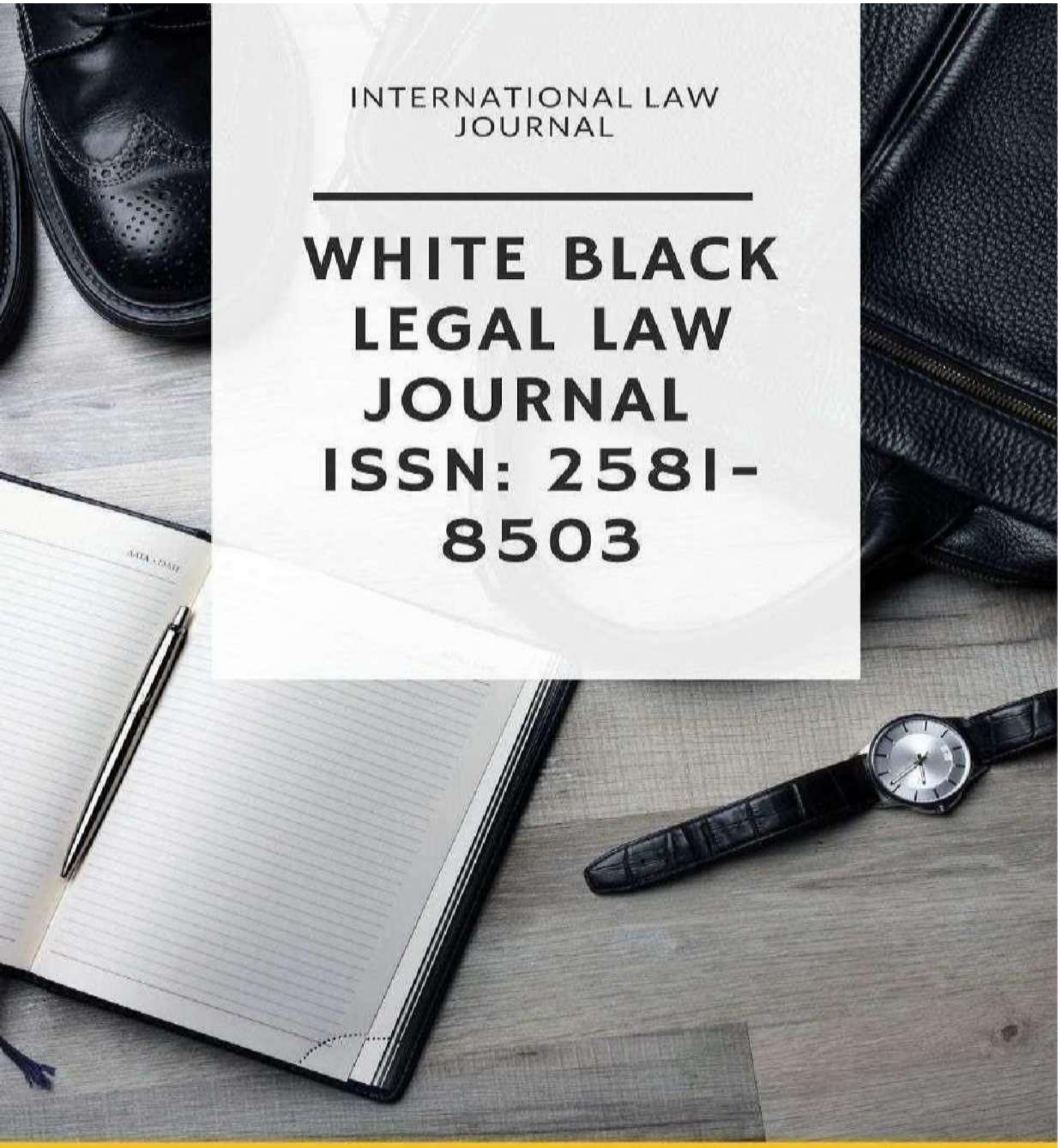

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DNA PROFILING AND CRIMINAL TRIALS IN INDIA: CHALLENGES OF CHAIN OF CUSTODY, EXPERT TESTIMONY AND CONSTITUTIONAL RIGHTS.

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ABSTRACT

India's criminal justice system is changing. Courts and police aren't leaning on witness testimonies like they used too they're turning to science instead. On the surface, that sounds like progress. Scientific tools promise more accurate and objective results. Still, this shift brings a bunch of new worries about how reliable these forensic techniques really are, how fair they're being used, and whether they're crossing ethical lines. This study digs into four major forensic methods: DNA profiling, polygraph tests, fingerprint analysis, and brain mapping. It looks at how Indian law treats each one, what the courts have said, and what the country's new criminal laws allow. DNA and fingerprints have earned a reputation as trustworthy scientific evidence, but in India, putting these tools to work isn't so simple. There are big problems like sloppy procedures, not enough labs or equipment, and almost no real oversight to keep things in check. Polygraph and brain mapping? The Supreme Court already shut those down as evidence. The reason's pretty clear: using them can trample someone's constitutional right not to incriminate themselves, which Article 20(3) of the Constitution protects. Recently, lawmakers brought in Section 349 of the Bharatiya Nagarik Suraksha Sanhita (BNSS), 2023, and Section 93 of the Bharatiya Sakshya Adhiniyam (BSA), 2023. These new rules give investigators more room to collect and use forensic evidence in court. But here's the catch they don't really put strong safeguards in place, so there's still a risk that investigations could get pushy or even cross the line. The takeaway? Relying too much on forensic science, with no one really watching, can put basic rights in danger and open the door to what you might call "scientific authoritarianism." In the end, the study calls for a careful, balanced approach: use forensic evidence, but stick to solid science, keep the courts and regulators involved, and always make sure the process is fair. That's the only way to stop wrongful convictions from hiding behind the mask of scientific certainty.

Key Words: DNA profiling, criminal justice system, DNA evidence, chain of custody, Forensic science, constitutional rights.

I. INTRODUCTION

DNA profiling has completely changed how courts in India solve crimes. It's become a go-to tool to pin down suspects, back up other evidence, or clear innocent people. But here's the thing: there's still no solid law to keep it in check. That makes privacy a big worry and leaves a lot of questions about how far police or courts should go. Courts like DNA's power to get closer to the truth, but they are clear you can't convict someone on DNA alone. So, what actually happens? Investigators pull DNA from blood, semen, hair, spit, skin, anything left behind. Each person's code is unique, so it's great for matching people to crime scenes or victims. Cops use it to zero in on the guilty, rule out the wrong suspects, piece together what happened, and even sort out messy family cases or find missing people. For years, the law let police collect body samples under old rules like sections 53 and 53A of the CrPC, mostly in rape cases. Newer laws from 2023 and a 2022 update give police even more leeway now they can store DNA from anyone arrested or in jail. This helps investigations but makes people nervous about government overreach and surveillance. When it comes to court, DNA is treated as expert evidence (used to be section 45, now it's section 39). But judges only trust it if science holds up and if it fits with the rest of the case. Usually, DNA isn't the only proof it backs up eyewitnesses, medical reports, or other clues. And collecting DNA touches on big rights: freedom from forced confessions (Article 20(3)) and the right to privacy (Article 21). Courts allow physical samples but draw the line at forcing people to talk, and they want strong reasons before ordering DNA, especially in touchy family disputes. Back in 2019, lawmakers tried to pass a bill to set ground rules, protect data, and build a national DNA bank. It never became law, so problems keep piling up too few good labs, sloppy sample handling, no clear process, risks of database misuse, and even judges struggling with the math behind DNA evidence. Scientific proof, especially DNA, now plays a huge role in India's justice system. It gives cops and courts hard facts way better than fuzzy memories or sketchy witnesses. With modern forensics DNA, fingerprints, ballistics, toxicology, digital trails from phones or CCTV police can solve cases faster, nail the right suspects, and set the innocent free before they get stuck in jail for nothing. New rules under the Bharatiya Nagarik Suraksha Sanhita (BNSS)[1] even force forensic teams to show up at serious crime scenes (think: crimes with a 7+ year punishment) and film the whole process, stopping tampering and keeping legit evidence. During trials, courts rely on scientific evidence as expert opinion (now section 39). But first, the proof must be reliable and relevant no junk science allowed. The Supreme Court, in cases like State of

[1] Bharatiya Nagarik Suraksha Sanhita, No. 45 of 2023, § 51-53, 106, 176(3), 193(3).

Haryana v. Bhagirath and Selvi v. State of Maharashtra, has backed using forensics if it doesn't trample on constitutional rights. This shift means more convictions in tough cases rape, murder, cybercrime and it protects the innocent by cutting down on mistakes from bad memories or dodgy witnesses. People start trusting the system more when evidence is solid, not just guesswork. Still, the system's got a long way to go. There aren't enough good labs India has only about seven per million people, way below global standards. Samples get mixed up, rules jump around from state to state, judges aren't always comfortable with science, and case backlogs slow everything down. India needs more labs, better training, tighter rules, and maybe even AI to speed things up if it wants forensics, especially DNA, to truly lead the way in criminal justice.

II. EVOLUTION OF FORENSIC DNA ANALYSIS

Forensic DNA analysis has come a long way since the 1980s. What started as a bit of scientific curiosity is now a key part of criminal investigations all over the world, including India. It lets investigators identify people from the tiniest biological traces think blood, hair, or even something you touched. The whole thing really kicked off in 1984 with British geneticist Alec Jeffreys. At the University of Leicester, he stumbled onto DNA fingerprinting using a technique called Restriction Fragment Length Polymorphism, or RFLP. Basically, this method looked at hypervariable regions in DNA minisatellites or VNTRs by cutting up the DNA, separating it on a gel, and using radioactive probes to see the patterns. It was slow, messy, and needed a lot of good DNA micrograms, not just a speck. Processing could take weeks, and the results weren't always easy to interpret. Still, it made history in the UK's Enderby murders case in 1986-87. For the first time, DNA cleared an innocent suspect and nailed the real killer, Colin Pitchfork. That was the first time DNA evidence got someone convicted in court. Then came a game-changer. In the mid-1980s, Kary Mullis invented the Polymerase Chain Reaction (PCR). Suddenly, scientists could copy tiny amounts of DNA just a few nanograms, even from old or degraded samples like bloodstains or hair roots. Analysis time dropped from weeks to days, and more labs could actually do the work. By the late 1980s, PCR-based methods pretty much replaced RFLP. Early on, there was DQ-alpha typing in the 1990s, which focused on a single DNA marker. Soon after, Short Tandem Repeat (STR) profiling became the gold standard. STRs looked at 13 to 24 specific spots across the chromosomes, using fluorescent primers, multiplex PCR, and capillary electrophoresis. The result? Strong 20-allelic profiles and match probabilities that topped 1 in a trillion. STR profiling opened the door to massive

databases like the FBI's CODIS, launched in 1998. Suddenly, investigators could solve cold cases, search for familial matches, and untangle DNA mixtures. Other techniques expanded the toolkit too: mitochondrial DNA (MTDNA) testing helped when only skeletal remains or hair shafts (without nuclei) were available, and Y-chromosome STRs made it possible to trace male DNA in sexual assault cases. Real-time quantitative PCR (QPCR) came along in 1993, making it easier to figure out exactly how much DNA you had before starting, so you didn't overwhelm or lose the signal. By 1997, protocols for low-template DNA (LTDNA) could pull useful profiles from as little as a single cell. All in all, what started as a laborious, niche scientific experiment now sits at the heart of solving crimes, catching criminals, and clearing the innocent with a level of accuracy that would've sounded like science fiction just a few decades ago. Forensic DNA work in India really took off in the late 1980s, keeping pace with the rest of the world but adding its own unique spin. It started when Dr. Lalji Singh and his team at the CSIR-Centre for Cellular and Molecular Biology in Hyderabad developed VNTR probes. That put India among the first three countries worldwide with this capability. Pretty soon, they were solving big cases think the 1991 Rajiv Gandhi assassination, where DNA linked LTTE suspects using blood and tissue evidence, or the 2008 Aarushi Talwar murder. India's very first forensic lab actually opened back in 1957 in Calcutta, but DNA units really started popping up after the 1990s. Central Forensic Science Laboratories in Delhi, Kolkata, Chennai, and Hyderabad started using ABI Genetic Analyzers and CODIS-compatible STR kits like Power Plex and Identifier. By the 2000s, labs switched to faster, automated DNA extraction using silica columns and magnetic beads and even introduced LAMP-PCR for higher throughput. More labs opened, like CFSL Chandigarh in 2018, and state labs under the National Forensic Sciences University followed in 2020, often bringing in robotics. Recent legal changes, like the BNSS 2023 (Sections 52-54, 176), now require crime scene videography and direct expert involvement, which has sped up the adoption of DNA tech though there's still a big gap between rural and urban areas. These days, DNA forensics in India is moving fast. Next-Generation Sequencing (NGS) platforms like Illumina MiSeq and Thermo Ion Torrent, around since 2010 let labs process millions of DNA reads at once. That means they can untangle complex mixtures, predict things like eye color or ancestry, detect family relationships even without reference samples, and work with badly degraded evidence. Rapid DNA devices like the ANDE Rapid ID (FDA-approved in 2012) can spit out STR profiles right at the crime scene in just 90 minutes, skipping the lab altogether. And with portable tools like PacBio's SMRT sequencer and Oxford Nanopore's tech, even field agents can get real-time DNA results. In India, places like NCCB are running NGS pilot projects, and there's talk of creating DNA

databanks like the US NDIS, though the DNA Technology Bill from 2019 is still stuck in limbo. Challenges remain labs need better validation standards, stronger contamination controls, and more training for judges under BSA Section 39. Still, DNA forensics keeps playing a vital role in the search for truth, and it's only getting more powerful as technology evolves.

III. CONCEPT AND IMPORTANCE OF CHAIN OF CUSTODY

Chain of custody is all about carefully tracking evidence from the second someone picks it up at a crime scene until it shows up in court. Every handoff, every bag it's put in, every time it's opened or moved someone writes it all down. They note who handled it, when and where, what it looks like, how it was packaged, and how it was stored. No detail is too small, because this record proves the evidence stayed real, untouched, and safe from tampering or mix-ups.If this chain breaks, even for a moment, you can't trust the evidence. Judges might throw it out, and cases can fall apart. That's why every step matters: the collecting officer logs it, seals it up, fills out the forms, and makes sure it gets to the lab or court without anyone slipping in or swapping anything. Even outside of crime scenes, people use this process for tracking products, medicines, or digital files anywhere you need to prove something hasn't been altered. In the end, keeping a solid chain of custody is what lets everyone in court trust the evidence. It blocks defense challenges and stops technicalities from wiping out important forensic proof. It's about keeping things honest, keeping cases strong, and making sure the right evidence tells its story. India's new criminal code, the Bharatiya Nyaya Sanhita (BNS), sets the stage for chain of custody rules, but you won't find one neat section spelling everything out. Instead, the system comes together through key sections in the Bharatiya Nagarik Suraksha Sanhita (BNSS), 2023, and the Bharatiya Sakshya Adhiniyam (BSA).[2] The whole point is to keep evidence intact, every step of the way. Take BNSS Section 106: it tells the police exactly how to seize suspected criminal property and demands that they document every handoff. This paperwork isn't just busywork it's what keeps evidence credible. Then there's Section 176(3), which kicks in for serious crimes (those with seven years or more in prison). It lays down strict rules for collecting forensic samples things like fingerprints, DNA, or blood. Police have to follow tight protocols for bagging, storing, and moving this evidence so nobody can mess with it before it gets to the lab. BNS Section 61(2) makes tampering with evidence a crime officially, it's forgery. Courts treat an unbroken chain of custody as critical. If there's a gap in the paperwork or the process, judges can toss out the evidence, especially in cases under laws like the NDPS Act. The system

[2] Bharatiya Sakshya Adhiniyam (BSA), 2023, §§ 22, 39, 168.

relies on testimony or production orders under BSA Section 168 to prove that a piece of evidence is the real deal. There's good science behind all this. Forensic samples biological, chemical, or physical are fragile. Blood or tissue can break down if you don't store them right. Heat, light, and bacteria can ruin them before they even reach the lab. Volatile chemicals can escape or react if the packaging fails. So, the rules call for things like tamper-evident seals, cold storage (think 4°C for perishable items), and as little handling as possible. All this keeps the original molecular structure safe for DNA analysis, toxicology, or trace detection. Detailed logs track the evidence from crime scene to courtroom, making sure the sample tested is the same one police collected no contamination, no mix-ups. Chain of custody isn't just a technicality. It pins responsibility on everyone who handles the evidence cops, technicians, lab analysts. If someone gets sloppy, skips a log entry, or breaks a tamper seal, they're on the hook. Courts watch for gaps that could mean contamination or swapping, and if they find problems, the whole case can fall apart. Evidence gets suppressed, cases dismissed, and the people involved can face professional or even criminal consequences. These records protect honest practitioners from bogus defense claims, but they also mean every handler is personally responsible. Mess up, and your expert testimony might get thrown out, or worse, you could face malpractice suits or charges for tampering under BNS[3] . When the chain of custody breaks down, everything can fall apart. Courts usually throw out that piece of evidence, since it's impossible to trust that it hasn't been tampered with, swapped, or contaminated somewhere between the crime scene and the courtroom. Judges almost always side with the defense here, striking out key items like DNA samples, drugs, weapons, or digital files. Suddenly, the prosecution is missing its strongest proof. It gets a lot harder sometimes impossible to prove guilt beyond a reasonable doubt. That's how cases get downgraded, plea deals become a lot sweeter, or charges just vanish altogether. People who actually committed the crime sometimes walk free just because the paperwork wasn't airtight. The fallout doesn't stop there. Forensic experts and witnesses look bad, investigations drag on as the process has to start over, and the whole thing costs the system more money. Plus, cops and lab techs risk facing disciplinary action, lawsuits, or even getting charged themselves if their mistakes look like negligence or, worse, evidence tampering. Indian courts treat the chain of custody as a serious, almost sacred, safeguard even though it isn't spelled out word-for-word in laws like the Indian Evidence Act or CrPC. Instead, judges rely on old case law and principles from Section 136 of the Evidence Act, demanding clear proof that every link in the evidence trail is unbroken from the moment

[3] Bhartiya Nyaya Sanhita S. 61(2).

police seize something until it turns up in court.You see it in decisions like Prakash Nishad v. State of Maharashtra[4] , where the Supreme Court let a rape suspect go because there was no documentation showing how the DNA sample was collected or handled. No trail, no conviction the chain was broken, so the evidence just didn't hold up. In another case, Ashit Biswas v. State of W.B. (2024), the Calcutta High Court tossed out a drug conviction because of contradictions in witness statements about how the evidence got from point A to point B.Courts aren't totally rigid they might ignore small, harmless gaps if there's solid proof elsewhere, like in Mustak v. State of Gujarat, where they overlooked a lapse in how a bullet was transferred because everything else lined up. But when there's a serious break, especially with electronic evidence, the rules get strict. Cases like Anvar P.V. v. P.K. Basheer (2014) and Arjun Panditrao Khotkar v. Kailash Kushanrao Gorantyal (2020) make it clear: you need proper Section 65B(4) certificates for digital proof. Narcotics cases are even tighter; the NDPS Act demands strict sealing and paperwork under Sections 55 and 57.To keep all this in check, investigators rely on things like seizure memos, malkhana registers, and FSL reports. Recent rulings like Shatrughna Baban Meshram v. State of Maharashtra show that courts expect a rock-solid trail, especially in serious cases like rape or forensics. The point of all this? Chain of custody isn't just some technicality. It's crucial for fair trials in India. It protects the rights guaranteed by Articles 20(3) and 21 of the Constitution, making sure the evidence is real, reliable, and untampered. If there's no proper paper trail from the crime scene to the courtroom, courts risk letting in tainted evidence or, as in the Nishad case, letting guilty people off the hook even when DNA points right at them. At the same time, it prevents innocent people from being convicted based on sketchy or manipulated evidence. This whole system boosts transparency and forces investigators to follow strict protocols like those in BNSS Section 193(3) especially for serious crimes. It also gives prosecutors a way to fight back when the defense tries to poke holes. The Bombay High Court recently made it clear: Chain of Custody Registers must be kept for every case. No shortcuts. That's how you avoid wrongful convictions, stop real criminals from slipping through the cracks, and keep the public's trust in the justice system.

[4] *Prakash Nishad @ Kewat Zinak Nishad v. State of Maharashtra*, (2023) 8 SCC 152 (SC).

IV. EXPERT TESTIMONY: COMPETENCE, CREDIBILITY AND CROSS EXAMINATION

A. EXPERT TESTIMONY

Expert witnesses matter a lot in DNA evidence cases. They step in under Section 39 of the Bharatiya Sakshya Adhiniyam (BSA), 2023 previously Section 45 of the Indian Evidence Act and help judges make sense of all the science: from genetic profiling and match probabilities to the risks of contamination that most people just aren't trained to spot. Their job isn't just to explain the science, but to walk the court through every step sample collection, PCR amplification, STR analysis, and the complex math behind probabilistic genotyping. They also deal with real-world problems like chain of custody mistakes, which can make or break a case. Take Prakash Nishad v. State of Maharashtra (2023) for example: DNA matched, but the lack of expert testimony on how evidence was handled led to an acquittal.In serious crimes rape, murder, paternity disputes their word can be the difference between conviction and acquittal. Cases like Mukesh v. State (NCT of Delhi) (2017) and Anil v. State of Maharashtra (2014) show how forensic experts back up claims about DNA's uniqueness (like match probabilities that are literally one in a trillion), push back on defense claims about lab errors, and help get DNA evidence admitted under BNSS Sections 176(3) and 53. It's not just about giving an opinion it's about proving to the court that the science holds up, that protocols were followed, and that the evidence is reliable, all while making sure trials stay fair and aren't swayed by flashy but bad science.Thanks to the Bharatiya Nagarik Suraksha Sanhita (BNSS), 2023, DNA evidence now has solid legal backing. Section 53 lets authorities collect DNA samples from arrested people by taking bodily substances. Section 176(3) makes it mandatory for forensic experts to collect fingerprints, blood, or DNA at crime scenes for serious offenses and to record everything on video, keeping the chain of custody airtight so the evidence actually stands up in court. Section 193(3) locks in rules for how evidence moves from the scene to the lab, banning tampering along the way. If there's a dispute, Section 329(4) allows scientific expert reports as direct evidence, even if the expert can't attend in person. The BSA, 2023, nails down DNA's place as valid evidence under Section 39. DNA analysis now stands right alongside fingerprints and handwriting as recognized expert opinion so long as it's relevant, the science is sound (think STR profiling), and the chain of custody is intact to shut down contamination accusations. Courts always weigh how strong the DNA evidence is versus any risk of unfair prejudice, and they stick to constitutional protections like Article 20(3)[5] by tossing out coerced

[5] Constitution of India, Arts. 20(3), 21.

or unverified samples. Indian courts take a careful, realistic approach to expert evidence under Section 39. They see it as an informed opinion on science, art, foreign law, or identity only if it comes from a truly qualified expert. But it's never binding; the judge still calls the shots. The Supreme Court wants three things for admissibility: genuine expertise, trustworthy methods (sometimes holding them up to Daubert-like scrutiny), and solid credentials. Plus, they always look for other evidence to back up the expert's claims. In Murari Lal v. State of Madhya Pradesh, for instance, the court threw out unsupported handwriting opinions; in Malay Kumar Ganguly v. Dr. Sukumar Mukherjee, it made clear that judges can reach their own conclusions, even when experts disagree. Cross-examination keeps experts honest—speculative methods or bias get tossed out. But judges can always adjust how much weight they give the expert's opinion, focusing on what actually helps them understand the science, like DNA, without letting experts take over the fact-finding job.

B. RELIABILITY AND ADMISSIBILITY STANDARDS

In India, DNA evidence has to jump through some serious hoops before it counts in court, especially under the new Bharatiya Nagarik Suraksha Sanhita (BNSS) and Bharatiya Sakshya Adhiniyam (BSA) from 2023. First off, the law demands tight procedures and real scientific backing. Courts want to see that everything's been handled right no sloppy work, no chance for tampering or contamination. BNSS Section 176(3) makes it clear: for major crimes (the ones carrying at least seven years in prison), police must collect forensic, including DNA, samples right at the scene. They need to record the whole thing on video, seal the evidence in tamper-proof packaging, and keep an unbroken chain of custody, just like Section 193(3) spells out from the moment something's picked up, all the way to the lab. Sections 51 and 52 let investigators take bodily samples from suspects, but they can't force someone to give evidence against themselves, thanks to Article 20(3).The BSA's Section 39 treats DNA evidence like any other expert opinion, say, fingerprints. But it's not enough just to have a DNA sample; the court wants proof that the methods used are reliable think validated STR-PCR techniques with really low error rates. The labs have to be accredited, like those following FSL standards, and the analysis must use sound probabilistic genotyping, free from bias. Courts use something close to the Daubert test: they weigh how much the DNA evidence actually proves against any risk of unfairness, and they'll toss out anything if the chain of custody isn't clear or if the expert can't handle cross-examination. The Supreme Court has hammered this point home: only DNA evidence that's handled perfectly no mix-ups, no degradation gets to stand in court.

- The Frye standard comes from a 1923 U.S. case called Frye v. United States[6]. Back then, courts wanted to make sure that any scientific evidence especially anything new or unfamiliar was already accepted by most scientists in that field before it showed up in a courtroom. For a long time, this meant things like polygraphs or early DNA tests had a tough time getting in. Judges waited until the wider scientific community gave a thumbs-up, especially since people argued a lot about how reliable PCR testing was, so DNA evidence didn't get much traction until everyone agreed on its accuracy.But things changed in 1989 when federal courts moved to the Daubert standard. This new approach doesn't just ask if scientists agree it looks at whether the method can be tested, whether it's been reviewed by other scientists, what its error rates are, and whether there are clear operating procedures.In India, courts haven't locked themselves into the old Frye rule when it comes to DNA or other expert evidence, especially under Section 39 of the BSA. Instead, they lean toward something like Daubert. Judges look at how reliable the method is, who handled the evidence, whether the lab has the right credentials, and if the findings line up with other facts in the case. You see this in cases like Pantangi Balarama Venkata Ganesh v. State of A.P., where the court allowed DNA evidence even if the entire scientific community hadn't signed off yet so long as the process followed proper safeguards.In short, Indian courts care more about whether the science actually works in practice, not just whether everyone agrees it should. They want proof that the evidence is solid, the handling was clean, and the science holds up especially with techniques like STR profiling. Still, when there are gaps in validation or procedures, judges sometimes fall back on Frye-like caution, making sure the science isn't shaky at its core before letting it influence a verdict.
- The Daubert standard comes from a 1993 Supreme Court case, Daubert v. Merrell Dow Pharmaceuticals[7], Inc. Before this, courts relied on the Frye test, which was a lot stricter. With Daubert, judges step in as gatekeepers under Federal Rule of Evidence 702. Their job? Take a hard look at any scientific expert's testimony before letting it into court. The standard isn't rigid it gives judges a framework, not a checklist. They look at things like: Can the theory or technique be tested? Has it been peer-reviewed? Are there known error rates? Does it follow standard procedures? And do experts in the field generally accept it? All this helps keep out unreliable "junk science" like wild

[6] Frye v. United States, 293 F. 1013 (D.C. Cir. 1923).
[7] Daubert v. Merrell Dow Pharmaceuticals, Inc., 509 US 579 (1993) (US Sup Ct).

speculation about causes and lets in solid evidence, such as DNA profiling, once methods like PCR and STR became proven and reliable. The Supreme Court extended this approach in Kumho Tire Co. v. Carmichael in 1999, so now it covers all kinds of expert testimony, not just scientific ones. Judges hold pretrial hearings to decide if the evidence does more good than harm, weighing its value against the risk of unfair prejudice under Rule 403.In India, courts have started informally using Daubert-like reasoning under Section 39 of the Bharatiya Sakshya Adhiniyam when it comes to DNA evidence. They focus on whether the methods are repeatable, the chain of custody is solid, and the lab is accredited—not just whether experts agree. The goal is to make sure forensic opinions actually help judges and don't take over the fact-finding process.

- India doesn't officially follow either the Frye standard—where you need "general acceptance" in the scientific community or the Daubert standard's flexible rules for admitting scientific evidence. Instead, Indian courts go for a more practical, case by case approach under Section 39 of the Bharatiya Sakshya Adhiniyam (BSA). Judges look at whether the evidence matters to the case, if it's reliable based on things like how the method works, possible errors, peer reviews, and whether there's supporting proof, but there's no fixed checklist they have to tick off. The Frye test, which came out of a 1923 U.S. case and relies heavily on scientific consensus, doesn't really catch on in India. Courts sometimes mention it, but usually with a fair bit of skepticism, especially since it would've kept out newer forensic methods like early DNA testing until everyone agreed on them. Indian judges care more about solid, empirical proof than whether a scientific community gives its stamp of approval. You see this in decisions like Selvi v. State of Karnataka (2010), where the court banned narco-analysis. On the other hand, Daubert, which asks about things like testing, peer review, error rates, standards, and acceptance, has influenced how higher courts in India look at scientific evidence. For example, in cases involving DNA or expert testimony, courts now demand a clear chain of custody and lab accreditation to show the evidence is reliable. Some legal scholars actually want India to adopt formal Daubert-like rules in the BSA 2023, hoping that will help block unreliable "junk science" as forensic evidence becomes more common. The challenge is finding that balance: giving judges the flexibility to handle each case fairly but also setting up enough safeguards to keep out bad science and unfair prejudice.

V. DNA PROFILING AND CONSTITUTIONAL RIGHTS IN INDIA

A. CONSTITUTIONAL RIGHTS

- In 2017, the Supreme Court of India's nine-judge bench, in the Justice K.S. Puttaswamy (Retd.) v. Union of India[8] case, made it clear: privacy is a fundamental right. It's baked into Article 21's promise of life and personal liberty, and it's tied to the freedoms under Articles 14 and 19 too. The judgment tossed out old decisions like M.P. Sharma (1954) and Kharak Singh (1963) that refused to treat privacy as its own right. Instead, the court took a broad view privacy covers everything from personal information and decision-making to your physical space and body. It even stretches into the digital world, especially with concerns about the Aadhaar biometric scheme and the way it links welfare benefits to personal data.Still, privacy isn't untouchable. The court set up a three-step test for when the state can intrude: there has to be a law allowing it, the goal has to be legitimate (think national security), and the action must be proportional meaning there needs to be a clear connection, the state should use the least intrusive way, and there should always be a balance. The idea is to protect dignity and stop the government from crossing the line with things like surveillance or taking DNA samples.This ruling didn't just stay on paper. It sparked new data protection laws, like the DPDP Act, 2023. It also changed how forensic investigations work, making sure there are real safeguards against forcing people to give up biometric data under BNSS Sections 51-53. The bottom line: investigative needs matter, but so does your right to informational self-determination.
- Bodily autonomy sits at the heart of the right to life and personal liberty in Article 21 of the Indian Constitution. It's really about a person having full control over their own body deciding on medical treatments, reproductive choices, or whether to undergo invasive procedures. Indian courts have pushed this idea forward in big ways. Take the Supreme Court's decision in Suchita Srivastava v. Chandigarh Administration (2009): the judges made it clear that a woman's right to continue or end a pregnancy is part of her personal liberty. That means the law has to respect her privacy, dignity, and control over her body, even while weighing state interests in fetal health under the Medical Termination of Pregnancy Act. In 2022, the X v. Principal Secretary case went further, saying unmarried women can't be blocked from safe abortions up to 24 weeks if there are fetal anomalies. The Court called out forced pregnancies as a clear violation of

[8] *Justice K S Puttaswamy (Retd) v Union of India* (2017) 10 SCC 1 (SC).

Article 21.Jacob Puliyel v. Union of India (2022) tackled bodily autonomy during a public health crisis. The Court said people can say no to vaccination, and the state can only step in with restrictions if they're fair and not arbitrary. Then, in Common Cause v. Union of India (2018), the Court recognized the right to die with dignity, accepting passive euthanasia and letting people create living wills. No one can be forced to stay alive in hopeless medical situations.These decisions all build on the right to privacy laid out in Puttaswamy. They block non-consensual acts like forced sterilisations or narco-analysis, as in Selvi v. State of Karnataka (2010). Even when the law allows things like DNA sampling under BNSS Sections 51-53, it demands strict safeguards, informed consent when possible, and a careful check to make sure human dignity isn't undermined.

- Article 20(3) of the Indian Constitution protects people from being forced to testify against themselves. If someone's been formally accused say, through an FIR or a complaint the police or anyone else can't make them give statements or sign documents against their will. But this right doesn't cover everything. It's all about "testimonial" evidence, like confessions or written answers. Physical evidence think fingerprints, blood, or DNA doesn't count. That's allowed under the BNSS (Sections 51-53), and the Supreme Court made this clear way back in the State of Bombay v. Kathi Kalu Oghad (1961).For this protection to kick in, you need proof of coercion. If someone confesses voluntarily, that's fair game in court. Later, in Selvi v. State of Karnataka (2010), the Supreme Court went further and said forced narco-analysis, polygraph tests, or brain mapping violate both mental privacy and the right against self-incrimination. Even before that, in Nandini Satpathy v. P.L. Dani (1978), the Court said authorities can't force accused people to write out answers. If investigators ignore these rights and try to use forced testimony anyway, BSA Section 22 says that evidence gets tossed out. The law's trying to keep things fair protecting people from being bullied into talking, but still letting forensic experts use material samples when they need to.

B. WHETHER DNA SAMPLING VOILATES FUNDAMENTAL RIGHTS

DNA sampling, when done under clear laws like BNSS Sections 51-53 and 176(3), doesn't break the fundamental rights under Articles 20(3) or 21 of the Indian Constitution. The Supreme Court has repeatedly said there's a big difference between forcing someone to give a statement and collecting physical evidence like blood, fingerprints, or DNA. Article 20(3) only protects people from being forced to testify against themselves not from giving physical

samples. This isn't just theory; the court settled it in State of Bombay v. Kathi Kalu Oghad (1961), then again in Selvi v. State of Karnataka[9] , and more recently in Das @ Anu v. State of Kerala (2022). They all agreed: DNA extraction in cases like sexual assault doesn't count as self-incrimination because there's no "statement" involved. Now, Article 21 is about privacy and bodily autonomy. Since the Puttaswamy (2017) ruling, the state can interfere with these rights only for legitimate reasons like criminal investigations and only if it follows a three-part test. There has to be a valid law (like the BNSS sections), no less intrusive way to get the information, and a balance between the harm and the benefit. Procedures matter: police need consent if possible, collections should be on camera, there must be a proper chain of custody, and doctors need to oversee the process. These checks help protect dignity, but things get stricter with forced paternity tests courts demand solid reasons because of presumptions about legitimacy under BSA Section 116.So, DNA profiling is constitutionally valid in criminal cases as long as the rules are followed. It makes justice stronger without trampling rights across the board. India still doesn't have a comprehensive law for DNA databanks. The DNA Technology (Use and Application) Regulation Bill has been floating around since 2009, but it's still not law. For now, storage and retention are handled piecemeal under BNSS Sections 176(3) and 193(3), plus Supreme Court directions like in Kattavellai @ Devakar v. State of Tamil Nadu (2025), which require videography, tamper-proof storage, and sending samples to forensic labs but say nothing about keeping DNA forever.This leads to some real problems. Labs sometimes hang onto DNA samples even after someone's acquitted or a case ends. The draft Bill says labs should destroy biological material after profiling but there's no way to enforce this, so DNA profiles can linger in poorly monitored government labs, putting privacy at risk. India's forensic infrastructure isn't perfect either; blood samples sometimes aren't refrigerated, labs get overcrowded, and there's no national standard for how to organize DNA indexes (like crime scenes, suspects, or missing persons). All this leaves room for misuse, like unauthorized familial searching or expanding the databank beyond criminal identification. There are also big constitutional questions. Keeping genetic data without authorization can reveal sensitive health or family info, clashing with Article 21 and the DPDP Act 2023's limits on data collection. The draft Bill's penalties for leaks aren't tough enough to really stop them. It's clear India needs independent oversight, automatic timelines for destroying DNA profiles, and strict limits like the 13-loci rule in CODIS, to make sure no one's traits or health information gets exposed.

[9] *Selvi v State of Karnataka* (2010) 8 SCC 96 (SC).

VI. CONCLUSION

DNA profiling has changed the way criminal trials work in India. It gives courts solid, scientific evidence that can either convict someone or clear their name. But it's not all smooth sailing. Problems keep popping up like sloppy chain of custody, shaky expert testimony, and questions about people's rights under the law. These gaps need fixing, fast, if we want DNA evidence to actually help justice instead of hurting it. Take the chain of custody, for example. Sometimes people don't log transfers properly, leave samples unsealed, or mess up forensic lab records. It happens a lot, mostly because training and resources aren't the same everywhere. When these mistakes happen, defense lawyers jump on them. They argue that the evidence can't be trusted, which goes against what Section 193(3) of the BNSS expects. Cases like Prakash Nishad in 2023 show how these issues can lead to acquittals, and honestly, it erodes people's trust in the whole process. Expert testimony is another sticking point. Under Section 39 of the BSA, experts are supposed to answer tough questions about how they interpret DNA like how they deal with mixed samples or the chance of contamination. But courts don't always get into the details, partly because labs are swamped and protocols aren't standardized. This makes it easy for juries to put too much faith in DNA, even though, technically, courts are supposed to treat expert opinions with caution. Then there's the big constitutional stuff. Article 20(3) lets the police collect physical DNA samples without forcing anyone to testify against themselves. But after the Puttaswamy decision, privacy and bodily integrity under Article 21 mean that the government has to be careful—collection and storage have to be balanced and justified. India's DNA Bill is still stuck in limbo, so there are no clear rules for DNA databanks. That leaves the door open for misuse, endless data retention, and surveillance fears, especially now with the new DPDP Act. To actually make DNA evidence work for justice, India needs to step up: set uniform forensic procedures, require real reliability hearings like Daubert tests, set up independent oversight, and finally pass laws to regulate DNA databanks. Only then can courts really balance the power of DNA technology with the rights that keep trials fair and credible.