviation accident investigations leverage forensic expertise to identify the causes of accidents, contributing to safety improvements and legal inquiries. These findings have practical applications in litigation, insurance claims and regulatory investigations.

Forensic meteorology unravels weather-related mysteries and disasters, providing critical evidence in cases related to accidents, environmental damage, and insurance claims resulting from unusual meteorological events. Environmental forensics identifies pollutants and holds responsible parties accountable for environmental contamination, ensuring compliance with environmental laws in legal proceedings, including matters related to geological hazards. Wildlife forensics combats illegal wildlife trade and poaching, aiding in species identification and origin, thus providing vital evidence for legal cases. In legal contexts, forensic seismology studies seismic activity and vibrations from various sources, detecting, locating, and assessing

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<sup>26</sup> 'Crime-Scene Investigation and Forensic Sciences' (*Britannica*)  
<<https://www.britannica.com/topic/police/Crime-scene-investigation-and-forensic-sciences>> accessed 08 December 2023

explosive events related to criminal activities, terrorism, or industrial accidents by examining seismic data, and contributing to investigations and legal proceedings.

A specialized field examining geological evidence, it plays a pivotal role in criminal investigations, environmental disputes, and disaster inquiries, providing valuable insights into geological aspects. In criminal investigations, experts link geological materials found at crime scenes, like soil, rocks, or minerals, to their origins, aiding in the pursuit of justice. Similarly, it identifies sources and causes of environmental contamination, essential in legal proceedings to determine liability and support damage claims. After natural disasters or industrial accidents, it reveals underlying geological conditions that may have triggered events such as landslides, earthquakes, or volcanic eruptions, facilitating disaster response and mitigation. Furthermore, in cases of illegal trade in geological materials, it addresses illicit excavation and trading of minerals, fossils and specimens while pinpointing their sources to combat illegal activities and protect geological resources.

Forensic linguistics is instrumental in cases involving threats, extortion, or anonymous communication, employing advanced techniques like authorship attribution to unmask the origin of anonymous messages, aiding law enforcement in tracking down potential suspects. Authentication methods used for historical documents and artifacts become valuable for preserving cultural heritage. They ensure the protection of these irreplaceable treasures from theft, forgery, and unauthorized alterations, safeguarding the integrity of our shared history.

Food safety and quality assurance rely on forensic techniques to detect contaminants and pathogens, playing a vital role in legal actions like product recalls and liability claims. In India, the detection of excessive lead levels in Maggi noodles resulted in a nationwide product recall and subsequent legal consequences, underscoring the critical role of forensic methods in ensuring food safety. In the realm of sports science and forensic biomechanics, the focus is on not only optimizing athletes' performance and preventing injuries but also using cutting-edge technologies like motion capture and biometric analysis to precisely identify the biomechanical factors contributing to specific injuries, providing crucial evidence in legal disputes and injury claims. Forensic nursing goes beyond evidence collection and medical care for assault or abuse

victims; it often involves testifying as an expert witness in court, shedding light on the medical aspects of cases and helping the legal system understand the full scope of the victim's condition.<sup>27</sup>

The assertion that law is the ultimate science finds substantial support in the multifaceted world of forensic science, where the extensive intersections between forensic disciplines and the legal system are undeniable. This versatility and interdisciplinary nature, only makes it a pivotal component in the pursuit of truth and justice. However, it's essential to emphasize that each forensic field maintains its unique identity, contributing valuable insights and methodologies beyond the courtroom. Forensic science indeed underscores the idea that law is the ultimate science, but it's essential to recognize that the various areas of forensic science maintain their unique identities beyond their intersections with the legal realm. Moreover, forensic scientists rigorously adhere to scientific methodologies, conducting experiments, analysing data, and contributing to broader scientific knowledge through academic research and publication in scientific journals. Their work extends beyond the boundaries of legal investigations, offering insights into scientific challenges and pushing the frontiers of knowledge within their respective fields. Forensic scientists extend their expertise far beyond legal confines, contributing to various academic fields and industries. Their diverse skills in areas like archaeology, ecology, healthcare, disaster management, anthropology, cyber forensics, and sports performance enhancement allow them to tackle non-legal challenges effectively for instance their work aids in comprehending ancient civilizations, preventing environmental harm, advancing medical research, facilitating disaster recovery, deepening our understanding of human evolution, ensuring digital security, and optimizing athletes' performance. This brief selection showcases the multi-faceted impact of forensic science, although numerous other instances abound.<sup>28</sup> This ability to provide answers, seek truth and aid in the pursuit of justice highlights forensic science as an exceptional and indispensable scientific field.

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<sup>27</sup> Happy Sharer, 'What is Forensic Science? An In-Depth Exploration of the Different Branches and Benefits' (*The Enlightened Mindset*, 13 January 2023) <<https://www.tffn.net/what-type-of-science-is-forensic-science/>> accessed 08 December 2023

<sup>28</sup> *Ibid*

In conclusion, the intertwining of forensic science with the legal system underscores the role of law as a unifying force across scientific domains. However, the distinct scientific identities, methodologies, and contributions of forensic fields make a compelling case that forensic science, while closely associated with the law, is an independent and multifaceted scientific discipline, rich in its contributions to a wide array of challenges facing society.

## CONCLUSION

Law and forensic science share a close-knit relationship, particularly in criminal cases. Forensic science is an indispensable component of legal proceedings, providing crucial scientific evidence and analysis to establish case facts and determine the culpability of individuals. As Mokokoma Mokhonoana astutely put it, 'Crime gave us law; science gave us forensics'. This succinct statement encapsulates the essence of how crime has birthed the legal system, while the realm of science has provided the invaluable tool of forensics underscoring the intricate balance between the two. Moreover, it reflects the idea that where there is any legal intersection in any discipline, it has the capacity to take on a legal form because the law inherently possesses this adaptability. Therefore, it illustrates that while the law can be viewed as the ultimate science due to its capacity to encompass a wide array of fields, it also highlights that each scientific discipline retains its own unique identity beyond the legal framework. This distinction raises the notion that law is the ultimate science – it is, and it isn't. It is in the sense that law can incorporate diverse fields into its purview, and it isn't because these scientific disciplines remain distinct in their objectives and methods, contributing significantly to the broader scientific community. This dual role of law, as both the ultimate science and a harmonious coexistence of various scientific disciplines, is the essence of the enduring dialogue between law and science.<sup>29</sup>

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<sup>29</sup> Charul Mishra, 'Forensic science under criminal law' (*iPleaders*, 13 September 2020) <<https://blog.iPLEaders.in/forensic-science-criminal-law/>> accessed 08 December 2023