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THE ROLE, RELEVANCE, AND LEGAL CHALLENGES OF FORENSIC SCIENCE IN THE CRIMINAL JUSTICE SYSTEM: A COMPREHENSIVE COMPARATIVE STUDY OF OLD LEGISLATIONS (IEA, CrPC, IPC) AND NEW CRIMINAL LAWS (BSA, BNSS, BNS)

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ABSTRACT

Forensic science has transitioned from a peripheral investigative tool to a core cornerstone of the modern criminal justice administration. Historically, criminal adjudication relied heavily upon ocular testimony, confessionals, and circumstantial evidence—modalities vulnerable to human fallibility, witness hostility, memory decay, and coercive police practices. The integration of empirical scientific methodology into legal proceedings provides courts with objective, verifiable, and highly reliable physical evidence.

This paper presents a rigorous legal and forensic analysis of the role, admissibility, and evidentiary value of forensic science within the Indian judicial framework. A central objective of this study is the comprehensive statutory mapping between traditional codes—the Indian Evidence Act 1872 (IEA), Code of Criminal Procedure 1973 (CrPC), and Indian Penal Code 1860 (IPC)—and the newly enacted criminal statutory framework: the Sakshya Bharatiya Adhiniyam 2023 (BSA), Bharatiya Nagarik Suraksha Sanhita 2023 (BNSS), and Bharatiya Nyaya Sanhita 2023 (BNS). The paper further examines constitutional boundaries under Article 20(3) and Article 21, international admissibility tests (Frye Standard and Daubert Test), the

evidentiary weight of expert opinion, and practical bottlenecks such as chain of custody failures and forensic infrastructure deficits.

1. INTRODUCTION AND HISTORICAL EVOLUTION

1.1 Conceptual Framework: Science at the Crossroads of Law

The term 'forensic' originates from the Latin 'forensis', denoting 'of or before a forum or court of law'. Forensic science encapsulates the application of broad scientific principles, techniques, and specialized knowledge to legal questions and criminal investigations. It serves as an impartial nexus where physical laws intersect with statutory jurisprudence.

The foundational theoretical bedrock of forensic science rests upon Locard's Exchange Principle, formulated by Dr. Edmond Locard. The principle postulates: 'Every contact leaves a trace.' Whenever a perpetrator enters a crime scene or interacts with a victim/object, a mutual transfer of physical material occurs—such as epidermal cells, blood, latent fingerprints, hair follicles, synthetic fibers, soil, or digital artifacts. Forensic science systematically isolates, preserves, and analyzes these microscopic traces to establish an irrefutable link between the perpetrator, victim, and locus criminis.

1.2 Historical Evolution in India

Early jurisprudence in India, as reflected in ancient treatises like Kautilya's Arthashastra and Manusmriti, recognized rudimentary methods for detecting poisons, handwriting discrepancies, and physical injuries. However, the formal institutionalization of forensic science commenced under British administration in the 19th century:

- **1849:** Establishment of the Chemical Examiner's Laboratory in Calcutta.
- **1897:** Creation of the world's first Fingerprint Bureau in Calcutta, spearheaded by Sir Francis Galton along with Indian pioneers Sub-Inspectors Azizul Haque and Hem Chandra Bose.
- **1952:** Establishment of the first Central Forensic Science Laboratory (CFSL) in Calcutta.
- **Modern Era:** The enactment of the National Forensic Sciences University Act 2020 and the criminal law reforms of 2023 have positioned forensic science as a mandatory, institutionalized pillar of criminal investigation.

2. STATUTORY MAPPING AND VERIFIED LEGAL FRAMEWORK

The legislative transition from 19th-century colonial enactments to the 2023 modern legal codes marks a paradigm shift toward mandatory scientific investigation. Below is an exhaustive section-by-section statutory verification and comparative analysis across the Indian legal framework.

2.1 Indian Evidence Act, 1872 (IEA) vs. Bharatiya Sakshya Adhiniyam, 2023 (BSA)

The rules governing expert testimony, electronic records, and physical evidence have been modernized under the BSA 2023:

1. Expert Opinion: Section 45 IEA -> Section 39 BSA

Under Section 45 of the IEA 1872, the court may seek the opinion of experts on points of foreign law, science, art, handwriting, or finger impressions. In the Bharatiya Sakshya Adhiniyam 2023, this provision is codified under Section 39(1). The new provision explicitly expands the scope of expert testimony to cover digital, electronic, and modern technological fields, recognizing certified cyber experts as formal experts.

2. Examiner of Electronic Evidence: Section 45A IEA -> Section 39(2) BSA / Section 79A IT Act

Section 45A of IEA (inserted via IT Act 2000) allowed expert opinion regarding information stored in digital or electronic form. Under BSA 2023, this is integrated directly into Section 39(2), referencing designated Examiners of Electronic Evidence notified under Section 79A of the Information Technology Act 2000.

3. Primary & Secondary Electronic Evidence: Section 65A/65B IEA -> Section 61, 62 & 63 BSA

One of the most critical updates is the treatment of electronic records. Section 65B of IEA 1872 required a mandatory certificate for admitting secondary electronic evidence. Under BSA 2023, Section 61 declares electronic records as primary documentary evidence if generated, stored, or processed simultaneously in multiple devices. Section 63 BSA replaces Section 65B IEA, streamlining the mandatory certification requirement (under Section 63(4) BSA) for secondary electronic records.

4. Comparison of Signatures/Fingerprints: Section 73 IEA -> Section 73 BSA

Section 73 of IEA empowered courts to direct any person to provide specimen writings or finger impressions for comparison. Under BSA 2023, Section 73 retains this judicial power and explicitly incorporates digital signatures and electronic authentication inputs.

2.2 Code of Criminal Procedure, 1973 (CrPC) vs. Bharatiya Nagarik Suraksha Sanhita, 2023 (BNSS)

The procedural machinery for collecting forensic samples has been overhauled in the BNSS 2023:

1. Medical Examination of Accused: Section 53 CrPC -> Section 51 BNSS

Section 53 CrPC authorized registered medical practitioners to examine an arrested person (including collection of blood, bodily fluids, hair, and DNA). Under BNSS 2023, this is re-enacted under Section 51 BNSS with enhanced procedural safeguards.

2. Examination of Rape Accused & Victim: Section 53A & 164A CrPC -> Section 52 & 184 BNSS

Section 53A CrPC mandated forensic medical examination (including DNA profiling) of persons accused of sexual assault. Under BNSS 2023, Section 52 BNSS governs the accused's examination, while Section 184 BNSS governs the victim's medical examination (replacing Section 164A CrPC).

3. Specimen Signatures, Voice Samples & Fingerprints: Section 311A CrPC -> Section 349 BNSS

Section 311A CrPC empowered Magistrates to order a person to give specimen signatures or handwriting. Section 349 BNSS significantly broadens this power, allowing Magistrates to order voice samples, finger impressions, and specimen handwriting even during the investigation phase.

4. Mandatory Crime Scene Investigation: Statutory Innovation of Section 176(3) BNSS

Section 176(3) of BNSS 2023 introduces a groundbreaking statutory mandate: For any offence punishable with imprisonment for seven years or more, the visit of a forensic expert to the crime scene and the forensic videography/photography of the collection process are made compulsory across India.

2.3 Indian Penal Code, 1860 (IPC) vs. Bharatiya Nyaya Sanhita, 2023 (BNS)

Forensic investigation frequently relies on statutory criminal definitions codified under substantive penal law. Key mapping includes:

• **Fabricating False Evidence:** Section 192 IPC -> Section 228 BNS (Penalizes creating false physical or digital forensic evidence to mislead judicial proceedings).

• **Destruction of Evidence:** Section 201 IPC -> Section 238 BNS (Penalizes causing disappearance of crime scene physical evidence or giving false forensic info).

• **Offence of Rape & Scientific Proof:** Section 375/376 IPC -> Section 63/64 BNS (Where DNA profiling under Section 52/184 BNSS forms crucial evidentiary corroboration).

2.4 Comprehensive Comparative Statutory Table

Subject Matter / Forensic Domain	Old Legislation & Section	New Legislation & Section (2023)	Legal Significance & Key Modification
Expert Opinion (Forensic Evidence)	IEA 1872, Section 45	BSA 2023, Section 39(1)	Broadened scope to include digital experts, cyber forensics, and modern scientific fields.
Electronic Evidence Certificate	IEA 1872, Section 65B	BSA 2023, Section 63	Mandatory certificate under Sec 63(4) BSA for admitting secondary electronic records.
Medical & DNA Exam of Accused	CrPC 1973, Section 53 / 53A	BNSS 2023, Section 51 / 52	Statutory authority to collect blood, hair, semen, and DNA profiling samples from suspects.
Specimen Handwriting & Voice	CrPC 1973, Section 311A	BNSS 2023, Section 349	Empowers Magistrate to order specimen handwriting, fingerprints, and voice recordings.
Mandatory Crime Scene Visit	No direct CrPC equivalent	BNSS 2023, Section 176(3)	Mandatory forensic team visit & videography for offences punishable

			with >= 7 years prison.
Fabricating / Tampering Evidence	IPC 1860, Section 192 / 201	BNS 2023, Section 228 / 238	Criminal liability for altering crime scene material, digital records, or forensic samples.

3. KEY FORENSIC DISCIPLINES AND JUDICIAL APPLICATION

3.1 DNA Profiling and Genetic Jurisprudence

Deoxyribonucleic Acid (DNA) profiling represents the 'gold standard' of modern forensic identification. Except for identical twins, no two individuals possess identical nuclear DNA sequences. In criminal litigation (homicide, sexual offences, mass disasters) and civil litigation (paternity disputes, inheritance claims), DNA evidence holds unparalleled probative force.

Judicial Approach: In Senthil v. State and Mukesh & Anr. v. State (NCT of Delhi) [Nirbhaya Case, (2017) 6 SCC 1], the Supreme Court of India emphasized that scientifically collected and properly chain-preserved DNA evidence carries exceptionally high probative value. DNA testing has served dual judicial ends: securing the conviction of guilty perpetrators and exonerating wrongfully accused individuals.

3.2 Dactyloscopy (Fingerprint Analysis)

Fingerprint identification rests on two immutable principles: uniqueness (friction ridge patterns are unique to every individual) and permanence (patterns remain unchanged from birth until post-mortem decomposition). Under Section 45 IEA / Section 39 BSA, fingerprint expert testimony is admissible. The rollout of NAFIS (National Automated Fingerprint Identification System) has revolutionized suspect identification across Indian law enforcement agencies.

3.3 Digital, Mobile, and Cyber Forensics

With the proliferation of cybercrime and digitized criminal communication, digital forensics—involving extraction and analysis of hard drives, mobile devices, CCTV footage, server logs, and encrypted messaging—has become essential.

Judicial Landmark: In Arjun Panditrao Khotkar v. Kailash Kushanrao Gorantyal [(2020) 7 SCC 1], a Three-Judge Bench of the Supreme Court resolved conflicting jurisprudence, holding that the production of a certificate under Section 65B(4) IEA [now Section 63(4) BSA] is a mandatory condition precedent for admitting secondary electronic records into evidence.

3.4 Forensic Toxicology and Ballistics

• **Forensic Toxicology:** Involves toxicological screening of viscera, blood, and bodily fluids to detect poisons, narcotics, or chemical toxins. Viscera reports are decisive in cases of suspected homicidal or suicidal poisoning.

• **Forensic Ballistics:** The scientific examination of firearms, spent cartridges, and striation marks. Ballistic experts establish whether a specific bullet was discharged from a seized firearm to a mathematical certainty.

4. CONSTITUTIONAL AND ETHICAL JURISPRUDENCE

The coercive extraction and application of forensic samples must strictly adhere to the fundamental rights guaranteed under Part III of the Constitution of India. Courts maintain a meticulous balance between investigative necessity and constitutional safeguards.

4.1 Article 20(3): Right Against Self-Incrimination

Article 20(3) mandates that 'No person accused of any offence shall be compelled to be a witness against himself' (Nemo Tenetur Seipsum Accusare).

In the landmark Eleven-Judge Constitution Bench ruling in State of Bombay v. Kathi Kalu Oghad [AIR 1961 SC 1808], the Supreme Court held that compelling an accused to furnish specimen signatures, handwriting, thumb impressions, or physical bodily samples does not violate Article 20(3). The Court clarified that 'to be a witness' means imparting personal knowledge through oral or written statements, whereas physical bodily traits are physical material facts, not testimonial utterances.

4.2 'Selvi v. State of Karnataka (2010)': Watershed Precedent

In Selvi & Ors. v. State of Karnataka [(2010) 7 SCC 1], the Supreme Court laid down a fundamental constitutional principle regarding neuro-scientific investigative techniques. The Court held that the involuntary administration of Narco-Analysis, Polygraph (Lie Detector) tests, and Brain Electrical Activation Profile (BEAP) / Brain Mapping violates Article 20(3) (self-incrimination) and Article 21 (Right to Personal Liberty and Mental Privacy).

The Court ruled that forced neuro-testing intrudes upon 'mental privacy'. However, if an accused voluntarily consents to polygraph or narco tests, test results may be conducted, though the statements themselves remain inadmissible. Only physical information or evidence subsequently discovered based on voluntary statements is admissible under Section 27 of the Evidence Act [now Section 23 BSA].

4.3 Article 21: Right to Privacy and Personal Autonomy

Following the landmark ruling in K.S. Puttaswamy v. Union of India [(2017) 10 SCC 1], privacy is recognized as an intrinsic fundamental right. In civil suits concerning paternity, courts exercise extreme restraint in ordering involuntary DNA tests. In Ashok Kumar v. Raj Wanti [(2021) 1 SCC 22], the Supreme Court reaffirmed that courts should not order DNA testing routinely; an order for DNA examination must satisfy the test of 'eminent need' and compelling necessity.

5. EVIDENTIARY VALUE AND ADMISSIBILITY STANDARDS

5.1 Corroborative Nature of Expert Opinion

Under Indian jurisprudence, expert opinion under Section 45 IEA / Section 39 BSA is advisory and corroborative in nature; it does not constitute conclusive proof. The expert witness acts as an advisor to the court, not the judge.

In State of H.P. v. Jai Lal [(1999) 7 SCC 280] and Ramesh Chandra Agrawal v. Regency Hospital Ltd. [(2009) 9 SCC 709], the Supreme Court held that the credibility of an expert opinion depends entirely upon the soundness of the scientific reasons and experimental data provided in the report. If direct ocular evidence is completely untrustworthy, scientific evidence cannot save the prosecution; conversely, if eyewitness testimony is pristine, minor forensic discrepancies will not automatically destroy the prosecution case.

5.2 International Admissibility Tests: Frye Standard vs. Daubert Test

The legal validity of forensic techniques in comparative global jurisprudence relies on two seminal U.S. doctrines:

1. The Frye Standard (Frye v. United States, 293 F. 1013 [D.C. Cir. 1923]): Scientific evidence is admissible only if the underlying technique has gained 'general acceptance' within the relevant scientific community.

2. The Daubert Test (Daubert v. Merrell Dow Pharmaceuticals, 509 U.S. 579 [1993]): Replaced the Frye standard, designating the trial judge as a 'gatekeeper'. Admissibility hinges on four criteria:

a) **Falsifiability:** Can the scientific theory or technique be empirically tested?
b) **Peer Review:** Has the technique been subjected to peer review and publication?
c) **Known Error Rate:** What is the known or potential error rate of the technique?
d) **General Acceptance:** Does it enjoy widespread acceptance in the scientific discipline?

6. PRACTICAL CHALLENGES AND SYSTEMIC BOTTLENECK

Despite statutory recognition, the operational efficacy of forensic science in the Indian judicial ecosystem faces major impediments:

6.1 Break in Chain of Custody

The evidentiary validity of forensic material hinges upon an unbroken 'Chain of Custody'. From initial collection at the crime scene, sealing, transport, laboratory analysis, to presentation before court, every custodian must document handling. Indifferent police handling, improper temperature preservation, or compromised sealing breaks the chain, rendering samples contaminated or tampered. Courts consistently reject forensic findings when the chain of custody is compromised.

6.2 Infrastructure Deficits and Case Pendency

India faces an acute deficit of accredited Forensic Science Laboratories (FSLs). The disparity between crime volume and analytical capacity leads to severe backlogs. Chemical viscera analysis, DNA reports, and cyber forensic extractions frequently take months or years, stalling trial proceedings and undermining the fundamental right to a speedy trial under Article 21.

6.3 Crime Scene Preservation and Training Gaps

Primary Investigating Officers (IOs) often lack formal training in forensic scene management. Failure to cordon off crime scenes leads to contamination of latent footprints, fingerprints, and biological fluid trace evidence before expert teams arrive.

7. RECOMMENDATIONS AND WAY FORWARD

To realize the full potential of forensic jurisprudence under the new 2023 legislative framework, systemic reforms are required:

1. Institutional Capacity Building: Allocate substantial budgetary resources to expand FSL infrastructure, establish mobile forensic units in every district, and achieve ISO/IEC 17025 accreditation across laboratories.

2. Standardized Operating Procedures (SOPs): Enforce uniform national SOPs for crime scene preservation, evidence packaging, digital hash creation, and chain of custody documentation.
3. Independent Forensic Cadre: Establish an autonomous Statutory Forensic Authority to govern quality control, expert accreditation, and insulate forensic scientists from administrative police pressure.
4. Mandatory Continuous Legal Training: Conduct mandatory training modules for trial judges, prosecutors, and police officers regarding modern digital, DNA, and ballistics forensics.

8. CONCLUSION

Forensic science has fundamentally transformed modern criminal adjudication, shifting judicial decision-making from subjective ocular testimony toward objective scientific truth. The enactment of the Bharatiya Sakshya Adhiniyam 2023, Bharatiya Nagarik Suraksha Sanhita 2023, and Bharatiya Nyaya Sanhita 2023—especially statutory mandates like Section 176(3) BNSS for compulsory crime scene visits—marks a monumental step forward.

However, law on paper must be matched by infrastructure on the ground. Science is an instrument of truth; but without unbroken chains of custody, adequately equipped FSLs, and constitutional adherence, scientific evidence risks compromise. By combining statutory mandates with rigorous scientific execution, India's judicial system can achieve the ideal balance of effective crime prosecution and robust protection of fundamental rights.

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